

MUHANDISLIK

& IQTISODIYOT

*ijtimoiy-igʻtisodiy, innovatsion texnik,
fan va taʼlimga oid ilmiy-amaliy jurnal*

2026-YIL

SENTYABR / 9-SON, II-QISM



Milliy nashrlar

OAK: <https://oak.us/pages/4802>

05.00.00 – Texnika fanlari

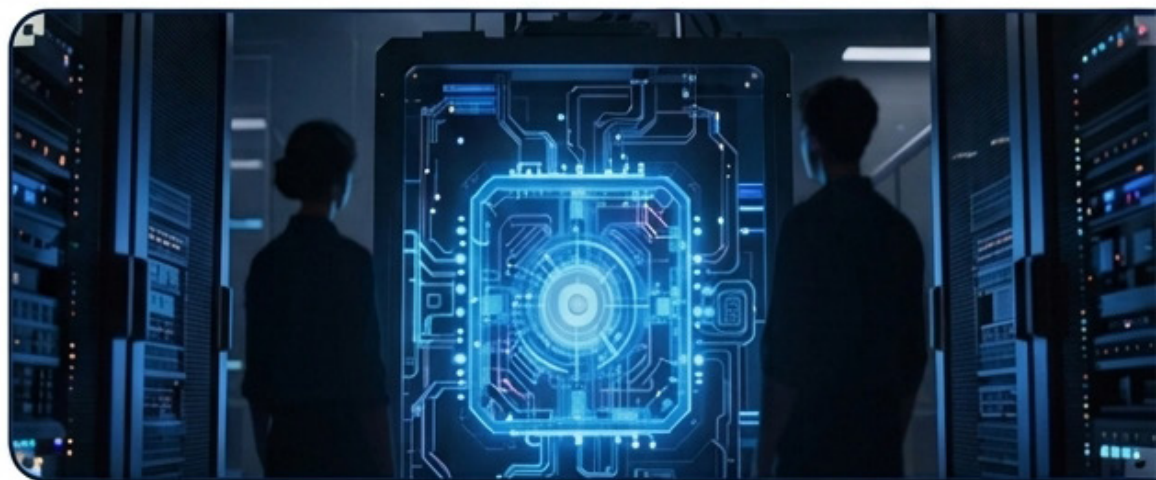
08.00.00 – Iqtisodiyot fanlar



Google
Scholar

ISSN
INTERNATIONAL
STANDARD
SERIAL
NUMBER
INTERNATIONAL CENTRE

OpenAIRE



ISSN: 3060-463X

РЭУ.РФ
ИМЕНИ Ф.Р. РЕКАНОВА
ФИЗИКО-МАТЕМАТИЧЕСКИЕ НАУКИ



muhandislik & iqtisodiyot

ijtimoiy-iqtisodiy, innovatsion texnik,
fan va ta'limga oid ilmiy-amaliy jurnal

Elektron nashr, 2026-yil, sentyabr.

Bosh muharrir:

Zokirova Nodira Kalandarovna, iqtisodiyot fanlari doktori, DSc, professor

Bosh muharrir o'rinbosari:

Shakarov Zafar G'afurovich, iqtisodiyot fanlari bo'yicha falsafa doktori, PhD, dotsent

Tahrir hay'ati:

Abduraxmanov Kalendar Xodjayevich, O'z FA akademigi, iqtisodiyot fanlari doktori, professor

Sharipov Kongratbay Avezimbetovich, texnika fanlari doktori, professor

Maxkamov Baxtiyor Shuxratovich, iqtisodiyot fanlari doktori, professor

Abduraxmanova Gulnora Kalandarovna, iqtisodiyot fanlari doktori, professor

Shaumarov Said Sanatovich, texnika fanlari doktori, professor

Turayev Bahodir Xatamovich, iqtisodiyot fanlari doktori, professor

Nasimov Dilmurod Abdulloyevich, iqtisodiyot fanlari doktori (DSc), professor

Allayeva Gulchexra Jalgasovna, iqtisodiyot fanlari doktori, professor

Arabov Nurali Uralovich, iqtisodiyot fanlari doktori, professor

Maxmudov Odiljon Xolmirzayevich, iqtisodiyot fanlari doktori, professor

Xamrayeva Sayyora Nasimovna, iqtisodiyot fanlari doktori, professor

Bobonazarova Jamila Xolmurodovna, iqtisodiyot fanlari doktori, professor

Irmatova Aziza Baxromovna, iqtisodiyot fanlari doktori, professor

Bo'taboyev Mahammadjon To'ychiyevich, iqtisodiyot fanlari doktori, professor

Shamshiyeva Nargizaxon Nosirxuja kizi, iqtisodiyot fanlari doktori, professor,

Xolmuxamedov Muhsinjon Murodullayevich, iqtisodiyot fanlari nomzodi, dotsent

Xodjayeva Nodiraxon Abdurashidovna, iqtisodiyot fanlari nomzodi, dotsent

Amanov Otabek Amankulovich, iqtisodiyot fanlari bo'yicha falsafa doktori (PhD), dotsent

Toxirov Jaloliddin Ochil o'g'li, texnika fanlari bo'yicha falsafa doktori (PhD)

Qurbonov Samandar Pulatovich, iqtisodiyot fanlari bo'yicha falsafa doktori (PhD)

Zikriyoyev Aziz Sadulloyevich, iqtisodiyot fanlari bo'yicha falsafa doktori (PhD)

Tabayev Azamat Zaripbayevich, iqtisodiyot fanlari bo'yicha falsafa doktori (PhD)

Sxay Lana Aleksandrovna, iqtisodiyot fanlari bo'yicha falsafa doktori (PhD), dotsent

Ismoilova Gulnora Fayzullayevna, iqtisodiyot fanlari nomzodi, dotsent

Djumaniyazov Umrbek Ilxamovich, iqtisodiyot fanlari nomzodi, dotsent

Kasimova Nargiza Sabitdjanovna, iqtisodiyot fanlari nomzodi, dotsent

Kalanova Moxigul Baxritdinovna, dotsent

Ashurzoda Luiza Muxtarovna, iqtisodiyot fanlari bo'yicha falsafa doktori (PhD)

Sharipov Sardor Begmaxmat o'g'li, iqtisodiyot fanlari bo'yicha falsafa doktori (PhD)

Tursunov Ulug'bek Sativoldiyevich, iqtisodiyot fanlari doktori (DSc), dotsent

Bauyetdinov Majit Janizaqovich, Toshkent davlat iqtisodiyot universiteti dotsenti, PhD

Botirov Bozorbek Musurmon o'g'li, Texnika fanlari bo'yicha falsafa doktori (PhD)

Sultonov Shavkatjon Abdullayevich, Kimyo fanlari doktori, (DSc)

Jo'raeva Malohat Muhammadovna, filologiya fanlari doktori (DSc), professor.

Yusupov Maxamadamin Abduxamidovich, iqtisodiyot fanlari nomzodi (DSc), professor

Kalonova Moxigul Baxritdinovna, iqtisodiyot fanlari nomzodi (PhD), dotsent

Mirzayev Kulmamat Djanzakovich, iqtisodiyot fanlari nomzodi (DSc), professor.

Karimova Nilufar Sadirdin qizi, iqtisodiyot fanlari bo'yicha falsafa doktori (PhD)

Norboyev Odil Abrayevich, iqtisodiyot fanlari bo'yicha falsafa doktori (PhD), dotsent

Karimova Nilufar Sadirdin qizi, iqtisodiyot fanlari bo'yicha falsafa doktori (PhD)

Pardaev Umidjon Uralovich, iqtisodiyot fanlari doktori (DSc), professor

Xolmirzayev Ulug'bek Abdulazizovich, Iqtisodiyot fanlari doktori (DSc)

muhandislik & iqtisodiyot

ijtimoiy-iqtisodiy, innovatsion texnik,
fan va ta'limga oid ilmiy-amaliy jurnal

- 05.01.00 – Axborot texnologiyalari, boshqaruv va kompyuter grafikasi
- 05.01.01 – Muhandislik geometriyasi va kompyuter grafikasi. Audio va video texnologiyalari
- 05.01.02 – Tizimli tahlil, boshqaruv va axborotni qayta ishlash
- 05.01.03 – Informatikaning nazariy asoslari
- 05.01.04 – Hisoblash mashinalari, majmualari va kompyuter tarmoqlarining matematik va dasturiy ta'minoti
- 05.01.05 – Axborotlarni himoyalash usullari va tizimlari. Axborot xavfsizligi
- 05.01.06 – Hisoblash texnikasi va boshqaruv tizimlarining elementlari va qurilmalari
- 05.01.07 – Matematik modellash
- 05.01.11 – Raqamli texnologiyalar va sun'iy intellekt
- 05.02.00 – Mashinasozlik va mashinashunoslik
- 05.02.08 – Yer usti majmualari va uchish apparatlari
- 05.03.02 – Metrologiya va metrologiya ta'minoti
- 05.04.01 – Telekommunikatsiya va kompyuter tizimlari, telekommunikatsiya tarmoqlari va qurilmalari. Axborotlarni taqsimlash
- 05.05.03 – Yorug'lik texnikasi. Maxsus yoritish texnologiyasi
- 05.05.05 – Issiqlik texnikasining nazariy asoslari
- 05.05.06 – Qayta tiklanadigan energiya turlari asosidagi energiya qurilmalari
- 05.06.01 – To'qimachilik va yengil sanoat ishlab chiqarishlari materialshunosligi
- 05.08.03 – Temir yo'l transportini ishlatish
- 05.08.06 – "G'ildirakli va gusenisali mashinalar va ularni ishlatish" (texnika fanlari)
- 05.09.01 – Qurilish konstruksiyalari, bino va inshootlar
- 05.09.04 – Suv ta'minoti. Kanalizatsiya. Suv havzalarini muhofazalovchi qurilish tizimlari
- 10.00.06 – Qiyosiy adabiyotshunoslik, chog'ishtirma tilshunoslik va tarjimashunoslik
- 10.00.04 – Yevropa, Amerika va Avstraliya xalqlari tili va adabiyoti
- 08.00.01 – Iqtisodiyot nazariyasi
- 08.00.02 – Makroiqtisodiyot
- 08.00.03 – Sanoat iqtisodiyoti
- 08.00.04 – Qishloq xo'jaligi iqtisodiyoti
- 08.00.05 – Xizmat ko'rsatish tarmoqlari iqtisodiyoti
- 08.00.06 – Ekonometrika va statistika
- 08.00.07 – Moliya, pul muomalasi va kredit
- 08.00.08 – Buxgalteriya hisobi, iqtisodiy tahlil va audit
- 08.00.09 – Jahon iqtisodiyoti
- 08.00.10 – Demografiya. Mehnat iqtisodiyoti
- 08.00.11 – Marketing
- 08.00.12 – Mintaqaviy iqtisodiyot
- 08.00.13 – Menejment
- 08.00.14 – Iqtisodiyotda axborot tizimlari va texnologiyalari
- 08.00.15 – Tadbirkorlik va kichik biznes iqtisodiyoti
- 08.00.16 – Raqamli iqtisodiyot va xalqaro raqamli integratsiya
- 08.00.17 – Turizm va mehmonxona faoliyati

Ma'lumot uchun, OAK
Rayosatining 2024-yil 28-avgustdagi 360/5-son qarori bilan "Dissertatsiyalar asosiy ilmiy natijalarini chop etishga tavsiya etilgan milliy ilmiy nashrlar ro'yxati"ga texnika va iqtisodiyot fanlari bo'yicha "Muhandislik va iqtisodiyot" jurnali ro'yxatga kiritilgan.

Muassis: "Tadbirkor va ishbilarmon" MChJ

Hamkorlarimiz:

1. Toshkent shahridagi G.V.Plexanov nomidagi Rossiya iqtisodiyot universiteti
2. Toshkent davlat iqtisodiyot universiteti
3. Toshkent irrigatsiya va qishloq xo'jaligini mexanizatsiyalash muhandislari instituti" milliy tadqiqot universiteti
4. Islom Karimov nomidagi Toshkent davlat texnika universiteti
5. Muhammad al-Xorazmiy nomidagi Toshkent axborot texnologiyalari universiteti
6. Toshkent davlat transport universiteti
7. Toshkent arxitektura-qurilish universiteti
8. Toshkent kimyo-texnologiya universiteti
9. Jizzax politexnika instituti



MUNDARIJA

O'ZBEKISTON TIJORAT BANKLARIDA KREDIT RISKINI ERTA ANIQLASH TIZIMINI SUN'IY INTELLEKT ASOSIDA TAKOMILLASHTIRISH.....	9
Kobilova Ozoda Abdishukur qizi	
BUYUK BRITANIYA STARTAP EKOTIZIMINI BOSHQARISH MODEL VA O'ZBEKISTON UCHUN SABOQLAR.....	15
Sodiqov Elmurod Shomurod o'g'li	
ФИНАНСОВЫЕ ОГРАНИЧЕНИЯ АГРОБИЗНЕСА, РЕФОРМА ИНСТИТУТА НЕПЛАТЁЖЕСПОСОБНОСТИ И ГЕОГРАФИЯ СЕЛЬСКОЙ БЕДНОСТИ: УЗБЕКИСТАН, 2015–2025 ГОДЫ.....	21
Адилов Шерзот Шамильевич	
AHOLI DAROMADLARI VA ISTE'MOL XARAJATLARINI TADQIQ ETISHNING ZAMONAVIY EKONOMETRIK YONDASHUVLARI	30
Farmonov Dilshod Po'latovich	
SUN'IY INTELLEKT TRANSFORMATSIYASI SHAROITIDA INSON KAPITALIGA QO'YILADIGAN KOMPETENSIYAVIY TALABLARNING O'ZGARISHI: XALQARO TENDENSIYALAR VA O'ZBEKISTON UCHUN USTUVOR YO'NALISHLAR	36
Durdona Davletova	
KICHIK BIZNES SOHASIDA INSON KAPITALINI RIVOJLANTIRISH VA MEHNAT MUNOSABATLARINI TARTIBGA SOLISH OMILLARI, USULLARI HAMDA FUNKSIYALARI	56
Ulug'muradova Nodira Berdimuradovna	
O'ZBEKISTONDA YAKKA TARTIBDAGI TADBIRKORLARNI SOLIQQA TORTISHNING AMALDAGI MEXANIZMI.....	61
Erxanov Muxammadjon Absayitovich	
BOSHQARUV TIZIMIDA IQTISODIY SAMARADORLIKNI OSHIRISHNING ZAMONAVIY MEXANIZMLARI.....	68
Safarov Shohboz Vahob o'g'li	
EVALUATION OF THE PHYTOREMEDIATION POTENTIAL OF AZOLLA CAROLINIANA FOR THE REMOVAL OF TOXIC METALS FROM INDUSTRIAL EFFLUENTS	72
Azimov Shavkat Shuxratovich	
STABLE CEMENT COMPOSITES BASED ON WASTE TIRE RUBBER AND FLY ASH	78
Daminov Oybek, Egamberdiyev Elmurod, Xoliqulov Odiljon	
KICHIK BIZNES VA XUSUSIY TADBIRKORLIK SUBYEKTLARIDA ISHLAB CHIQARILGAN MAHSULOTLARNING EKSPORT SALOHİYATINI BAHOLASH.....	85
Xikmatullayeva Nargiza Jamoliddin qizi	
CO-LOCATED SMALL MODULAR REACTORS AS AN ALTERNATE AC POWER SOURCE FOR LARGE NUCLEAR UNITS UNDER REGIONAL GRID CASCADING CONDITIONS: A DESIGN-BASIS ASSESSMENT FOR UZBEKISTAN	90
Turaeva Dilnavoz	

CO-LOCATED SMALL MODULAR REACTORS AS AN ALTERNATE AC POWER SOURCE FOR LARGE NUCLEAR UNITS UNDER REGIONAL GRID CASCADING CONDITIONS: A DESIGN-BASIS ASSESSMENT FOR UZBEKISTAN

Turaeva Dilnavoz

Master's Student, KEPKO International Nuclear Graduate School (KINGS), Ulsan, Republic of Korea

Email: torayevadilnavoz@gmail.com

Abstract: Uzbekistan's first nuclear power plant will place two RITM-200N small modular reactors (SMRs) and two VVER-1000 units on one site in the Jizzakh region. The SMR units arrive first, four to six years ahead of the first large unit. The plant will connect to the Central Asian Power System, a synchronous interconnection shared with four neighbouring states, which cascaded in August 2026 when the loss of 600 MW of hydroelectric generation propagated across four countries and took roughly five hours to restore. Loss of off-site power is the dominant external initiator of station blackout. A cascading interconnection failure is a common-cause event, removing every off-site source at once. Together these facts raise a question the published literature has not examined: can co-located SMR units serve as an on-site alternate AC power source for the large units during a wide-area grid collapse? This paper screens that question against five criteria drawn from IAEA guidance on electrical power system design and station blackout provisions, namely capacity adequacy, response time, independence, self-survival, and commissioning sequence. Capacity is not the constraint. A single 55 MWe RITM-200N unit exceeds the emergency AC demand of one safety train at a large pressurized-water reactor by roughly an order of magnitude. The commissioning sequence is favourable as well, since the SMR units will have several years of operating record before the first VVER-1000 needs them. Two findings limit the claim. The RITM-200N cannot replace emergency diesel generators, which must accept load within ten to thirty seconds of a start signal; and it cannot be credited at all unless it survives the grid event itself through house-load operation, a capability the public design literature does not establish. The configuration is therefore a candidate for alternate AC credit rather than emergency power replacement. The paper closes by defining the reliability analysis needed to settle it.

Keywords: station blackout, loss of off-site power, alternate AC power source, small modular reactor, RITM-200N, VVER-1000, Central Asian Power System, Uzbekistan.

Annotatsiya: O'zbekistonning birinchi atom elektr stansiyasida Jizzax viloyatidagi bitta maydonda ikkita RITM-200N kichik modulli reaktori (KMR) va ikkita VVER-1000 energiya bloki joylashtiriladi. KMR energiya bloklari birinchi bo'lib, dastlabki yirik energiya blokidan to'rt-olti yil oldin ishga tushiriladi. Atom elektr stansiyasi to'rtta qo'shni davlat bilan umumiy bo'lgan sinxron birlashma — Markaziy Osiyo elektr energetika tizimiga ulanadi. 2026-yil avgust oyida mazkur tizimda kaskadli buzilish yuz bergan: 600 MVt gidroelektr energiya ishlab chiqarish quvvatining yo'qotilishi to'rtta mamlakat bo'ylab tarqalgan va tizimni tiklash taxminan besh soat davom etgan. Tashqi elektr ta'minotining yo'qotilishi stansiyaning to'liq elektrsizlanishidagi asosiy tashqi boshlang'ich hodisa hisoblanadi. Elektr energetika tizimining kaskadli ishdan chiqishi umumiy sababli hodisa bo'lib, barcha tashqi elektr ta'minoti manbalarini bir vaqtning o'zida ishdan chiqaradi. Ushbu faktlar e'lon qilingan ilmiy adabiyotlarda hali ko'rib chiqilmagan quyidagi savolni yuzaga keltiradi: bir maydonda joylashtirilgan KMR energiya bloklari keng hududli elektr tarmog'i qulashi vaqtida yirik energiya bloklari uchun maydondagi muqobil o'zgaruvchan tok manbai sifatida xizmat qila oladimi? Maqolada ushbu savol atom elektr stansiyalarining elektr ta'minoti tizimlarini loyihalash va stansiyaning to'liq elektrsizlanishiga oid qoidalar bo'yicha MAGATE yo'riqnomalaridan kelib chiqadigan beshta mezon asosida baholanadi: quvvatning yetarliligi, javob berish vaqti, mustaqillik, o'z-o'zini saqlab qolish qobiliyati va ishga tushirish ketma-ketligi. Quvvat cheklovchi omil emas. Bitta 55 MWe quvvatga ega RITM-200N energiya bloki yirik suv-suvli reaktorning bitta xavfsizlik kanali uchun zarur bo'lgan avariya o'zgaruvchan tok quvvatidan taxminan bir tartibga ko'p quvvatga ega. Ishga tushirish ketma-ketligi ham qulay, chunki birinchi VVER-1000 unga ehtiyoj sezguniga qadar KMR energiya bloklari bir necha yillik ekspluatatsiya tajribasiga ega bo'ladi. Biroq, ikkita xulosa ushbu da'voni cheklaydi. RITM-200N ishga tushirish signali berilganidan keyin o'n-o'ttiz soniya ichida yuklamani qabul qilishi kerak bo'lgan avariya dizel-generatorlarning o'rnini bosa olmaydi. Shuningdek, u elektr tarmog'idagi hodisaning o'zidan, ya'ni o'z ehtiyojlari uchun ishlash rejimi orqali omon qolmasa, umuman ishonchli manba sifatida hisobga olinishi mumkin emas. Ochiq loyiha adabiyotlarida bunday qobiliyat mavjudligi tasdiqlanmagan. Shunday qilib, mazkur konfiguratsiya avariya o'zgaruvchan elektr ta'minotining o'rnini bosuvchi emas, balki muqobil o'zgaruvchan tok manbai sifatida hisobga olish uchun nomzod hisoblanadi. Maqola ushbu masalani yakuniy hal etish uchun zarur bo'lgan ishonchlilik tahlilini belgilash



bilan yakunlanadi.

Kalit soʻzlar: stansiyaning toʻliq elektrsizlanishi, tashqi elektr taʼminotining yoʻqotilishi, muqobil oʻzgaruvchan tok manbai, kichik modulli reaktor, RITM-200N, VVER-1000, Markaziy Osiyo elektr energetika tizimi, Oʻzbekiston.

Аннотация: Первая атомная электростанция Узбекистана разместит на одной площадке в Джизакской области два малых модульных реактора (ММР) RITM-200N и два энергоблока ВВЭР-1000. Энергоблоки ММР будут введены в эксплуатацию первыми — на четыре–шесть лет раньше первого крупного энергоблока. АЭС будет подключена к Центральноазиатской энергосистеме — синхронному объединению, общему для четырёх соседних государств. В августе 2026 года в данной системе произошло каскадное нарушение, когда потеря 600 МВт гидроэлектрогенерации распространилась на четыре страны, а восстановление заняло около пяти часов. Потеря внешнего электроснабжения является доминирующим внешним иницирующим событием при полном обесточивании станции. Каскадный отказ объединённой энергосистемы представляет собой событие с общей причиной, одновременно выводящее из строя все внешние источники электроснабжения. Совокупность этих факторов поднимает вопрос, который не рассматривался в опубликованной литературе: могут ли размещённые на одной площадке энергоблоки ММР служить резервным источником переменного тока на площадке для крупных энергоблоков во время широкомасштабного коллапса энергосистемы? В статье данный вопрос рассматривается по пяти критериям, сформированным на основе руководящих документов МАГАТЭ по проектированию систем электроснабжения и положениям, касающимся полного обесточивания станции: достаточность мощности, время реагирования, независимость, способность к автономному выживанию и последовательность ввода в эксплуатацию. Мощность не является ограничивающим фактором. Один энергоблок RITM-200N мощностью 55 МВт(э) превышает аварийную потребность в переменном токе одного канала безопасности крупного водо-водяного реактора примерно на порядок. Последовательность ввода в эксплуатацию также является благоприятной, поскольку энергоблоки ММР будут иметь несколько лет эксплуатационной истории до того, как первый ВВЭР-1000 начнёт нуждаться в них. Два вывода ограничивают данное утверждение. RITM-200N не может заменить аварийные дизель-генераторы, которые должны принимать нагрузку в течение десяти–тридцати секунд после подачи сигнала запуска; кроме того, его нельзя учитывать в качестве надёжного источника вообще, если он сам не переживает аварийное событие в энергосистеме за счёт работы на собственные нужды, наличие которой не подтверждено открытой проектной литературой. Таким образом, данная конфигурация является кандидатом для зачёта в качестве резервного источника переменного тока, а не заменой аварийному электроснабжению. В заключении статьи определяются необходимые виды анализа надёжности для окончательного решения данного вопроса.

Ключевые слова: полное обесточивание станции, потеря внешнего электроснабжения, резервный источник переменного тока, малый модульный реактор, RITM-200N, ВВЭР-1000, Центральноазиатская энергосистема, Узбекистан.

INTRODUCTION

Nuclear plants depend on the grid they supply. That dependence is unusual among industrial facilities, and it does not end when the reactor trips. A shut-down reactor still generates decay heat, and removing that heat still requires power. The supply comes from off-site sources first, from emergency diesel generators when those fail, and from batteries and passive systems when the diesels fail too. Losing off-site power and on-site emergency AC power at the same time is called station blackout. It has been understood since the 1980s as a leading contributor to core damage frequency [1], and the events at Fukushima Daiichi in 2011 showed the concern was not academic.

The plant under construction in Uzbekistan's Jizzakh region will be built into a grid whose vulnerability to this class of event is documented rather than hypothetical. Ground was broken as part of a partnership with Rosatom valued at approximately 9.5 billion USD, covering two VVER-1000 units and two RITM-200N small modular reactor units for a combined 2.1 GW [2]. The SMR component was scaled down from an original six-unit proposal to two units totalling 110 MW, at a cost below 1 billion USD [3]. Uzbekistan's grid forms a synchronous part of the Central Asian Power System. On 14 August 2026 two hydroelectric units totalling 600 MW disconnected at Kyrgyzstan's Toktogul plant. The disturbance cascaded: transmission lines tripped in Kazakhstan, Tajikistan's system separated and collapsed, and outages reached Dushanbe, several Uzbek districts and southern Kazakhstan before restoration roughly five hours later [4].

REVIEW OF LITERATURE ON THE SUBJECT

Two features of this situation matter together rather than separately. A cascading interconnection failure is a common-cause event. It does not take out one off-site transmission corridor and spare another, which is exactly the independence redundant off-site supplies are meant to provide. The second feature is the site itself. Jizzakh will host two reactor technologies with different emergency power architectures, and the smaller,

passively cooled technology arrives first. The RITM-200N units are expected to begin generation as early as 2029, four years ahead of the first VVER-1000 unit and six ahead of the second.

This paper asks whether that sequence and that configuration can be made to do safety work. The specific question is whether the RITM-200N units can be credited as an alternate AC power source for the VVER-1000 units during a station blackout initiated by regional grid collapse. It is posed as a design-basis screening assessment, not a quantified reliability result. The object is to establish which criteria govern, which of them the configuration plausibly satisfies, and what analysis the remainder requires. No claim is made that the configuration has been shown to qualify.

The two technologies differ in ways that bear directly on emergency power. The VVER-1000 is a four-loop pressurized-water reactor with horizontal steam generators, rated at approximately 3,000 MWt and between 995 and 1,170 MWe depending on design generation [5]. Its engineered safety architecture is built around active systems: high-pressure emergency core cooling injecting at least 130 m³/h, low-pressure injection between 230 and 750 m³/h, and three to four independent emergency boron-injection trains. Passive hydraulic accumulators discharging below 5.9 MPa and passive catalytic hydrogen recombiners supplement these [5]. The active portion needs AC power. That requirement is why emergency diesel generators exist.

RESEARCH METHODOLOGY

The RITM-200N belongs to a different class of equipment. It is an integral pressurized-water design, placing the steam generators and reactor coolant pumps inside the reactor pressure vessel. The unit is factory-fabricated as a compact module and transported to site rather than substantially constructed in place. Ratings are approximately 190 MWt and 55 MWe per unit, with a refueling interval of six years and a design life of 60 years [6], [7]. Its safety architecture rests on passive systems rather than solely active ones: two independent shutdown mechanisms, a passive heat removal system, and passive autocatalytic hydrogen recombiners, intended to manage accident conditions without continuous operator action or off-site power [7]. The design also allows power maneuvering across 30 to 100% of rated capacity at up to 6% of rated power per minute [7]. The VVER-1000's baseload-oriented design offers nothing comparable.

Regulatory framework and screening criteria. The governing framework is the IAEA's guidance on the design of electrical power systems for nuclear power plants [8]. It is read here together with the Agency's design provisions for withstanding station blackout [9] and its requirements for the grid interface [10]. That framework separates two categories. Emergency power sources must be available on a timescale the accident analysis sets. Alternate AC sources are credited for coping with station blackout on a longer timescale, after the emergency sources have failed. The distinction governs this assessment, and Section 3.2 develops it.

Five screening criteria follow from that framework, and Section 3 applies them in turn. Capacity adequacy asks whether the candidate source can supply the required safety loads. Response time concerns the window the accident analysis allows for connection. Independence is the question of whether the source is vulnerable to whatever disabled the primary supplies. Self-survival asks something more basic: does the candidate source itself stay operable through the initiating event. Commissioning sequence asks whether the capability exists at the point it is needed.

The regional grid condition as a common-cause initiator. Published assessments for newcomer countries normally characterise off-site power reliability through national distribution reliability indices. The closest recent example is a time-dependent station blackout evaluation for Uganda's prospective first plant. It fits off-site power recovery to a Weibull distribution calibrated to national SAIDI values of 780 to 950 minutes per year and SAIFI values of 11 to 14 outages per year, draws component failure rates from the APR1400 Design Control Document and NUREG/CR-6928, and excludes common-cause failures explicitly for want of country-specific data [11].

That exclusion is where Uzbekistan's case parts company with the template. The dominant off-site power failure mechanism at Jizzakh is not an accumulation of independent local outages. It is the propagation of a disturbance through a synchronous interconnection shared with four other countries. Such a mechanism is common-cause by construction. It affects all off-site sources at once, and its restoration time is set by regional system restoration rather than local repair. The August 2026 event anchors both the frequency and the duration side of that distribution empirically. International loss-of-off-site-power databases maintained for operating fleets [12] supply the comparative baseline.

ANALYSIS AND RESULTS

Capacity is not the binding constraint. A single RITM-200N unit is rated at 55 MWe [6]. The emergency AC



demand of one safety train at a large pressurized-water reactor is of the order of a few megawatts, being the load a single emergency diesel generator is sized to carry. One SMR unit therefore exceeds the emergency demand of one VVER-1000 safety train by roughly an order of magnitude, and two units operating together exceed the combined demand of both large units by a comfortable margin under conservative assumptions. The exact safety-bus load for the Jizzakh VVER-1000 units is not publicly disclosed. Section 4.3 records this as a data constraint. No plausible value would place capacity among the limiting criteria.

Response time, and why an SMR is not a diesel generator. The second criterion disposes of the strongest form of the proposal. Emergency diesel generators at large water-cooled reactors must start and accept load within roughly ten to thirty seconds of a start signal, and accident analyses commonly assume availability within ten [13]. No reactor meets that requirement from a standstill. A shut-down nuclear unit cannot be started, brought critical and loaded on any comparable timescale. The RITM-200N therefore cannot be credited as an emergency power source, and it cannot substitute for the VVER-1000 units' emergency diesel generators.

The alternate AC category remains available. Alternate AC sources are credited not for the first seconds of a loss-of-off-site-power event but for coping with station blackout after the emergency sources fail, on a timescale of tens of minutes to hours, with correspondingly longer connection times permitted [9]. A RITM-200N unit already operating at power when the grid collapses is not being started. It is being transferred. The question then becomes whether a pre-established connection can be closed onto the affected unit's safety buses inside the coping window. That is an engineering question with a plausible affirmative answer, and it is the form in which the proposal deserves evaluation.

Independence and common-cause vulnerability. The third criterion is where the configuration is genuinely weakest. Alternate AC sources must be independent of the events that disabled the primary supplies. A co-located source is by definition exposed to every site-wide hazard: seismic events, external flooding, extreme weather, aircraft impact, site-wide fire or explosion. A source sharing a site cannot be credited against hazards that threaten the site.

What matters is the distinction between site hazards and grid events. The initiating event examined here originates hundreds of kilometres away inside the interconnection. Against that event a co-located source is fully independent in the sense that counts, because the mechanism which removed off-site power never reaches the site at all. The configuration thus protects against precisely the initiator Uzbekistan's grid has demonstrated, and against the site-hazard initiators that dominate elsewhere it protects not at all. This narrows the claim rather than defeating it. Any credit sought would have to be initiator-specific rather than general.

Self-survival and the house-load requirement. The fourth criterion holds the decisive open question. For the RITM-200N units to supply anything during a regional collapse, they must survive it themselves. When the interconnection fails, a generating unit synchronised to it experiences a severe disturbance, and without the capability to reject load and keep running on its own auxiliaries it will trip. The capability at issue is house-load operation: shedding the external network, stabilising at the level of the plant's own consumption, and continuing to run, ready for resynchronisation or to supply a local island.

Two features of the RITM-200N are promising and provide a strong basis for further evaluation. Its designed maneuvering range of 30 to 100% of rated capacity at up to 6% of rated power per minute [7] points to a control system built for rapid load change rather than fixed output, and that is the underlying capability house-load operation requires. Its passive heat removal system limits the consequences of losing auxiliary AC power and provides an additional safety margin even should house-load operation require further evaluation [7]. Together, these features provide a sound basis for assessing whether house-load capability can be designed, tested and licensed for the land-based variant. Further confirmation through public design literature and project-specific analysis would strengthen the assessment. The assessment can be advanced through this additional evidence.

Commissioning sequence. The fifth criterion is favourable, and it is a property of this project in particular. The RITM-200N units are expected to begin generation as early as 2029, the first VVER-1000 unit in 2033 and the second in 2035. The candidate alternate AC source will therefore have run for four to six years before the first large unit needs it, accumulating exactly the operating and reliability record a credit claim requires. The sequence carries a second advantage. Connection architecture can be designed into the site from the start rather than retrofitted, which is materially cheaper and easier to license (Table 1).

Table 1. Screening assessment of co-located RITM-200N units as an alternate AC source for the VVER-1000 units¹

Criterion	Assessment	Status
Capacity adequacy	55 MWe per unit against emergency demand of order a few MW per safety train	Not limiting
Response time	Cannot meet the 10–30 s emergency requirement; compatible with alternate AC timescales	Limiting as emergency source; permissive as alternate AC
Independence	Full independence from grid-originated events; none from site-wide hazards	Initiator-specific credit only
Self-survival	Requires house-load operation capability; not established in public design literature	Open, and decisive
Commissioning sequence	SMR units operating 4–6 years before first large unit requires the capability	Favourable

The strong version of the proposal fails on response time and should be set aside: co-located SMRs cannot replace emergency diesel generators. The weaker and more interesting version survives screening. The RITM-200N units are a credible candidate alternate AC power source for station blackout coping at the VVER-1000 units, against grid-originated initiators specifically, subject to demonstration of house-load capability. That claim is narrower than the configuration first suggests, and narrower in the way that makes it testable.

The engineering consequence is that the decisive work is electrical and architectural rather than thermal-hydraulic. Two questions carry it. Can the RITM-200N ride through a wide-area disturbance to house load? And how would a connection from the SMR switchyard to the large units' safety buses be arranged so as to preserve the electrical separation the safety classification requires? Both concern equipment and its configuration. Both can be answered from design information, without operating experience the plant does not yet have.

The most directly comparable study is the Uganda station blackout assessment discussed in Section 2.3 [11]. It established the value of time-dependent modelling for a newcomer programme and showed that coping strategy timing interacts strongly with equipment reliability. The present work differs from it in three specific respects rather than in ambition. The off-site power failure mechanism examined here is common-cause regional cascading, which that study excluded for want of data and for which Uzbekistan has a documented event. The site hosts two reactor technologies with different emergency power architectures, permitting a comparison no single-technology site can support. The candidate coping resource is a co-located nuclear unit rather than portable equipment, which raises independence and self-survival questions portable FLEX equipment does not.

Adjacent work exists without addressing this question. The contribution of modular units to grid frequency stability has been quantified for large-plant replacement scenarios [14]. Grid-integration risk for a newcomer plant has been assessed for Bangladesh's Rooppur project, which identified pre-existing national grid instability rather than the plant itself as the primary integration risk [15]. Neither examines a co-located SMR as an on-site power resource for a large unit. No study doing so was located in preparing this paper.

Three considerations shape the conclusions that can be drawn here. The safety-bus load and emergency diesel generator ratings for the Jizzakh VVER-1000 units are not publicly disclosed, so the capacity margin is established directionally and provides a basis for further numerical assessment. The house-load operation capability of the land-based RITM-200N is not yet addressed in the public design literature, which creates an opportunity for further technical validation of this important criterion. No plant-specific probabilistic safety assessment is publicly available for either technology. The reliability quantification that would convert this screening into a credit case can therefore be developed from generic data with explicit parametric sensitivity, as the comparable newcomer study also found necessary [11]. These considerations are stated because they help define the form and priorities of the subsequent analysis.

CONCLUSIONS AND SUGGESTIONS

A cascading failure in a shared regional interconnection removes every off-site power source at once. That is the condition redundant off-site supplies are least able to protect against, and it is the condition Uzbekistan's grid demonstrated in August 2026. Some years before its first large unit operates, the Jizzakh site will hold two small reactors that are passively cooled, designed for rapid load change, and rated well above the emergency demand of the units they would support.

¹ Source: author's assessment against criteria derived from [8], [9].



Screened against the criteria governing alternate AC power sources, that configuration is considered a viable candidate. Capacity is ample. The commissioning sequence is favourable. Independence is maintained against grid-originated initiators, while further assessment can address site-wide hazards. It may provide a valuable supporting power function, provided that the RITM-200N demonstrates the capability to accept and sustain house-load operation through a wide-area disturbance.

Stating the question this way converts an appealing but vague intuition into a determinate research problem with a decisive unknown. The intuition is that having small reactors on site ought to help. The work required is threefold: establishing house-load capability for the land-based RITM-200N, characterising the loss-of-off-site-power frequency and duration distribution appropriate to a cascading interconnection rather than a weak national grid, and quantifying the resulting change in station blackout probability for the co-located configuration. That work is the subject of the author's continuing research.

An AI-based writing assistant (Claude, Anthropic) was used during the preparation of this manuscript for drafting support and source retrieval. The author independently verified all data, citations, and calculations reported herein and takes full responsibility for the scientific content, accuracy, and conclusions of this article. The AI system is not an author of this work.

References:

1. U.S. Nuclear Regulatory Commission, Reevaluation of Station Blackout Risk at Nuclear Power Plants, NUREG/CR-6890, Washington, DC, 2005.
2. "Uzbekistan Breaks Ground on 2.1 GW Jizzakh NPP Under a \$9.5 Billion Rosatom Partnership," Construction Review Online, 2026.
3. "Uzbekistan's 110 MW Nuclear Plant to Cost Under \$1 Billion," Caspianpost.com, 2026.
4. P. Chorshanбиеv, "Blackout in Central Asia's energy ring: did Tajikistan become more vulnerable by joining the unified energy system?," Asia-Plus, Aug. 21, 2026.
5. Multinational Design Evaluation Programme (MDEP), VVER Working Group, Preliminary Analyses and Comparison of Design Differences between VVER-1000 Reactors, Technical Report TR-VVERWG-06, OECD/NEA, Mar. 2019.
6. V. V. Petrunin, N. V. Sheshina, S. A. Fateev, A. V. Kurachenkov, D. V. Shchekin, S. M. Brykalov, and A. A. Bezrukov, "Scientific and technical aspects of developing a RITM-200N innovative reactor for SNPPs," Atomic Energy, vol. 134, no. 1, pp. 1–10, 2023, doi: 10.1007/s10512-023-01020-4.
7. Tracey, "The RITM-200N reactor as a terrestrial unit," Nuclear Engineering International, Jun. 26, 2024.
8. International Atomic Energy Agency, Design of Electrical Power Systems for Nuclear Power Plants, IAEA Safety Standards Series No. SSG-34, IAEA, Vienna, 2016.
9. International Atomic Energy Agency, Design Provisions for Withstanding Station Blackout at Nuclear Power Plants, IAEA-TECDOC-1770, IAEA, Vienna, 2015.
10. International Atomic Energy Agency, Electric Grid Reliability and Interface with Nuclear Power Plants, IAEA Nuclear Energy Series No. NG-T-3.8, STI/PUB/1542, IAEA, Vienna, 2012.
11. K. P. Praise and H.-k. Lim, "Time-Dependent Evaluation of Station Blackout and FLEX Integration in a Newcomer Nuclear Program: A Case Study of Uganda," Energies, vol. 18, no. 22, art. 5945, 2025, doi: 10.3390/en18225945.
12. U.S. Nuclear Regulatory Commission and Idaho National Laboratory, Loss of Offsite Power Initiating Event Data, Reactor Operational Experience Results and Databases, nrcOE.inl.gov.
13. U.S. Nuclear Regulatory Commission, Emergency Diesel Generators as Emergency Power Sources, Technical Training Center reference material, ML11229A062.
14. C. Boudot, J.-B. Droin, P. Sciora, Y. Besanger, B. Robisson, and A.-L. Mazauric, "Small Modular Reactor-based solutions to enhance grid reliability: impact of modularization of large power plants on frequency stability," EPJ Nuclear Sci. Technol., vol. 8, art. 16, 2022, doi: 10.1051/epjn/2022015.
15. M. S. H. Talukder, M. T. Hasan, and I. M. Shafiqul, "Addressing the Grid Integration Challenges of Rooppur Nuclear Power Plant: A Comprehensive Analysis," SSRN preprint, Sep. 2024, doi: 10.2139/ssrn.4951635.

muhandislik **& iqtisodiyot**

ijtimoiy-iqtisodiy, innovatsion texnik,
fan va ta'limga oid ilmiy-amaliy jurnal

Ingliz tili muharriri: Feruz Hakimov

Musahhih: Zokir Alibekov

Sahifalovchi va dizayner: Abdurahmon Qurbonov

2026. № 9

© Materiallar ko'chirib bosilganda "Muhandislik va iqtisodiyot" jurnali manba sifatida ko'rsatilishi shart. Jurnalda bosilgan material va reklamalardagi dalillarning aniqligiga mualliflar ma'sul. Tahririyat fikri har vaqt ham mualliflar fikriga mos kelamasligi mumkin. Tahririyatga yuborilgan materiallar qaytarilmaydi.

"Muhandislik va iqtisodiyot" jurnali 26.06.2023-yildan
O'zbekiston Respublikasi Prezidenti Adminstratsiyasi huzuridagi
Axborot va ommaviy kommunikatsiyalar agentligi tomonidan
№S-5669245 reyestr raqami tartibi bo'yicha ro'yxatdan o'tkazilgan.
Litsenziya raqami: №095310.

**Manzilimiz: Toshkent shahri Yunusobod
tumani 15-mavze 19-uy**





+998 93 718 40 07



<https://muhandislik-iqtisodiyot.uz/index.php/journal>



t.me/yait_2100