Ten-Year Network Development Plan of Georgia 2022-2032

Transmission System Operator JSC “Georgian State Electrosystem”

Legal basis of Ten Year Network Development Plan

Ten Year Network Development Plan of Georgia is elaborated according of "Law Of Georgia On Electricity And Water Supply"

Author of Ten Year Network Development Plan

Ten Year Network Development Plan of Georgia is elaborated by the TSO of Georgia JSC Georgian State Electrosystem (GSE) by agreement with agreement of transmission licensees LTD Energotrans and JSC Sakrusenergo.

The consultations regarding use of information, materials and analysis given in in Ten Year Network Development Plan, also about the implementation of requirements of this plan may be provided by TSO. Tel.: +(99532) 2 510 202.

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The discussion and approval of Ten Year Network Development Plan

The plan discussed and agreed by the Government on August 8 of 2022 session.

The plan approved by the Minister of Economy and Sustainable Development of Georgia on August 9, 2022 by # 1-1/343 order.

Ministry of Economy and Sustainable Development of Georgia, Georgian National Energy and Water Supply Regulatory Commission the transmission system operator, other agencies and interested took part in discussions of Ten Year Network Development Plan.

Action of Ten Year Network Development Plan

Ten Year Network Development Plan is obligatory implemented act.

The plan is designed for the period 2022 to 2032 (inclusive).

Licensees/subjects responsible for implementation of the plan are shown in Annex D-4.

The implementation of Ten Year Network Development Plan is controlled by the Ministry of Economy and Sustainable Development of Georgia.

Document content

The current document is a printable English version of the ten-year network development plan of Georgia for 2022-2032, which, unlike the Georgian full document, only includes the following sections:

Main document

1. Executive Resume;
2. List of existing and perspective power plants;
3. Identified projects and investment needs for Infrastructure strengthening.

Annexes

1. Cost estimates of planned projects;
2. Map of transmission network of Georgia.

Full version of the document is only available in Georgian language. To get its electronic version, please see the link below from GSE's official web site:

https://www.gse.com.ge/sw/static/file/TYNDP_GE-2022-2032_GEO_NEW.pdf

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Annexes:

1 Executive Resume

Electric power sector composes an important part of the national economy having enormous influence on the social status of Georgia's population, and therefore development of the energy infrastructure constitutes the countrywide strategic goal.

The emerged cross-border electricity trade opportunities, high electricity demand growth and need for evacuation of the energy generated by the planned power plants, call for investments in the transmission infrastructure for ensuring adequate development of the network. Such objective targets availability of the transmission network capable ensuring of the consistent response to generation and demand growth by reliable and safe transportation of electricity, without any interruptions caused by outage of any single network element.

This Ten-Year Plan presents the time-tagged program designed for reinforcing infrastructure of the national transmission system, addressing the existing problems, responding to the future challenges and implementing the opportunities. It assumes adequate evolution of Georgian power system considering realistic scenarios and projects relevant to 2022-2032 time span.

The Ten-Year Plan aims at presentation and analysis of the future environment and reduction of uncertainties to obtain plausible projections and establish unified and well-structured vision about transmission grid development.

In general, development of the transmission system is a long-term process targeting reinforcement, expansion and upgrading of the network in line with generation and demand growth.

This document covers all components relevant to the development of Georgian power system. However, other projects that are not included in this Ten-Year Plan may also be reviewed in current and/or subsequent years. In addition, some projects described herein may be modified, implemented in shorter timeframes or delayed. All such changes will be accounted for in 2023-2033 version of this plan.

The goal of GSE is development of stable, reliable, cost-effective and efficient transmission system ensuring at any development stage:

- Security of Supply, network reliability, Power quality;
- Sufficient transfer capacity for fulfilling increased consumption, integration of renewable energy sources into the network and power exchange with neighboring countries;
- Preparedness for integration into ENTSO-E's Ten-Year Network Development Plan.

The reason of long-term development planning is explained by the need for the future transmission network satisfying all applicable design requirements, main from which is **single contingency (N-1) criterion**.

In case additional reasonable projects will be identified, they will be considered in the next Ten-Year Network Development Plan of Georgia.

The planning process shall consist of the following major stages:

- Data collection;
- Data processing;

- Modelling;
- removing or mitigating any deficiencies;
- Preparation of the unified transmission grid development plan.

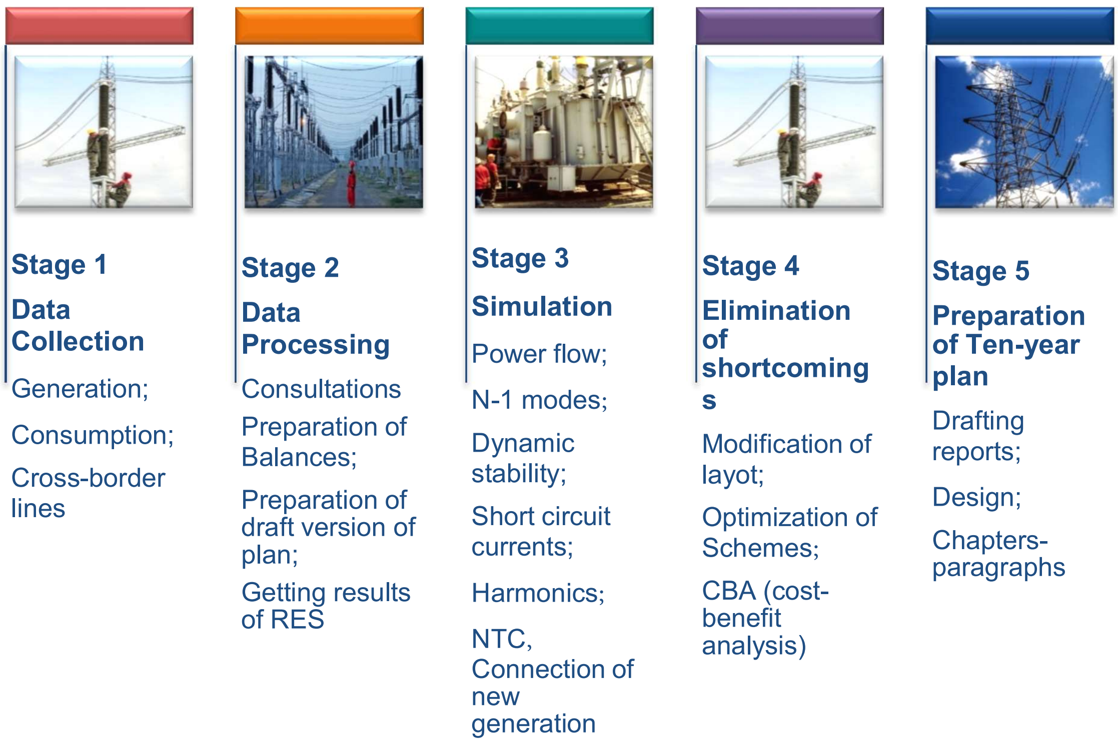

Fig. 1.1 Preparation stages of Unified Georgian Transmission Network Development Plan

1.1 Data Management

Inputs for Ten year Plan include: Information on installed capacities, outputs, geographical locations, categories and their commissioning years of the planned hydropower plants as well as decommissioning dates of aged power plants represent; forecasted characters of consumption growth in power system; agreements with neighboring countries about construction of cross-border infrastructure; Assignments from Ministry of Economy and Sustainable Development of Georgia and memorandums of Georgian government, based on which changes in projects are implemented; Minimal technical requirements on power plants and their units and specific requirements on back-to-back stations.

The design parameters of perspective plants, which are used in harmonic and dynamic analyses are obtained with the collaboration of MoESD. In case of the absence of such data, some typical parameters are used from the base of typical parameters for generators, which is established by the specialists of GSE.

For technical calculations, engineering software PSS/E and Disgilent PowerFactory are used.

1.2 Planning Period

The planning period was divided into the following three time spans:

1. **Short-Term Planning Period** extended over 3 years after the base year (2021), i.e. the period of 2022-2024.

2. **Mid-Term Planning Period**, covering 4th and 5th years from the base year (2021), i.e. the period of 2025-2026.

3. **Long-Term Planning Period**, including 6th to 10th years from the base year (2021), i.e. the period from 2027 to 2032.

1.3 Operating strategy, security of supply and adequacy level of Power system

Operation strategy. For purposes of analyzing power system security and designing appropriate control systems, it is helpful to conceptually classify the system-operating conditions into five states: normal, Caution, emergency, in extremis and restorative.

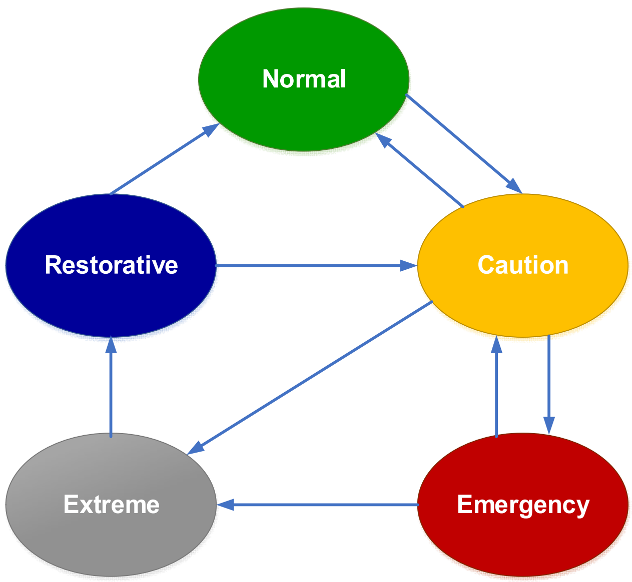

Fig. 1.2 Power system operating states

In the normal state, all system variables are within the normal range and no equipment is being overloaded. The system operates in a secure manner and is able to withstand a contingency without violating any of the constraints. This means there are enough reserves of generation in power system as well as enough reserves of transmission system capacity. System meets N-1, G-1 and N-G-1 conditions.

The system enters the Caution state if the security level falls below a certain limit of adequacy, or if the possibility of a disturbance increases because of adverse weather conditions such as the approach of severe storms. In this state, all system variables are still within the acceptable range and all constraints are met. However, the system has been weakened to a level where a contingency may cause an overloading of equipment that places the system in an emergency state. If the disturbance is very severe, the in extremis (or extreme emergency) state may result directly from the alert state.

Preventive action, such as generation shifting (security dispatch) or increased reserve, can be taken to restore the system to the normal state. If the restorative steps do not succeed, the system remains in the alert state.

The system enters the emergency state if a sufficiently severe disturbance occurs when the system is in the alert state. In this state, voltages at many buses are low and/or equipment loadings exceed short-term emergency ratings. The system is still intact and may be restored to the alert state by the initiating of emergency control actions: fault clearing, excitation control, fast-valving, generation tripping, generation run-back, HVDC modulation, and load curtailment. If the above measures are not applied or are ineffective, the system is in extrem mode; the result is cascading outages of possibly a shut-down of a major portion of the system. Control actions, such as load shedding and controlled system separation, are aimed at saving as much of the system as possible from a widespread blackout.

The restorative state represents a condition in which control action is being taken to reconnect all the facilities and to restore system load. The system transits from this state to either the alert state or the normal state, depending on the system conditions.

Whenever all elements are in normal state as well as all parameters are within their normal range, operation of Georgian transmission network corresponds to the “Caution state”. Therefore, **the most critical problem of Georgian transmission network is security of supply and leitmotif of transmission network development within next ten years will be security of supply** and **its improvement as well as upgrade of system reliability.**

1.4 Bottlenecks and Development Drivers of Georgian Transmission Network

Main network bottlenecks. Georgian transmission network is predominantly oriented from west to east. The most of the energy is generated in the west part of the country (total installed capacity of the HPPs located at the west amounts to 2510 MW), with the main consumption in the east part (Tbilisi-Rustavi node). Such imbalance is especially explicit during spring and summer, when due to the high water flows available in Georgian rivers, the thermal power units located at the east (near Gardabani) are not operated, and the power flows in the west-to-east direction.

The problem is faced in the west part of the system (500/220 kV mains along Enguri-Zestaponi route) during tripping of 500 kV OHL Imereti, because 220 kV mains are unable to transfer full load flow. Cross border lines of Georgian transmission network are not basically backed-up and their outages create risk of emergency. Furthermore, there are several 220 kV dead-end lines trip of which is some threat for system stability.

In the recent years, following the power consumption, the peak loading of substations has increased sharply* , especially in Tbilisi and Batumi nodes. N-1 criteria is not fulfilled in some substations, which means the restriction of the consumers will be necessary in case of outage of one of the (auto)transformers.

* - with an exclusion of COVID-19 pandemic period

Below are listed weaknesses experienced along this route:

- Non backed-up Interconnetion lines:
  - Kavkasioni, 500 kV;
  - Mukhrani veli 500 kV;
  - Alaverdi, 220 kV;
  - Meskheti, 400 kV;
  - Adjara, 220 kV;
- Radial/inadequately backed-up Network of West Georgia:
  - Imereti, 500 kV;
  - Zekari, 500 kV;
  - Autotransformer at Enguri, 500/220 kV;
  - Egrisi 1,2, 220 KV;
  - Kolkhida 2a, 220 KV;
  - Kolkhida 2, 220 KV;
- Batumi supply grid:
  - Paliastomi 1,2, 220 KV;
- 220 kV grid of Shida Kartli, backed-up inadequately:
  - Surami;
  - Urbnisi;
  - Liakhvi;
  - Aragvi;
- Dead end transmission lines:
  - Kolkhida 3, 220 KV;
  - Derchi, 220 KV;
  - Lomisi, 220 KV;
  - Manavi, 220 KV;
  - Paravani, 220 KV;
  - Sno (Ksani – Dariali HPP), 500 KV;

Development Drivers. The Georgian Transmission Network were designed for parallel operation with the North Caucasus and Armenia/Azerbaijan power systems. Specifically, generation of the HPPs located in the West Georgia was transmitted to Russia, while the power plants located in the East Georgia were supplied with fuel from Azerbaijan.

After Georgia re-gained independence, prices for fuel supply for thermal units of Georgia grew significantly, and currently eastern part of Georgia is supplied with power from the HPPs located at the west. Meanwhile, Turkish energy markets becomes steadily attractive entailing construction of the HVDC back-to-back station in Akhaltsikhe, as well as encouring the majority of the greenfield projects that are under development in Georgia. Due to its geographical location, Georgian transmission network may be used for energy transit between 1) Russia and Armenia/Iran, 2) Azerbaijan and Turkey, 3) Russia and Turkey, and 4) Armenia/Iran and Turkey.

It should be mentioned, that the existing speed governors of hydro plants are old-fashioned or broken and the majority of thermal power plants are depreciated.

Georgian power system endures acute shortage of operating reserves resulting in law power quality in isolated regimes. In addition, when any large power unit fails, emergency control system initiates load shedding. For dealing with such situation, sufficient operating reserves shall be provided by both construction of regulated hydro power plants (with water storage) and high capacity combined-cycle gas turbines as well as rehabilitation of the existing thermal power plants.

- Prospective regulated HPPs
- Prospective seasonal HPPs
- Prospective demand growth
- Thermal power plants scheduled for decommissioning
- New combined cycle thermal power plants
- ⇔ Necessary upgrades of cross-border (inter-system) links
- ⇔ Necessary upgrades of internal network links
- O Existing bulk generation region
- O Existing bulk demand region

Fig. 1.3 Map illustrating development drivers of Georgian electric power network

Assuming above, the main development drivers of Georgian transmission network development drivers will be targeted to:

- Fulfillment of single contingency (N-1) criterion (improvement of reliability);
- Transmission of the existing generation;
- Reclamation of the new energy resources / integration of new HPPs into the network;
- Increasing network potential with respect to power transit;
- Establishment of reliable power supply centers for promoting development of potential production/tourist centers;
- Responding to the (naturally) increasing demand in the power system;
- Replacement of the aged thermal units with flexible and cost-effective combined-cycle thermal power plants;
- Provision of sufficient operating reserves;
- Improvement of the power quality.

1.5 Forecasted Energy and Capacity Balances

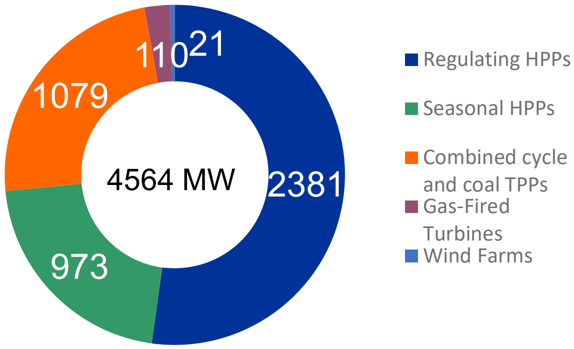

Fig. 1.4 Installed capacities of the existing power plants

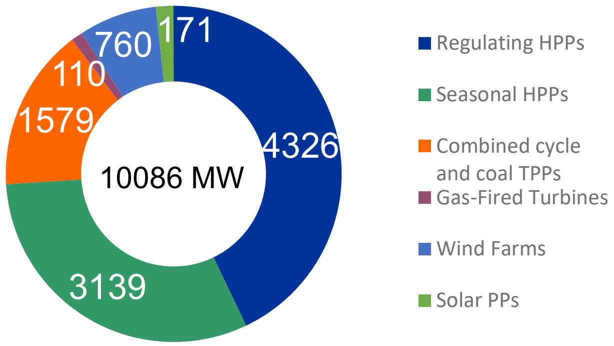

Fig. 1.5 Installed capacities of power plants as for 2032

At present, total installed capacity of electric power plants operated in Georgia amounts to 4564 MW. From this, 2381 MW is generated by the so called “regulated” HPPs (with water storage), 973 MW by “seasonal” (run-of-river) HPPs, 110 MW by Gas Turbines, 21 MW Wind farms and 1079 MW by thermal power plants and combined-cycle gas turbines (Fig. 1.4). Roughly 74% of the total in-country installed capacity is provided by HPPs, including 52% generated by regulated hydro power plants.

For 2032, the total installed capacity available in Georgian power system will grow to 10086 MW (Fig. 1.5). From this, 4326 MW will be attributed to regulated HPPs, 3139 MW to seasonal HPPs, 760 MW to Wind Power Plants, 171 MW to Solar Power Plants, 110 MW to Gas turbines and 1579 MW to high efficiency combined cycle TPP’s and older Gardabani TPP’s Units Nos. 3, 4 and 9. For 2032, percentage share of hydropower in total national installed capacity will grow to 74%, including 43% share of regulated hydro power plants. This will ensure use of the water stored during flood season for low flow periods, thus reducing dependence on import of electricity and fossil fuels necessary for operation of thermal power plants. It is noteworthy that share of wind and solar power plants for 2032 will be approximately 10%.

Base of load and generation growth, the annual energy balance of Georgia for all the scenarios has been drawn up. Below is given balance of energy for the scenario (fig 1.6) considering on time integration of all prospective power plants into the grid and annual consumption growth of 3%.

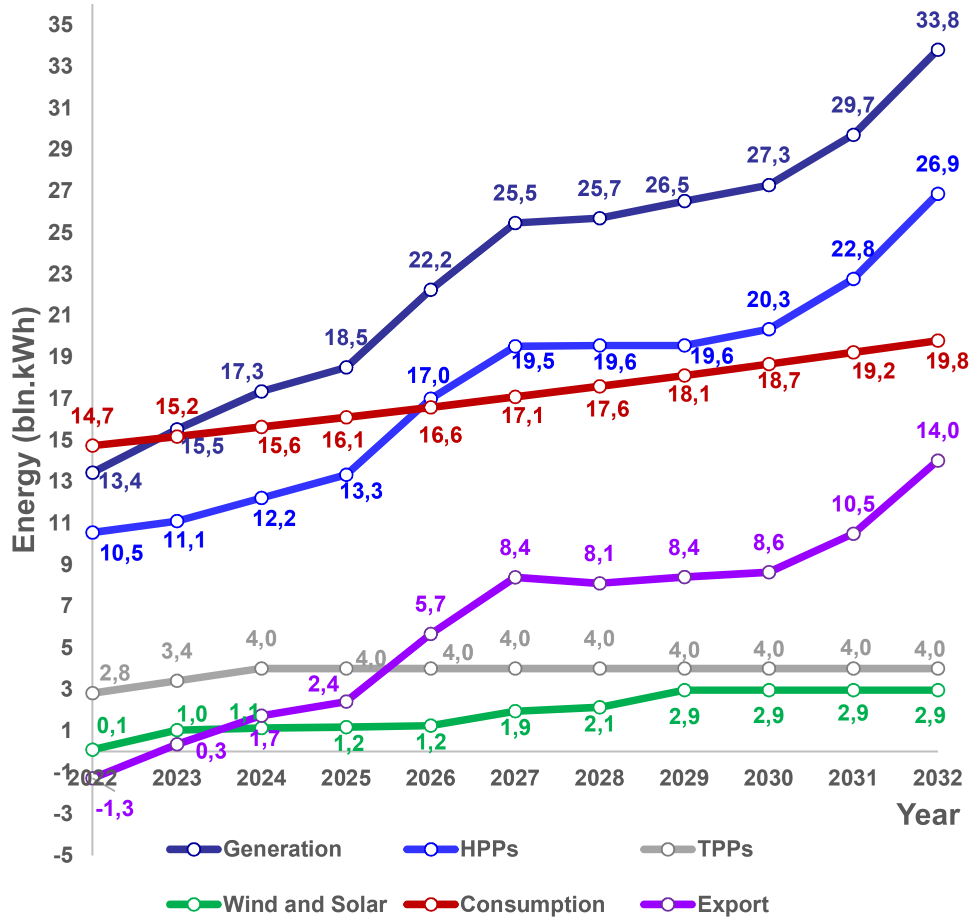

Fig. 1.6 Georgian generation, consumption and export graphs for L2G3

Summary. Based on forecasted balances presented above, it may be concluded that construction of the new cross-border lines with neighboring states is necessary. The most critical period in terms of intensity of the power export is flood season, including so called Summer Maximum and Summer Minimum regimes.

1.6 Development Scenarios and Methodology

Planning scenarios are defined to represent the future environment. Scenario analysis is necessary to obtain realistic picture of a future. Scenarios are means to approach the uncertainties and acknowledge interaction between these uncertainties.

Each scenario encompasses several planning cases, i.e. particular situations that may occur within the framework of the specific planning scenario.

At least the following three time horizons shall be considered:

- Short-term horizon (typically 1-3 years);
- Mid-term horizon (typically 4-5 years);
- Long-term horizon (typically 6-10 years).

Investments encompassed for transmission network reinforcement which correspond transmission network development plan should include all the represented cases and should encompass commissioning dates of new network elements.

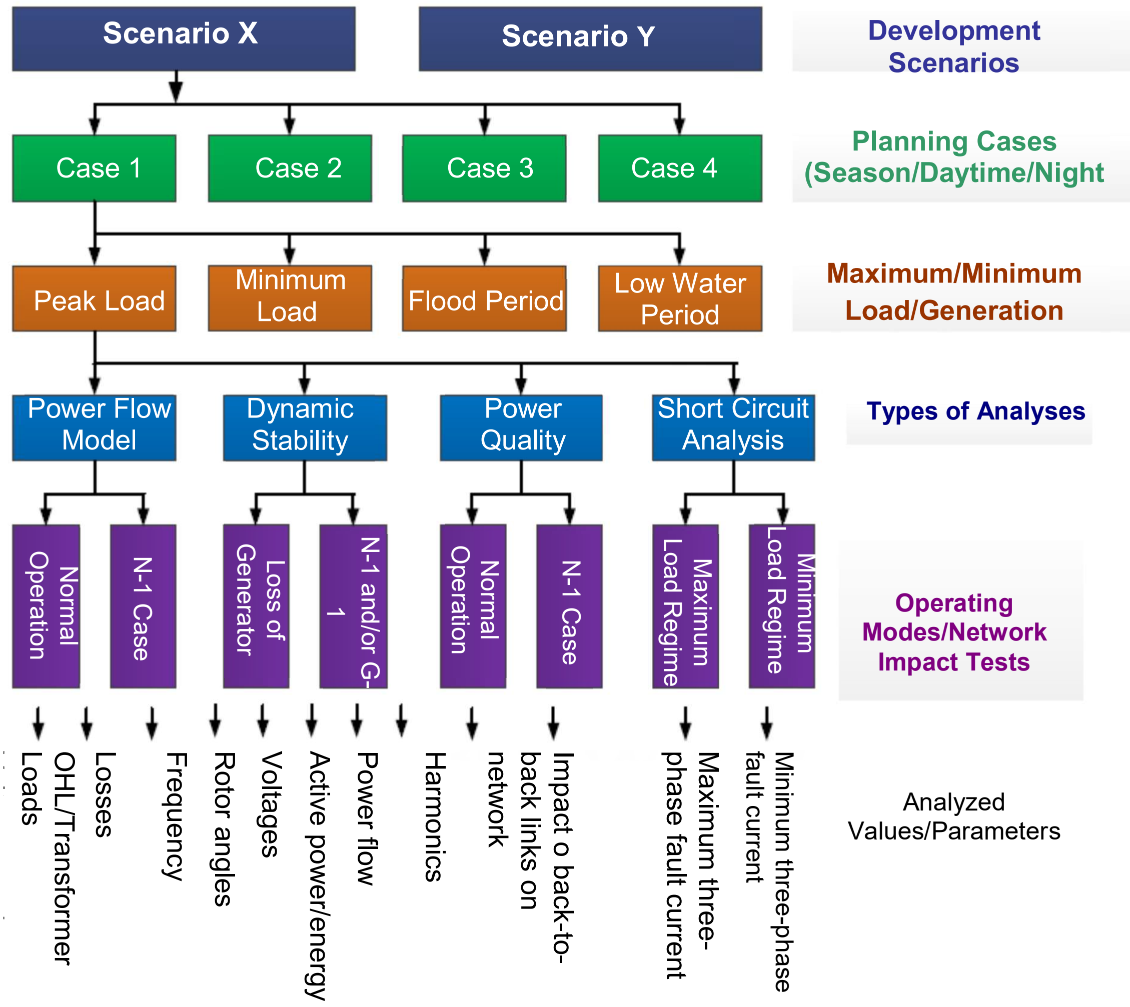

Fig. 1.7 Process of technical analysis of the scenarios

Analysis and network impact tests shall be performed for each design case to identify future problems and adequate technical requirements for network reinforcements. **The line of critical importance for the country is selected based on requirement of fulfilling N-1 criterion without the need of shedding the customer loads.**

The following studies have been performed for checking the planned network reliability status:

- Power flow analysis
- Short circuit analysis
- Voltage analysis
- Stability analysis
- Harmonic analysis

Several scenarios of Georgian transmission network development were reviewed. Information about prospective generation facilities to be integrated into the network was used as the input data for planning. Such facilities were divided into the following categories:

Category 1 (K1): Power plants under construction;

Category 2 (K2): Power plants Under Licensing stage;

Category 3 (K3): power plants Under feasibility-studies.

Table 1.1 Demand & Genaration growth scenarios

GROWTH OF LOAD | GENERATION	"G1" 10%[Y]+90%[Y+10]	"G2" 25%[Y]+75%[Y+5]	"G3" 100%[Y]
1 % growth "L1"	L1G1	L1G2	L1G3
3 % growth "L2"	L2G1	L2G2	L2G3
5 % growth "L3"	L3G1	L3G2	L3G3

Consumption forecast annual growth rate in base scenario is 3%, which was defined based on the analysis of forecast of economic parameters received from Ministry of economy and sustainable development.

The table gives various options of annual consumption growth and generation commissioning. G1 scenario envisages commissioning of 10% of the total installed capacity of prospective power plants in the planned timeframes, and integration of the rest capacity will be postponed by 10 years, G2 – timely commissioning of 25% of total installed capacity, and the rest 75% - after 5 years, while G3 - timely integration of full composition of prospective generation - 100% integration into the network.

Generally, development of transmission grid depends on scenario of integration of new generation and power demand growth rate. Anyway, in case of development by any scenario until 2035-2045 all three categories of new hydro power plants will be integrated into the grid. As for demand – it represents combination of internal demand and power export. In other words, if internal demand is being less increased, then power export will be increased more and vise-versa. Hence, **in case of development of generation and demand by any scenario, transmission grid shall be developed by the same option corresponding to timely integration of generation.**

1.7 Generation Adequacy

The software PLEXOS can choose what type of power plants to build. It is represented in the scenario of free optimization. In most cases, it builds wind, solar and run-of-river power plants, and comparatively fewer reservoir hydros. The main reason for the abovementioned is that the generation profile of wind and solar plants in monthly resolution is more stable than one from reservoir hydros.

System adequacy indicators are satisfied in all considered scenarios. The generation price in G1 and G2 scenarios, in which integration of renewable resources take place is the same. Though the G2 ensures integration of reservoir hydros, which enhance the system's flexibility a lot, so, this scenario is prioritized. When it comes to G0 scenarios, the load is covered by thermal power plants.

From the above mentioned, the requirements of energy safety, energy independence and energy availability are met most optimally in the G2 scenarios, when reservoir hydros are built with wind and solar power plants. These plants ensure providing of equal and stable generation throughout the year. Reservoir hydro plants compensate for the instabilities caused by renewables in minute and hour time spans.

1.8 Identified Projects and Required Investments

The projects planned for implementation have been divided into the following three groups:

1. ***Internal Projects,*** including the projects affecting power transit and reliability;
2. ***Cross-Border Projects***, i.e. the projects affecting capacity and reliability of the transit flows among the power systems of Georgia and its neighboring states;
3. ***Local Projects,*** comprising 220 kV and 110 kV dead-end feeder lines.

Transmission Licensee does not implement local projects. The direct impact on development of the transmission network is provided only by Cross-Border and Internal Projects. Therefore, 17 of such projects were selected for detailed review.

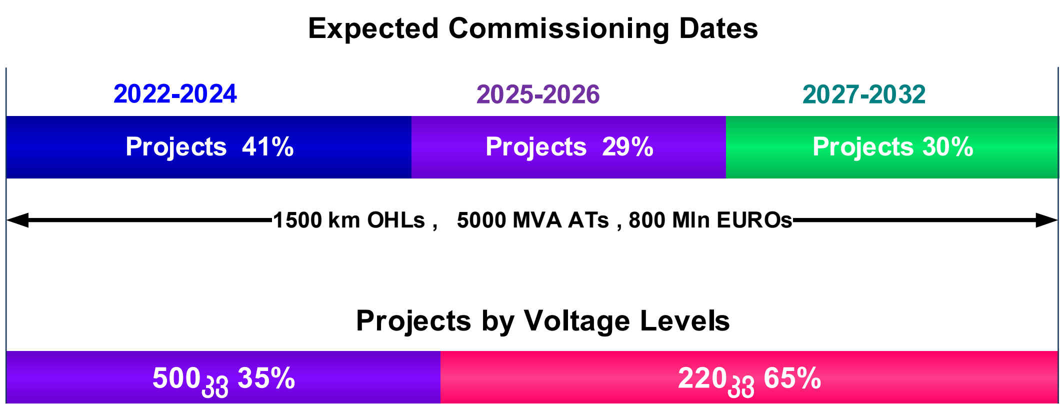

Fig. 1.8 Summarized Data of internal system and cross-border importance Projects

The Cost-Benefit Analysis (CBA) has been performed for the foregoing 17 projects planned for implementation in the transmission network during 2022-2032. Applying the CBA methodology, expected benefits where weighted against estimated investment costs and environmental impacts individually for each project.

In 2022-2032, the sum of new, rehabilitated and doubled circuit OHLs length is about 1500 km, whilst the total installed capacity of substations reaches 5000 MVA, which ensure several topics: improving existing grid reliability and meeting N-1 criteria at all stages of development; performing the transit hub of Georgia and exchanging more than 1000 MW power between as East and West, as well as North and South; integrating of additional 3500-4000 MW hydro power plants, for which required investment is forecasted as about 800 million Euros.

1.9 Major Calculation Results

Power flow analysis. In the base case, nodal voltages and power flows in the transmission remain within acceptable limits for the total planning horizon of 10 years. Meantime, during 2021-2025 (i.e. prior to the planned construction of 500 kV OHL Jvari-Tskaltubo-Akhaltsikhe), 220 kV network in the West

Georgia is overloaded under single contingency (N-1) case, namely if 500 kV OHL Imereti is lost. As a result, ECS initiates shedding of 200-300 MW load in the eastern part of Georgia along with generation reduction by the same amount in Enguri-Vardnili nodes in order to avoid mentioned.

Power losses. Power losses in Georgian transmission network at 500/400/330/220 kV voltage levels very in the range of 0.71%-3.35% percent.

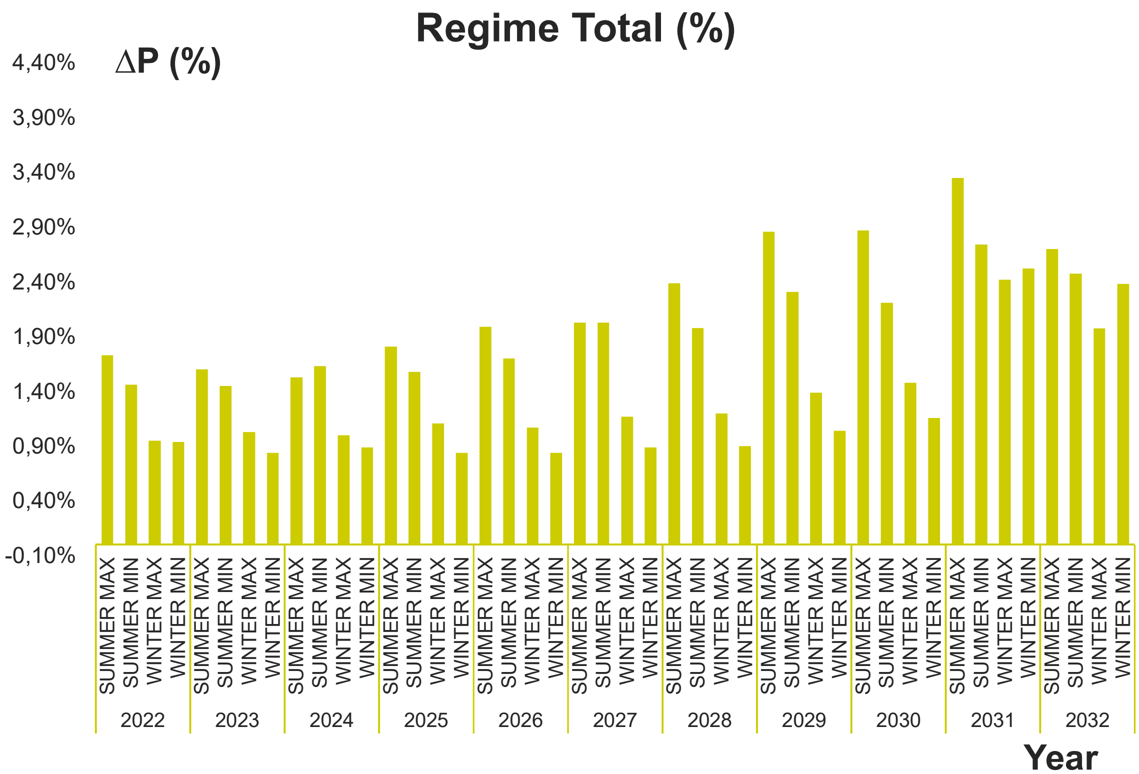

Fig. 1.9 Dynamics of transmission losses during 2022-2032 by seasons

Short circuit analysis. For the Ten-Year Network Development Plan of Georgia, the maximum and minimum short circuit currents have been calculated for the most critical and characteristic years (2022, 2026, 2032). The maximum short circuit currents were calculated assuming operation of all generators and cross-border lines of Georgian electric power system, while the case when the fewer number of generators appropriate to the summer minimum regime are operated, and all cross-border OHLs are switched off was considered when calculating the minimum short circuit current values. As calculations showed, in certain substations, the estimated short-circuit currents for 2032 are 70%-80% higher than for 2022 and may 100% exceed the current values. Therefore, electrodynamical and thermal ratings of the equipment installed in power plants and substations should be verified to timely make relevant replacements.

Dynamic Stability Analysis studies power system behavior and ability of maintaining synchronous operation of the generators during limited contingencies. Such analysis was performed for maximum summer demand mode of Georgian power system for 2021, 2025 and 2030, considering the following disturbances: Emergency tripping of 500 kV OHLs; Outage of 500/220 kV autotransformers; Tripping of back-to-back link or 400 kV Georgia-Turkey line; Shutdown of the power units of Enguri HPP, 9th Thermal Unit and Khudoni HPP.

According to results of the analysis, Georgian transmission network (power system) maintains stability during any disturbances, subject to the following preconditions: During 2021-2025, in cases involving tripping/shutdown of 500 kV OHL Imereti, 500 kV OHL Kavkasioni, power unit of Enguri HPP or 9th Thermal Unit, ECS should intervene for shedding of the appropriate customer loads and/or generation facilities. During 2025-2032, system stability is naturally maintained in case of any disturbances.

Harmonic analysis. The most powerful source of harmonics in Georgian electric power system is 700 MW Akhaltsikhe HVDC back-to-back station. In near future new 350 MW HVDC links will be added at SS Akhaltsikhe. In addition, construction of 700 MW HVDC back-to-back station in Armenia near to Georgian border is planned which will be connected to Georgian transmission grid. For the base case (N), analysis included calculation of individual and Total Harmonic Distortion rates, while for single contingency (N-1) cases (considering having one of 220 kV or 500 kV lines out of operation), only Total Harmonic Distortion (THD) was calculated. According to derived results, all THDs, for both N and N-1 modes are within the standard limits.

Summary: based on results of above analyses, the planned transmission network is reliable, provides stability of the power system and maintains system parameters within the limits set forth in the Grid Code.

1.10 Georgian Transmission System Development Indicators

Future constructions of 500/400/220/110 kV OHLs and substations planned during next ten year are mainly intended for integration of the new hydro power plants, necessity of improving reliability and security of supply as well as increment of transit potential.

Table 1.2 Summary data on High-voltage OHLs and substations

Overhead Lines		Substation autotransformers and Back-to-Back Links	
Rated Voltage (kV)	Length (Km)	Rating (kV)	Capacity (MVA)
500	937	500/400	700
400	32	500/330	0
330	21	500/220	3960
220	1797	330/220	400
110	3550	220/110	6634
Sum	**6337**	**Sum**	**11694**

The following diagram illustrates dynamics of total generation capacity (MW), installed apparent capacity of 500/400/330/220/110 kV transformers and autotransformers (MVA) and total length of transmission lines expressed in 500 kV OHL equivalent (km).

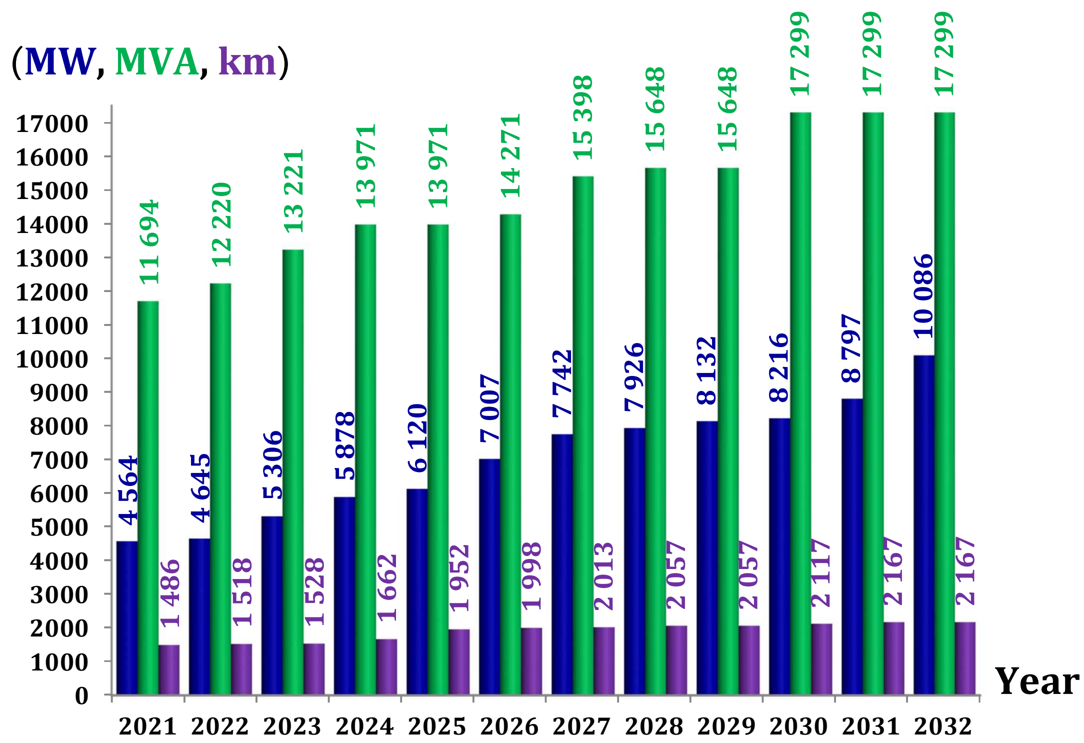

Fig. 1.10 Dynamics of Georgian generation and 500/400/330/220/110 kV transmission infrastructure development during 2021-2032

Several indicators describing development of Georgian transmission network were calculated from the diagram given on Fig. 1.10, such as length of overhead line needed for evacuation of 1 MW installed generation capacity (in 500 kV OHL equivalents) and total installed capacity of 500/400/330/220/110 kV (auto)transformers.

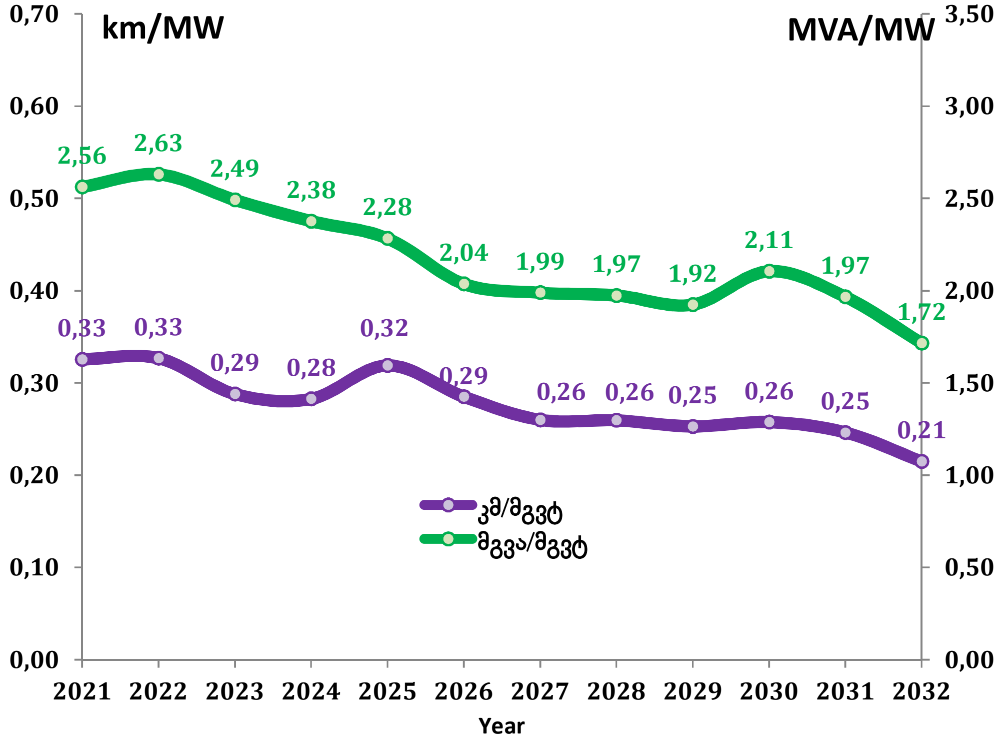

Fig. 1.11 Relationship between development of Georgian transmission network and generation infrastructure

Summary: Despite reduction of unit equivalent length of the transmission network and specific capacity of (auto)transformers per evacuated 1 MW generation, the calculations show that during 2025-2032, Georgian power system will be more stable comparing to 2021-2024 time span. Therefore, it is apparent that improvement of the reliability is accompanied by improvement of network effectiveness and cost-efficiency.

1.11 Capabilities of Power Exchange with Neighboring States in 2025-2032 Time Span

The existing cross-border links serve for power exchange between Georgia and Russia and transit from Russia and Azerbaijan to Turkey, as well as for bidirectional power exchange between Georgia and Turkey, Azerbaijan and Armenia. However, such power flows are restricted due to both limitations stemmed from the acceptable operating modes of national power system and physical capacities of above cross-border OHLs (fig. 1.12 and tab. 1.3).

For 2025-2032 horizon, Georgia, due to its geographical location, will gain an important role in the planned regional integration of the power systems of the Caucasian (and Black Sea) countries assuming promotion of energy trading between these countries and development and use of Georgian hydropower resources.

For 2025-2032, cross-border links between Georgian and its neighboring power systems will significantly advance, allowing 1050 MW power exchange increase with Turkey, 1600 MW with Russia and 700 MW with Armenia. There is already possibility of 700-1000 MW power exchange between powers systems of Georgia and Azerbaijan.

Table 1.3 Power exchange capabilities with neighboring power systems

Country	Cross-border line, conductor	Nom. Voltage (kV)	Exchange	TTC Summer (MW)	TTC Winter (MW)	Mode
Russia	,,Kavkasioni“	500	Export	570	650	S
			Import	570	650	S
	,,Stepantsminda“ (Ksani-Stepantsminda-Mozdok)	500	Export	1000	1000	S
			Import	1000	1000	S
	,,Salkhino“	220	Export	50	50	I
			Import	150	150	I
Azerbaijan	,,Mukhranis Veli“	500	Export	630	710	S
			Import	630	710	S
	,,Gardabani“ ^{2022}	330	Export	630	710	S
			Import	630	710	S
Armenia	,,Alaverdi“	220	Export	150 / 100	150 / 100	S / I
			Import	150 / 100	150 / 100	S / I
	,,Marneuli“ (Marneuli-Ayrum)^{2025}	400	Export	700	700	B
			Import	700	700	B
Turkey	,,Meskheti“	400	Export	1050	1050	B
	„Tao“ (Akhaltsikhe-Tortum)^{2025}		Import			
	,,Adjara“	220	Export	150 / 150	150 / 150	I/ R
			Import	150 / 150	150 / 150	I / R

S synchronous mode
I isolated mode
B operation with Back-to-back station
R in the reserve

In particular, each of the 400 kV OHLs “Tao” and “Meskheti” can transfer up to 1500 MW but their total transfer capacity is limited by the ones of Akhaltsikhe HVDC back-to-back units, value of which will equal to 1050 MW after 2030.

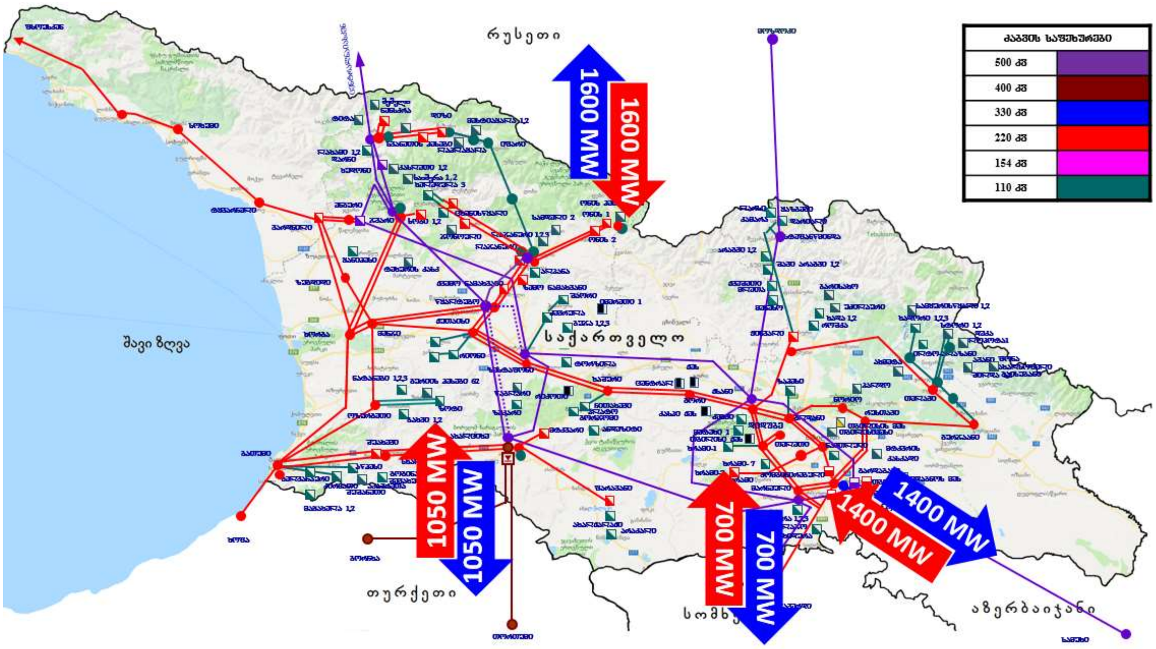

Fig. 1.12 Cross-border transfer capacities between power systems of Georgia and its neighboring countries as for 2032

1.12 Opportunities of integration of renewable energy sources into the transmission network of Georgia

In recent years, the interest in construction of wind and solar power plants in Georgia has been particularly increased. Therefore, Georgian Electricity Transmission System Operator JSC "Georgian State Electrosystem", with the support of European consultant's consortium DIgSILENT-DMCC-R2B, has studied the possibilities of integration of variable renewable energy sources into the Georgian power system. The results of the research are as follows:

- ✓ Till 2020-2021 years (after implementation of balancing mechanisms) Georgian power system can integrate 333 MW wind and 130 MW solar power plant (25% of potential);
- ✓ By 2025, it is possible to integrate about 500 MW wind and 250 MW solar power plants in the grid, however, according to additional undergoing studies, the limits may be updated.
- ✓ By 2030, above-mentioned forecasted values for wind and solar energy are respectively 1332 MW and 520 MW (100% potential).

1.13 Ten-year development plan of SCADA and information technology (IT)

Georgian State Electrosystem (GSE) is the transmission system operator serving the function to maintain system stability and reliability for short-term and long-term periods. Especial challenge is to balance the system usage-supply and export-import in real time (online) so that to maintain power quality parameters within normal limits. Another challenge is to manage energy system, and to maintain stability and integrity in emergency modes. In order the company to be able to generate and exchange all required accurate data for energy management, it is necessary to integrate a variety of information technology platforms applied to GSE system, which should correspond to the Ten-Year Network Development Plan of Georgia. This is the basis for SCADA and Information Technology (IT) Development Plan, which, along with transmission network development, is part of mentioned ten-year plan.

1.14 New challenges and relevant solutions

1. **Electro mobiles –** Possible drastic increase of peak load; "prosumers" – system decentralization and nonpredictability and customers with changing requirements. *Solution/mitigation*: construction of Hydro Power Plants (HPPs) with reservouis, enhancement of energy efficiency, introduction of power storage stations and batteries, construction of thermal plants and inter-system power transmission infrastructure, perfection of control and operation systems, introduction of "smart grids", introduction of dynamic transfer capacity of transmission lines, optimal integration of wind and solar power stations (possibly with storage batteries), introduce VSC PLUS and FACTS equipment, utilize up-to-date planning and designing methods and software solutions.
2. **Challenges associated with the construction of new transmission lines by the end of next decade:** *solution/mitigation*: visual-friendly constructions, installation of multiple current towers and, under some exceptions, construction of cable transmission lines.
3. **Challenges associated with market liberalization.** *Solution/mitigation*: renewal of system control program and readiness for the trade with the Europe's domestic power market before-day and within-day, as well as rehabilitation of existing power stations as per "systemic service concept".
4. **Possible cyber attack risks and informational safety challenges.** *Solution/mitigation*: GSE conducts personnel awareness and introduction of ISO 27001 safety standard. Besides, foreign cyber security experience is adopted and relevant GSE staff ensures cyber security at all times.
5. **Pandemic.** Coronavirus (COVID-19) represents the last active epidemic of an infectious disease occurring worldwide. *Solution/mitigation*: In order to its prevention, the whole civil world including Georgia takes into account the recommendations elaborated by "World Health Organization" generally considering to maintain hygienic norms and the minimal safe distance between people as well as to move to the remote working mode in case of important part of the work fields. As a result, the risk of further spreading of mentioned infection decreases significantly. In this regard, working of Georgian state electrosystem JSC as well as whole Georgia is effective and successful.

1.15 Strategic Environmental Assessment

GSE aims for the construction of transmission infrastructure, which will provide reliable consumption, as well as minimal adverse environmental effect. This 10-year plan envisages strategic environmental assessment of all main projects.

1.16 Conclusion

Transmission system operator, together with transmission licensee strives to provide reliable and high quality services to its customers and develop its own infrastructure that is necessary for supporting to economic development of Georgia. The projects presented and discussed in this Ten-Year Plan represent an adequate response to the changes in economical and energy environment. GSE believes that implementation of these projects will meet wishes of Georgian society as well as will allow the national economy to effectively address the challenges and ensure the better future.

2 Existing and perspective PPs

2.1 Generation Data

Georgian power system is characterized by asymmetric generation/consumption pattern due to law demand and high generation in summer and high demand and low generation in winter allowing Georgia to export the power during summer period. During winter, when less water is available for HPPs, thermal power's share in total generation increases to 28% from the less than 1% in summer.

The third of aggregated energy produced in the country comes from the largest Enguri HPP having installed capacity of 1,300 MW. Second largest power plant is Vardnili cascade HPPs. This tandem, together with other relatively lower capacity HPPs compose the pool of regulating hydro power plants with total installed capacity of about 2,380 MW (1,992 MW comes from reservoir HPPs, 389 MW from daily regulating HPPs).

By the end of 2021, total installed capacity was equal to 4563 MW, which includes installed capacity of HPPs 3353 MW, wind power plants 20.7 MW and thermal power plants 1190 MW.

Tab. 2.1 Existing Power Plants in Georgian Power System for the end of 2021

№	Power Plant	Installed capacity (MW)	Number of units	Type	Commissioning years
1	Enguri HPP	1300	5x260	Regulating	1978
2	Vardnili 1 HPP	220	3x73.33	Regulating	1971
3	Khrami 1 HPP	113.5	3x37.6 + 1x0.65	Regulating	1947
4	Khrami 2 HPP	110	2x55	Regulating	1963
5	Shaori HPP	38.4	4x9.6	Regulating	1955
6	Dzevrula HPP	80	4x20	Regulating	1956
7	Jinvali HPP	130	4x32.5	Regulating	1984
8	Rioni HPP	48	4x12	Run-of-River	1933
9	Gumati HPP cascade	66.7	4x11 + 3x7.6	Run-of-River	1958-1956
10	Vartsikhe HPP cascade	184	8x23	Run-of-River	1976-1977
11	Lajanuri HPP	111.8	3x37.28	Daily Reg	1960
12	Zahesi HPP	36.8	4x3.2 + 2x12	Run-of-River	1927
13	Ortachala HPP	18	3x6	Run-of-River	1954
14	Chitakhevi HPP	21	3x7	Run-of-River	1949
15	Atshesi HPP	16	2x8	Run-of-River	1937
16	Satskhene HPP	14	2x7	Run-of-River	1992
17	Khadori HPP	26	2x12+2x1	Run-of-River	2004
18	Larsi HPP	19.5	2x6.5	Run-of-River	2014
19	Paravani HPP	87	2x43.27	Run-of-River	2014
20	Bjuja HPP	12.2	3x4.08	Small HPP	1956
21	Tetrikhevi HPP	13.6	2x6.8	Small HPP	1952
22	Alazani HPP	4.8	2x2.4	Small HPP	1942
23	Abhesi HPP	2.01	1x0.888+2x0.56	Small HPP	1928
24	Sioni HPP	9.1	2x4.57	Small HPP	1964

25	Ritseula HPP	6.3	1x3.816+2x1.29 6	Small HPP	1967
26	Chala HPP	1.5	1x1.5	Small HPP	1941
27	Chkhori HPP	5.4	1x2.9+1x2.45	Small HPP	1967
28	Dashbashi HPP	1.3	3x0.42	Small HPP	1935
29	Mashavera HPP	0.8	1x0.8	Small HPP	1949
30	Kabala HPP	1.5	3x0.45	Small HPP	1953
31	Kakhareti HPP	2.1	2x1.04	Small HPP	1957
32	Martkopi HPP	3.9	1x3.87	Small HPP	1952
33	Intsoba HPP	1.8	1x0.6+2x0.6	Small HPP	1998
34	Kazbegi HPP 2	0.38	2x0.19	Small HPP	1951
35	Energetiki HPP	0.59	1x0.59	Small HPP	2006
36	Algeta HPP	1.3	1x1+1x0.25	Small HPP	2006
37	Matchakhela HPP	1.6	2x0.8	Small HPP	1957
38	Misaktsieli HPP	3	1x2+1x1	Small HPP	1964
39	Skuri HPP	1		Small HPP	1958
40	Tiriponi HPP	3.2	2x1.6	Small HPP	1951
41	Khertvisi HPP	0.3	2x0.152	Small HPP	1950
42	Kinkisha HPP	0.9	2x0.452	Small HPP	1954
43	Atchi HPP	1	1x0.74+1x0.288	Small HPP	1958
44	Rustavi HPP	0.5		Small HPP	2009
45	Sulori HPP	0.8		Small HPP	2009
46	Okami 2007 HPP	1.6		Small HPP	2009
47	Boldoda HPP	2.5		Small HPP	2009
48	Zvareti HPP	0.2		Small HPP	2010
49	Pshavela HPP	2.9	1x2.9	Small HPP	2010-2015
50	Igoeti HPP	2	1x0.525+1x1.25	Small HPP	1953
51	Sanalia HPP	5		Small HPP	2007
52	Mini khadori 1 HPP	0		Small HPP	2011
53	Khadori 2 HPP	6	2x3	Small HPP	2012
54	Khani HPP	0.3		Small HPP	2012
55	Racha HPP	11	2x5.5	Small HPP	2013
56	Dagva HPP	0.1		Small HPP	2013
57	Alazani 2 HPP	6	2x3	Small HPP	2013
58	Shilda HPP	5	2x2.5	Small HPP	2013
59	Kazbegi HPP	6	2x3	Small HPP	2014
60	Bakhvi-3 HPP	10	2x4+1x2	Small HPP	2013
61	Pantiani HPP	0.4		Small HPP	2012
62	Aragvi HPP	8.5	2x4.7	Small HPP	2014
63	Akhmeta HPP	9.1	2x4.57	Small HPP	2014
64	Pshavela HPP	1.95		Small HPP	2015
65	Kazreti HPP	2.5		Small HPP	2014
66	Debeda HPP	3.2	2x1.6	Small HPP	2015
67	Shakshaheti HPP	1.9	1x1.9	Small HPP	2014

68	Maksania HPP	0.315	1x0.315	Small HPP	2017
69	Dariali HPP	108	3x36	Run-of-River	2016
70	Saguramo HPP	4.2	2x2.25	Run-of-River	2016
71	Khelvachauri HPP	47.48	5x9,1+1 x 1,98	Daily Reg	2016
72	Marneuli HPP	0.25	1x0.25	Small HPP	2016
73	Shuakhevi HPP	178.72	2x89.36	Daily Reg	2017*
74	Goresha HPP	0.125	1x0.125	Small HPP	2017
75	Kintrisha HPP	5.50	2x2.75	Run-of-River	2017
76	Nabeglavi HPP	2	2x1	Run-of-River	2017
77	Skurididi HPP	1.33	1x1.33	Run-of-River	2018
78	Shilda 1 HPP	1.20	1x1.2	Run-of-River	2018
79	Kheor HPP	1.48	1x1.48	Run-of-River	2018
80	Bodorna HPP	2.5	1x2.5	Run-of-River	2018
81	Kasleti 2 HPP	9.1	2x4.55	Run-of-River	2018
82	Jonouli 1 HPP	1.85	1x1.85	Run-of-River	2018
83	Kirnati HPP	51.22	4x12.33+1x1.9	Daily Reg	2018
84	Old Energy HPP	21.39	3x7.13	Run-of-River	2018
85	Aragvi 2 HPP	1.95	1x1.95	Run-of-River	2019
86	Mestiachala 1 HPP	20	2x10	Run-of-River	2019
87	Mestiachala 2 HPP	30	3x10	Run-of-River	2019
88	Avani HPP	3.5	2x1.75	Run-of-River	2019
89	Oro HPP (Zemo orozman HPP)	1.12	1x1.12	Run-of-River	2019
90	Chapala HPP	0.43	1x0.43	Run-of-River	2020
91	Khelra HPP	3.38	2x1.69	Run-of-River	2020
92	Ifari HPP	2.98	2x1.49	Run-of-River	2020
93	Dzama HPP	0.811	2x0.405	Run-of-River	2020
94	Sashuala 2 HPP	5	1x5	Run-of-River	2020
95	Lakhami 2 HPP	9.5		Run-of-River	2020
96	Lakhami 1 HPP	7.0	2x3.5	Run-of-River	2020
97	Sashuala 1 HPP	7.5	1x7.5	Run-of-River	2021
98	Skhalta HPP	9	3x3	Run-of-River	2021
99	Tbilisi sea HPP	0.6	0.6	Run-of-River	2021
100	Dvirula HPP	2	2	Run-of-River	2021
101	Khrami HPP	1.13		Run-of-River	2021
102	Roshka 2 HPP	1.99		Run-of-River	2021
103	Roshka 3 HPP	1		Run-of-River	2021
104	Akhatani HPP	0.6	2x0.3	Run-of-River	2021
105	Unit №9	300	1x300	Thermal Power Plant	1991
106	Units №3, №4	272	130+142	Thermal Power Plant	1963
107	Gas turbine	110	2x55	Thermal Power Plant	2006
108	Tkibuli Coal TPP	13	2x6.5	Thermal Power Plant	2011
109	Gardabani CCGT	230	2x75+80	Thermal Power Plant	2015
110	TPP (Rustavi Azoti)	9.1	9.1	Thermal Power Plant	2020

111	Gardabani CCGT 2	255	2x84+87	Thermal Power Plant	2020
112	Wind Farm	20.7	6x3.45	Wind farm	2016
I	**Sum of Regulating HPPs**	**2381.1**			
II	**Sum of RoR HPPs**	**972.8**			
III	**HPPs in total**	**3353.9**			
IV	**TPPs in total**	**1189.1**			
V	**Wind farm**	**20.7**			
VI	**System**	**4563.7**			

2.2 Perspective PPs

The initial information for transmission grid development are following: 1. Load and Generation data, specifically, type of new object, installed capacity, annual output, commissioning date, category; Decommissioning dates of old power plants, load growth scenarios.

Data about generation (Table 2.2) was received from Ministry of Economy and Sustainable Development of Georgia

Table 2.2 Perspective HPPs with predicted data

№	Name	Installed Capacity (MW	Generation (Gwh)	Type
1	Natseshari HPP	1,9	8,5	Run-of-River
2	Shakshaheti HPP	0,3	1,8	Run-of-River
3	Chordula HPP	2	9	Run-of-River
4	Roshka 1 HPP	1	5,7	Run-of-River
5	Jagon-Nashumi HPP	1,8	8,8	Run-of-River
6	Mtkvari HPP	53	230	Run-of-River
7	Nakra HPP	7,5	35,2	Run-of-River
8	Lukhuni 2 HPP	17	86,5	Run-of-River
9	Chani HPP	0,5	3,5	Run-of-River
10	Jandara HPP	0,3	2,1	Run-of-River
11	Akhalkalaki 1 HPP	7,5	39,2	Run-of-River
12	Akhalkalaki 2 HPP	1,6	9,8	Run-of-River
13	Goginauri HPP	4,7	18,7	Run-of-River
14	Berali HPP	0,9	5,3	Run-of-River
15	Khobi 2 HPP	46,7	202	Run-of-River
16	Korsha HPP	1,5	7,9	Run-of-River
17	Chiora HPP	14,2	68,4	Run-of-River
18	Tashiskari HPP	1,2	8,6	Run-of-River
19	Duman mashavera HPP	2	11	Run-of-River
20	Stori 1 HPP	33,6	150	Run-of-River
21	Dageti HPP	0,8	7,1	Run-of-River
22	Zoti HPP	46,1	172,2	Run-of-River
23	Sashuala HPP	2,6	13,3	Run-of-River
24	Shevaburi HPP	1,9	15,4	Run-of-River
25	Notsarula 3 HPP	1,8	9,4	Run-of-River
26	Digomi HPP	11,3	62,8	Run-of-River
27	Cemi HPP	0,5	2,9	Run-of-River
28	Skurdidi 3 HPP	1,4	10,6	Run-of-River

29	Basra 1 HPP	1,9	11,7	Run-of-River
30	Basra 2 HPP	1,9	16,7	Run-of-River
31	Boko HPP	0,5	2,8	Run-of-River
32	Buja 1 HPP	1,7	9,6	Run-of-River
33	Buja 2 HPP	1,1	5,5	Run-of-River
34	Buja 3 HPP	2	11,2	Run-of-River
35	Darchi HPP	16,9	93,6	Run-of-River
36	Zemo Karabukakhi HPP	1	6,3	Run-of-River
37	Kasleti 1 HPP	7,6	43,5	Run-of-River
38	Narovani HPP	0,6	2,6	Run-of-River
39	Roshka 4 HPP	0,9	4,3	Run-of-River
40	Sakaura HPP	11,6	59,4	Run-of-River
41	Samkuristskali 1 HPP	4,8	25,7	Run-of-River
42	Samkuristskali 2 HPP	26,3	129,3	Run-of-River
43	Sulori 1 HPP	0,9	7,4	Run-of-River
44	Sulori 2 HPP	3,5	26,8	Run-of-River
45	Plato, Borjomi HPP	11,8	45	Run-of-River
46	Toloshi HPP	1,5	10,6	Run-of-River
47	Udzilaurta HPP	8,5	41,5	Run-of-River
48	Gebi HPP	14,3	71	Run-of-River
49	Gere HPP	9,4	41,3	Run-of-River
50	Khuberi HPP	1,8	7,5	Run-of-River
51	Metekhi 1 HPP	36,7	145	Daily Reg
52	Makvaneti 1 HPP	1,3	5	Run-of-River
53	makvaneti 2 HPP	0,9	3,9	Run-of-River
54	Khokhnistskali 1 HPP	1,1	5,5	Run-of-River
55	Khokhnistskali 2 HPP	1,6	7,5	Run-of-River
56	Khokhnistskali 3 HPP	2	12,2	Run-of-River
57	Kodalistskali HPP	0,9	5,5	Run-of-River
58	Vale HPP	3,9	12,9	Run-of-River
59	Baramidze HPP	7,8	36,2	Run-of-River
60	Bakhvi 1 HPP	12	50	Run-of-River
61	Bobnev HPP	0,5	2,2	Run-of-River
62	Bjineura HPP	0,1	0,8	Run-of-River
63	Gubazeuli 6 HPP	3	20	Run-of-River
64	Deka HPP	1,2	5,7	Run-of-River
65	Dmanisi HPP	1,9	16,9	Run-of-River
66	Tbilisi HPP	20,2	113	Run-of-River
67	Lakhashuri HPP	2	10,3	Run-of-River
68	Lajanuri 2 HPP	5,4	30,9	Run-of-River
69	Lajanuri 3 HPP	5,4	33,3	Run-of-River
70	Lahlachala HPP	12	52,7	Run-of-River
71	Lopota 1 HPP	5,9	33,4	Run-of-River
72	Lukhra HPP	3,6	18	Run-of-River
73	Majieti HPP	12,3	63,3	Run-of-River
74	Mashavera HPP	2	10,4	Run-of-River
75	Mashavera 1 HPP	1,9	8,6	Run-of-River
76	Mashavera 2 HPP	1,9	8,6	Run-of-River
77	Nakra 1 HPP	5,9	31,3	Run-of-River
78	Nakra 2 HPP	4,4	22,7	Run-of-River
79	Nakhiduri HPP	7,2	51	Run-of-River
80	Notsarula 1 HPP	1,8	8,8	Run-of-River
81	Notsarula 2 HPP	4,9	21,6	Run-of-River
82	Rachkha HPP	3	11,5	Run-of-River

83	Sadmeli 2 HPP	4,5	22,5	Run-of-River
84	Sorgiti 1 HPP	13	59,8	Run-of-River
85	Sorgiti 2 HPP	10	47,6	Run-of-River
86	Torzila HPP	1,7	6,9	Run-of-River
87	Qveda zeni HPP	1,7	7,4	Run-of-River
88	Qvemo Orozmani HPP	0,6	4,4	Run-of-River
89	Geskuri HPP	0,7	3,1	Run-of-River
90	Shavi Aragvi HPP	3	13,6	Run-of-River
91	Shavi Aragvi 1 HPP	5,3	25,2	Run-of-River
92	Chirukhistskali HPP	1,9	11,4	Run-of-River
93	Dzegvi HPP	15,7	82,4	Run-of-River
94	Tseva HPP	1,7	8,7	Run-of-River
95	Khada 1 HPP	2,6	17,3	Run-of-River
96	Khada 2 HPP	1,1	7,5	Run-of-River
97	Khadori 3 HPP	5,4	27,5	Run-of-River
98	Khevi HPP	3,1	21,6	Run-of-River
99	Khvarguli HPP	5,3	23	Run-of-River
100	Shushaneti HPP	1,3	7,6	Run-of-River
101	Sachale HPP	0,7	4,3	Run-of-River
102	Qvedi HPP	1,7	9,9	Run-of-River
103	Arakali HPP	1,9	14,2	Run-of-River
104	Lesulukhe HPP	5,7	40,4	Run-of-River
105	Memuli HPP	12	52,2	Run-of-River
106	Nanari HPP	1,8	9,1	Run-of-River
107	Zeguri HPP	1,8	12,2	Run-of-River
108	Khofuri HPP	5,2	21	Run-of-River
109	Jejora HPP	1	5,4	Run-of-River
110	Alpana HPP	55,4	253,4	Run-of-River
111	Akhalsofeli HPP	5,3	30,9	Run-of-River
112	Baisubani HPP	5	27,4	Run-of-River
113	Bjuja 2 HPP	1,8	13,2	Run-of-River
114	Mashavera 3 HPP	1,9	8,6	Run-of-River
115	Meneso HPP	8,2	40,7	Run-of-River
116	Mleta HPP	4,9	31,3	Run-of-River
117	Mulkhura HPP	29,1	116,2	Run-of-River
118	Mtkvari Casc 4 HPP	78,1	614,9	Run-of-River
119	Natanebi 3 HPP	9,1	64,4	Run-of-River
120	Rioni-Chanchakhi HPP	36,6	165,6	Run-of-River
121	Cveshura HPP	9	43	Run-of-River
122	Tita HPP	4,5	23,8	Run-of-River
123	Fona HPP	10,6	55,1	Run-of-River
124	Qvesheti HPP	10,4	69,9	Run-of-River
125	Chartali HPP	2,5	14,9	Run-of-River
126	Khaishura 1 HPP	22,4	89,2	Run-of-River
127	Khaishura 2 HPP	16,6	71,9	Run-of-River
128	Khani HPP	6	28,9	Run-of-River
129	Jonouli 2 HPP	32	129,2	Run-of-River
130	Barisakho HPP	13,5	64,3	Daily Reg
131	Namakhvani HPPs Cascade	433	1500	Seasonal reg
132	Paldo HPP	7,4	48,2	Run-of-River
133	Andeziti HPP	1,1	4,3	Run-of-River
134	Dgvani HPP	5,7	24,6	Run-of-River
135	Zarzma HPP	5,7	22,1	Run-of-River

136	Khrami 7 HPP	11	55	Run-of-River
137	Stori 2 HPP	11,4	50,5	Run-of-River
138	Chirukhi HPP	5,3	27,4	Run-of-River
139	Bakhvi 2 HPP	36	123	Run-of-River
140	Zeskho 1 HPP	20,3	97,7	Run-of-River
141	Zeskho 2 HPP	7	38,2	Run-of-River
142	Ilto-Alazani HPPs Cascade	139,5	521,9	Run-of-River
143	Kamara HPP	23	113	Run-of-River
144	Natanebi 2 HPP	10,2	69,6	Run-of-River
145	Tekhura HPPs Cascade	112	650	Run-of-River
146	Tskhenistskali 1 HPP	22,3	102,3	Run-of-River
147	Khobi 1 HPP	45,5	201,5	Run-of-River
148	Gubazeuli HPP	6,1	27,1	Run-of-River
149	Laskadura HPP	6,6	33	Run-of-River
150	Kvirila HPP	6,6	40	Run-of-River
151	Akavreta HPP	20	84	Run-of-River
152	Machakhela 1 HPP	30	127	Run-of-River
153	Machakhela 2 HPP	19	115	Run-of-River
154	Natenebi 1 HPP	6,4	40,3	Run-of-River
155	Oni 1 HPP	122,5	441,2	Run-of-River
156	Oni 2 HPP	83,7	339	Run-of-River
157	Nenskra HPP	280	1200	Seasonal reg
158	Dizi HPP	250	960	Seasonal reg
159	Kheledula 3 HPP	51	255	Run-of-River
160	Tskhenistskali HPPs Cascade	357	1683	Run-of-River
161	Khudoni HPP	702	1500	Seasonal reg
162	Kvanchianari HPP	230	920	Seasonal reg
	Sum	**4111,4**	**16674,6**	

Table 2.3 Prospective TPPs

№	NAME	Installed capacity (MW)	Efficiency (%)	Type
1	3-Thermal	250	55	CCGT
2	4-Thermal	250	55	CCGT

3 Identified Projects and Investment Needs for Infrastructure strengthening

3.1 Identified Projects

As noted above (ref. to Sections 2 and 6), the projects to be implemented in the transmission network has been divided into the following three groups:

1. ***Internal Projects,*** including the projects affecting power transit and reliability;
2. ***Cross-Border Projects***, i.e. the projects affecting capacity and reliability of the transit flows among the power systems of Georgia and its neighboring states;
3. ***Local Projects,*** comprising 220 kV and 110 kV dead-end feeder lines.

The direct affect on development of the transmission network is provided only by Cross-Border and Internal Projects.

The estimated costs, as well as lengths and commissioning dates of these projects are of a forecasted nature, and GSE shall in no event be liable for their inaccuracy. These data shall be subject of review and specification during implementation of the projects by consultants and/or project developers.

Seventeen projects described below are of the system wide importance, and when implemented, will address current and future challenges. Each of these projects will provide individual infrastructural elements of the transmission network, although consisting of several sub-projects and/or power lines and substations operated at one or several rated voltages.

Sixteen from described projects assume construction of overhead line or substation, and the remaining one – construction of HVDC link along with AC transmission line.

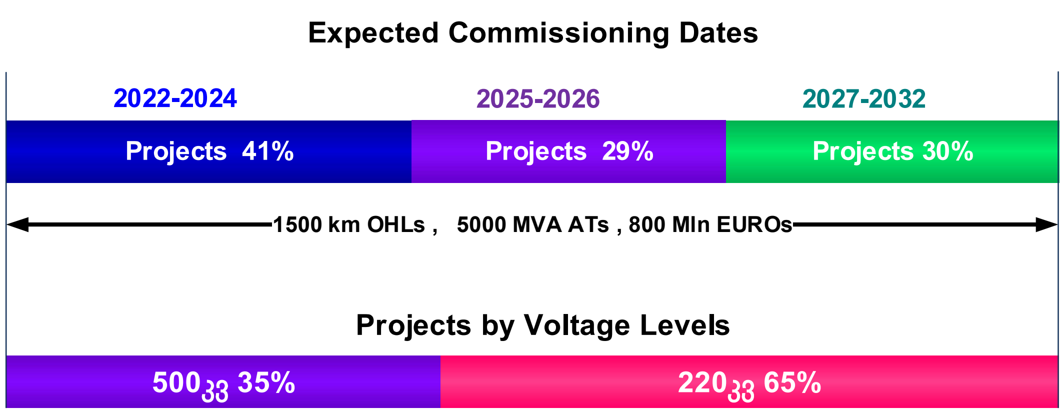

Fig. 3.1 Summarized Data of System-Importance Projects

As shown on the diagram given on Fig. 3.1, 41% of the projects will be commissioned during 2022-2024. This time span denoted as “short-term planning period”.

In 2025-2026, another 29% of the identified projects will be commissioned. This time span belongs to "mid-term planning period" covering the planned projects, which general characteristics and estimated technical and economical parameters are already determined.

In 2027-2032, rest 30% of the identified projects will be commissioned. This time span belongs to "long-term planning period".

The total length of transmission lines scheduled for 2022-2032 (accounting for each individual circuit) amounts to approximately 1500 km, and the total apparent capacity of the substations planned for the same period to 5000 MVA. It should be noted that 4 projects will serve for reinforcement of cross-border interconnections, including one projects envisaging construction of HVDC back-to-back link and interconnection line to Turkey, and other three interconnection projects with Russia, Azerbaijan and Armenia. Seven Project will increase internal transfer capacity and reliability.

The possible dates of projects start-up do not include dates for the land acquisition procedures, hence the extension of these procedures may delay project completion.

Description of Each below presented project is composed of the following items:

- **Project Name**;
- **Project Importance**;
- **Commissioning Year**;
- **Forecasted Investment**, specifies the estimated project implementation costs in million Euros;
- **Current Status**, describes ongoing progress status of specific project.
- **Capacity of Integrated HPPs**, specifies installed capacities (in MW) of the HPPs to be integrated into the network by relevant project.
- **Reduction of Losses**, specifies incremental network losses to be incurred without specific project or any of its critical elements.
- **Increase of Network Transfer Capacity (Normal/Emergency Modes)**, specifies incremental network transfer capacity of the network (in MW) under steady state and contingencies (loss of parallel line) after implementation of specific project.
- **Project Flexibility Level**, specifies dependence of the project implementation on forecasted commissioning/network interconnection dates of HPPs, bulk increase of the load at specific node, etc.
- **Project Components**, lists appropriate OHLs, autotransformers, reactors and other elements of the transmission system included into the specific project scope.
- **Purpose of Project**, specifies project objectives.
- **Brief Description**, provides short narrative about project purpose, terrain conditions, etc.

Project Name: **Jvari-Khorga**

Project Importance: System

Project Commissioning Year: 2022

Forecasted Investment: 22.6 million Euros (For the elements to be completed)

Current Status: On construction stage

Capacity of Integrated HPPs: 204 MW

Reduction of Losses: 12552 MWh

Increase of Network Transfer Capacity (Normal/Emergency Modes): 200/400 MW

Project Flexibility and Influence on Reliability: High

Project Components:

To be Completed ➢

- P.1.1 Double circuit 220 kV OHL ''Odishi-1,2" (Jvari- Khorga), length 60 km,

Completed ✓

- Loop in//loop out of 500 kV OHL "Kavkasioni" to/from SS ''Jvari", 16 km (2x8 km);
- 500/220 kV SS Jvari, with installed capacity of 500 MVA;
- 180 (3x60) Mvar reactor to be installed in SS Jvari-500;
- 220/110 kV SS Khorga, with installed capacity of 400 MVA;
- Construction of second circuit 220 kV OHL "Menji-Khorga", conductor: 2xAC-400; Capacity: 400 MW;
- Installation of 2 bays in SS Menji for "Khorga-1,2" (Menji-Khorga);
- Loop in/loop out of 220 kV OHL Paliastomi-2 to/from 220/110 kV SS Khorga.

Purpose of Project:

- Improving reliability of power supply of Abkhazia, Samegrelo, Adjara and Guria (back up of OHLs Egrisi-1,2);
- Contributing to elimination of voltage instability problems in Batumi region (Adjara), improving reliability of the regional power supply and evacuation of the power generated by local HPPs;
- Integration of Khobi cascade HPPs into the network;
- High reliability and power evacuation of Khobi cascade and support to power export to Turkey;
- Upgrading flexibility of OHL Kavkasioni;
- Ensuring power supply of Poti Industrial Zone;
- Reinforcement of 220 kV grid in West part of Georgia;
- Reduction of consumers to be tripped by system automatic.

Project Description:

Jvari-Khorga is a multipurpose project designed for addressing several important objectives. The most important desired project outcome is improved reliability of West Georgia's 220 kV network. Specifically, after 220 kV OHL Paliastomi-2 is tied to SS Khorga, Jvari-Enguri and Khorga nodes will be interconnected by four parallel 220 kV OHLs thus increasing reliability of the power supply of 220 kV substations Enguri, Vardnili, Zugdidi, Khorga and Menji as well as backing up 500/220 kV autotransformer installed in SS Enguri, and 220 kV OHLs Egrisi-1,2, Kolkhida-2a, Kolkhida 2 and Paliastomi-2(1). Along with "Tskaltubo-Zestaponi", this project will increase transfer capacity of 220 kV main of entire east part of Georgian transmission network and in some extent will back up 500 kV OHL Imereti, resulting decrease of amount of consumers to be tripped by ECS (Emergency Control System) in case of emergency outage of above mentioned 500 kV OHL.

In addition, tie-line connecting SS Khorga with OHL Paliastomi will improve power supply of 220 kV SS Batumi and entire Adjara and Guria Regions (due to significant shortening of this line's Batumi-Khorga section). Also, voltage instability problem in SS Batumi will be eliminated, and evacuation of the power generated by Shuakhevi HPP will be provided (at the first stage, only Batumi - Shuakhevi HPP section of 220 kV OHL Batumi-Akhaltsikhe will be constructed). One of the major purposes of SS Khorga is ensuring power supply of Poti Free Industrial Zone and prospective port. This substation may be connected with prospective power plants to be constructed in Samegrelo and west part of Lower Imereti, as well as with the ones planned in Jvari area (e.g. Khobi HPPs).

Fig. 3.2 Single-line diagram of "Jvari-Khorga" Project

Table 3.1 Power plants integrated by the project "Jvari – Khorga"

№	Name	Installed capacity (MW)	Generation (million kWh)
1	Khobi 2 HPP	47.7	202
	Khobi 1 HPP	45.5	201.5
2	Tekhura HPPs cascade	112	650
	Total	**204.2**	**1053.5**

Project Name: **Batumi-Akhaltsikhe**

Project Importance: System

Project Commissioning Year: 2023-2024

Forecasted Investment: **33.3 mln Euros (For the elements to be completed)**

Current Status: On construction stage

Capacity of Integrated HPPs: 200 MW

Reduction of Losses: 15029 MWh

Increase of Network Transfer Capacity (Normal/Emergency Modes): 800/800 MW

Project Flexibility and Influence on Reliability: High

Project Components:

To be Completed ➢

- P.2.1 Double-circuit 220 kV OHL Shuakhevi-Akhaltsikhe, line length: 90 km, capacity: 2x400 MW;
- P.2.2 220/110/35 kV autotransformer in SS Shuakhevi.

Completed ✓

- Installation of 2 bays for 220 kV double-circuit OHL "Batumi-Akhaltsikhe" in 500 kV SS Akhaltsikhe;
- *Double-circuit 220 kV OHL Batumi-Shuakhevi, Line length 50 km, transfer capacity 2x400 MW; arrangement of two 220 kV bays in Batumi substation for 220 kV OHL Batumi – Akhaltsikhe.*

Purpose of Project:

- Improving reliability of the power supply to Adjara and Guria (backing up OHLs Paliastomi-1,2);
- Increasing export potential to Turkey;
- Providing high quality and reliable integration of Shuakhevi HPP, other prospective HPPs to be constructed in Adjara into the transmission network;
- Increment of reliability of west part of transmission network.

Project Description:

This is multipurpose project. First, this line will integrate Shuakhevi HPP and Skhalta HPP (sum 187 MW) into network and ensure reliable evacuation of their power output. HPPs will be connected to both 220 kV substations of Batumi and Akhaltsikhe, and thus, along the sections Batumi-Shuakhevi-Akhaltsikhe the single contingency (N-1) criterion will be met under any operating regime. From SS Batumi-220, generation of Shuakhevi HPP may be further evacuated as for in-country supply (towards 220 kV substations Menji and Khorga), so for exporting to Turkey via Akhalcikhe HVDC B2B station. Implementation of this project will improve reliability of the power supply to 220 kV SS Batumi (as well as entire Adjara and Guria Regions) due to connections with Shuakhevi and Skhalta HPPs.

This project will play role in reliability increment of west part of transmission network – resulting in decrease of load to be shedded by 100 MW in case of outage of 500 kV OHL "Imereti".

220 kV OHL Shuakhevi – Batumi was commissioned in 2017, which provides evacuation of Shuakhevi HPP capacity; "Shuakhevi-Akhaltsikhe" section will be commissioned in 2023.

According to the project, installation of 125 MW 220/110/35 kV auto-transformer at Shuakhevi HPP is planned, in order to integrate of adjacent HPPs into the network as well as to improve reliability of supply of adjacent 110/35 kV distribution network.

Fig. 3.3 Single-line diagram of "Batumi-Akhaltsikhe" Project

Table 3.2 Power plants integrated by the project "Batumi – Akhaltsikhe"

№	Name	Installed capacity (MW)	Generation (million kWh)
1	Shuakhevi HPP	178	437
2	Skhalta HPP	9	27
3	Chirukhistskali HPP	1.9	11.4
4	Chirukhi HPP	5.3	27.4
5	Dgvani HPP	5.7	24.6
	Total	**200**	**527.4**

Project Name: **Ksani-Stepantsminda-Mozdok**

Project Importance: System/Transit

Project Commissioning Year: 2030

Forecasted Investment: **26.7 mln Euros (For the elements to be completed)**

Current Status: Preliminary system analysis for the project has been completed (GSE)

Capacity of Integrated HPPs: 199 MW

Reduction of Losses: 3237 MWh

Increase of Network Transfer Capacity (Normal/Emergency Modes): 700/1000 MW

Project Flexibility and Influence on Reliability: Very high

Project Components:

To be Completed ➢

- P.3.1 500/110 kV SS “Stepantsminda”, with installed capacity of 250 MW;
- P.3.2 500 kV OHL Stepantsminda-Border to Russia, length 13 km.

Completed ✓

- 500 kV OHL SS “Ksani” – SS “Stepantsminda”, length 100 km;
- 12.6 km section of Ksani –Stepantsminda, 133/166 section;
- Installation of 110 kV bay for 500 kV OHL “Ksani-Stepantsminda” in 500 kV SS Ksani;
- Temporary 110 kV OHL connection between SS Ksani-500 and 500 kV OHL Ksani-Stepantsminda, length: 0.7 km.

Purpose of Project:

- Reliable realization of the power transit potential along the route Russia-Georgia-Armenia-Iran;
- Backing up the existing 500 kV OHL Kavkasioni (Georgia-Russia);
- Increasing the potential of a primary reserve (Frequency containment reserve);
- Network integratin of hydro power plants located in Tergi River basin.

Project Description:

Implementation of this project will represent significant step towards improvement of reliability and stability of the entire Georgian transmission network. At present, Georgian electric power system mainly is synchronized with Russian system that is very advantageous with respect of reliability and frequency regulation (Russian system is 50 and more times larger comparing to the Georgian one). However, 405 km long 500 kV cross-border OHL Kavkasioni that is the only available link between Georgian and Russian systems can not ensure very high reliability of such parallel operation; due to significant length of this line, as well as extreme complexity of its route crossing the Great Caucasus Range, probability of emergencies on this line are quite high, and each emergency causes immediate full suspension of the power exchange with Russia.

It must be mentioned, that for Georgian power system, Russian power system is the main provider of primary reserve, which becomes unavailable as interconnection line – „Kavkasioni“ trips, then Georgian power system starts operating in an isolated mode and the ability of frequency regulation gets worsened significantly. The loss of 50 MW and more power may cause more than 1Hz drop in frequency and generation or load shutting down by under-frequency load shedding automatics or over-frequency generator tripping. After fulfilling esteemed project, such risks will no longer occur. What’s more, even in case of the sudden loss of about 1000 MW generation or load, Georgian power system will maintain a synchronous mode with Russian grid and transient stability will be maintained as well. The “Ksani-

Stepantsminda-Mozdok" project will minimize risks of the loss of transited capacity with Russian power system, reserve interconnection "Kavkasioni" 500 kV OHL and ensure transit reliability with Russian grid in case of 700-1000 MW capacity transit by fulfilling N-1 criteria.

In addition, operation of this line will allow increasing of the power exchange with Russia by about 1000 MW that will be definitely required during perspective, when bulk power trading is envisaged between Russia, Armenia and Iran (along with additional imported volumes required during winter season to cover Georgian power shortage). Also, the same line will be used for integration of the HPPs to be constructed in Tergi River basin (Larsi HPP, Dariali HPP, etc) into the network through 500/110 kV SS Stepantsminda. Moreover, this project will result in improved reliability of the power flows to 500 kV SS Ksani. It shall be noted that 500 kV section "Ksani – Stepantsminda" is finished, which in the first stage (2019-2030 Years) will operate on 110 kV and provide not only import of Larsi HPP and Dariali HPP power into the transit network, but also provide alternative power supply of the existing 110 kV substations, which are connected in 110 kV OHL "Jinvali HPP – Kazbegi substation". After the project section between Mozdok and Stepantsminda will be constructed by Russian party, the entire OHL Ksani-Stepantsminda-Mozdok will be shifted to 500 kV. For interconnection of Larsi HPP, Dariali HPP and other HPPs from this region, 500/110 kV Autotransformer will be installed in SS Stepantsminda. The project alignment will consist of complex sections running through narrow gorges of Aragvi and Tergi Rviers, especially when crossing Caucasus Range followed by relatively flat terrain at the north.

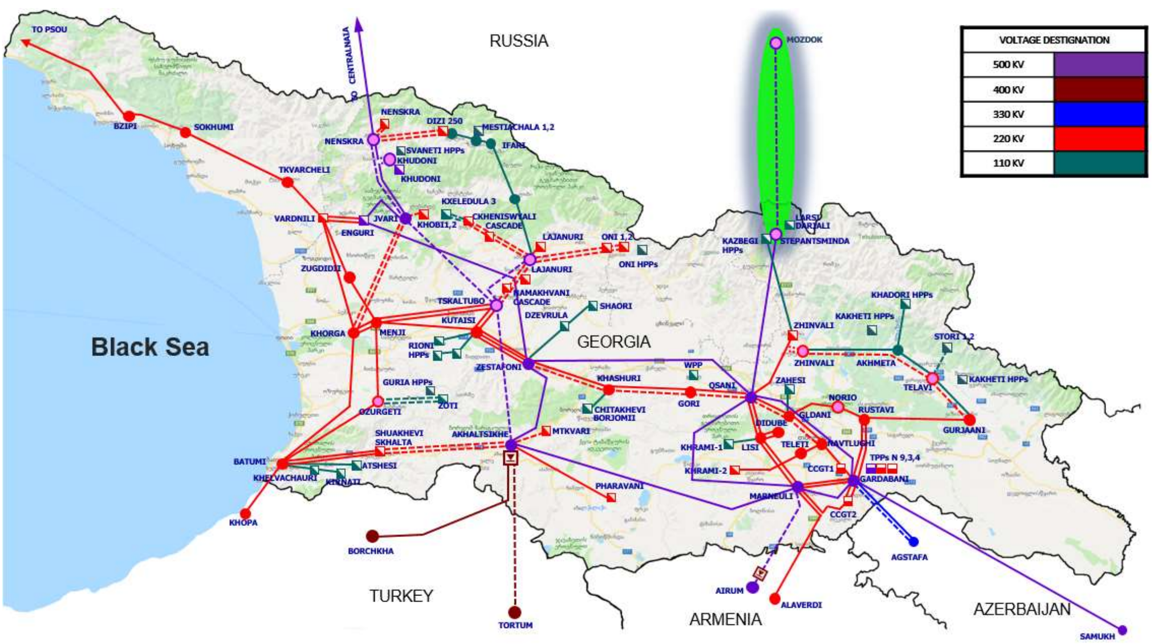

Fig. 3.4 Single-line diagam of "Ksani-Stepantsminda-Mozdok" Project

Table 3.3 Power plants integrated by the project "Ksani – Stepantsminda – Mozdok"

№	Name	Installed capacity (MW)	Generation (million kWh)
1	Larsi HPP	20	100
2	Dariali HPP	108	521
3	Aragvi HPP	8	50
4	Kazbegi HPP	6	35
5	Aragvi 2 HPP	2	13
6	Shavi aragvi HPP	3	13.6

7	Shavi aragvi 1 HPP	5.3	25.2
8	Khada 1,2	3.7	25
9	Meneso HPP	8.2	41
10	Kamara HPP	23	113
11	Mleta HPP	5	31
12	Qvesheti HPP	10.4	70
	Total	**202.6**	**1037.8**

Project Name: **Marneuli-Ayrum**[1]

Project Importance: System/Transit

Project Commissioning Year: 2025

Forecasted Investment: **20 mln Euros (For the elements to be completed)**

Current Status: Construction works are ongoing

Capacity of Integrated HPPs: 0 MW

Reduction of Losses: <1 MW

Increase of Network Transfer Capacity (Normal/Emergency Modes): 700/700 MW

Project Flexibility and Influence on Reliability: High

Project Components:

To be Completed ➢

- P.4.1 500 kV OHL "Marneuli – Ayrum" (to Armenian power system) length - 35.56 km (construction of new OHL of 18.56 km – from SS "Marneuli 500" to Georgia-Armenia border);
- P.4.2 Reconstruction of section between towers N42-N109 of 500 kV OHL "Mukhrani" (part of the OHL Marneuli-Airum), 17 km.

Purpose of Project:

- Increasing power transit capabilities from Russia to Armenia/Iran.
- Black Start Possibility
- Increase export/import opportunities with Armenia.

Project Description:

By implementing the „Marneuli-Airumi" project, the 500 kV SS „Marneuli", with a 500 kV OHL, will be connected to the 500 kV branch of the SS „Airum" in Armenia, on which in turn will be connected (3X350 MW) 500/400 KV HVDC converter station with installed capacity at first stage 350 MW, second stage 700 MW and at third stage 1050 MW, From here double-circuit 400 KV OHL (Airumi-Ddmasheni-Noravani-Iran) will go to Iran. Thus, through this project, it will be possible to implemented transit 1050 MW of capacity from Georgia (and Russia) to Armenia (and Iran) and vice-versa. Practically 500 kV OHL "Marneuli-Airum" will be an extension of the transit road "Mozdok-Stepantsminda-Ksani". Capacity will be transferred from substation "Ksani" to substation "Marneuli" through three 500 kV "roads": Ksani-Marneuli, Ksani-Zestaponi-Akhaltsikhe-Marneuli, Ksani-Gardabani-Marneuli, which provides high reliability of power exchange between Russia-Georgia and Armenia-Iran. Through the 500 kV OHL between Georgia and Armenia, power exchange capability will be increased, also by a strong connection of SS Marneuli to the electrical system, will be possible to restore the system from zero.

Within the project framework, it is planned to build 500 KV OHL from the tower N42 of 500 KV OHL „Muxrani" to Georgia-Armenia border (18.56 km). length of 500 kV OHL „Marneuli-Airumi" on the territory of Georgia will be 35.56 km. The OHL consists of newly, to be constructed (18.56 km) and existing (17 km) sections.

As part of the Marneuli-Airum project, for safe and reliable operation of the line, reconstruction and rehabilitation of 17 km section between the towers N42-N109 is necessary.

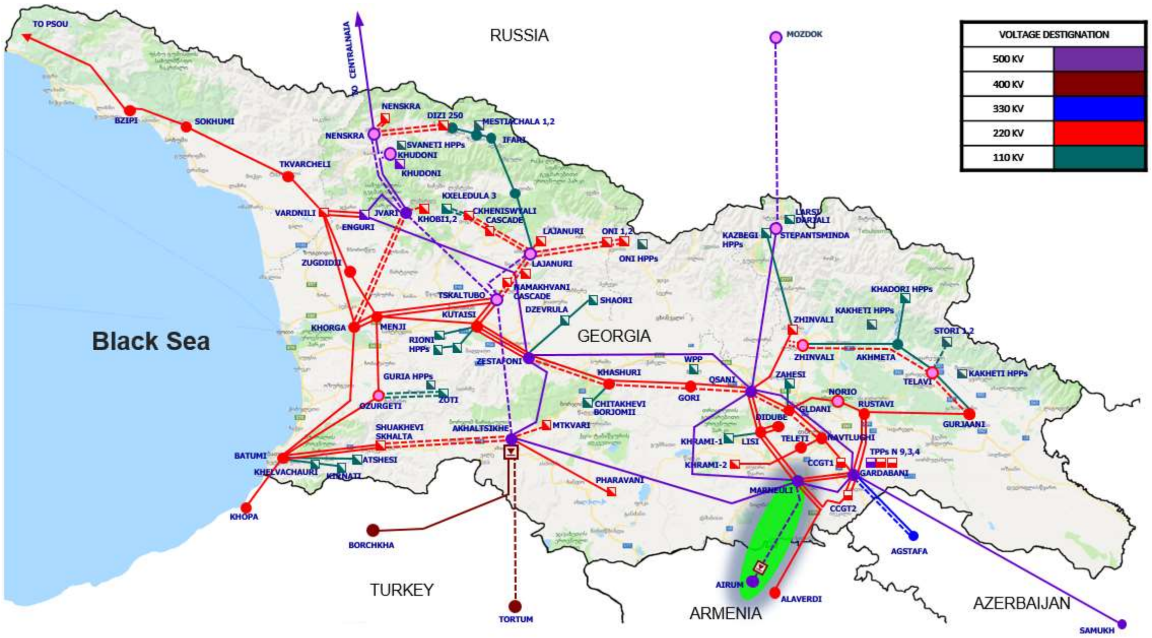

Fig. 3.5 Single-line diagram of "Marneuli-Ayrum" Project

1 - ***Project will be implemented by JSC "Sakrusenergo"***

Project name: **Rehabilitation of 220 KV OHL „Kolkhida-1"**
Project importance: System
Project Commissioning Year: 2023
Forecasted Investment: **3.8 million Euros**
Current Status: Preliminary system regime analysis for the project has been completed (GSE)
Capacity of Integrated HPPs: <10 MW
Reduction of Losses: <1 MW
Increase of Network Transfer Capacity (Normal/Emergency Modes): 150 MW
Project Flexibility and Influence on Reliability: High

Project Components:

- P.5.1 Reabilitation of 220 KV OHL „Kolkhida-1".

Purpose of Project:

- Improving of Power system reliability and security of supply – Backing up 500 KV OHL „Imereti";
- Decreament of emergency risks, quantity of emergency outages and energy not supplied.

Project Description:

Reinforsment of 220 KV network is considered, that will increase system stability and decrease load shedding capacity due to Emergency Control System activation caused by switching off 500 KV line "Imereti".

Calculation results show that after finishing project "Jvari – Khorga" and "Tskaltubo – Zestaponi", switching off 500 KV OHL "Imereti" (if the load was about 425 MW) will load 220 KV OHL "Kolkhida" between 180-225 MW. That is 30% more than the load on parallel lines "Senaki 1" and "Senaki 2".

Considering technical conditions of OHL "Kolkhida 1" the transfer capacity of the line is less than 139 MW. Reinforcement of the line and increasing transfer capacity till 300 MW is required.

Fig. 3.6 Single-line diagram of project "Rehabilitation of Kolkhida-1"

Project Name: **Jvari-Tskaltubo-Akhaltsikhe**

Project Importance: System

Project Commissioning Year: 2023-2025

Forecasted Investment: **104.5 mln Euros**

Current Status: The feasibility study has been completed. **Special necessity of the project for Georgian transmission system has been identified**

Capacity of Integrated HPPs: 3285 MW

Reduction of Losses: 27478 MWh

Increase of Grid Transfer Capacity (Normal/Emergency Modes): 1200/2100 MW and 2400/4200 MW

Project Flexibility and Influence on Reliability: Very high

Project Components:

- P.6.1 500 kV SS "Tskaltubo" (501 MW, 250 MW regulating reactor);
- P.6.2 Extension of 500 kV SS "Akhaltsikhe" for connection to 500 kV OHL"Tskaltubo – Akhaltsikhe"; arrangement of bays;
- P.6.3 500 kV OHL "Jvari – Tskaltubo", length - 80 km;
- P.6.4 Double circuit design of 500 kV OHL Tskaltubo-Akhaltsikhe with the construction of single circuit, length 104 km.

Purpose of Project:

- Increment of Power system reliability and security of supply – back up of 500 kV backbone Enguri-Zestaponi-Akhaltsikhe (OHL "Imereti" and OHL "Zekari");
- Decreament of emergency risks, quantity of emergency outages and energy not supplied;
- Increasing capability and reliability of the power transfer from Russia and Enguri Node to Turkey/Armenia;
- Increasing systems voltage regulating abilities;
- Reservation of 500/220 KV AT of Zestaponi;
- Safe Evacuation of generation power to the main grid: Khudoni HPP, Nenskra HPP, HPPs of Enguri and its tributaries, Tskenistskali Cascade, Namakhvani Cascade and Kheledula HPP; transit this power to the consumers (Tbilisi-Rustavi nodes) and as an export (to Armenia and Turkey).

Project Description:

This is the most necessary strategic importance project for Georgian electric power system, which when completed will upgrade the Western Georgian 500 kV system from the existing low reliability radial scheme (Enguri-Zestaponi) to the ring layout (Enguri-Zestaponi-Akhaltsikhe-Tskaltubo-Jvari-Enguri). Such upgrade will simultaneously address several major issues, including:

1. Improved reliability of the existing network. The reason is that even prior to construction of Khudoni HPP and Nenskra HPP, additional 500 kV OHL is necessary in the western part of the transmission network to ensure both full back up of 500 kV OHL Imereti and Zekari and reliable evacuation of the power generated by Enguri HPP towards the East Georgia and Akhaltsikhe-Borchka cross-border line. At present, during emergency shutdowns of OHL Imereti, EMS devices initiate shedding of the 70%-80% of the load fed from this line in the Eastern Georgia (east from Kutaisi) and matching generation in the West Georgia (mainly Enguri HPP) that often exceeds 700 MW. No such event will occur after this project is implemented.

2. Besides generation of Enguri HPP, Enguri Node receives power flow imported via 500 kV OHL Kavkasioni further evacuation of which towards Akhaltsikhe-Tbilisi is restricted by transmission capacity and reliability of OHL Imereti. By ommissioning of 500 kV OHL Jvari-Tskaltubo-Akhaltsikhe will address this problem and transfer capacity of internal Georgian network from Jvari-to Akhaltsikhe will increase.
3. Khudoni HPP, Nenskra HPP, Mestiachala, Tekhuri Cascade, Alpana HPP, Namakhvani Cascade, Tskhenistskali Cascade, Kheledula HPP, Oni HPP Cascade and other approximately 500 MW of HPP capacity will be transported to the consumption centers through the Jvari, Tskaltubo and Zestaponi substations and also will be exported to Turkey, Azerbaijan and Armenia. 500/220 kV substation Tskaltubo provides the connection between Jvari-Tskaltubo, Tskaltubo-Akhaltsikhe lines to the 220 kV network. It will reserve 500/220 kV substation in Zestaponi and provide voltage regulation in 500 kV network (Installation of 250 MV regulated reactor is provided in the substation).Some modifications have been made in project "Jvari-Tskaltubo-Akhaltsikhe", based on which, 500 kV OHL Tskaltubo-Akhaltsikhe will be constructed on double-circuit towers at initial stage, but in order to minimize investments at this stage, only one circuit of this line will be arranged. In next years, respectively to the commissioning of HPPs, the growth of both the consumption and the cross-border exchange capabilities with Turkey and Armenia, construction of second circuit will be implemented.

Implementation of the project would be necessary even if integration of above mentioned HPPs was not realized.

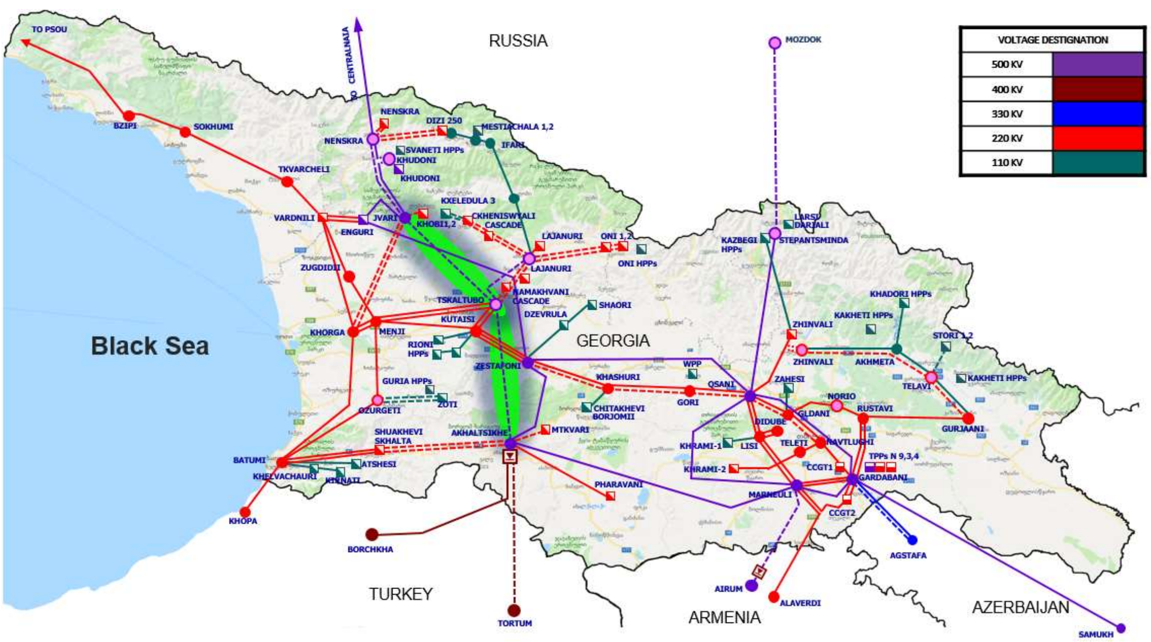

Fig. 3.7 Single-line diagam of "Jvari-Tskaltubo-Akhaltsikhe" Project

Table 3.4 Power plants integrated by the project "Jvari – Tskaltubo – Akhaltsikhe"

№	Name	Installed capacity (MW)	Generation (million kWh)
1	Mestiachala 1 HPP	20	69
2	Mestiachala 2 HPP	30	107
3	Lakhami 1 HPP	7	37
4	Lakhami 2 HPP	10.5	50
5	Kasleti 2 HPP	9	45.8
6	Khelra HPP	3	17
7	Ifari HPP	3	17
8	Natseshari HPP	1.9	8.5
9	Cordula HPP	2	9
10	Jagon-Nashumi HPP	1.8	8.8
11	Nakra HPP	7.5	35.2
12	Berali HPP	0.9	5
13	Khobi 2 HPP	46.7	202
14	Chiora HPP	14.2	68.4
15	Lukhuni HPP	17	86.5
16	Notsarula 3 HPP	1.8	9.4
17	Kasleti 1 HPP	7.6	43.5
18	Khuberi HPP	1.8	7.5
19	Boko HPP	0.5	2.8
20	Gebi HPP	14.3	71
21	Gere HPP	9.4	41.3
22	Sakaura HPP	11.6	59.4
23	Darchi	17	93.6
24	Qvedazeni HPP	1.7	7.4
25	Lahlachala HPP	12	52.7
26	Nakra 1 HPP	3.7	19.3
27	Nakra 2 HPP	5	22.1
28	Rachkha HPP	3	11.5
29	Lukhra HPP	3.6	18
30	Majieti HPP	12.3	63.3
31	Notsarula 1,2 HPP	6.7	30.4
32	Lajanuri 2 HPP	5.4	30.9
33	Lajanuri 3 HPP	5.4	33.3
34	Sadmeli HPP	4.5	22.5
35	Geskuri HPP	0.7	3.1
36	Lakhashuri HPP	2	10.3
37	Qvedi HPP	1.7	9.9
38	Sorgiti 1 HPP	13	59.8
39	Sorgiti 2 HPP	10	47.6
40	Khvaraguli HPP	5.3	23
41	Memuli HPP	12	52.2
42	Zeguri HPP	1.8	12.2
43	Khofuri HPP	5.2	21
44	Nanari HPP	1.8	9.1
45	Jejora HPP	1	5.4
46	Khaishura 1 HPP	22.4	89.2
47	Khaishura 2 HPP	16.6	71.9
48	Mulkhura HPP	29.1	116.2
49	Tita HPP	4.5	23.8
50	Jonouli 2 HPP	32	129

51	Alpana HPP	55.4	253.4
52	Rioni-CHanchakhi HPP	36.6	165.6
53	Cveshura HPP	9	43
54	Namakhvani HPPs cascade	433	1500
55	Khobi 1 HPP	45.5	201.5
56	Laskadura HPP	6.6	33
57	Zeskho 1 HPP	20.3	97.7
58	Zeskho 2 HPP	7	38.2
59	Tskhenistskali 1 HPP	22.3	102.3
60	Tekhura HPPs cascade	112	650
61	Oni 1 HPP	122	441
62	Oni 2 HPP	84	339
63	Nenskra HPP	280	1200
64	Dizi HPP	250	960
65	Kheledula 3 HPP	51	255
66	Tskhenistskali HPPs cascade	357	1683
67	Khudoni HPP	702	1500
68	Kvanchianari HPP	230	920
	Total	**3284.6**	**12472.5**

Project Name: **Svaneti**

Project Importance: System

Project Commissioning Year: 2027-2030

Forecasted Investment **85 mln Euros**

Current Status: The feasibility study is ongoing

Capacity of Integrated HPPs: 1690 MW

Reduction of Losses: 12698 MWh

Increase of Network Transfer Capacity (Normal/Emergency Modes): 700 MW

Project Flexibility and Influence on Reliability: Moderate

Project Components:

- P.7.1 500/110 kV SS Khudoni, 250 MVA;
- P.7.2 Loop in/Loop out of 500 kV OHL "Kavkasioni" in/from SS ''Khudoni", length 0.5 km;
- P.7.3 500/220 kV SS "Nenskra", 2x501 MVA;
- P.7.4 Loop in/Loop out of 500 kV OHL "Kavkasioni" in/from SS ''Nenskra", length 2 km;
- P.7.5 2-circuit 220 kV OHL Nenskra HPP-SS Nenskra, length 1 km;
- P.7.6 Double-circuit 220 kV OHL Nenskra-Mestia, length 57 km;
- P.7.7 500 kV OHL Nenskra-Jvari, length 47 km;
- P.7.8 Extension of 500 kV SS "Jvari" for connection of 500 kV OHL Jvari-Nenskra and arrangement of bays;

Purpose of Project:

- Safe Evacuation of small and medium HPPs planned in Svaneti region;
- Safe Evacuation of generation power to the main grid from Enguri river and its tributaries;
- Integration of Nenskra HPP into the grid;
- Integration of Khudoni HPP into the grid.

Project Description:

In Svaneti, in the area from 110/35 kV substation Khudoni substation to Mestia substation is planned small and medium-sized hydropower plants with total installed capacity is approximately 200 MW. It is impossible to evacuate this capacity through the existing infrastructure, therefore, for the year 2024 it is planned to build a new 500/110 kV substation, in where Loop In - Loop Out of existing 500 kV OHL " kavkasioni will bi implemented and by this way will be evacuated the capacity of existing and prospective HPPs planned in Upper Svaneti. It should be noted that in the future, in case of construction of Khudoni HPP, its connection to the mentioned substation will be considered. The project will be implemented through the joint efforts of GSE and Hpps representatives.
Apart from small and medium HPPs, it is also planned to build powerful HPPs in Svaneti region, such as: Nenskra (280 MW), Khudoni (702 MW), Dizi (250 MW) and Kvanchianari (230 MW). The total capacity of these hydropower plants is about 1400 MW, for which the project envisages the construction of 500 kV OHL Jvari-Nenskra, 500/220 kV substation "Nenskra" and the construction of a two-chain 220 kV main Nenskra-Mestia (Nenskra-Dizi), which ensures strong connection of HPPs to the network by meeting the N-1 criterion. It should be noted that the main purpose of the 220 kV OHL Nenskra-Mestia (Dizi HPP) is to integrate the Dizi HPP (250 MW) into network, whose construction, according to preliminary information, is planned near Mestia. As for the 220 kV substation and the connection with the substation Mestia, its implementation is considered not at the expense of the GSE, but at the expense of the project implementing party. The implementation of this project depends on the construction of Dizi HPP, therefore a number of technical issues will be clarified in the future.
This project fully serves the capacity outcome from HPPs. Therefore the construction of certain sections of it will depend on the input of generating capacities in specific nodes.

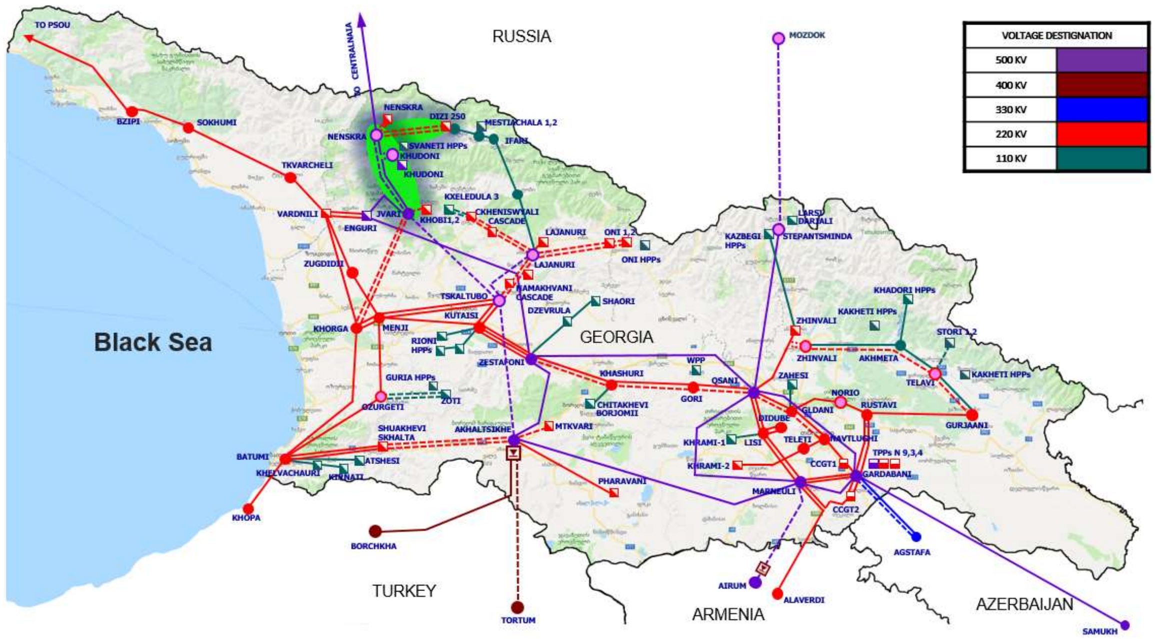

Fig. 3.8 Single-line diagram of "Svaneti" Project

Table 3.5 Power plants integrated by the project "Svaneti"

№	Name	Installed capacity (MW)	Generation (million kWh)
1	Lakhami 1 HPP	8	45
2	Lakhami 2 HPP	8	45
3	Ifari HPP	3.3	17
4	Khelra HPP	3.7	17
5	Kasleti 2 HPP	8	45
6	Nakra HPP	7.5	35.2
7	Natseshari	1.9	8.5
8	Jagon-Nashumi	1.8	8.8
9	Khuberi HPP	1.8	7.5
10	Kasleti 1	7.6	43.5
11	Darchi HPP	18	93.6
12	Lukhra HPP	3.6	18
13	Nakra 1,2 HPP	8.7	54
14	Lahlachala HPP	12	52.7
15	Khumpreri	32	125
16	Qveda zeni HPP	1.7	6.6
17	Khaishura 1 HPP	32	125
18	Khaishura 2 HPP	23	101
19	Tita HPP	4.5	23.8
20	Memuli HPP	12	52.2
21	Mulkhura HPP	29.1	116.2
22	Nenskra HPP	280	1219
23	Dizi HPP	250	960
24	Khudoni HPP	702	1528
25	Kvanchianari HPP	230	920
	Total	**1690.2**	**5667.6**

Project Name: **Racha and Namakhvani**

Project Importance: System

Project Commissioning Year: 2023-2030

Forecasted Investment **95.1 mln Euros**

Current Status: The feasibility study is ongoing

Capacity of Integrated HPPs: 1450 MW

Reduction of Losses: 8043 MWh

Increase of Network Transfer Capacity (Normal/Emergency Modes): 700 MW

Project Flexibility and Influence on Reliability: Moderate

Project Components:

- P.8.1 New 220/110 kV 250 MVA substation "Lajanuri";
- P.8.2 Extension of 220 kV SS "Tskaltubo";
- P.8.3 220 kV OHL SS Lajanuri-Lajanuri HPP, length 4 km;
- P.8.4 500 kV OHL Lajanuri-Tskaltubo, length 49 km;
- P.8.5 Double-circuit (splitted conductor into two parts in each phase) 220 kV OHL Namakhvani-Tskaltubo (construction of 2-nd circuit of OHL "Derchi"), length 24 km;
- P.8.6 Double-circuit (splitted conductor into two parts in each phase) 220 kV OHL Namakhvani-Tvishi-Lajanuri, length 34 km;
- P.8.7 2-circuit 220 kV OHL Oni-Lajanuri, length 55 km;
- P.8.8 2-circuit 220 kV OHL Kheledula-Lajanuri, lengh 45 km;
- P.8.9 Extension of 220/110 kV SS Lajanuri with 500 kV switchyard, 801 MVA.

Purpose of Project:

- Integration of HPPs located in Mestia Region into the grid;
- Integration of Tskhenistskali Cascade HPPs and Kheledula HPP into the grid;
- Integration of Oni Cascade HPPs and the ones from Racha region into the grid.
- Evacuation of the power generated by Namakhvani Cascade HPPs (Upper and lower Namakhvani HPPs);
- Backing up of 500 kV OHL Lajanuri-Tskaltubo.

Project Description:

This project integrates approximately 1300 MW HPPs into the grid and ensures the reliable evacuation of the power output, therefore the construction of the several parts will depend on the integration of the generation capacity in certain nodes.

The following generation capacities will gather in 220/110 kV substation Lajanuri:

- 220/110 kV parts of this substation – local perspective HPPs – approximately 120 MW In total;
- With 110 kV OHL Ifari-Jaxunderi-Lajanuri – existing and perspective HPPs of Upper Svaneti, 77 MW in total;
- With 220 kV OHL Oni-Lajanuri – existing and planned HPPs located near Oni Cascade and Oni, 350 MW in total;
- 220 kV Kheledula-Lajanuri – Kheledula HPP and Tskhenistskali Cascade, 400 MW in total;

Double-circuit 220 kV OHL “Derchi” (Tskaltubo-Lajanuri) and 500 kV OHL Lajanuri-Tskaltubo (on initial stage 220 kV operation voltage) will be connected to new Lajanuri substation. These overhead lines with above mentioned capacities will integrate Namakhvani cascade into the network. On these purpose, construction of the double-circuit 220 kV OHL Lajanuri-tskaltubo (one line will tie-line to Upper Namakhvani HPP and the other line will tie-line to Lower Namakhvani HPP) is planned that will provide evacuation of Namakhvani cascade's power towards SS "Tskaltubo". For this period the construction of new ss Lajanuri, 220 kV OHL Lajanuri HPP – SS Lajanuri and accordingly 500 kV OHL Lajanuri-Tskaltubo shall be completed to ensure reliable evacuation of power generated by Lajanuri HPP, hydro power plants, planed in Racha region and HPPs of Svaneti towards Tskaltubo. On the first stage, connection of the Lower Namakhvani to the network is planned to the lower part of new 500 kV OHL Lajanuri-Tskaltubo – lower Namakhvani-Tskaltubo, whereas after constructing second chain of the 220 kV OHL "Derchi" (Lajanuri-Tskaltubo) Namakhvani HPP will be switched to this line.

The 220 kV infrastructure (Tskaltubo-Namakhvani-Lajanuri), together with the 500 kV OHL Tskaltubo-Lajanuri, satisfies the N-1 criterion in the Lajanuri-Tskaltubo section; this means that even in the case of a outage of any of these lines, these power stations will continue to smoothly feed energy to the grid.

The above-mentioned 500/220 kV transmission lines will connect the new Lajanuri substation to one of the central nodes of the transmission network, the Tskaltubo substation, where the main power flow will be delivered at 500 kV. The Tskaltubo substation will also be connected to powerful 500 kV nodes in the form of Akhaltsikhe and Zestaponi substations, from where it will be possible to transfer the capacity of the mentioned stations for export, from the Akhaltsikhe node to Turkey, as well as to large centers of consumption – from Zestaponi to Rustavi-Tbilisi.

This project fully serves the capacity of these HPPs. Therefore the construction of certain sections of it will depend on the input of generating capacities in specific nodes.

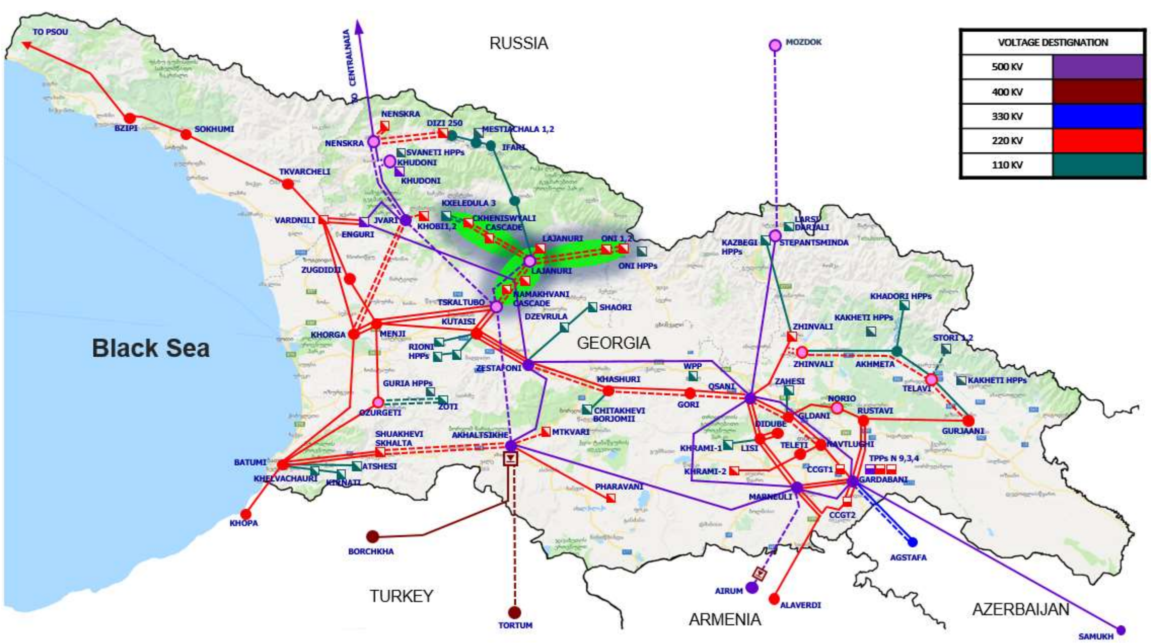

Fig. 3.9 Single-line diagram of "Racha and Namakhvani" Project

Table 3.6 Power plants integrated by the project "Racha and Namakhvani"

№	Name	Installed capacity (MW)	Generation (million kWh)
1	Mestiachala 1 HPP	20	69
2	Mestiachala 2 HPP	30	107

3	Chordula	2	9
4	Berali HPP	0.9	5
5	Lukhuni 2 HPP	17	86.5
6	Chiora HPP	14.2	68.4
7	Boko HPP	0.5	2.8
8	Gebi HPP	14.3	71
9	Gere HPP	9.4	41.3
10	Sakaura HPP	11.6	59.4
11	Sadmeli 2 HPP	4	23
12	Lakhashuri HPP	2	10.3
13	Rachkha HPP	3	11
14	Lajanuri 2 HPP	5.4	30.9
15	Lajanuri 3 HPP	5.4	33.3
16	Lahlachala HPP	12	53
17	Geskuri HPP	0.7	3.1
18	Sorgiti 1 HPP	13	59.8
19	Sorgiti 2 HPP	10	47.6
20	Khvaraguli HPP	5.3	23
21	Notsarula 1,2 HPPs	6.7	30.4
22	Notsarula 3 HPP	1.8	9.4
23	Majieti HPP	12.3	63.3
24	Qvedi HPP	2	10
25	Nanari HPP	1.8	9.1
26	Khofuri HPP	5.2	21
27	Zeguri HPP	1.8	12.2
28	Jejora HPP	1	5.4
29	Jonouli 2 HPP	32	129
30	Alpana HPP	55.4	253.4
31	Chveshura HPP	9	43
32	Rioni-Chanchakhi HPP	36.6	165.6
33	Namakhvani HPPs cascade	433	1496
34	Laskadura HPP	6.6	33
35	Zeskho 1 HPP	20.3	97.7
36	Zeskho 2 HPP	7	38.2
37	Tskhenistskali 1 HPP	22.3	102.3
38	Oni 1 HPP	122	441
39	Oni 2 HPP	84	339
40	Kheledula 3 HPP	51	255
41	Tskhenistskali HPPs cascade	357	1683
	Total	**1449.5**	**6051.4**

Project Name: **Guria**
Project Importance: System
Project Commissioning Year: 2023-2024
Forecasted Investment: **27.6 mln Euros**
Current Status: The feasibility study is ongoing
Capacity of Integrated HPPs: 162 MW
Reduction of Losses: 14274 MWh
Increase of Network Transfer Capacity (Normal/Emergency Modes): <5 MW
Project Flexibility and Influence on Reliability: Medium

Project Components:

- P.9.1 220/110 kV 250 MVA SS Ozurgeti with the perspective of increase;
- P.9.2 Loop in/loop out of 220 kV OHL "Paliastomi-1" to/from 220/110 kV SS Ozurgeti;
- P.9.3 Double-circuit 110 kV OHL "Ozurgeti – Zoti HPP", 47 km, 2x110 MW capacity.

Purpose of Project:

- Integration of prospective HPPs of Guria region into the grid;
- Improvement of Security of Supply of Guria region;
- Increment of reliability of supply of Batumi region.

Project Description:

Main scope of this project is integration of prospective HPPs of Guria into the grid (up to 160 MW in total). For this purpose, tie-line from 220 kV OHL "Paliastomi-1" (Menji-Batumi) to the 220 kV part of new SS Ozurgeti will be constructed. This will improve security of supply of Batumi and Adjara regions as well as will additionally soften voltage problem in SS Batumi due to the supplying this substation by OHLs Ozurgeti-Batumi and Khorga-Batumi instead of two long ones (Vardnili-Batumi and Menji-Batumi). Hence, opportunity of power evacuation from this SS will be increased.

The Ozurgeti substation will also be connected to the new 110 kV OHL Ozurgeti-Zoti line, which will provide reliable generation for promising HPP resources in the Guria region.

Fig. 3.10 Single-line diagram of "Guria" Project

In order to improve security of supply of consumers of Adjara and Guria regions: **Distribution company has to be obligated to construct tie-lines from existing 110 kV OHLs "Chakvi" (existing "Ozurgeti-110" – "Batumi 110") and "Anaseuli" (existing "Ozurgeti-110" – "Kobuleti-110") to the new 220/110 kV SS Ozurgeti.**

Table 3.7 Power plants integrated by the project "Guria"

№	Name	Installed capacity (MW)	Generation (million kWh)
1	Sashuala 1 HPP	7	33
2	Sashuala 2 HPP	5	23
3	Zoti HPP	46	172.2
4	Sashuala HPP	2.6	13
5	Basra 1 HPP	1.4	11.7
6	Basra 2 HPP	1.9	16.7
7	Makvaneti 1 HPP	1.3	5
8	Makvaneti 2 HPP	0.9	3.9
9	Bakhvi 1 HPP	12	50
10	Baramidze HPP	8	36
11	Gubazeuli 6 HPP	3	20
12	Khevi HPP	3	21.6
13	Natanebi 3 HPP	9.1	64.4
14	Bjuja 2 HPP	1.8	13.2
15	Natenebi 2 HPP	10.2	69.6
16	Bakhvi 2 HPP	36	123
17	Gubazeuli HPP	6.1	27.1
18	Natanebi 1 HPP	6.4	40.3
	Total	162	744

Project Name: **Akhaltsikhe-Tortum**

Project Importance: Transit

Project Commissioning Year: 2024-2030

Forecasted Investment: **176.8 mln Euros**

Current Status: The feasibility study is ongoing

Capacity of Integrated HPPs: 0 MW

Reduction of Losses: 31000 MWh

Increase of Network Transfer Capacity (Normal/Emergency Modes): 350 MW

Project Flexibility and Influence on Reliability: High

Project Components:

- P.10.1 400 kV OHL Akhaltsikhe-Tortum; Length: 150 km (33 km to Georgia-Turkey border); Capacity 1850 MW;
- P.10.2 Extension of 500 kV SS Akhaltsihke for connecting 400 kV OHL "Akhaltsihke-Tortum";
- P.10.3 Third 350 MW, 500/400 kV back-to-back link at SS Akhaltsihke.

Purpose of Project:

- Improved reliability and power exchange capabilities between Georgia and Turkey;
- Baking up OHL Akhaltsikhe-Borchka.

Project Description:

In the coming years, the integration of large capacity hydropower plants into the Georgian energy system is envisaged, the total capacity and output of which in the spring-summer period exceeds the country's consumption and growth rates. Consequently, a surplus of this capacity must be exported. Of the neighboring countries, Turkey is the most attractive in this respect. At the same time, in winter, during the period of low water, the Georgian system may need to import energy from the Turkish system (for example, in some periods in 2021, the Akhaltsikhe-Borchkha line imported about 500 MW). The shutdown of this line could have caused an accident (due to the shutdown of the Akhaltsikhe-Borchkha line, in some cases it was necessary to limit the 500-600 MW user in the Georgian system in order to avoid a shutdown of the system). Therefore, in order to avoid the loss of large import-export capacity, it is planned to build a new 400 kV OHL Akhaltsikhe-Tortum connecting with Turkey.

This line, compared to the existing 400 kV line Akhaltsikhe-Borchkha, which goes to south-west from Akhaltsikhe, will be able to export power to Turkey with high reliability. Whereas, power of Borchkha HPP, Derineri HPP and power of HPPs in the black sea region of Turkey is added to the power of Akhalstikhe-Borchkha line which goes to west of Turkey. Floody period of the Turkish and Georgian HPPs is at the same time. Therefore, during April, May and June power transit from Gerogia is very often restricted.

On the other hand, the Tortum node, which is located south of Akhaltsikhe is close to consumption centers located in this region. Therefore, capacity export to this direction will be cared out practicly without any obstructive factors. Also, two 400 kV voltage tie line with Turkey (Akhaltsikhe-Borchka and Akhaltsikhe-Tortum) will reserve each-other and in case outage of one line, second will fully assume transit function.

In the future, is also planned to increase the install capacity of Akhaltsikhe HVDC up to 1050 MW, this will be implemented by commissioning of third power unit with 350 MW capacity

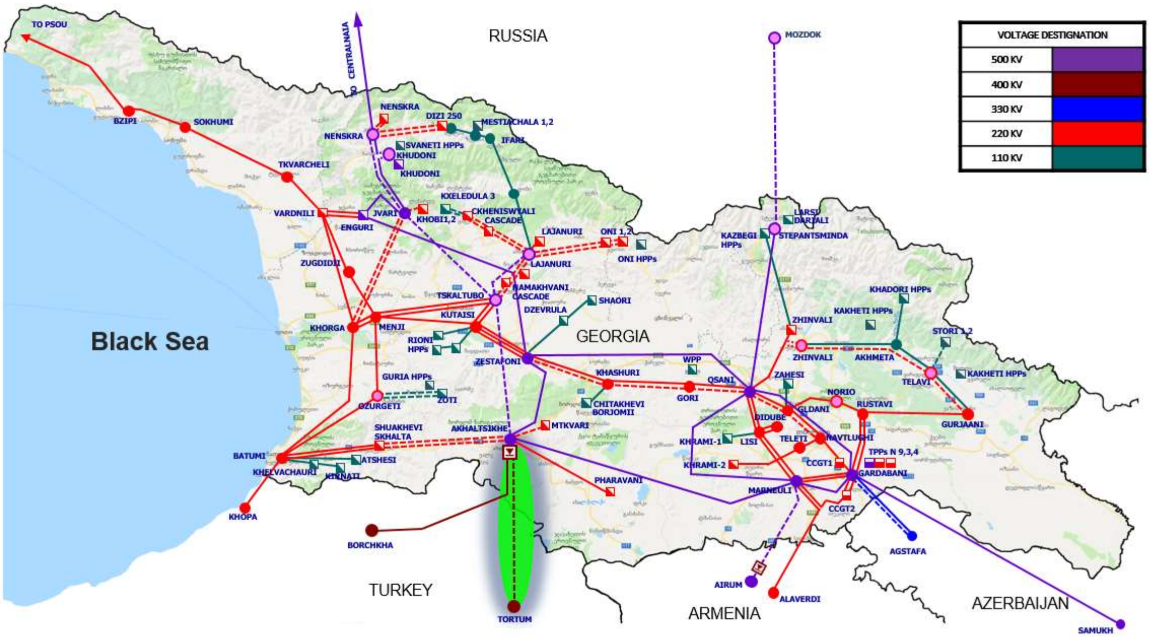

Fig. 3.11 Single-line diagram of "Akhaltsikhe-Tortum" Project

Project name: **Rehabilitation of 500 kV OHL "Imereti"**[1]

Project importance: System

Project Commissioning Year: 2026

Forecasted Investment: **22.5 million Euros**

Current Status: Preliminary system regime analysis for the project has been completed (GSE)

Capacity of Integrated HPPs: >1000 MW

Reduction of Losses: 42000 MW.H

Increase of Network Transfer Capacity (Normal/Emergency Modes): >1200/2100 MW

Project Flexibility and Influence on Reliability: High

Project Components:

- P.11.1 Rehabilitation of 500 KV OHL "Imereti", length 128 km

Purpose of Project:

- Improvement of network stability and reliability of supply, reservation of 500 KV "Jvari – Tskaltubo – Akhaltsikhe";
- Decreasing the number of emergency situations, emergency switches and quantity of non-delivered power;
- Improved reliability of the power transfer from Khudoni - Enguri basin towards the east (towards Armenia);
- Improved ability and reliability of the power transfer from Russia and Enguri towards to Turkey/Armenia;
- Improved reliability of power evacuation from Khudoni HPP, Nenskra HPP and their tributaries HPPs towards consumption (Tbilisi, Rustavi) and export (Turkey, Armenia).

Project Description:

500 kV OHL "Imereti" is connectiong Enguri HPP generation node (<1500 MW) to consumption located in eastern part of Georgia. It should be mentioned that 500 kV OHL "Kavkasioni" is connected to Enguri node and in the eastern part of Georgia is located HVDC (700 MW) with the 400 KV OHL "Meskheti", connecting Georgia and Turkish systems.

The peak summer demand of Georgia is rising with 5% each year. (due to the pandemic situation, 2020 is an exception) During this period TPPs located in eastern part of Georgia are not under the operation. During dry period of summer the generation from seasonal HPPs are reduced and the significant part of consumption and export in turkey are fed from Enguri HPP. It should be mentioned that exporting Enguri HPP power in turkey is limited due to the 500 KV OHL "Imereti", the current capacity of the line is 854-970 MW. In case of demand growth, transferring enough power from Enguri to east will become unavailable, in spite of enough water in Enguri Reservoir. In this case reduction of export and starting TPPs will be needed. Increasing capacity of 500 kV OHL "Imereti" till its nominal value (≈2000 MW) will be actual even after building parallel OHLs "Jvari – Tskaltubo – Akhaltsikhe". This parallel OHLs will reserve 500 kV "Imereti" outage, but OHL "Imereti" will not be able to reserve outage any of its parallel 500 kV lines. The rehabilitation of 500 kV OHL "Imereti" is one of the most important project.

It should be noted that the rehabilitation of 500 kV OHL Imereti should be implemented after the completion of the construction of 500 kV OHLs Jvari-Tskaltubo-Akhaltsikhe.

1 - Element of Project P.11.1 will be implemented by JSC "Sakrusenergo"

Fig. 3.12 Single-line diagram of project “Rehabilitation of Imereti”

Project name: **Renovation of substations**

Project importance: System

Project Commissioning Year: 2022-2028

Forecasted Investment: **21.2 million Euros**

Current Status: Preliminary system regime analysis for the project has been completed (GSE)

Capacity of Integrated HPPs: 0 MW

Reduction of Losses: >1 MW

Increase of Network Transfer Capacity (Normal/Emergency Modes): >100 MW

Project Flexibility and Influence on Reliability: Moderate

Project Components:

To be Completed ➢

- P.12.1 110 kV switchyard and 2x63 MVA 220/110 kV autotransfermers in SS "Akhaltsikhe-500";
- P.12.2 Arrangement of two 110 kV bays at SS Zestafoni;
- P.12.3 Renovation of 15 substations;
- P.12.4 110/35 kV switchyard 220/110/35 kV autotransfermers in SS “Oni-220".

Purpose of Project:

- Improving of stability of Georgian power system as well as security of consumers' supply.

Project Description:

According to today’s situation, distribution system of Samtskhe-Javakheti is connected to the transmission system with long infrastructure at Khashuri-Khrami HPP direction. At this area conductor wires are too old, also generation facilities aren’t connected to the system at this area therefrom this area is less reliable for power supply.

Thus, in order to increase reliability of Samtskhe-Javakheti region power supply, is important to connect it to the 220 kV network (Akhaltsikhe).

Therefore, in order to solve above mentioned problem, for reliable supply of Youth Olympics and also to develop tourism infrastructure of the region is relevant to arrange 110 kV bus bures at Akhaltsikhe substation and connection of them to the distribution network.

The project " Renovation of 15 substation" Implies that, in 15 substations owned by GSE is planned several works, such as: planning open distribution equipment area, arrangement main and internal roads, arrangement of drainages, renovation of buildings, rehabilitation of outdoor lighting, installation of video cameras, painting of metal constructions of portals etc.

For integration of prospective small and medium HPPs located Oni region, in 220 kV SS Oni, construction of 110 kV switchyard and 220/110 kV autotransformer are planned. This will be implemented with construction of Oni HPP cascade and 220 kV OHL Oni-Lajanuri.

Purpose of arrangement of two 110 kV bays at 500 kV SS Zestaponi is the integration of 100 MW Imereti Wind power plant and reliable evacuation of its power to the transmission network.

Project name: **Reinforcement of Kakheti infrastructure**

Project importance: System

Project Commissioning Year: 2023-2027

Forecasted Investment: **64.6 million Euros**

Current Status: The feasibility study is ongoing

Capacity of Integrated HPPs: 252 MW

Reduction of Losses: 2820 MWh

Increase of Network Transfer Capacity (Normal/Emergency Modes): 300 MW

Project Flexibility and Influence on Reliability: Moderate

Project Components:

- P.13.1 110 kV OHL Stori HPP-NewTelavi, length 50 km;
- P.13.2 220/110/10 kV new substation in Telavi;
- P.13.3 Loop in/loop out of 110 kV OHL "Ikalto" to/from 220/110 kV SS Telavi new;
- P.13.4 Reconstruction and rehabilitation of 35 kV Tusheti infrastructure, length 35 km;
- P.13.5 2-circuit 220-kV OHL Gurjaani-New Telavi, with the construction of single circuit, length 44.2 km;
- P.13.6 2-circuit 220 kV OHL New Telavi-Akhmeta, , with the construction of single circuit, length 30 km; (Entering to SS Akhmeta is not implied);*
- P.13.7 Rehabilitation of 220/110 kV SS Gurjaani;
- P.13.8 2-circuit 220 kV OHL Akhmeta-New Zhinvali, with the construction of single circuit, length 33 km; (This OHL is continuation of OHL New Telavi-Akhmeta;*
- P.13.9 220/110 kV new substation in Zhinvali.

Purpose of Project:

- Integration of new HPPs from Kakheti district;
- Improving reliability, of Kakheti HPPs and Zhinvali HPP;
- Improving security of supply of Kakheti and Dusheti regions.

Project Description:

Kakheti is the largest region in the territory of Georgia, where the tourism infrastructure and industry are developing intensively, therefore It is important that energy supply to this region will be implemented with a reliable manner. Currently, the energy supply of Kakheti and Dusheti regions, as well as generation capacity from these regions is carried out by 220 kV OHL "Manavi" and 220 kV OHL "Lomisi". An accidental shutdown of one of these lines would result shutdown of consumption and generation in the respective region.

It's noteworthy that existing generation of Kakheti and Dusheti regions is about 150 MW. The capacities of prospective power plants – nearly 100 MW are added to this amount as well and totally 250 MW capacity should be evacuated from mentioned areas. Additionally, the construction of 180 MW "Ilto-Alazani" cascade HPPs is planned in Kakheti in long-term perspective. By accounting latter capacity, 430 MW generation will have to be evacuated from Kakheti and Dusheti. Therefore, projects of reinforcement of Kakheti infrastructure considers the construction of 220 kV network between Gurjaani to Zhinvali substations, new 220/110/10 kV substation in Telavi, double-circuit 220 kV OHL from Gurjaani SS to New Telavi SS, with installation of single circuit at first stage (until the development of big generation sources).

Double-circuit 220 kV OHL from New Telavi to Zhinvali substations will be constructed with installation of single circuit at the first stage. Construction of 220/110 kV substation in Zhinvali is also planned which will ensure the improvement of security of supply of Kakheti and Dusheti regions as well as reliability of generation evacuation with N-1 criteria from these areas. Besides this, rehabilitation of Gurjaani substation and construction of 110 kV infrastructure in direction of Stori (summary potential of Stori cascade HPPs and HPPs adjacent to Napareuli region is approximately 70 MW) is also planned. In order to develop the tourism potential in Tusheti, the project of Kakheti infrastructure reinforcement also includes the element considering the construction/rehabilitation of 35 kV network from Stori to Tusheti.

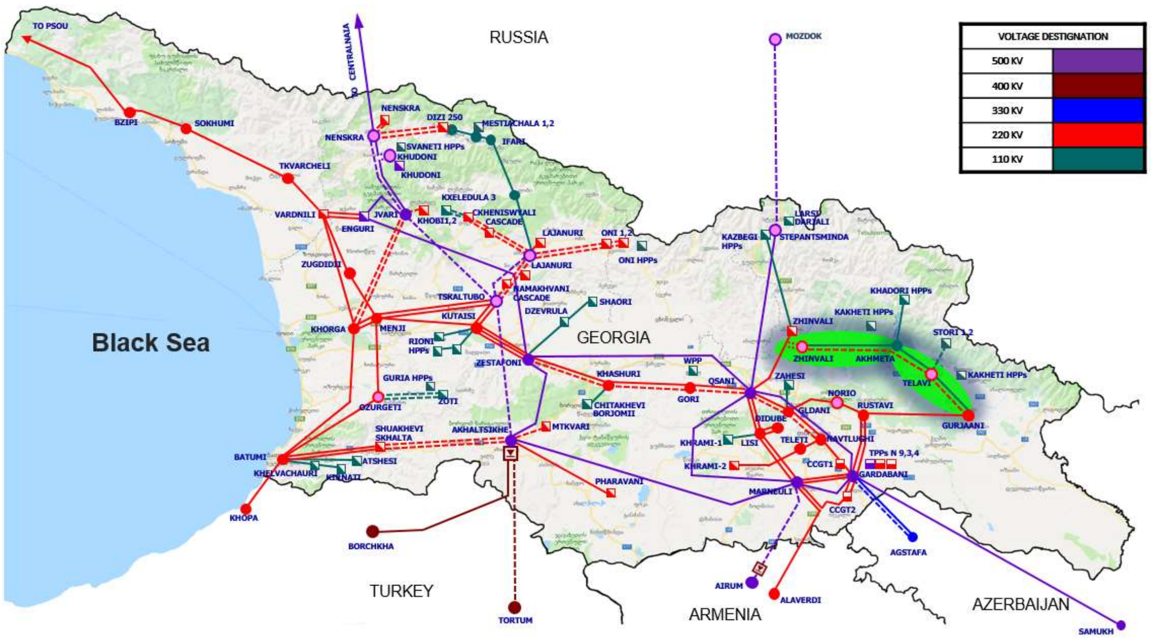

Fig. 3.13 Single-line diagram of project "Reinforcement of Kakheti infrastructure"

Table 3.8 Power plants integrated by the project "Reinforcement of Kakheti infrastructure"

№	Name	Installed capacity (MW)	Generation (million kWh)
1	Stori 1 HPP	33.6	150
2	Samkuristskali 1 HPP	5	26
3	Samkuristskali 2 HPP	26	129
4	Lopota 1 HPP	5.9	33.4
5	Deka HPP	1.2	5.7
6	Sachale HPP	0.7	4.3
7	Khadori 3 HPP	5.4	27.5
8	Baisubani HPP	5.3	30.9
9	Chartali HPP	2.5	14.9
10	Akhalsofeli HPP	5	27.4
11	Fona HPP	10.6	55
12	Stori 2 HPP	11.4	50.5
13	Ilto-Alazani HPPs cascade	139.5	522
	Total	**252.1**	**1076.6**

**** - the projects: P.13.6 double-circuit 220 kV OHL New Telavi – Akhmeta, with installation of single circuit and P.13.8 double-circuit 220 kV OHL Akhmeta – New Zhinvali, with installation of single circuit represents the whole (continuous) 220 kV OHL between the substations New Telavi and New Zhinvali, without loop-in/loop out into/from other substations.***

Project name: **Reactive power source (capacitor banks)**

Project Importance: System

Project Commissioning Year(s): 2023-2028

Forecasted Investment: **12 mln euros**

Current Status: Preliminary system regime analysis for Project has been completed (GSE)

Capacity of Integrated HPPs: 0 MW

Reduction in Losses: 38703 MWh

Increase of Network Transfer Capacity (Normal/Emergency Modes): 0 MW

Project Flexibility and Influence on Reliability: High

Project components:

- P.14.1 600 MVAR reactive power compensation equipment in 220 kV substations of Tbilisi region.

Purpose of Project:

- Maintaining of voltage levels in Georgian power system at permissible ranges during normal and N-1 state.

Project description:

While annual increase of electricity consumption in Georgia (due to the pandemic, 2020 is an exception), there are low voltage problems expected at bus bars of substations located in east part of the country. This issue is particularly noticeable in N-1 mode, in case of outage of 500 kV OHLs “Kartli-2” and “Vardzia” resulting significant decrease of voltage levels in east part of Georgian power system.

In order to avoid above-mentioned problem, it is necessary to install reactive power-generating equipment (in particular capacitor banks) at 220 kV substations located in East part of power system (Navtlugi, Gldani, Lisi, Didube, Ksani, Gardabani, Marneuli). It’s noteworthy that some substations may be replaced by other ones, which will be defined at the study phase.

Project name: **Security of supply of Tbilisi region**

Project Importance: System

Project Commissioning Year(s): 2023-2027

Forecasted Investment: 22.6 mln euros

Current Status: Preliminary system regime analysis for Project has been completed (GSE)

Capacity of Integrated HPPs: 0 MW

Reduction in Losses: 18856 MWh

Increase of Network Transfer Capacity (Normal/Emergency Modes): 400 MW

Project Flexibility and Influence on Reliability: High

Project components:

- P.15.1 Construction of second circuit of 220 kV OHL "Aragvi" and arrangement of bays;
- P.15.2 220/110/35 kV SS "Norio", with 2x125 MVA installed capacity;
- P.15.3 Loop in/loop out of 220 kV OHL "Varketili" in/from SS "Norio-220", length 2x4 km;
- P.15.4 Replacement of 500/220 kV 501 MVA autotransformer with 500/220 kV 801 MVA one in SS "Ksani-500".
- P.15.5 Reinforcement of 220 KV OHL "Kukia".

Purpose of Project:

- Ensuring of reliability of supply of Tbilisi;
- Connection of “Gardabani CCGT-2” to transmission network and reliable evacuation of its power;
- Reinforcement of Marneuli-Gardabani nodes.

Project description:

Consumption of Georgian power system is increasing annually (due to the pandemic, 2020 is an exception) what is particularly noticeable in Tbilisi region. Secure supply of this region is impossible by existing infrastructure. hence, the project of “Security of supply of Tbilisi region” is planned.

According to the results of prospective regimes, overloading of 500/220 kV autotransformer in Ksani SS as well as 220 kV OHLs Aragvi and Kukia will take place in case of N-1 scenarios of 500/220 kV autotransformers and 220 kV network of Tbilisi. Hence, replacement of existing (500 MVA) autotransformer with 801 MVA one and construction of second circuit-reinforcement of 220 kV OHLs Aragvi and Kukia is necessary.

Basis of the necessity of the construction of 220/110/35 kV SS Norio is demand growth at Lilo-Vaziani-Sartichala section. Its intensity has been reduced in recent period, therefore, mentioned substation will be constructed in line with consumption growth.

Fig. 3.14 Single line diagram of the project "Security of supply of Tbilisi region"

Project name: **Strengthening of Kartli 220 kV network**

Project Importance: System

Project Commissioning Year(s): 2025-2028

Forecasted Investment: **42 mln euros**

Current Status: Preliminary system regime analysis for Project has been completed (GSE)

Capacity of Integrated HPPs: 500 MW

Reduction in Losses: 3447 MWh

Increase of Network Transfer Capacity (Normal/Emergency Modes): 400 MW

Project Flexibility and Influence on Reliability: Moderate

Project components:

- P.16.1 Construction of second circuit of 220 kV OHL "Liakhvi", length 56 km;
- P.16.2 Rehabilitation of 220 kV OHL Navtlugi 1,2, length 38 km;
- P.16.3 Construction of second circuit of 220 kV OHL "Urbnisi", length 45 km;
- P.16.4 Construction of second circuit, of 220 kV OHL "Surami", length 67 km.

Purpose of Project:

- Reliable fulfillment of increasing consumption of east Georgia and reliable evacuation of power of CCGT-1;
- Reliable satisfaction of increased consumption in Eastern Georgia;
- Possibility of integration of prospective HPPs and renewable energy sources into the grid;
- Back up of 500 kV OHLs “Kartli-2” and “Vardzia”.

Project description:

About 50 years ago the east and west parts of Georgian transmission system were connected by single 220 kV OHL from 220 kV SS Zestafoni to 220 kV SS Gardabani (through 220 kv SS Navtlugi). The sections Zestafoni-Khashuri-Gori-Ksani and Navtlighi-CCGT1-Gardabani are still old and outdated.

Nowadays the operational limits of 220 kV OHL Navtlighi-CCGT1-Gardabani (Navtlugi 1, 2) are at a very low levels and it’s impossible to evacuate the full generation of Gardabani 1 CCGT in a safe and reliable manner.

The operational limits of 220 kV backbone Zestafoni-Khashuri-Gori-Ksani is very low as well. In the future, the increased consumption in the eastern Georgia will cause the overloading of above-mentioned backbone in N-1 mode, in particular in case of outage of “Kartli-2” or “Vardzia”. In order to avoid these constraints, rehabilitation of 220 kV OHL "Navtlugi 1, 2" and reconstruction of 220 kV backbone of Kartli (Zestaponi-Ksani) with double circuit construction is necessary. Also there is a RES integration projects in Zestafoni, Khashuri and Gori substations, which will be supported by this project. (Mtkvari cascade HPPs, Wind and Solar power plants)

It’s noteworthy that there is potential of development of 500 MW wind and solar power plants in Inner Kartli region. Therefore, reinforcement of mentioned magistral will ensure reliable evacuation of this capacity in direction of bulk demand centers as well as export.

Extension of the existing Gori substation and arrangement of additional bays is not possible for connection of neither overhead line nor generation source due to its location at densely populated area. Hence, it’s reasonable to construct 220 kV hub substation “Gori New” by the representative parties of above-mentioned prospective generation sources where loop in/loop out of single circuits of 220 kV OHLs Urbnisi and Liakhvi (after construction of their second circuits) will be implemented. Realization of mentioned scheme will reinforce mentioned 220 kV magistral as well as will connect the powerful generation sources into the transmission network.

On the OHLs shall be used such type of conductor that one chain of the OHL will be able to carry up to 500 MW of capacity, to meet the N-1 criterion.

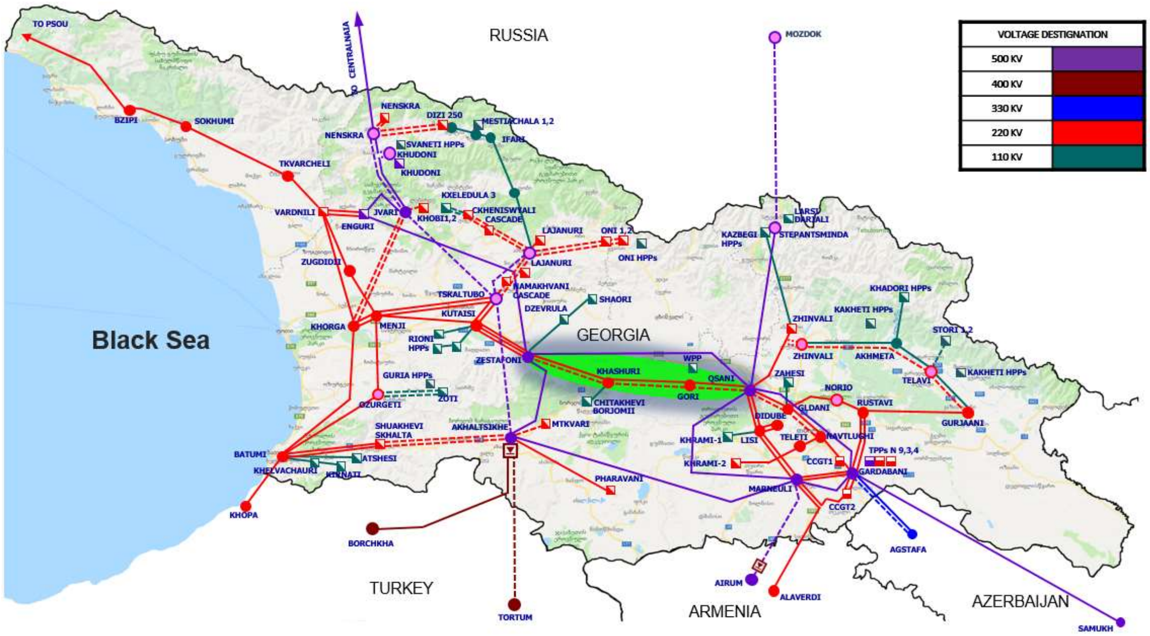

Fig. 3.15 Single line diagram of the project "Rehabilitation of 220 kV OHL Navtlugi-CCGT-Gardabani and construction second circuit of 220 kV backbone Zestafoni-Ksani"

Table 3.9 Power plants integrated by the project

№	Name	Installed capacity (MW)	Generation (million kWh)
1	Kaspi WPP	54	174,1
2	Nigoza WPP	50	197,8
3	Rikoti WPP	20	80
4	Pirveli WPP	110	388
5	Kareli WPP	10	41,1
6	Chero energy WPP	50	200
7	Urbnisi WPP	5,5	21,3
8	Zestafoni WPP	206	820
9	Ruisi WPP		
10	Diribula WPP		
11	Kartli WPP		
12	West Ruisi WPP		
13	North Ruisi WPP		
14	East Ruisi WPP		
15	Wind park		
	Total	**505,5**	**1922,3**

Project name: **Construction of second circuit of 330 kV OHL "Gardabani-Agstafa"[1]**

Project Importance: System

Project Commissioning Year(s): 2022

Forecasted Investment: **20 mln euros**

Current Status: Preliminary system regime analysis for Project has been completed (GSE)

Capacity of Integrated HPPs: >0 MW

Reduction in Losses: 200 MWh

Increase of Network Transfer Capacity (Normal/Emergency Modes): 400 MW

Project Flexibility and Influence on Reliability: Moderate

Project components:

- P.17.1 Construction of second circuit of 330 kV OHL "Gardabani-Agstafa", length 21 km (till Georgia-Azerbaijan border);
- P.17.2 Purchase, supply and installation supervision of 330/220 kV, 400 MW AT in substation Gardabani.

Purpose of Project:

- Providing 700–1000 MW of capacity exchange between Georgia and Azerbaijan with fulfillment of N-1 criteria;
- Increase of both power exchange ability and reliability in direction of Azerbaijan-Georgia-Turkey;
- Improvement of reliability of the synchronous ring of Georgia-Russia-Azerbaijan systems.

Project description:

Connection to the Azerbaijan Energy System cannot provide sufficient level of reliability, the its transfer capability in the N-1 mode does not exceed 240 MW (transfer capacity of 330 kV OHL Gardabani). In case of construction of its second circuit, which has already started on Azerbaijan side, its capacity will be equal to transfer capacity of 500 kV OHL Mukhranis veli providing the possibility of 700-1000 MW power exchange between Georgia and Azerbaijan consequently allowing uninterrupted 700 MW power exchange between power systems of Turkey and Azerbaijan via the Georgian one. In addition, the reliability of the operation of Georgia-Russia-Azerbaijan synchronous ring will be increased.

Fig. 3.16 Single line diagram of the project "Construction of second circuit of 330 kV OHL Gardabani-Agstafa

P.17.1 and P.17.1 Projects will be implemented by JSC "Sakrusenergo"

Project Name: **Georgia-Russia-Azerbaijan power system connection project (feasibility study)**

Project Importance: Transit

Project End Time: 2021-2022 Year

Forecasted Investment:

Current Status: Pre-works to start feasibility study

Capacity of Integrated HPPs: 0 MW

Reduction of Losses: <1 MW

Increase of Grid Transfer Capacity (Normal/Emergency Modes): 350 MW

Project Flexibility and Influence on Reliability: High

Project Components:

- *Will be defined after completion of the study.*

Purpose of Project:

- Determination of optimal Projects for strengthening Transmission infrastructure, for joint operation of Georgia-Azerbaijan-Russian systems;
- Increasing reliability of these systems, and Increasing potential of electricity exchange;
- Regulation of the flow (including circulation flow).

Project Description:

Nowadays, Georgia-Russia-Azerbaijan power systems unable to operate in one ring. One of the cross border tie(s) of this ring is always turned off, which reduces the reliability of all three systems and increase the risk for Georgia and/or Azerbaijan systems IPS/UPS to lose synchronization with other powers systems (CIS, Baltic, Ukraine, Georgia). This reduces Georgia and/or Azerbaijan system(s) inertia constants and capability of frequency containment reserves, therefore it worsens the safety level of supply and power quality. Besides this, potential of power trade is decreasing between systems, for example, one power system cannot implement power exchange in two other power systems if does not happen scheme weakening (operation with island mode). One of the reason is "circulating” flow, which will move in the direction of "clockwise" in case of Georgia-Russia-Azerbaijan ring. This project (Feasibility Study) has to identify the technology, technical characteristics, installation point(s) and operation philosophy of equipment(s) for cross border flow control, in order to make possible joint operation of Georgia-Azerbaijan-Russian systems.

Project Name: **Georgia-Romania Black Sea (submarine) interconnection cable project (feasibility study)**

Project Importance: Transit

Project End Time: 2020-2022 Year

Current Status: feasibility study is ongoing

Project data such as: forecasted investment, capacity of integrated power plants, reduction of losses, increase of grid transfer capacity, project flexibility and influence on reliability and project components will be clarified after completion of feasibility study.

Purpose of Project:

- Connection of Georgian electricity power system to Synchronous grid of Continental Europe;
- Creation of the opportunity for electricity trading with European countries;
- Increasing of transit potential;
- Improvement of energy security level of Caucasus region;
- Support in construction of power plants operating on renewable energy sources.

Project Description:

Georgia-Romania Black Sea submarine interconnection project will connect Georgian power system (and South Caucasus region) to Synchronous grid of Continental Europe, therefore, give opportunity to Georgia to implement electricity trade with European countries. Mentioned project will assist energy security of European Union and Caucasus region, support development of renewable energy sector, increase transit opportunities and trade options between European Union and South Caucasus region which will have positive impact on electricity producers and transmission system operators.

Based on preliminary data, construction of double-circuit 500 kV between existing 500 kV SS Jvari and new 500 kV SS Anaklia will be constructed. The next part will be two-pole 500 kV DC submarine cable Anaklia-Constanta. In order to implement such connection, construction of 500/500 kV DC converter station with installed capacity of 2x500 MW at Anaklia substation is considered. Implementation of this project may require additional reinforcement of high voltage network of mentioned interconnected power systems, which will be revealed after completion of feasibility study.

ANNEX-1 COST ESTIMATES OF PLANNED PROJECTS

Estimated Costs and Commisionning Years				
Project name	Project element			
	Esitmate commissioning year	№	Name	Estimate costs, EUROs
Jvari-Khorga	2022	P.1.1	Double circuit 220 kV OHL "Odishi-1,2" (Jvari- Khorga), length 60 km	
			Total Project Cost	**€ 22 603 600**
Batumi-Akhaltsikhe	2023	P.2.1	Double circuit 220-kV transmission line Shuakhevi HPP - Akhaltsikhe, length 90 km	
	2024	P.2.2	220/110/35 kV autotransformer in SS "Skuakhevi"	
			Total Project Cost	**€ 33 250 000**
Ksani-Stepantsminda-Mozdok	2030	P.3.1	500/110 kV SS "Stepantsminda", installed capacity 250 MVA	
	2030	P.3.2	500 kV OHL Stepantsminda-Border to Russia, length 13 km	
			Total Project Cost	**€ 26 736 242**
Marneuli-Airum	2025	P.4.1	500 kV OHL "Marneuli – Ayrumi" (to Armenian power supply system) length - 35.56 km (construction of new OHL of 18.56 km – from SS "Marneuli 500" to Georgian-Armenian border).	
	2025	P.4.2	Reconstruction of 500 kV OHL "Mukhrani" section between N42-N109 towers, length 17 km	
			Total Project Cost	**€ 20 000 000**
Rehabilitaion of Kolkhida-1	2023	P.5.1	Rehabilitaion of 220 kV OHL "Kolkhida-1", length 66 km	
			Total Project Cost	**€ 3 765 000**
Jvari-Tskaltubo-Akhaltsikhe	2023	P.6.1	500 kV substation "Tskaltubo", 501 MVA, 250 MVAR	
	2024	P.6.2	Extension of 500 kV SS "Akhaltsikhe"	
	2024	P.6.3	500 kV OHL Jvari-Tskaltubo, length 80 km	
	2025	P.6.4	Double circuit design of 500 kV OHL Tskaltubo-Akhaltsikhe with the construction of single circuit, length 104 km	
			Total Project Cost	**€ 104 489 216**
Svaneti	2024	P.7.1	500/110 kV SS "Khudoni", 250 MVA	
	2024	P.7.2	Loop in/Loop out of 500 kV OHL "Kavkasioni" in/from SS "Khudoni", length 0,5 km	
	2027	P.7.3	500/220 kV SS "Nenskra", 2x501 MVA	
	2027	P.7.4	Loop in/Loop out of 500 kV OHL "Kavkasioni" in/from SS "Nenskra", length 2 km	
	2027	P.7.5	2-circuit 220 kV OHL Nenskra HPP-SS Nenskra, length 1 km;	
	2028	P.7.6	2-circuit 220 kV OHL Nenskra-Mestia, length 57 km;	
	2030	P.7.7	500 kV OHL Nenskra-Jvariin, length 47 km;	
	2030	P.7.8	Extension of 500 kV SS "Jvari" for connection of 500 kV OHL Jvari-Nenskra and arrangement of bays	
			Total Project Cost	**€ 85 020 385**

Racha and Namakhvani	2023	P.8.1	New 220/110 kV 250 MVA substation "Lajanuri"	
	2023	P.8.2	Extension of 220 kV SS "Tskaltubo"	
	2023	P.8.3	220 kV OHL SS Lajanuri-Lajanuri HPP, length 4 km	
	2024	P.8.4	500 kV OHL Lajanuri-Tskaltubo, length 49 km	
	2025	P.8.5	Double-circuit (splitted conductor into two parts in each phase) 220 kV OHL Namakhvani-Tskaltubo (construction of 2-nd circuit of OHL "Derchi"), length 24 km	
	2025	P.8.6	Double-circuit (splitted conductor into two parts in each phase) 220 kV OHL Lower Namakhvani-Upper Namakhvani-Lajanuri, length 34 km (construction of 2-nd circuit of OHL "Derchi")	
	2025	P.8.7	2-circuit 110 kV OHL Oni-Lajanuri, in dimentions of 220 kv, length 55 km	
	2026	P.8.8	2-circuit 220 kV OHL Kheledula-Lajanuri, lengh 45 km	
	2030	P.8.9	Extension of 220/110 kV SS Lajanuri with 500 kV switchyard, 801 MVA	
			Total Project Cost	**€ 95 145 835**
Guria	2023	P.9.1	220/110 kV SS "Ozurgeti", 250 MVA	
	2023	P.9.2	Loop in/Loop out of 220 kV OHL "Paliastomi-1" in/from 220/110 kV SS "Ozurgeti"	
	2024	P.9.3	Double-circuit 110 kV OHL Ozurgeti-Zoti HPP, length 47 km	
			Total Project Cost	**€ 27 556 732**
Akhaltsikhe-Tortum	2024	P.10.1	Extension of 500 kV SS "Akhaltsihke" for connecting 400 kV OHL Akhaltsihke-Tortum and arrangement of bay	
	2025	P.10.2	400 kV OHL Akhaltsikhe-Tortum (till Georgia-Turkey border), length 33 km	
	2030	P.10.3	Third 500/400 kV back-to-back DC link at SS "Akhaltsikhe", 350 MW	
			Total Project Cost	**€ 176 789 216**
Rehabilitaion of Imereti	2026	P.11.1	Rehabilitation of 500 KV OHL "Imereti", length 128 km	
			Total Project Cost	**€ 22 500 000**
Renovation of substations	2022	P.12.1	110 kV switchyard and 2x63 MVA 220/110 kV autotransfermers in SS "Akhaltsikhe-500"	
	2023	P.12.2	Arrangement of 110 kV 2 bays in SS Zestafoni	
	2024	P.12.3	Renovation of 15 substations	
	2028	P.12.4	110/35 kV switchyard 220/110/35 kV autotransfermers in SS "Oni-220"	
			Total Project Cost	**€ 21 203 000**

Reinforcement of Kakheti Infrastructure	2023	P.13.1	Single circuit 110 kV OHL Stori hesi - New Telavi, length 50 km	
	2024	P.13.2	220/110/10 kV new substation in Telavi	
	2024	P.13.3	110 kV OHL Ikhalto loop in SS New Telavi	
	2025	P.13.4	Reconstruction and rehabilitation of 35 kV Tusheti infrastructure, length 35 km	
	2026	P.13.5	Double-circuit 220 kV OHL Gurjaani - New Telavi with the construction of single circuit, length 44.2 km	
	2026	P.13.6	Double-circuit 220 kV OHL New Telavi - Akhmeta with the construction of single circuit, length 30 km	
	2026	P.13.7	Rehabilitation of 220/110 kV SS Gurjaani	
	2027	P.13.8	Double-circuit 220 kV OHL Akhmeta - New Zhinvali with the construction of single circuit, length 33 km	
	2027	P.13.9	220/110 kV new substation in Zhinvali	
			Total Project Cost	**€ 64 649 000**
Reactive power source (capacitors)	2023-2028	P.14.1	600 MVAR reactive power compensation equipment in 220 kV substations of East Georgia	
			Total Project Cost	**€ 12 000 000**
Security of supply of Tbilisi region	2023	P.15.1	Construction of second circuit of 220 kV OHL "Aragvi", length 34 km and arrangement bays	
	2024	P.15.2	220/110 kV SS "Norio", with 2x125 MVA installed capacity	
	2024	P.15.3	Loop in/loop out of 220 kV OHL "Varketili" in/from SS "Norio-220", length 2x4 km	
	2026	P.15.4	Replacement of 500/220 kV 501 MVA autotransformer with 500/220 kV 801 MVA one in SS "Ksani-500"	
	2027	P.15.5	Construction of second circuit of 220 KV OHL "Kukia", lengs 17 km	
			Total Project Cost	**€ 22 613 000**
Reinforsment of Kartli 220 kV network	2025	P.16.1	Construction of second circuit of 220 kV OHL "Liakhvi", length 56 km	
	2026	P.16.2	Rehabilitation of 220 kV OHL Navtlugi 1,2, length 38 km	
	2028	P.16.3	Construction of second circuit of 220 kV OHL "Urbnisi", length 45 km	
	2028	P.16.4	Construction of second circuit of 220 kV OHL "Surami", length 67 km	
			Total Project Cost	**€ 42 000 000**
Construction of second circuit of 330 kV OHL "Gardabani-Agstafa"	2022	P.17.1	Construction of second circuit of 330 kV OHL "Gardabani-Agstafa", length 21 km (till Georgia-Azerbaijan border)	
	2022	P.17.2	Purchase, supply and installation supervision of 330/220 kV, 400 MW AT in substation Gardabani.	
			Total Project Cost	**€ 20 000 000**
			TOTAL COSTS	**€ 800 321 226**

ANNEX 2 - MAP OF TRANSMISSION NETWORK OF GEORGIA