

UDC 627.8(479.22) + 621.311.21

SCOPUS CODE 2105

<https://doi.org/10.36073/1512-0996-2025-3-255-259>**The Effect of Namakhvani HPP on Rioni Cascade HPPs**

Gurami Mirinashvili	Department of Electrical Power Engineering and Electronics, Georgian Technical University, Georgia, 0160, Tbilisi, 75, M. Kostava str. E-mail: guram.mirinashvili@gse.com.ge
Akaki Karseladze	Department of Electrical Power Engineering and Electronics, Georgian Technical University, Georgia, 0160, Tbilisi, 75, M. Kostava str. E-mail: akaki.karseladze@gse.com.ge
Archil Kokhtashvili	Department of Electrical Power Engineering and Electronics, Georgian Technical University, Georgia, 0160, Tbilisi, 75, M. Kostava str. E-mail: archil.kokhtashvili@gse.com.ge

Reviewers:**I. Gordiashvili**, Associate Professor, Faculty of Energy, GTU

E-mail: gordiashviliirakli02@gtu.ge

T. Jikia, Associate Professor, Faculty of Energy, GTU

E-mail: tamar.jikia@gse.com.ge

Abstract. The Namakhvani HPP project is the largest station of the “Rioni Hydroelectric Power Plant Cascade”, located in the river section between the Oni I Dam Project (1125 m.a.s.l) and the Vartsikhe IV HPP (23 m.a.s.l). There are currently four operating hydropower stations in the lower part of the Rioni River: Gumath HPP 1, Gumath HPP 2, and the Rioni and Vartsikhe HPP Cascade (4 HPPs). The Namakhvani Dam is located upstream of the existing HPPs in the Rioni Cascade and, due to its location, the Namakhvani project can have a significant impact on the generation and spill water management of the existing HPPs in the Rioni Cascade, as these HPPs are run-of-river plants and do not have any ability of regulating water flow. It can also bring great economic benefits to both the region and the country as a whole.

Keywords: Amakhvani hydro power plant; Rioni cascade; Rioni river basin.

Introduction

Georgia has large water resources. The main rivers on which important hydroelectric power plants are built are Enguri, Rion, Aragvi, Mtkvari, Chorokhi, Acharitskali and Tergi. The largest Hydro Power Plant in Georgia is Enguri, with an installed capacity of 1300 MW, and it is also one of the largest power plant in the region. In this report, we review the hydroelectric cascades located on the Rioni River and the impacts of the Namakhvani project on them. At present, we have Rioni, Gumati 1,2 and Vartsikhe hydroelectric cascades on Rioni river. Some of the mentioned HPPs have dams, but they do not have the means of regulation and work on the flow. In

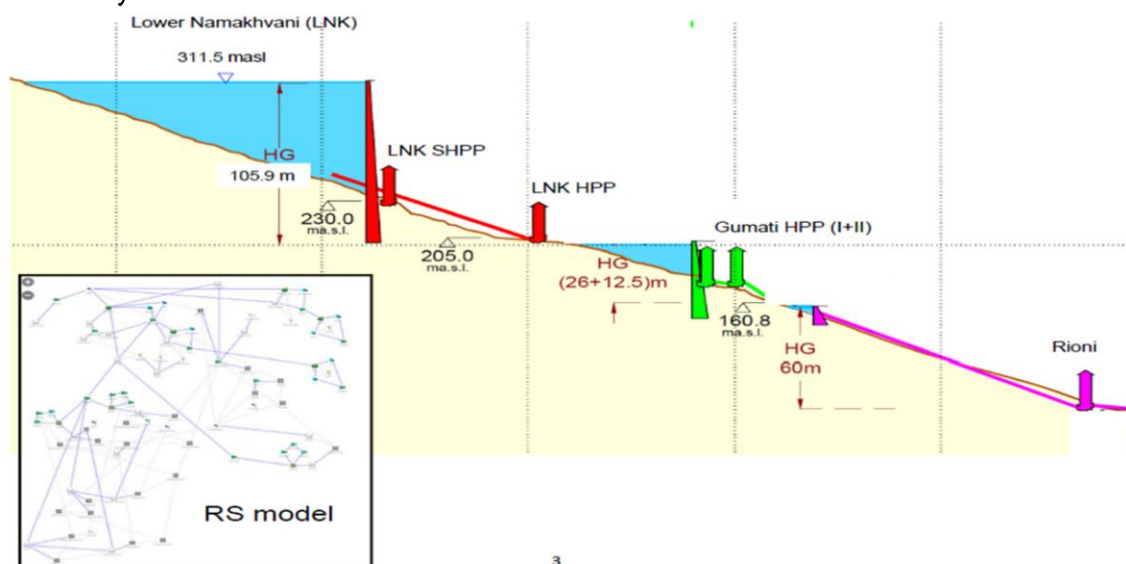
the main case, the generation of a separate HPP does not interfere with other downstream HPPs. The installed capacity of Namakhvani HPP is 433 MW and its annual generation is 1.514 billion kWh. The foundations of this project were laid during the Soviet Union, but due to the situation in the country at the end of the 80s, this project was no longer implemented. From an economic perspective, the Namakhvan HPP could play a significant role in addressing the future energy challenges of Georgia and the region. One of the most important aspects of the region's energy security is electricity, and the electricity generated by the Namakhvan HPP could increase the region's energy security. The proposed hydroelectric power plant should make a significant contribution to local employment, increase tax revenues, and reduce CO2 emissions.

Based on the available statistical data and design data of Namakhvani HPP, let's analyze what effect Namakhvani will have on other HPPs of Rioni valley.

The analysis was conducted to answer two questions:

- ✓ Will the Namakhvani Dam reduce the amount of water spilled for Rioni's HPPs during floods?
- ✓ What mode of operation of Namakhvani HPP is optimal for other HPPs of Rioni Cascade?

1.2 Visual layout of Namakhvani HPPs and Rioni Cascade HPPs



1.3 View Lower Namakhvani technical data

- ✓ Type of dam: gravity-arched
- ✓ Dam height: 99 meters
- ✓ Height above sea level: (294.5-311.5 m)
- ✓ Reservoir storage: 154.4 million cubic meters (15.16 million kWh)
- ✓ Live storage: 63.4 million m³
- ✓ Type of turbines: 3+1X - Francis
- ✓ Total installed capacity of the station: 333 MW (3X107+12)
- ✓ Average annual generation: 1.17 billion kWh

1.4 Technical data of hydroelectric power plants in Rioni Cascade

Name of the station	Installed capacity MW	Specific cost of water m ³ /MW	rated discharge m ³	Annual generation million kWh
Gumati 1	46,7	4,9	214	256
Gumati 2	22,8	3,2	214	138
Rioni	51	2,08	100	325
Vartsikhe	184	7,6	350	992
Sum	304,5			1711

2. Let's consider 3 options for operating the Kvemo Namakhvani reservoir

- ✓ Free operation of Namakhvani (negative impact on Rioni Cascade HPPs)
- ✓ Coordinated operation with Rioni Cascade HPP (positive impact on Rioni Cascade HPP)
- ✓ Intermediate operation of the reservoir for Namakhvani and Rioni cascades (10-hour peak mode)

2.1 Free operation of Namakhvani station and energy losses

- ✓ The total annual generation of Rioni Cascade HPPs is 1.432 billion kWh
- ✓ Total generation of Rioni cascade with negative influence of Namakhvani 1.155 billion kWh
- ✓ The difference is -276 million kWh
- ✓ Financial difference - 19,200,000 \$\$\$
- ✓ (The difference is calculated financially at 7 cents/kWh.)
- ✓ The total hydrogeneration of the electric system of Georgia (according to 10-year statistics) is 9.17 billion kWh, the energy lost under the influence of Namakhvani is 3% of this number.
- ✓ In total, the self-generated output of the reservoir + the energy lost in the cascade = 1.5-0.276 = 1.224 billion kWh
- ✓ $1,224/9,170 \times 100 = 13.3\%$
- ✓ In total, with the negative influence of Namakhvani on the cascade, the total production of hydrogeneration in Georgia will increase by 13.3%

2.2 Total optimization of electrical energy with the positive influence of Namakhvani HPP on Rioni cascade

- ✓ The total annual generation of Rioni Cascade HPPs is 1.432 billion kWh
- ✓ The total output of the Rioni cascade working as a cascade with Namakhvani is 1.798 billion kWh
- ✓ The difference is +366 million kWh
- ✓ Financial difference +25 620 000 \$\$\$
- ✓ (The difference is calculated financially at 7 cents/kWh.)
- ✓ The total hydrogeneration of Georgia's electricity system (with 10-year statistics) is 9.17 billion kWh, the energy optimized by Namakhvani is 4% percent of this number.

- ✓ In total, own generation of Namakhvani + energy optimized in cascade = $1.5 + 0.366 = 1.866$ billion kWh
- ✓ $1,866/9,170 \times 100 = 20.3\%$
- ✓ In total, with the positive influence of Namakhvani, the total production of hydrogeneration in Georgia will increase by 20.3%

2.3 Total loss of electrical energy with intermediate operation of Namakhvani HPP

- ✓ The total annual generation of Rioni Cascade HPPs is 1.432 billion kWh
- ✓ The total generation of the Rioni cascade with the intermediate influence of Namakhvani is 1.255 billion kWh
- ✓ The difference is -177 million kWh
- ✓ Financial difference - 12 390 000 \$\$\$
- ✓ (The difference is calculated financially at 7 cents/kWh.)
- ✓ The total hydrogeneration of the electric system of Georgia (with 10-year statistics) is 9.17 billion kWh, the energy loss due to the intermediate influence of Namakhvani is 1.9% of this number.
- ✓ In total, the energy lost in the self-production of Namkhvani-Cascade = $1.5 - 0.177 = 1.323$ billion kWh
- ✓ $1,378/9,170 \times 100 = 14.4\%$
- ✓ In total, with the intermediate influence of Namakhvani, the total production of hydrogeneration in Georgia will increase by 14.4%

Conclusion

Let's summarize the results from the three options discussed above:

- ✓ During the free operation of Namakhvani, the generation of Rioni Cascade HPPs decreases by -19%, however, with the help of Namakhvani's own generation, the total hydrogeneration of Georgia increases by +13.3%.
- ✓ In case of agreed operation, the generation of Rioni Cascade HPPs increases by +26%, Namakhvani's own generation is added to it, and the total hydrogeneration of Georgia increases by +20.3%.
- ✓ In the case of the intermediate option, the generation of Rioni Cascade HPPs decreases by -12% in total, and with the addition of Namakhvani's own generation, the total hydrogeneration of Georgia increases by +14.4%.

Based on the summary of this information, we can conclude that the Namakhvani project is one of the largest projects for energy in Georgia and this project can radically change the energy sector of Georgia. Therefore, the operation of Namakhvani and similar scale hydro plants should be agreed with the transmission system operator, in order to take into account, the mode of operation of other hydro plants and optimize the hydro sector as a whole, and not just adjust to the interests of one specific station.

UDC 627.8(479.22) + 621.311.21

SCOPUS CODE 2105

<https://doi.org/10.36073/1512-0996-2025-3-255-259>**ნამახვანი ჰესის გავლენა რიონის კასკადურ ჰესებზე**

გურამი მირინაშვილი	ელექტროენერგეტიკისა და ელექტრომექანიკის დეპარტამენტი, საქართველოს ტექნიკური უნივერსიტეტი, საქართველო, 0160, თბილისი, მ. კოსტავას 75 E-mail: guram.mirinashvili@gse.com.ge
აკაკი ქარსელაძე	ელექტროენერგეტიკისა და ელექტრომექანიკის დეპარტამენტი, საქართველოს ტექნიკური უნივერსიტეტი, საქართველო, 0160, თბილისი, მ. კოსტავას 75 E-mail: akaki.karseladze@gse.com.ge
არჩილ კობტაშვილი	ელექტროენერგეტიკისა და ელექტრომექანიკის დეპარტამენტი, საქართველოს ტექნიკური უნივერსიტეტი, საქართველო, 0160, თბილისი, მ. კოსტავას 75 E-mail: archil.kokhtashvili@gse.com.ge

რეცენზენტები:**ი. გორდიაშვილი**, სტუ-ის ენერგეტიკის ფაკულტეტის ასოცირებული პროფესორი

E-mail: gordiashviliirakli02@gtu.ge

თ. ჯიქია, სტუ-ის ენერგეტიკის ფაკულტეტის ასოცირებული პროფესორი

E-mail: tamar.jikia@gse.com.ge

ანოტაცია. ნამახვანი ჰესის პროექტი რიონის ჰესების კასკადში ყველაზე დიდი ჰიდროსადგურია, რომელიც განთავსებულია მდინარე რიონის ზედა მონაკვეთზე — ონი I ჰესსა (ზ.დ. 1125 მ) და ვარციხე IV ჰესს (ზ.დ. 23 მ) შორის. ამჟამად რიონის ქვედა დინებაში მოქმედებს ოთხი ჰიდროსადგური: გუმათი I, გუმათი II და რიონისა და ვარციხის ჰესების კასკადი (სულ ოთხი ჰესი). ნამახვანი ჰესის მდებარეობა არსებულ სადგურებზე ზემოთ განაპირობებს მის არსებით გავლენას კასკადში არსებული ჰესების გენერაციისა და წყალგამოშვების მართვაზე, ვინაიდან ეს სადგურები მდინარის გატარების რეჟიმზეა მომართული და წყლის დინების რეგულირების შესაძლებლობა არ გააჩნია. ამასთან, ნამახვანი ჰესის პროექტი მნიშვნელოვან ეკონომიკურ სარგებელს მოიტანს როგორც რეგიონისთვის, ისე ქვეყნის მასშტაბით.

საკვანძო სიტყვები: ნამახვანი ჰესის პროექტი; რიონის ჰესების კასკადი; რიონის აუზი; ჰიდროგენერაცია.

*The date of review 23.04.2025**The date of submission 15.04.2025**Signed for publishing 25.09.2025*