Georgian State Electrosystem

Georgian Transmission System Resilience: GSE's Strategic Planning for Extreme Events

11th SEERC TAC Meeting Rome, January 2025

Contents

Georgian Power System Overview

GSE

Electricity generation:

- Total installed capacity: 4,621 MW
  - 3,410 MW - hydro (2,387 MW reservoir and 1023 MW RoR)
  - 1,190 MW - thermal
  - 21 MW – wind
- Distributed energy resources - 103 MW

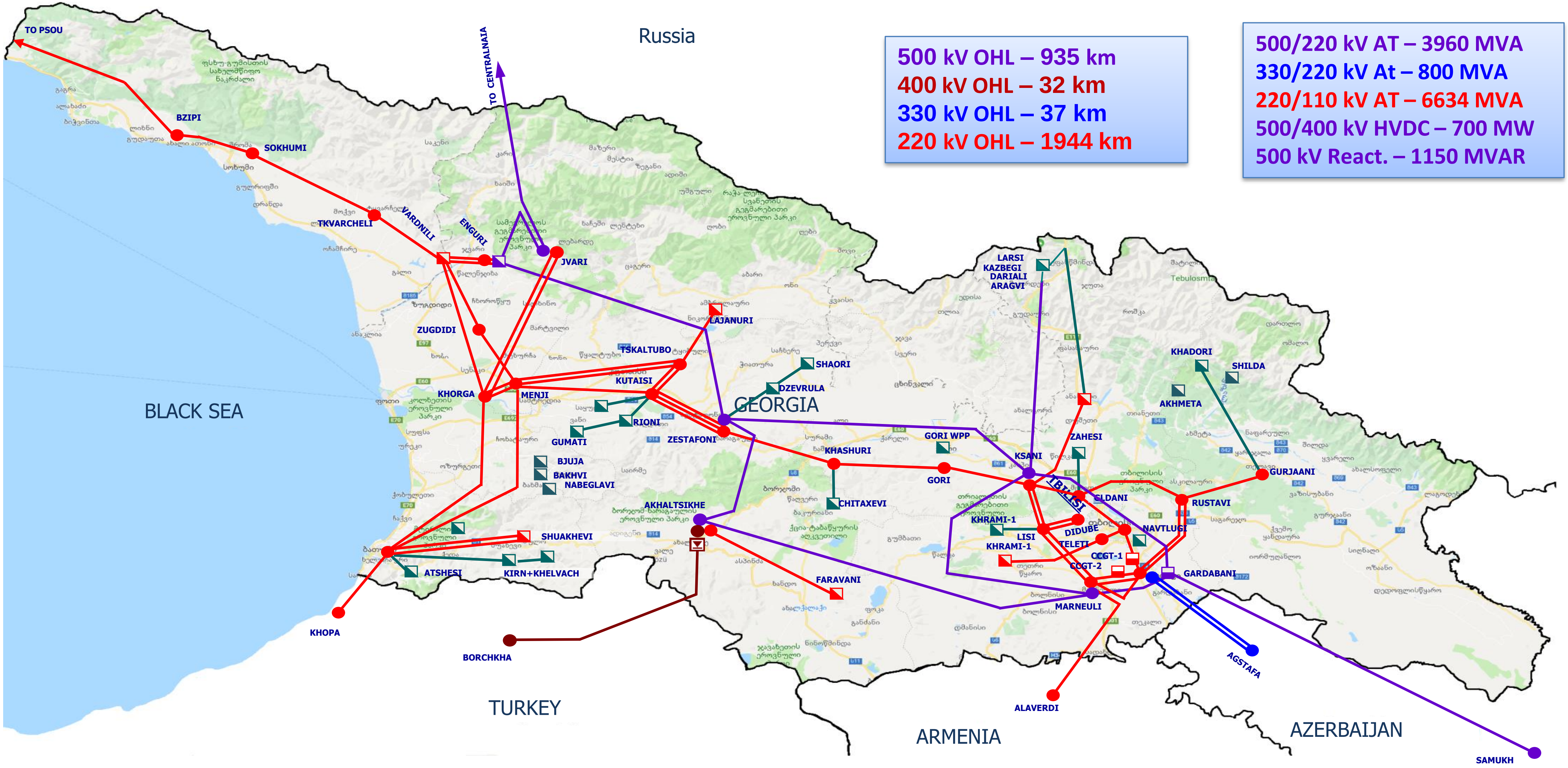
Electricity demand :

- 2024 Total Demand: 14.4 TWh
- 2024 Peak Load: 2.3 GW (August)
- Average Annual Demand Growth: 3.5 - 4.5%

Georgian transmission system is well interconnected with neighboring countries:

- Türkiye – 400kV AC (with DC B2B)
- Russia – 500kV and 220 KV AC
- Armenia – 220kV AC connection
- Azerbaijan – 500kV AC and 330kV AC

Georgian Power System Map



500 kV OHL – 935 km
400 kV OHL – 32 km
330 kV OHL – 37 km
220 kV OHL – 1944 km

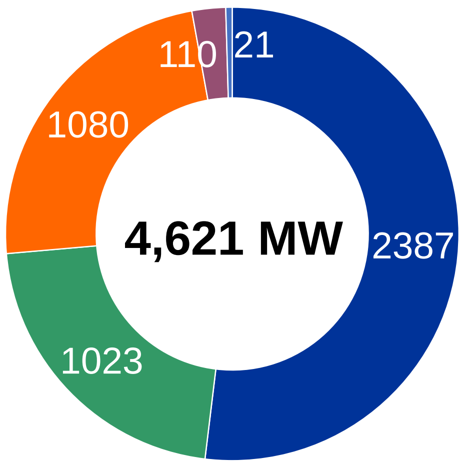
500/220 kV AT – 3960 MVA
330/220 kV At – 800 MVA
220/110 kV AT – 6634 MVA
500/400 kV HVDC – 700 MW
500 kV React. – 1150 MVAR

Georgian Power System Challenges

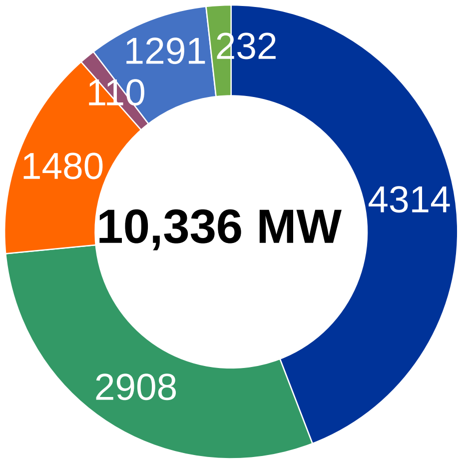
- Reduced flexibility – insufficient reserve capacity
- Stalled pipeline of new generation projects – leading to generation – demand gap
- Different synchronous zones around Georgia
- Georgia's electricity market is not coupled to any unified market, e.g., Pan-European market
- Non-backed-up interconnectors – lack of redundancy
- Radial or inadequately backed-up network

Existing and Planned Capacitates According to TYNDP*

2024



2034



YEAR	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Utility-Scale Solar Installed Capacity (MW)	0	0	5	96	164	232	232	232	232	232	232	232
WIND Installed Capacity (MW)	21	21	49	305	627	921	1176	1291	1291	1291	1291	1291

*** Georgia's 10-Year Network Development Plan (Link)***

Georgian Transmission System Resilience Study

GSE

- **Developer: Georgian State Electrosystem (GSE)** – Georgia's transmission system operator. The project concept originated from **CIGRE SEERC** study meetings and conferences. GSE has initiated R&D and project development in Georgia.

- **Primary focus:** Enhancing climate resilience to support the energy transition.

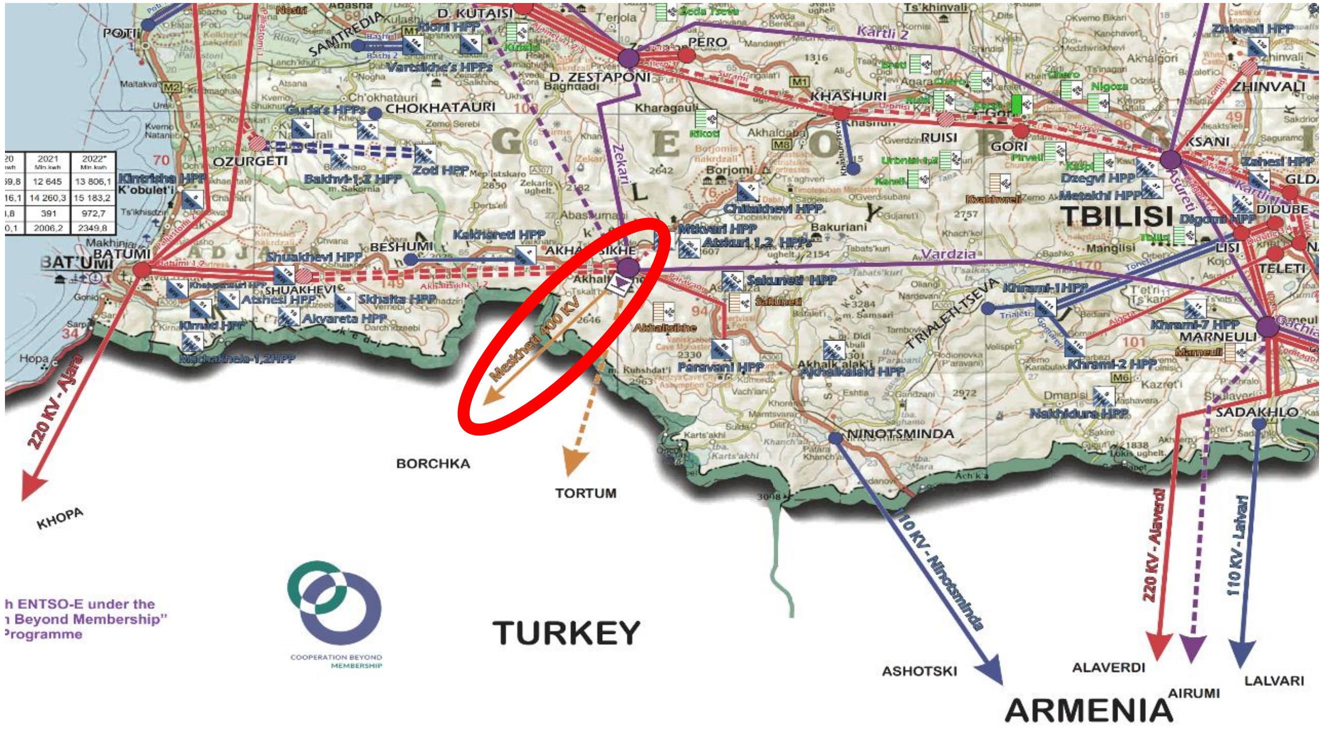
- **Objective:** Evaluate Georgia's transmission system resilience to extreme events, focusing on robustness, resourcefulness, rapid recovery, and adaptability to ensure supply security and network redundancy.

- **Key climate change issues:** heavy snow and ice coverage, landslides, earthquakes and avalanches debris flows and floods, extreme heat.

GSE operated EHV/HV lines damaged due to climate hazards

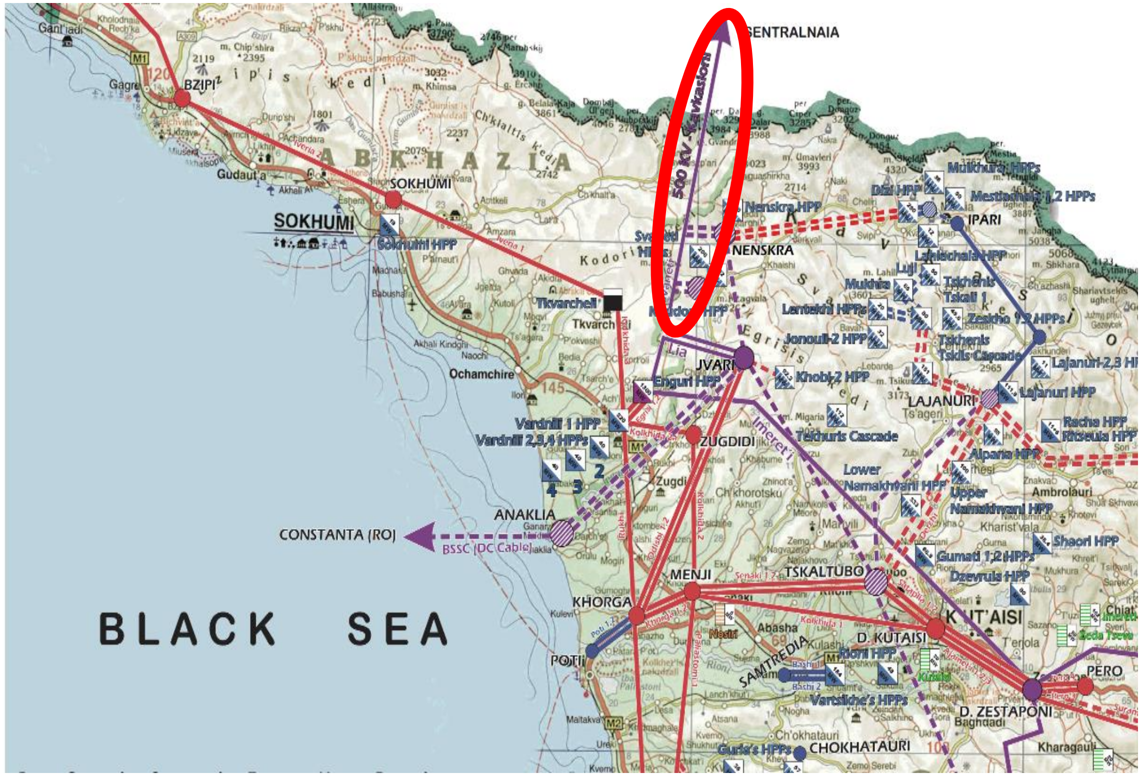
Extreme Events Impact on Transmission Infrastructure: Past Examples

- Damaged infrastructure of **400 kV OHL Meskheti** in 2017
- Caused by **heavy snow**
- The OHL interconnects Georgian power system to Turkey through B2B link



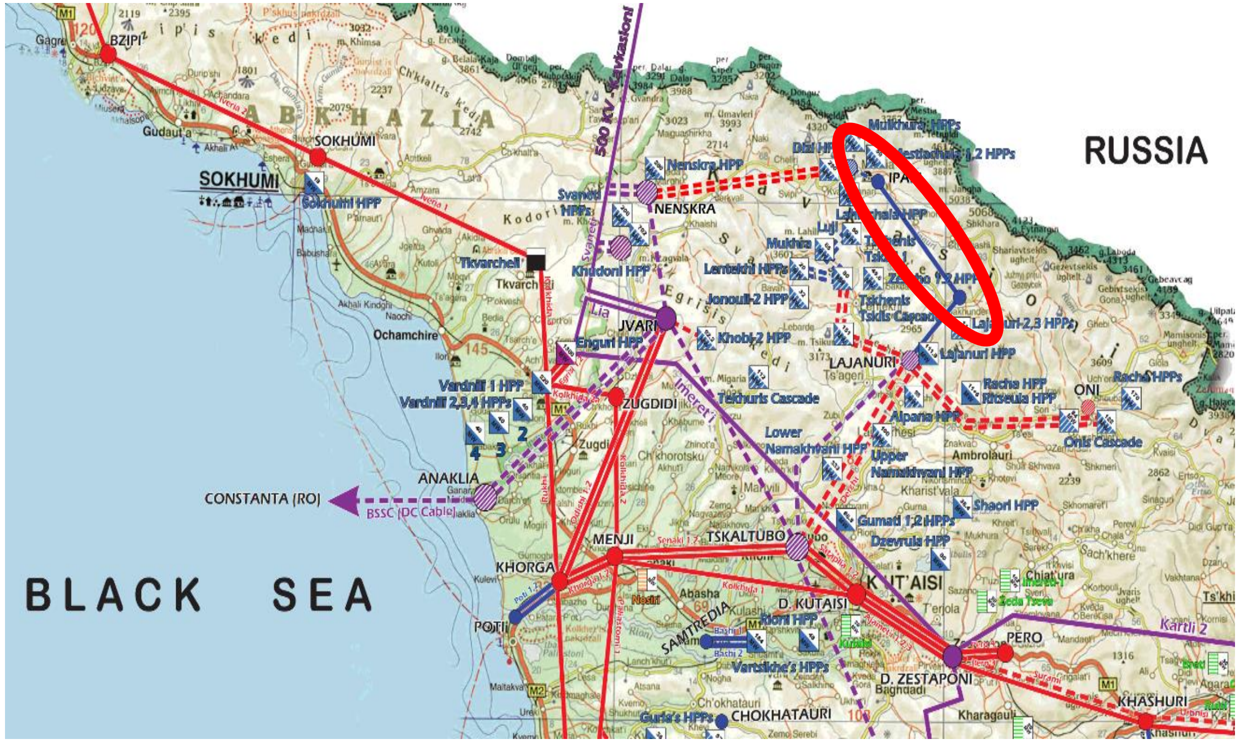
Extreme Events Impact on Transmission Infrastructure: Past Examples

- Damaged infrastructure of **500 kV OHL Kavkasioni** in 2018
- Caused by **heavy snow and wind**
- The OHL interconnects Georgian and Russian power systems



Extreme Events Impact on Transmission Infrastructure: Past Examples

- Damaged towers of **110 kV radial OHL Ifari**
- Caused by **heavy snow** in 2018-2021 years



Extreme Events Impact on Transmission Infrastructure: Past Examples

- **220 kV OHL Didgori** which is a part of ring configuration grid in eastern Georgia impacted by **ice coverage**
- Damaged towers of **220 kV OHL Koda** caused by heavy **hail and hurricane**

Technological Disruption in SCADA System in 2021

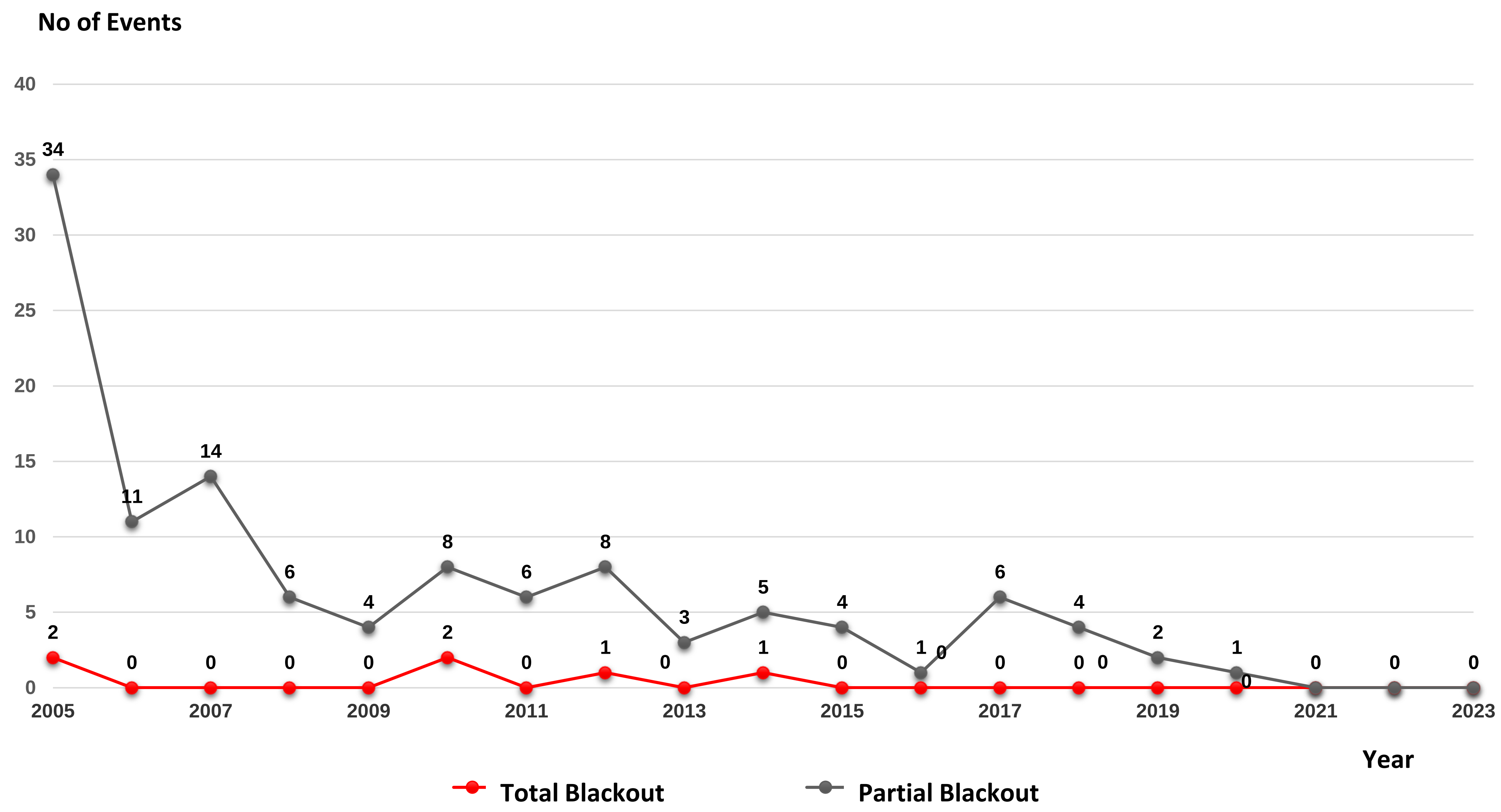
- A **failure in the cooling system of the server** led to a rise in temperature within the server rooms, exceeding the critical level of **45°C**. As a result, access to the control and monitoring software Spectrum for IT and SCADA users was completely terminated, putting GSE's critical infrastructure at risk.

- The incident triggered an emergency mode for the servers, resulting in a **total shutdown of part of the system**. The **backup dispatch center** of the SCADA system continued to operate. However, access to the Spectrum software for SCADA system users was temporarily suspended during the resolution of the technological disruption, which lasted between **30 to 40 minutes.**

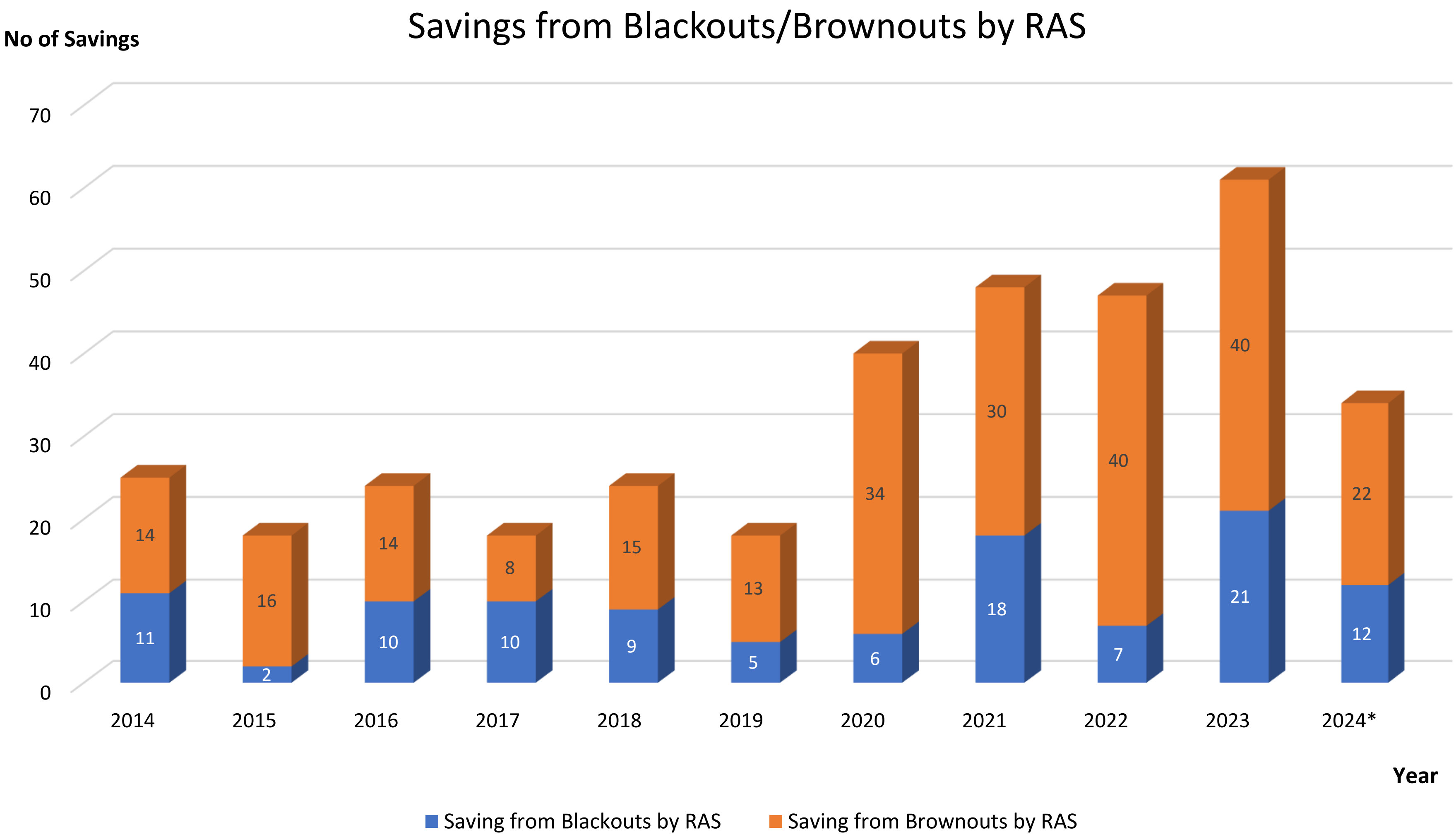
Taken and Planned Measures

- ✓ Procurement of Technical Support for UPS and Cooling Systems
- ✓ Regular monitoring and technical service of the UPS and cooling systems are conducted to ensure their optimal performance
- ✓ Detailed instructions have been developed to implement the necessary measures effectively
- ✓ To guarantee the uninterrupted operation of IT services, procurement of modern equipment is currently in progress
- ✓ Additionally, arrangements are being made for an independent SMS system to monitor the temperature of the server infrastructure

Georgia’s Blackout Stats 2003 - 2023



Saving from Blackouts & Brownouts by RAS



Electricity Crisis Scenarios

Identifying electricity crisis scenarios → **Evaluating scenarios** → **Ranking of scenarios**

Identifying electricity crisis scenarios

1. Identification of scenario
2. Cross-border dependencies
3. Description of scenario
4. Submission of scenario

Evaluating scenarios

1. Assessment of impact
2. Description of impact

Ranking of scenarios

1. Ranking of all scenarios

Electricity Crisis Scenarios

GSE

1 Scenario 1
2 Scenario 2
3 Scenario 3

STEP 1: Determine likelihood of scenario

- Identify class of likelihood

STEP 2: Determine impact of scenario

- Identify class of impact using risk indicators such as EENS and LOLE

Crisis likelihood scale

For classification of likelihood of crisis, a five-step scale is used:

Classification		Events per year	1 x in ... years	Description/example of initiating event
Very likely		≥ 0.5	2 or less	event expected practically every year, e.g. extreme winds/storms causing multiple failures of overhead lines may be expected nearly every year in some areas
Likely	1	0.2-0.5	2-5	event expected once in a couple of years, e.g. extreme heat wave causing limits on output of open-loop water-cooled power plants, low water levels at hydro plants, higher load, etc.
Possible	2	0.1-0.2	5-10	event expected or taken into consideration as a potential threat, e.g. cyber or malicious attack
Unlikely	3	0.01-0.1	10-100	very rare event with potentially huge impact, e.g. simultaneous floods causing unavailability of generation, distribution and transmission infrastructure
Very unlikely		≤ 0.01	100 or more	event not observed but potentially disastrous, e.g. earthquake causing a huge destruction of transmission, distribution and generation infrastructure

Crisis Impact Scale

Classification		EENS% (of annual demand)	LOLE [hours]	
Disastrous		≥0,25%	≥168	
Critical	2 3	≥0,05% and <0,25%	≥48 and <168	2 3
Major		≥0,01% and <0,05%	≥12 and <48	1
Minor	1	≥0,002% and <0,01%	≥3 and <12	
Insignificant		<0,002%	<3	

Electricity Crisis Scenarios

GSE

✓ Evaluation of scenarios

Scenario	Likelihood	EENS%	LOLE
1	Likely	Minor	Major
2	Possible	Critical	Critical
3	Unlikely	Critical	Critical

Support for the numbers:
- Likely: 1 every 2-5yrs → 20-50% probability
- Possible: … 5-10yrs → 10-20% probability
- Unlikely: …10-100yrs → 1-20% probability

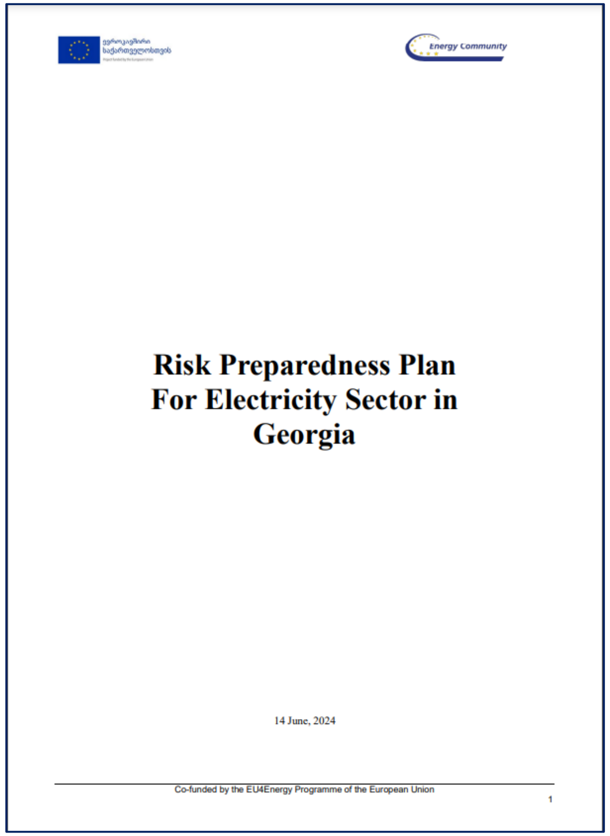
Impact		Likelihood				
EENS%	LOLE	Very likely	Likely	Possible	Unlikely	Very unlikely
Disastrous	Disastrous	Disastrous	Disastrous	Critical	Major	Minor
Disastrous	Critical	Disastrous	Critical	Critical	Major	Minor
Critical	Disastrous	Disastrous	Critical	Critical	Major	Minor
Disastrous	Major	Disastrous	Critical	Major	Major	Minor
Major	Disastrous	Disastrous	Critical	Major	Major	Minor
Disastrous	Minor	Disastrous	Critical	Major	Major	Minor
Minor	Disastrous	Disastrous	Critical	Major	Major	Minor
Disastrous	Insignificant	Disastrous	Critical	Major	Major	Minor
Insignificant	Disastrous	Disastrous	Critical	Major	Major	Minor
Critical	Critical	Disastrous	Critical	Ma 2	Min 3	Minor
Critical	Major	Critical	Critical	Major	Minor	Minor
Major	Critical	Critical	Critical	Major	Minor	Minor
Critical	Minor	Critical	Major	Major	Minor	Minor
Minor	Critical	Critical	Major	Major	Minor	Minor
Critical	Insignificant	Critical	Major	Major	Minor	Minor
Insignificant	Critical	Critical	Major	Major	Minor	Minor
Major	Major	Critical	Major	Major	Minor	Insignificant
Major	Minor	Major	Major	Minor	Minor	Insignificant
Minor	Major	Major	Ma 1	Minor	Minor	Insignificant
Major	Insignificant	Major	Major	Minor	Minor	Insignificant
Insignificant	Major	Major	Major	Minor	Minor	Insignificant
Minor	Minor	Major	Minor	Minor	Insignificant	Insignificant
Minor	Insignificant	Major	Minor	Minor	Insignificant	Insignificant
Insignificant	Minor	Major	Minor	Minor	Insignificant	Insignificant
Insignificant	Insignificant	Minor	Minor	Insignificant	Insignificant	Insignificant

Georgia's Risk Preparedness Plan

- On December 2, 2020, the Security of Electricity Supply rules were approved, in accordance with EU Regulation 2019/941 on risk preparedness in the electricity sector

- Risk Preparedness Plan is a strategic framework designed to mitigate risks, ensure quick recovery, and sustain operations during disruptions

- Prepared by GSE in cooperation with the Energy Community:
  - Competent authority – Ministry of Economy and Sustainable Development of Georgia
  - Crisis coordinator – Inter-Institutional Group for Energy Security (IGES)


Risk Preparedness Plan
For Electricity Sector in
Georgia

14 June, 2024

Co-funded by the EU4Energy Programme of the European Union

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Thank you for your engagement!

GSE
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