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Renewable energy generation units: regulatory challenges for energy transition

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GNERC

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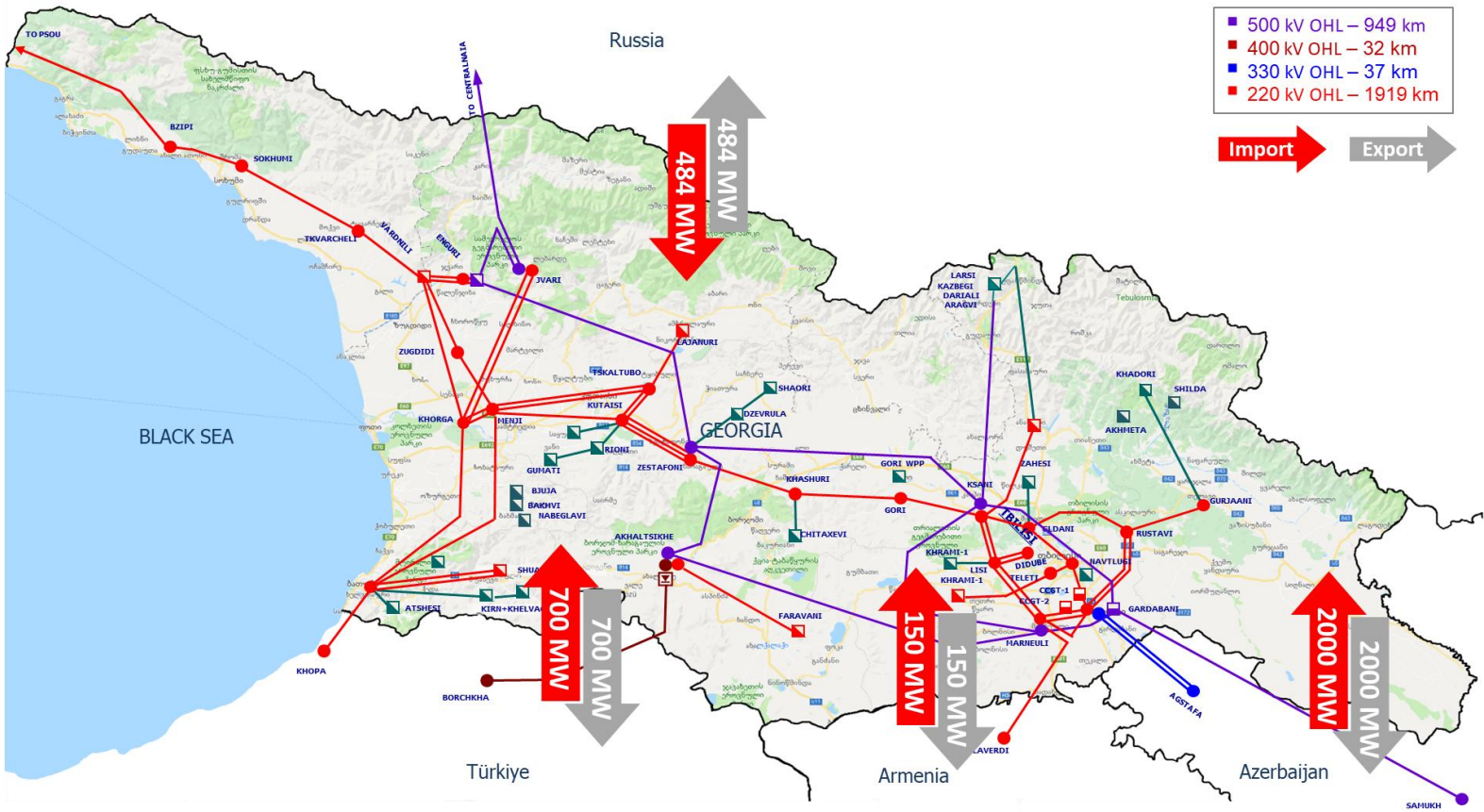
Georgian Power System Review

Installed Capacity	4,738 MW
Capacity Mix	74% Hydro, 25% Gas Turbines, 1% Wind,
Max and Min Demand	2,535 MW 1,100 MW
Aggregated Capacity of Distributed Energy Resources	273.3 MW
Transmission Voltages	110 kV, 220 kV, 500 kV
Interconnected Countries	Türkiye, Azerbaijan, Armenia and Russia
Interconnector Voltages	110kV, 220kV, 330kV, 400kV, 500kV



Georgia is a **hydro-dominated system**, which creates **seasonal variability and growing dependence on imports in winter**.

Georgia’s Electricity Generation and Demand

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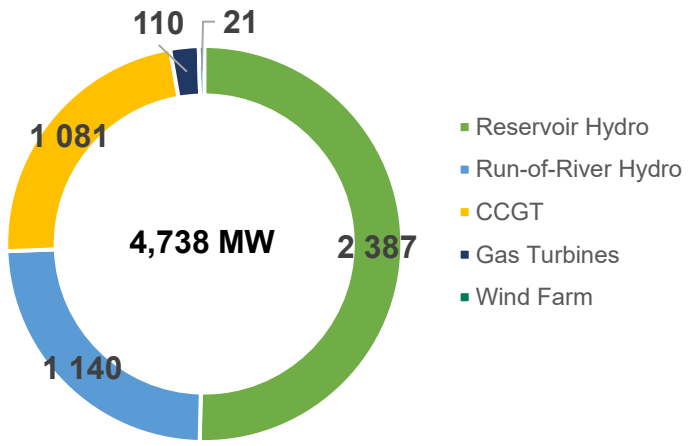
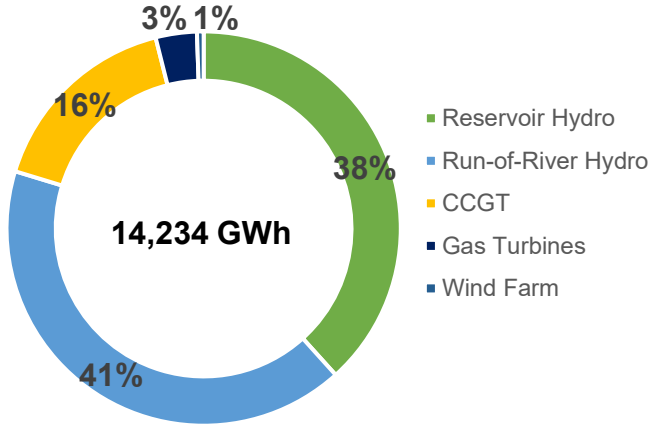
Existing Capacity Mix



Generation Mix



Georgia’s Electricity Generation Facts

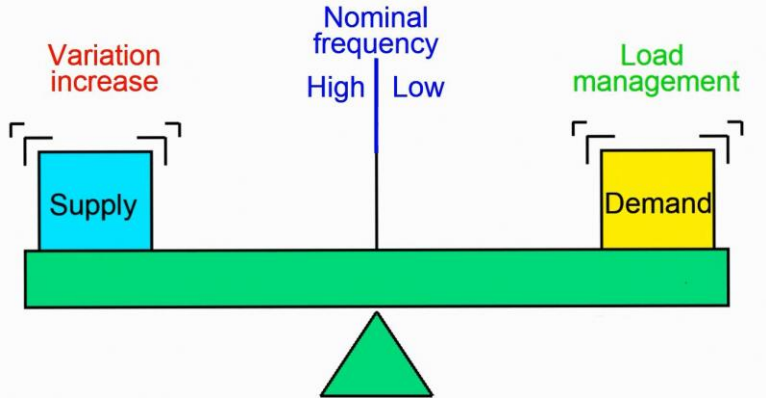
- 2025 Total Domestic Generation: 14,234 GWh
- Hydro generation was the largest contributor in 2025, representing 79% of total domestic generation.
- Average annual generation growth over the past 10 years: 3.4%

Georgia’s Electricity Demand Facts

- 2025 Total Demand: 15,194 GWh
- 2025 Summer Peak Load: 2,535 MW (Record High, July 31 at 17:00 pm)
- 2024 Total Demand: 14,414 GWh
- 2024 Peak Load: 2,287 MW
- Average annual demand growth over the past 10 years: 3.4%

Georgian Power System Challenges

- **Hydropower variability:** Hydro generation changes with seasons. Dry periods increase use of thermal power and imports.
- **Reserve capacity:** Existing reserves may be insufficient to fully cover the instability caused by renewables.
- **Operating in different synchronous zones:** Russia-Azerbaijan (IPS/UPS), Türkiye-Europe (CE), Armenia-Iran.
- **Radial or inadequately backed-up network:** difficult to meet N-1 reliability criterion.



Renewable Energy Integration

- ✓ ***4.5 GW** of solar PV and **4 GW** of wind potential estimated.*
- ✓ *Development of **2.1 GW** solar and **2.1 GW** wind projects considered in Ten Year Network Development Plan.*

Power Plant	Selected Projects	Total Capacity (MW)	Median Tariff (USDc/kWh)
Run-of-River Hydro	15	149.2	6.80
Wind	2	77	5.89
Solar	10	70	5.90

- ✓ **1st Capacity Auction - 300 MW offered**, 78 proposals submitted totaling 900 MW, three times higher than the target.

Power Plant	Selected Projects	Total Capacity (MW)	Median Tariff (USDc/kWh)
Run-of-River Hydro	32	183.15	6.38
Reservoir Hydro	8	52.95	7.50
Wind	7	204.15	5.90
Solar	10	239	5.27

- ✓ **2nd Capacity Auction** - **800 MW offered** for hydropower, wind, solar, and other renewables.
- ✓ 147 projects were submitted, totaling 1,877 MW, about 2.3 times higher than the target.

Challenges of Integrating High Levels of Renewable Energy

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- Grid expansion needs high investment - cost recovery is required to make it sustainable.
- The energy transition is fast. It requires major grid upgrades under strict deadlines, which adds complexity.
- Approval processes are long. Environmental concerns and public opposition can delay projects.
- Expanding the grid while keeping it stable is difficult. It requires integration of innovative technologies, large investments and cross-border cooperation.
- Equipment and skilled labor are limited. These shortages can slow down projects.
- Grid connection management for large volumes of renewable applications.

GNERC Regulatory Perspective on Grid Modernization

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- **Monitoring Advanced System Tools**

GNERC supports the use of modern monitoring technologies such as **Wide-Area Monitoring Systems (WAMS)** to improve real-time grid visibility and faster disturbance detection.

- **Advanced Power System Analysis**

System operators use advanced modelling tools (**DIgSILENT PowerFactory, PSS/E, PSCAD**) to analyze grid dynamics and ensure **frequency and voltage stability**.

- **Resilience-Focused Network Planning**

GNERC promotes grid planning that strengthens **system resilience**, especially in response to **renewable integration, climate risks, and extreme events**.

- **Battery Storage and Grid Expansion**

Upcoming **energy storage projects and transmission upgrades** are important for improving **system flexibility, reliability, and regional connectivity**.

- **Digital Asset Management and Infrastructure Renewal**

Digital tools help manage **aging infrastructure and large-scale grid investments**, while GNERC ensures that these investments are **efficient and justified for consumers**.

Battery Energy Storage System (BESS) Project

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✓**The implementation of the 1st large-scale BESS is essential for a secure, stable, and independent energy supply of Georgia.**

- **200 MW / 200 MWh** BESS integration is in the **2028 pipeline.**
- Estimated investment is **150 million USD**. The project is supported by the Asian Development Bank, and a tendering process is presently underway.

- BESS will provide frequency support to the system and connect to the 220 kV 'Ksani 500' substation, about 50 km from Tbilisi.
- Additional BESS projects are under evaluation, with up to 500 MW of storage planned by 2030.
- Some generation projects that cause significant instability and raise supply security concerns are required to include battery storage to obtain grid connection permits.

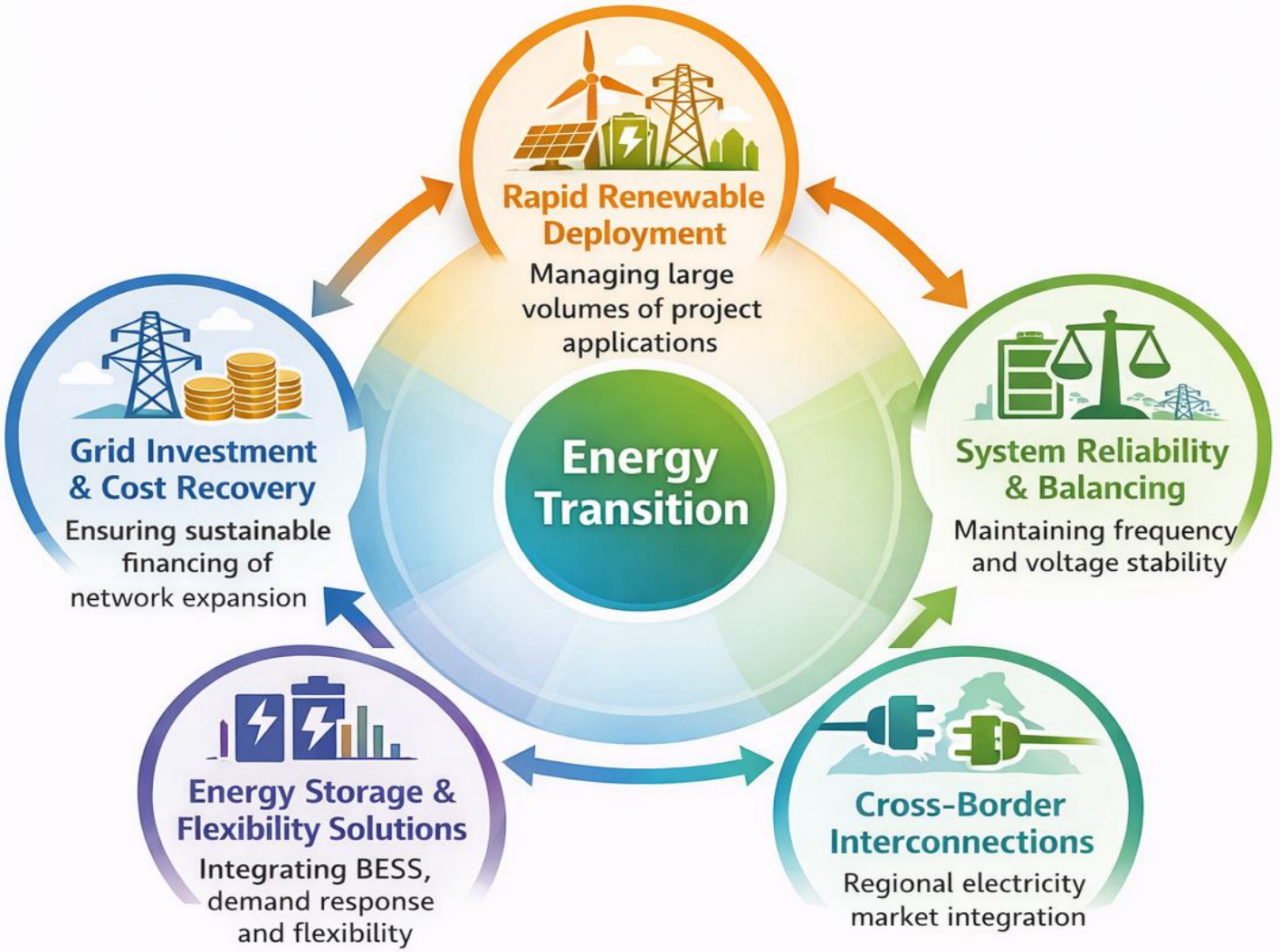
Georgia – Romania Black Sea Submarine Cable Project

- Aim: Improve Georgia's power transmission and link the South Caucasus to Southeast Europe.
- Objective: Help countries around the Black Sea boost energy security, use cleaner energy, and develop renewables.
- Estimated Investment: **USD 3.5 billion.** The project is supported by the World Bank.
- Current Status: Under the seabed investigation stage.

The cable will connect Georgia with Romania:

- It will run **1,155 km**, with **1,115 km** under the sea, reaching depths up to **2,200 m**.
- HVDC cable will use VSC technology, operate at **±525 kV**, and have a capacity of **1,300 MW.**

Key Regulatory Challenges for the Energy Transition



Regulatory Tools for Grid Stability in High-Renewable Systems

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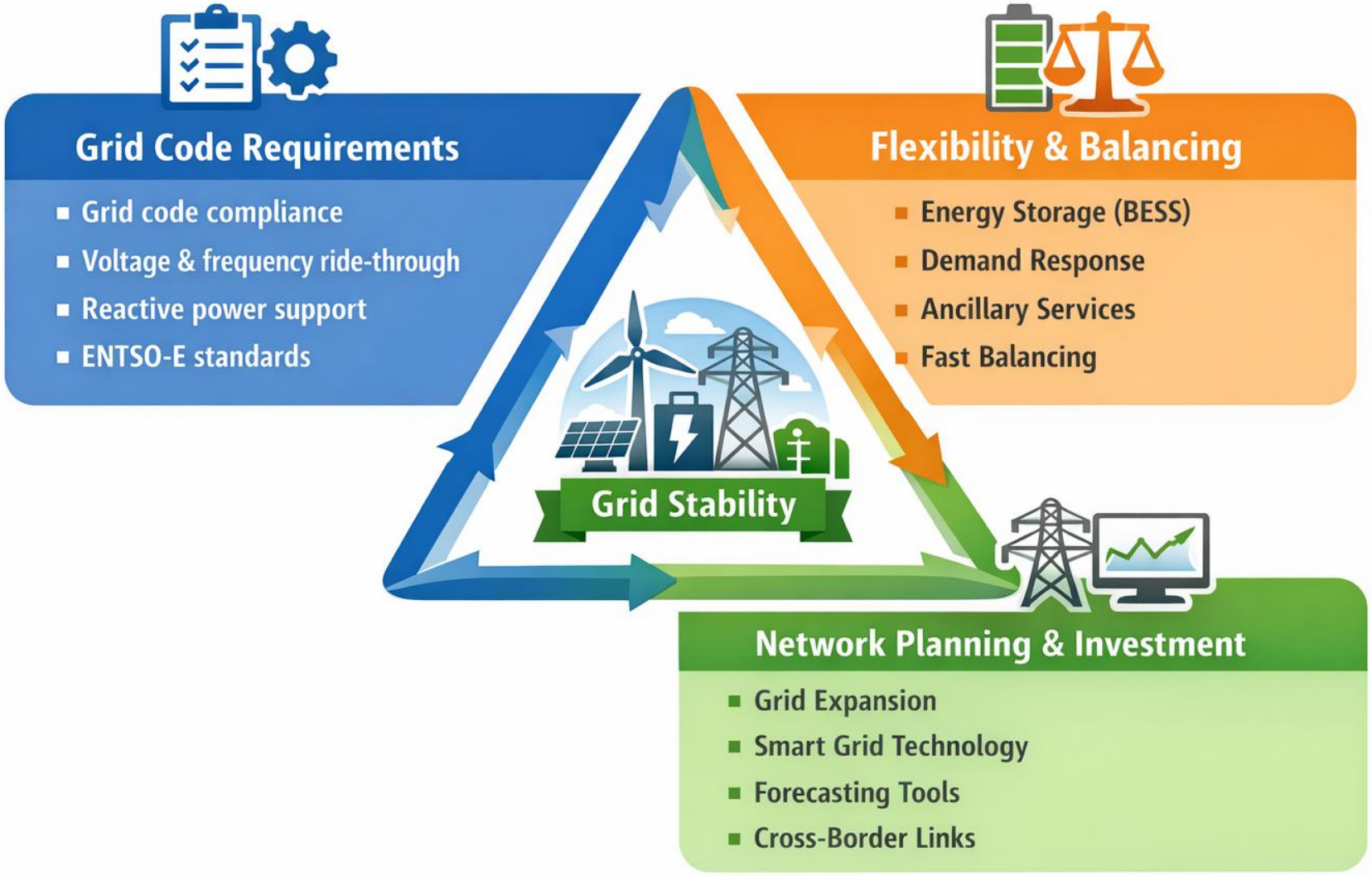
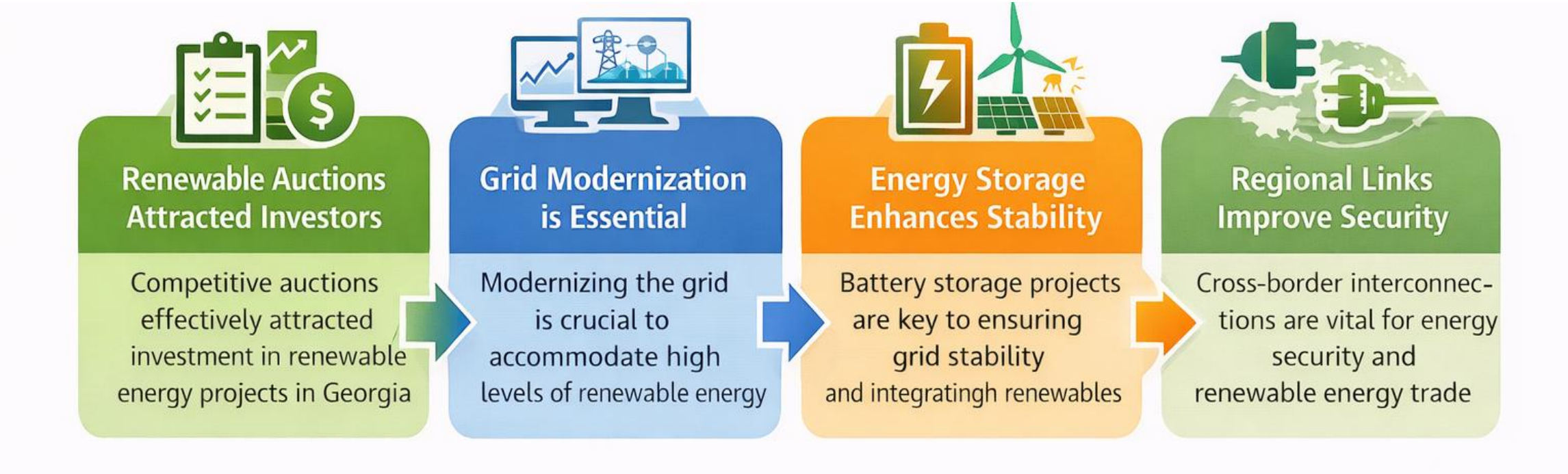


Lessons Learned from Georgia



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THANK YOU FOR YOUR ATTENTION!

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