

4-2-2024

IMPLEMENTING A SOLAR PHOTOVOLTAIC STATION IN WATERING SYSTEMS UTILIZING COMPLEX SOFTWARE

Akbarxon Sarvar o'g'li Uroqov

Tashkent State Technical University, Tashkent, Republic of Uzbekistan, Student,
urakovakbar12@gmail.com, <https://orcid.org/0009-0005-5810-0762>; urakovakbar12@gmail.com

Faxriddin Jaylovovich Nosirov

Tashkent State Technical University, Tashkent, Republic of Uzbekistan, Doctor of Technical Sciences,
Professor, <https://orcid.org/0000-0003-3295-8187>; nosirov-0173@mail.ru

G'olibjon Pardayevich Arzikulov

Tashkent State Technical University, Tashkent, Republic of Uzbekistan, Candidate of Mathematical
Sciences, Associate Professor, azikulov79@mail.ru, <https://orcid.org/0000-0001-9066-0595>;

Follow this and additional works at: <https://btstu.researchcommons.org/journal>

Zarina Amriddin qizi Sayfutdinova

Part of the [Aerospace Engineering Commons](#), [Biomedical Engineering and Bioengineering Commons](#),
Tashkent State Technical University, Tashkent, Republic of Uzbekistan, Student,
zarinasayfutdinova305@gmail.com, <https://orcid.org/0009-0009-1596-1342>,
[Civil and Environmental Engineering Commons](#), [Electrical and Computer Engineering Commons](#),
[Environmental Engineering Commons](#), and the [Mechanical Engineering Commons](#)

Recommended Citation

Uroqov, Akbarxon Sarvar o'g'li; Nosirov, Faxriddin Jaylovovich; Arzikulov, G'olibjon Pardayevich; and Sayfutdinova, Zarina Amriddin qizi (2024) "IMPLEMENTING A SOLAR PHOTOVOLTAIC STATION IN WATERING SYSTEMS UTILIZING COMPLEX SOFTWARE," *Technical science and innovation*: Vol. 2024: Iss. 1, Article 8.

DOI: <https://doi.org/10.59048/2181-0400>

E-ISSN: 2181-1180

.1554

Available at: <https://btstu.researchcommons.org/journal/vol2024/iss1/8>

This Article is brought to you for free and open access by Technical Science and Innovation. It has been accepted for inclusion in Technical science and innovation by an authorized editor of Technical Science and Innovation. For more information, please contact urajapbaev@gmail.com.

Print ISSN 2181-0400
Online ISSN 2181-1180

**TECHNICAL SCIENCE
AND INNOVATION**

**TEXNIKA FANLARI
VA INNOVATSIYA**

**ТЕХНИЧЕСКИЕ НАУКИ
И ИННОВАЦИЯ**

№1/2024

Tashkent 2024

Founder:

TASHKENT STATE
TECHNICAL UNIVERSITY
NAMED AFTER ISLAMA KARIMOV

**The Chief Editor and Chairman
of the Editorial Board:**

TURABDJANOV Sadriddin Maxamatdinovich

Assistants:

DONAEV Sardor Burkhanovich,
ZARIPOV Oripjon Olimovich

The Executive Secretares:

MAKHMAREZHABOV Dilmurod Bakhtiyarovich
MATYOKUBOV Nurbek Rustamovich

Editorial board:

B.Sh.Kedelbaev (Kazakhstan), N.R.Prokapchuk (Belarus), Sh.Sultanova, G.Ixtiyarova, R.Ismoilov, Gürbüz Güneş (Turkey), Yu.Li (China), Ait-Kaddour Abderrahmane (Turkey), Sh.Ne'matov, I.Tadjibayev, V.S.Kublanov(Russia), V.Quvondiqov, T.Mag'rupov, Z.M.Yuldashev (Russia), V.Kovalev (Belarus), Marius Mohr (Germany), E.Egamberdiyev, M.Musaev, N.Makhmudov, Sh. Narziev, Elena Alexandrovna Timofeeva (Russia), S.J.Galiev (Kazakhstan), M.G.Rakhutin (Russia), A.Qayumov, J.Toshov, S.Gaibnazarov, S.Sayyidqosimov, S.Matkarimov, A.A.Vercheba (Russia), Sh.Ochilov, B.Boymirzaev, D.Gorobtsov (Russia), Q.Allaev, N.Yusupbekov, Peter Schegner (Germany), N.Zikrillayev, I.Rakhmonov, D.Tashmuhammedova, Vitaly Shimansky (Russia), Kirill Nekrasov (Russia), Sanjiv Gupta (India) I.Siddikov, Sh.Latibov, R.Babakhodjaev, B. Umirzakov, Dj.Yusupov, J.Sevinov, A. Turg'unboev, G.Boboev, G. Mavlonov, U.Mamirov, M.Bobojonov, R.Karimov, T.Gayibov, N.Pirmatov, Ekkehard Bolte (Germany), Steffen Grossmann (Germany), B.K.Aliyarov (Kazakhstan), Nishiyama Kiyohisa, Sh.Shoobidov, N.Turakhodjaev, A.P.Kartoshkin (Russia), J.Safarov, Q.Mirzayev, A.Abduazimov, K.Karimov, N.Dunyashin, D.Samandarov, Kim, Ki Buem (Korea), Sang-Young Shin (Korea), Ruizhi Wu (China), S.L.Rovin (Belarus).

Our address:

Tashkent 100095, Universitet str., 2

Phone:

71-246-92-35

Journal Homepage:

<https://btstu.researchcommons.org/journal/>

E-mail:

tdtjournal@mail.ru

Telegram:

https://t.me/tsi_TSTU

The materials published in the present journal, cannot be reproduced in full or in part without the written permission of edition. The opinion of edition not always coincides with opinion of authors. For reliability of data submitted in journal, the responsibility lies with articles authors and advertisers.

C O N T E N T S**CHEMISTRY AND CHEMICAL TECHNOLOGY**

- N.Z.Saydalieva.** Globular Protein For Surface Modification of Cellulose-Containing Materials 5
V.D.Khamidova. Dying of Natural Silk Deglued by Various Methods. 10
Kh.Sh.Sultonov, Sh.T.Khojiev, G.B.Beknazarova, M.S.Saidova. Selective Oxidation of Iron in Chalcopyrite For Enhanced Copper Recovery 15

CIVIL AND ENVIRONMENTAL ENGINEERING

- R.M.Rakhimov.** Solving Water Resources Problems - Water Saving in the Republic of Uzbekistan 21
A.X.Rasulev, S.S.Sulaymanov, N.B.Gaibnazarova. Theory of Development and Improvement of the Mathematical Model of the Methodology of Public Control in the Management of Occupational Safety and Industrial Risks 25

GEOLOGICAL ENGINEERING

- M.N.Juraev, A.R.Almordonov, B.U.Mukhammadiev.** Ore-Generating Role of the Focal Structure During the Formation of Apogranitoid Tungsten Mineralization at the Yakhton Deposit 29

ELECTRICAL AND COMPUTING ENGINEERING

- Sh.A.Sultanova, J.E.Safarov, A.A.Mambetsheripova.** Modelling of Heat Transfer in an Air Solar Collector 37

THERMAL ENERGY AND POWER ENGINEERING

- F.J.Nosirov, A.S.Uroqov, G.P.Arzikulov, Z.A.Sayfutdinova.** Implementing a Solar Photovoltaic Station in Watering Systems Utilizing Complex Software 44
M.O.Gafurova, K.G.Abidov. Electromagnetic Field Model as a Source of Water Cavitation Energy 51
A.I.Mirolimov, X.M.Iliev. Research of The Influence of Dust on Photovoltaic Modules 56
N.B.Pirmatov, D.R.Abdullabekova. Use of Mathematical Skills For Technical Condition Assessment of Power Autotransformers 60

MECHANICAL ENGINEERING

- Yu.A.Akhmedjanov.** Experimental Studies on Determination of Loading and Laws of Motion of the Accelerator of the Raw Material Chamber of the Saw Gin 66

CONTROL OF TECHNOLOGICAL PARAMETERS

- O.V.Tuyboyov.** Quantitative Assessment and Characterization of Tool Wear Phenomena in Advanced Manufacturing Processes 74
Z.N.Mukhiddinov. A Study on the Influence of Cutting Parameters on Surface Roughness and Visualization Through Contour Plots And 3D Surface Profiles 80

Muassis:ISLOM KARIMOV NOMIDAGI
TOSHKENT DAVLAT
TEXNIKA UNIVERSITET**Bosh muharrir****va tahririyat hay'atining raisi:**
TURABDJANOV Sadridin Maxamatdinovich**Muovinlar:**DONAYEV Sardor Burxonovich,
ZARIPOV Oripjon Olimovich**Mas'ul kotiblar:**MAXMAREJABOV Dilmurod Baxtiyarovich
MATYOKUBOV Nurbek Rustamovich**Tahririyat hay'ati:**

B.Sh.Kedelbaev (Qozog'iston), N.R.Prokapchuk (Belarusiya), Sh.Sultanova, G.Ixtiyarova, R.Ismoilov, Gürbüz Güneş (Turkiya), Yu.Li (Xitoy), Ait-Kaddour Abderrahmane (Turkiya), Sh.Ne'matov, I.Tadjibayev, V.S.Kublanov (Rossiya), V.Quvondiqov, T.Mag'rupov, Z.M.Yuldashev (Rossiya), V.Kovalev (Belarusiya), Marius Mohr (Germaniya), E.Egamberdiyev, M.Musaev, N.Maxmudov, Sh. Narziev, Elena Alexandrovna Timofeeva (Rossiya), S.J.Galiev (Qozog'iston), M.G.Rakhutin (Rossiya), A.Qayumov, J.Toshov, S.Gaibnazarov, S.Sayyidqosimov, S.Matkarimov, A.A.Vercheba (Rossiya), Sh.Ochilov, B.Boymirzaev, D.Gorobtsov (Rossiya), Q.Allaev, N.Yusupbekov, Peter Schegner (Germaniya), N.Zikrillayev, I.Rakhmonov, D.Tashmuhammedova, Vitaly Shimansky (Rossiya), Kirill Nekrasov (Rossiya), Sanjiv Gupta (Hindiston), I.Siddikov, Sh.Latibov, R.Babakhodjaev, B. Umirzakov, Dj.Yusupov, J.Sevinov, A. Turg'unboev, G. Mavlonov, U.Mamirov, M.Bobojonov, R.Karimov, G.Boboyev, T.Gayibov, N.Pirmatov, Ekkehard Bolte (Germaniya), Steffen Grossmann (Germaniya), B.K.Aliyarov (Qozog'iston), Nishiyama Kiyohisa, Sh.Shoobidov, N.Turakhodjaev, A.P.Kartoshkin (Rossiya), J.Safarov, Q.Mirzayev, A.Abdiazimov, K.Karimov, N.Dunyashin, D.Samandarov, Kim, Ki Buem (Koreya), Sang-Young Shin (Koreya), RuiZhi Wu (Xitoy), S.L.Rovin (Belarusiya).

Tahririyat manzili:

100095, Toshkent sh., Universitet ko'chasi 2.

Telefon:

71-246-92-35

Jurnalning bosh sahifasi:<https://btstu.researchcommons.org/journal/>**E-mail:**tdtjournal@mail.ru**Telegram:**https://t.me/tsi_TSTU

Ushbu jurnaldagi chop etilgan materiallar tahririyatning yozma ruxsatisiz to'liq yoki qisman qayta chop etilishi mumkin emas. Tahririyatning fikri mualliflar fikri bilan har doim ham mos tushmasligi mumkin. Jurnaldagi yoritilgan materiallarning haqqoniyligi uchun maqolalarning mualliflari va reklama beruvchilar mas'uldirlar.

MUNDARIJA**KIMYO VA KIMYOVIY TEXNOLOGIYA**

- N.Z.Saydaliyeva.** Sellyuloza asosidagi to'qimachilik materiallarini yuzaviy modifikatsiyalash uchun globulyar oqsil 5
- V.D.Xamidova.** Turli usullar bilan yelimsizlantirilgan tabiiy ipakni bo'yash 10
- H.Sh.Sultonov, Sh.T.Hojiev, G.B.Beknazarova, M.S.Saidova.** Xalkopiritdagi temirni selektiv oksidlash orqali mis ajratib olinish darajasini oshirish 15

FUQAROLIK VA EKOLOGIYA MUHANDISLIGI

- R.M.Raximov.** O'zbekiston Respublikasida suv resurslari muammolarini yechish – suv tejamkorligi 21
- A.X.Rasulev, S.S.Sulaymanov, N.B.Gaibnazarova.** Mehnat havfsizligi va ishlab chiqarish xavflarini boshqarishda xaqiqiy nazorat uslubini matematik modelini ishlab chiqish va takomillashtirish nazariyasi 25

GEOLOGIYA MUHANDISLIGI

- M.N.Jurayev, A.R.Almardonov, B.U.Muxammadiyev.** Yaxton konida apogranit volfram ma'danlashuvining shakllanishida ochag (uyasimon) strukturasi ma'dan xosil bo'lishidagi roli 29

ELEKTROTEXNIKA VA KOMPYUTER MUHANDISLIGI

- Sultanova SH.A., Safarov J.E., Mambetsheripova A.A.** Quyosh kollektorida issiqlik almashinish jarayonini modellashtirish 37

ISSIQLIK ENERGETIKASI VA ENERGETIKA

- F.J.Nosirov, A.S.Uroqov, G.P.Arzikulov, Z.A.Sayfutdinova.** Kompleks dasturiy ta'minotni qo'llagan holda sug'orish tizimida quyosh fotoelektrik stansiyasidan foydalanish 44
- M.O.Gafurova, Q.G.Abidov.** Elektromagnit maydon modeli suvning kavitatsiya energiyasi manbai sifatida 51
- A.I.Mirolimov, X.M.Iliyev.** Fotoelektrik modullarga changni ta'sirini tadqiqot 56
- N.B.Pirmatov, D.R.Abdullabekova.** Kuch avtotransformatorlarining texnik holatini baholash uchun matematik ko'nikmalardan foydalanish 60

MASHINASOZLIK

- Yu.A.Axmedjanov.** Arra djin xom ashyo kamerasi tezlatkichining yuklanishi va harakat qonunlarini aniqlash uchun eksperimental tadqiqotlar 66

TEXNOLOGIK PARAMETRLAR NAZORATI

- O.V.Tuyboyov.** Ishlab chiqarish jarayonlarida kesuvchi asboblarning yeyilishi xarakteristikallari va miqdoriy baholash 74
- Z.N.Muxiddinov.** 3D profilli grafiklar va chiziqli grafiklari vizualizatsiyasi yordamida kesish parametrlarining ishlov berilgan yuzadagi sirt g'adir-budirligiga ta'sirini o'rganish 80

Учредитель:

ТАШКЕНТСКИЙ ГОСУДАРСТВЕННЫЙ
ТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ ИМЕНИ
ИСЛАМА КАРИМОВА

**Главный редактор и председатель
редакционной коллегии:**

ТУРАБДЖАНОВ Садритдин Махаматдинович

Заместители:

ДОНАЕВ Сардор Бурханович,
ЗАРИПОВ Орипжон Олимович

Ответственный секретари:

МАХМАРЕЖАБОВ Дилмурод Бахтиярович
МАТЕКУБОВ Нурбек Рустамович

Редакционная коллегия:

Б.Ш.Кедельбаев (Казахстан), Н.Р.Прокапчук (Беларусь), Ш.Султанова, Г.Ихтиярова, Р.Исмоилов, Gürbüz Güneş (Турция), Ю.Ли (Китай), Ait-Kaddour Abdelgahmane (Турция), Ш.Неъматов, И.Таджибаев, В.С.Кубланов (Россия), В.Кувондинов, Т.Магруппов, З.М.Юлдашев (Россия), В.Ковалёв (Беларусь), Marius Mohr (Германия), Э.Эгамбердиев, М.Мусаев, Н.Махмудов, Ш. Нарзиев, Елена Александровна Тимофеева (Россия), С.Дж.Галиев (Казахстан), М.Г.Рахутин (Россия), А.Каюмов, Ж.Тошов, С.Гайбназаров, С.Сайидкосимов, С.Маткаримов, А.А.Верчеба (Россия), Ш.Очилов, Б.Боймирзаев, Д.Горобцов (Россия), Г.Аллаев, Н.Юсупбеков, Петер Шегнер (Германия), Н.Зикриллаев, И.Рахромонов, Д.Ташмухаммедова, Виталий Шиманский (Россия), Кирилл Некрасов (Россия), Санджив Гулга (Индия), И.Сиддиков, Ш.Латыбов, Р.Бабаходжаев, Б.Умирзаков, Дж.Юсупов, Ж.Севинов, А. Тургунбоев, Г. Мавлонов, У.Мамиров, М.Бободжонов, Р.Каримов, Г.Бобоев Т.Гайбов, Н.Пирматов, Ekkehard Volte (Германия), Steffen Grossmann (Германия), Б.К.Алияров (Казахстан), Нисияма Киёхиса, Ш. Шообидов, Н.Тураходжаев, А.П.Картошкин (Россия), Дж.Сафаров, К.Мирзаев, А.Абдуазимов, К.Каримов, Н.Дуняшин, Д.Самандаров, Ким, Ки Буэм (Корея), Сан Ён Шин (Корея), Руйжи Ву (Китай), С.Л.Ровин (Беларусь).

Адрес редакции:

100095, г. Ташкент, ул. Университетская, 2.

Телефон:

71-246-92-35

Домашняя страница журнала:

<https://btstu.researchcommons.org/journal/>

E-mail:

tdtjournal@mail.ru

Телеграм:

https://t.me/tsti_TSTU

Материалы, опубликованные в настоящем журнале, не могут быть полностью или частично воспроизведены без письменного разрешения редакции. Мнение редакции не всегда совпадает с мнением авторов материалов. За достоверность сведений, представленных в журнале, ответственность несут авторы статей и рекламодатели.

СОДЕРЖАНИЕ**ХИМИЯ И ХИМИЧЕСКАЯ ТЕХНОЛОГИЯ**

- Н.З.Сайдалиева.** Глобулярный белок для поверхностной модификации целлюлозосодержащих материалов..... 5
- В.Д.Хамидова.** Крашение натурального шелка, обесклеенного различными методами..... 10
- Х.Ш.Султанов, Ш.Т.Хожиев, Г.Б.Бекназарова, М.С.Саидова.** Селективное окисление железа в халькопирите для повышения извлечения меди 15

ГРАЖДАНСКАЯ И ЭКОЛОГИЧЕСКАЯ ИНЖЕНЕРИЯ

- Р.М.Рахимов.** Решение проблем водных ресурсов - экономия воды в Республике Узбекистан 21
- А.Х. Расулев, С.Сулайманов, Н.Б.Гайбназарова.** Теория разработки и совершенствования математической модели методологии общественного контроля в управлении охраной труда и производственными рисками..... 25

ГЕОЛОГИЧЕСКАЯ ИНЖЕНЕРИЯ

- М.Н.Жураев, А.Р.Алмордонов, Б.У.Мухаммадиев.** Рудогенерирующая роль очаговой структуры при формировании апогранитоидного вольфрамового оруденения на месторождения Яхтон..... 29

ЭЛЕКТРОТЕХНИКА И ВЫЧИСЛИТЕЛЬНАЯ ТЕХНИКА

- Ш.А.Султанова, Ж.Э.Сафаров, А.А. Мамбетшерипова.** Моделирование теплообмена в воздушной солнечной коллектор.... 37

ТЕПЛОВАЯ ЭНЕРГЕТИКА И ЭНЕРГЕТИКА

- Ф.Ж.Носиров, А.С.Уроков, Г.П.Арзикулов, З.А.Сайфутдинова.** Использование солнечной фотоэлектрической станции в системах полива с применением комплексного программного обеспечения .. 44
- М.О.Гафурова, К.Г.Абидов.** Модель электромагнитного поля как источника кавитационной энергии воды..... 51
- А.И.Миролимов, Х.М.Илиев.** Исследование влияния пыли на фотоэлектрических модулей 56
- Н.Б.Пирматов, Д.Р.Абдуллабекова.** Использование математических навыков для оценки технического состояния силовых автотрансформаторов..... 60

МАШИНОСТРОЕНИЕ

- Ю.А. Ахмеджанов** Экспериментальные исследования по определению нагруженности и законов движения ускорителя сырьевой камеры пильного джина 66

КОНТРОЛЬ ТЕХНОЛОГИЧЕСКИХ ПАРАМЕТРОВ

- О.В.Туйбойов.** Количественная оценка и характеристика явлений износа инструмента в современных производственных процессах . 74
- З.Н.Мухиддинов.** Исследование влияния параметров резания на шероховатость поверхности и визуализация через контурные графеты и 3D профили поверхности 80

IMPLEMENTING A SOLAR PHOTOVOLTAIC STATION IN WATERING SYSTEMS UTILIZING COMPLEX SOFTWARE

F.J.NOSIROV, A.S.UROQOV, G.P.ARZIKULOV, Z.A.SAYFUTDINOVA (Tashkent State Technical University, Tashkent city, Republic of Uzbekistan)*

Received: February 21, 2024; Accepted: March 30, 2024; Online: April 08, 2024;

Abstract: This article explores the benefits of transitioning from traditional agricultural irrigation systems to more cost-effective alternatives powered by renewable energy sources. By integrating solar photovoltaic technology into irrigation processes, significant reductions in resource wastage, estimated at 45-50%, are achievable through the implementation of drip irrigation techniques. This results in enhanced agricultural productivity. Moreover, the utilization of solar panels in green zones mitigates surface temperature increases, contributing to a 2-5% boost in electricity production. Currently, irrigation facilities primarily rely on the main energy grid. However, transitioning to renewable energy sources decreases reliance on non-renewable fuels, reduces greenhouse gas emissions, and fosters ecological improvements. Photoelectric stations offer an eco-friendly and economical electricity source, enhancing the Republic's power system. Grid-connected photovoltaic plants alleviate strain on the grid and fully satisfy the energy demands of irrigation pumps. Design analyses of a solar photovoltaic plant were conducted utilizing the PVsyst program to ascertain its capacity to power pumping stations and determine solar energy potential.

Keywords: solar energy, grid-connected photovoltaic plant, irrigation, pumping, drought, ecology, PVsyst, metenorm

Annotatsiya: Ushbu maqolada bugungi kundagi qishloq xo'jaligi tizimlarini tubdan yangi tejamkor sug'orish tizimlariga o'zgaritish, sug'orish uskunalari talab qiladigan elektr energiyasini qayta tiklanuvchi energiya qurilmalari orqali qoplash va uning ko'rsatadigan ijobiy ko'rsatgichlari o'rganildi. Tomchilatib sug'orish orqali sug'orish maydonlari talab qiladigan sug'orish resurslari isrofini 45-50% ga kamaytirish va qishloq xo'jaligi ekinlarini yetishtirishdagi hosildorlikni oshishini ko'rishimiz mumkin. Qolaversa, yashil zonalarga o'rnatilgan quyosh panellari sirtida harorat oshishi kamayadi. Elektr energiyasi ishlab chiqarish 2-5 % ga ortadi. Bugungi kunda sug'orish inshootlari asosiy tarmoqqa ulangan holda faoliyat ko'rsatadi. Asosiy tarmoqda energiya iste'moli kamaysa, qayta tiklanmaydigan yoqilg'ilar yoqilishi kamayadi, atmosferaga chiqariladigan issiqxona gazlari hajm ko'rsatkichi pastlaydi, ekologik tizim yaxshilanadi. Fotoelektrik stansiyalar ekologik toza va arzon elektr energiyasi manbai hisoblanadi va ulardan foydalanish Respublika elektr tizimini yaxshilashga xizmat qiladi. Tarmoq fotoelektrik stansiyalari tarmoqning yuklamasini kamaytiradi, sug'orish nasoslari ta'lab qiladigan energiyani to'laligicha qoplaydi. Nasos stansiyalari elektr energiyasini qoplash uchun PVsyst dasturi orqali quyosh fotoelektrik stansiyasi loyihalash ishlari bajarildi, quyosh energetik potentsiali aniqlandi.

Kalit so'zlar: quyosh energetikasi, tarmoq fotoelektrik stansiyasi, sug'orish, nasos, qurg'oqchilik, ekologiya, PVsyst, metenorm.

Аннотация: В данной статье рассматриваются преимущества перехода от традиционных сельскохозяйственных систем полива к более экономически эффективным альтернативам, работающим на возобновляемых источниках энергии. Путем интеграции солнечной фотоэлектрической технологии в процессы полива достигается значительное сокращение потребления ресурсов, оцениваемое в 45-50% благодаря использованию техники капельного полива. Это приводит к повышению сельскохозяйственной продуктивности. Более того, использование солнечных панелей в зеленых зонах снижает повышение температуры на поверхности, что способствует увеличению производства электроэнергии на 2-5%. В настоящее время средства полива в основном зависят от основной энергетической сети. Однако переход к возобновляемым источникам энергии снижает зависимость от нефтяных топлив, уменьшает выбросы парниковых газов и способствует экологическим улучшениям.

*Nosirov Faxriddin Jaylovovich – Doctor of Technical Sciences, Professor, <https://orcid.org/0000-0003-3295-8187>;

Uroqov Akbarxon Sarvar ugli – Student, urakovakbar12@gmail.com, <https://orcid.org/0009-0005-5810-0762>;

Arzikulov Golibjon Pardayevich – Candidate of Mathematical Sciences, Associate Professor, azikulov79@mail.ru, <https://orcid.org/0000-0001-9066-0595>;

Sayfutdinova Zarina Amridin qizi – Student, zarinasayfutdinova305@gmail.com, <https://orcid.org/0009-0009-1596-1342>.

Фотоэлектрические станции предлагают экологически чистый и экономичный источник электроэнергии, улучшая энергетическую систему Республики. Подключенные к сети фотовольтаические установки снижают нагрузку на сеть и полностью удовлетворяют энергетические потребности насосов для полива. Проектирование солнечной фотоэлектрической установки проводилось с использованием программы PVsyst для определения ее способности обеспечивать энергией насосные станции и оценки потенциала солнечной энергии.

Ключевые слова: солнечная энергия, подключенная к сети фотовольтаическая установка, полив, насос, засуха, экология, PVsyst, метенорм.

Introduction

Since the onset of the 19th century, non-renewable natural resources such as oil, gas, and uranium have been utilized as primary energy sources. Thus far, these non-renewable resources have comprised nearly 90% of the global energy system. Emissions of various gases and harmful substances from conventional power plants have exerted significant environmental impacts. By 2024, the conservation of water resources, freshwater scarcity, and drought are projected to emerge as primary concerns for numerous regions worldwide. Moreover, the ongoing growth of the population in our Republic is amplifying the demand for water resources. The escalating population necessitates increasing investments in agriculture annually, contributing to poverty alleviation efforts in developing countries. Notably, the primary focal points on the agenda encompass achieving food security, enhancing nutrition, and fostering economic growth and development [8,9,10]. Concerning water supply, merely 20% of the water resources utilized by the Republic of Uzbekistan are sourced within its territorial boundaries. The remaining 80% originates from neighboring Tajikistan and Kyrgyzstan and is integrated into the water resources of the Republic.

Observations of temperature dynamics in the republic indicate a yearly increase of 0.22 C° in maximum temperature and a decrease of -0.36 C° in minimum temperature. Extrapolating from these findings, it is projected that after 20 years, the average annual temperature in the northern part of the republic will rise by 2-3 C°, while in the southern part, it will increase by 1 C°. This climate change scenario is expected to lead to a 10-15% rise in water evaporation from water surfaces and a 10-20% increase in water usage due to elevated rates of plant transpiration and irrigation. Consequently, this would result in an average rise in water consumption by 18%. [18,19,20]

Water resource sustainability in the republic is facing challenges in two main directions: firstly, the inadequacy of clean drinking water for the population and significant issues in supplying water resources for agricultural purposes. There are approximately 4.3 million hectares of arable land in the country (the total irrigated area in Central Asia is 7.9 million hectares, with Uzbekistan's share being approximately 55%).

Ninety percent of the country's water resources are utilized in agricultural production. As noted, approximately 20% of the water used in the country is sourced within the borders of the republic, while the remaining 80% is sourced from transboundary rivers - the Amu Darya and the Syr Darya. On average, 44-48 billion m³ of water are used annually in the country, with the majority, or 85%, allocated for agricultural irrigation purposes. According to experts, at present, 46 billion m³ of water are utilized for 3.2 million hectares of land, with 60% of it supporting crop cultivation. Approximately 23% of the total 180 thousand kilometers of irrigation networks are concrete-lined and have remained largely unchanged for 30-35 years. However, efficient utilization of water necessitates the implementation of water-saving technologies, particularly through the adoption of drip, sprinkler, and plastic film and tube-based irrigation methods. [4,19] Drip irrigation is a method of irrigation where water is delivered directly to the root zone of the plant in quantities equal to its demand. Unlike other irrigation methods, drip irrigation supplies water to the plant along the root zone in a controlled manner. Areas where crops are located within the irrigation field are uniformly irrigated. Excessive soil moisture does not occur, and erosion is minimized. [15,16]

In drip or sprinkler irrigation systems, pump units are utilized to generate the required pressure in the system and deliver the necessary amount of water to each point of the system. Drip irrigation systems are widely used in agricultural fields based on the location, size, and type of crops. Various types of pump units with different power ratings, which operate on electric power, are extensively employed in these systems. However, due to the conventional placement of agricultural consumers far from the grid, significant energy losses, incorrect metering of consumers, and other shortcomings in energy accounting are common in rural electrification systems. These deficiencies exacerbate the level of CO₂ emissions and contribute to the increase in the carbon footprint of the energy produced by thermal power plants. To mitigate losses in electric energy transportation, the establishment of nearby photovoltaic power stations for irrigation areas is being considered. The construction and integration of photovoltaic stations into the grid contribute to the

optimization of the Republic's energy system. [7,13,17]

Research Methods and the Received Results

To develop a photovoltaic station project, it is necessary to calculate the solar energy resources for the area where the station is located. This factor is considered necessary for calculating the installed capacity of the station. At a given point on the Earth's surface, denoted as $A(\varphi^0, \psi^0)$, the solar energy total potential concept typically refers to the average annual amount of solar radiation received on a horizontal receiving surface of 1 square meter over the course of one calendar year. This is denoted $E_{val}^G = (\frac{kW \cdot hour}{m^2 \cdot year})$ For all territories of FIC (MDH) countries, we utilize the well-known Angstrom formula for calculating $E_{val}^G(S)$ and E_{val}^G for an area S (km²) based on average monthly or average daily solar radiation data at point $A(\varphi^0, \psi^0)$.

$$E_{fakt}^G(\Delta t) = E_{ya}^G(\Delta t) * (a + b * \frac{T_{cc}^{fakt}}{T_{ss}^0}) \quad (1)$$

$$R_{pr}^G = R_{pr}^G(AM1) \cdot \left(\frac{R_{pr}^G(AM1)}{R_0}\right)^{AMm-1} = 1000 \cdot \left(\frac{1000}{1360}\right)^{AMm-1} \quad (3)$$

in this context, $R_{pr}^G(AM1)(\frac{W}{m^2})$ represents the standart interval power of solar radiation for a horizontal receiving surface at sea level in the southern latitudes of the Earth under clear atmospheric conditions. R_0 (W/m²) = 1360 W/m² –

$$m(\Delta t) = \frac{2}{\sqrt{\cos^2\theta(\Delta t) + \frac{2 \cdot L_a}{r_3} + \cos\theta(\Delta t)}} \cong \frac{2}{\sqrt{\cos^2\theta(\Delta t) + 0.06 + \cos\theta(\Delta t)}} \quad (4)$$

value of $\cos\theta(\Delta t)$ (according to 2) is

$$\cos\theta^0(\Delta t) = \sin\delta^0(\Delta t) \cdot \sin\varphi^0 + \cos\delta^0(\Delta t) \cdot \cos\varphi^0 \cdot \frac{\sin\omega_c}{\omega_c} \quad (5)$$

Here, $\cos\theta(\Delta t)$ (degr.) represents the average inclination angle of solar incidence during the time interval Δt . $\delta^0 = \delta^0(\Delta t)$ denotes the solar declination, determined within the time interval Δt using the Kupper formula:

$$\delta^0(\Delta t) = \delta_0 \cdot \sin\left(\frac{360}{365} \cdot (284 + n)\right) \quad (6)$$

here, $\delta_0 - 23^027' = 23.45^0$

In practical applications worldwide, the modified version of the Angstrom formula as presented above is often utilized, employing the Pejdo formula for its refinement.

$$E_{fakt}^G(\Delta t) = E_0^G(\Delta t) \cdot \left(a + b \cdot \frac{T_{cc}^{fakt}}{T_{ss}^0}\right) \quad (7)$$

The total solar energy resource value for the given point $A(\varphi^0, \psi^0)$ is increased to the area S (m²) per square meter [1,3]. In general, the energy received by the receiving surface can be determined using the following formula:

$$W_m = E_0 \cdot S_m \quad (8)$$

In this context, $E_{fakt}^G(\Delta t)$ represents the average annual value of solar radiation, expressed in kilowatt-hours per square meter $(\frac{kW \cdot hour}{m^2})$, or simply kilowatt-hours (kW * hour), received on a horizontal surface area for a given S (km²) over a period of Δt , which can be either 1 month or 1 day. The expression $E_{ya}^G(\Delta t)$ represents the solar radiation received on a horizontal surface area, expressed in kilowatt-hours per square meter $(\frac{kW \cdot hour}{m^2})$ or simply kilowatt-hours (kW * hour), during a period Δt (which can be either 1 month or 1 day) under clear open skies when $E_y^G(\Delta t) = E_{pr}^G(\Delta t)$. It is calculated using the following formula:

$$E_{ya}^G(\Delta t) = R_{pr}^G(\Delta t) \cdot \cos\theta(\Delta t) \cdot \Delta t \quad (2)$$

In this context, $R_{pr}^G(\Delta t)$ represents the average inreval power of the solar radiation received on a receiving surface in a normal orientation, expressed in watts per square meters (W/m²). It is derived from the following formula:

this denotes the solar radiation flux incident on a unit area (1 m²) of a solar collector at the boundary of the Earth's atmosphere, also known as solar constant or solar irradiance. The determination of atmospheric mass or the optical mass of the atmosphere is as follows:

calculated using the following formula:

The energy produced by solar panels depends on their installed orientation relative to the angle of incidence of sunlight, which varies seasonally. Solar panels are oriented once a month according to the angle of incidence relative to the tilt angle of the panel surface. This is determined by the following formula:

$$\beta_0 = \varphi - \delta_0 \quad (9)$$

In this context, φ represents the geographic latitude of the region, while δ_0 denotes the solar declination for the given month. The solar declination is determined using the Kupper formula as follows:

$$\delta = 23.45 \sin\left(360 \frac{284+n}{365}\right) \quad (10)$$

According to the (9), for the winter season in Tashkent city (with a geographic latitude of 41°15'52"), the optimal tilt angle can be determined as follows:

$$\beta_0 = 41^\circ - (-20.7^\circ) = 61.7^\circ$$

In the same manner, the optimal tilt angle for the summer season can be calculated as follows::

$$\cos\delta = \frac{\cos(23.5^\circ) + \cos(18.5^\circ)}{2} = 21.1^\circ$$

$$\beta_0 = 41^\circ - 21.1^\circ = 19.9^\circ$$

According to the seasonal variations, the optimal tilt angle for installing solar panels relative to horizontal flatness is as follows: 62° in winter, 41° in spring and autumn, and 20° in summer [2]. For Tashkent city, the installation of fixed structures is recommended within the range of 38° to 44° tilt angle. The useful work coefficient of solar panels depends on radiation. At Standard Test Conditions (STC) where solar irradiance $E_0 = 1000\text{W/m}^2$, temperature $T = 25^\circ\text{C}$, and air mass ($AM = 1.5$), the solar panel generates its maximum electrical energy. The variation in radiation or temperature affects the electrical energy output of photovoltaic panels. An increase in temperature leads to a decrease in the voltage output of the solar cells, which in turn affects the overall electrical energy generation. Figure 1 illustrates the change in the Volt-Ampere characteristics of the photovoltaic battery at temperatures of $T=25^\circ\text{C}$ and $T=60^\circ\text{C}$.

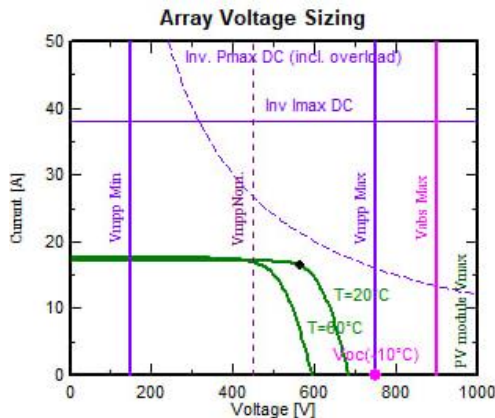


Fig. 1 The temperature dependence graph of the Volt-Ampere characteristic

Let's examine the energy properties of the photovoltaic panel. The nominal power of the photovoltaic panel, denoted as R_n , is calculated as follows:

$$R_n = U_{o.c} \cdot I_{sc} \cdot \xi = U_n \cdot I_n \quad (11)$$

In this context, $U_{o.c}$ represents the open-circuit voltage, I_{sc} denotes the short-circuit current, and ξ signifies the fill factor, which is the Volt-Ampere characteristic filling coefficient.

$$\xi = \frac{U_n \cdot I_n}{U_{o.c} \cdot I_{sc} \cdot \xi} \quad (12)$$

According to the (12) $\xi = 0.7 - 0.82$.

Based on the given values of $U_{o.c}$, I_{sc} , U_n , I_n the useful work coefficient of the solar panel is calculated as follows:

$$\eta = \frac{U_{x.x'} \cdot I_{sc} \cdot \xi}{E_0 \cdot S_m} \cdot 100\% \quad (13)$$

Through equation (13), it is possible to observe the impact of E_0 on the useful work coefficient [5].

The installation of solar panels in open fields and areas with regular sunlight supports active solar irradiation and harnesses normal radiation exposure. The utilization of photovoltaic stations in agricultural fields yields the intended outcome. Within agricultural irrigation systems, pumps are directly connected to the grid for operation. The primary function of the pump is to deliver water from the water source (well or river) to the water reservoir for irrigation. The water tank supplies irrigated areas with water. It is recommended to use solar photovoltaic stations to generate the electrical energy required for pump operation. Below, the integration scheme of the photovoltaic system with the irrigation system is presented in the figure 2.

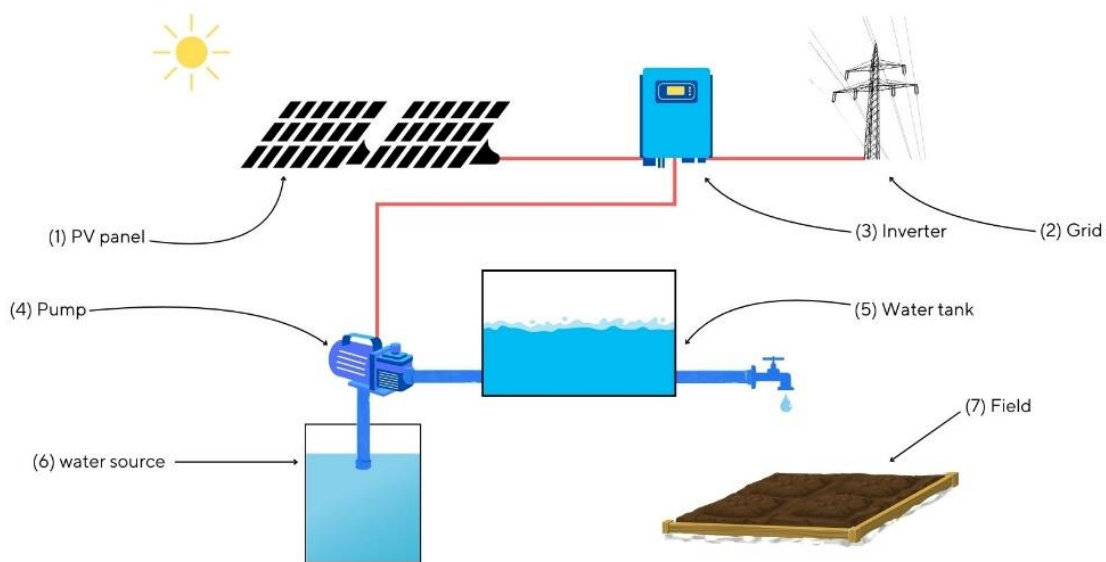


Fig. 2 Scheme of stand-alone PV pumping system

Here, 1- PV panels, 2-grid, 3-inverter, 4-pump, 5-water tank, 6-water source, 7-field

The main objective of the system is to develop new algorithms to supply the energy required for the pump through photovoltaic (PV) to meet the demand for water during the irrigation period. This algorithm encompasses the efficient and cost-effective production of energy, minimizing waste during the irrigation period. In irrigation, photovoltaic pump systems utilize two methods: "real-time" and "pumping" methods. In the "real-time" method, the pump operates using solar energy during available sunlight hours to fill the water reservoir (tank). In the

"pumping" method, electrical energy is stored in batteries and can be used to pump water during the night. We employ the "real-time" method. To fill the water reservoir (tank) according to the area to be irrigated, we select a pump that consumes 7 kW of electrical energy. Considering an inverter efficiency coefficient of $k=1.2$, we determine the required inverter power as follows [11,6,14]:

$$Q_{in}=Q_{c(r)} * k \tag{14}$$

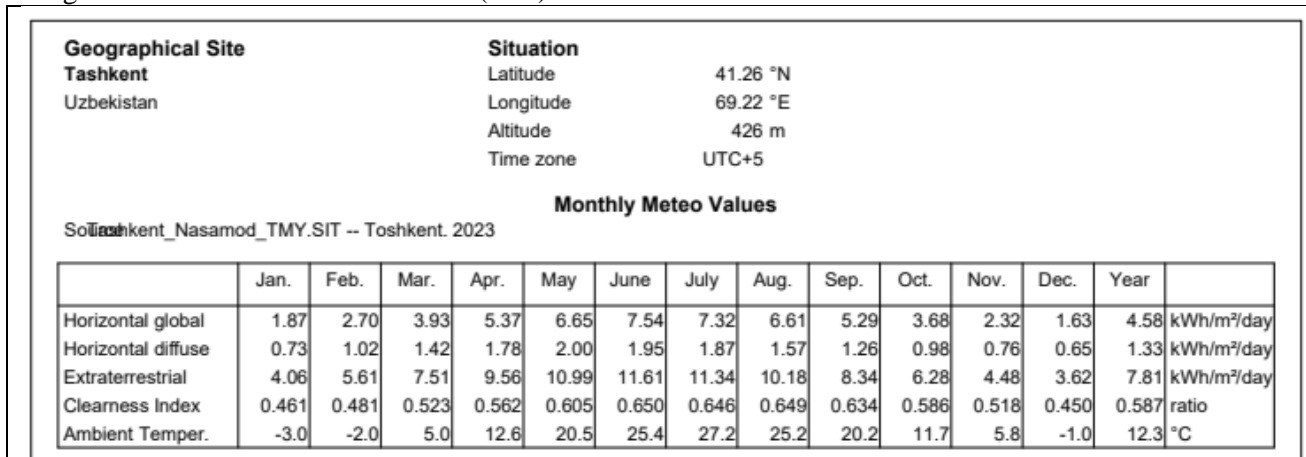


Fig. 3 Monthly Meteo Values obtained from Meteonorm

For the design of solar photovoltaic stations, we utilize the PVsyst software. PVsyst is a sophisticated software tool designed for the analysis, measurement, and evaluation of complex solar photovoltaic systems. It is specifically tailored for the design of solar photovoltaic stations with pumps, connected to the network, and operates beyond the network. It incorporates extensive databases of weather conditions and solar photovoltaic system components, facilitating comprehensive analysis. PVsyst is preferred by engineers, researchers, and practitioners because it can import weather data and

personal information from various sources. The initial data for the PVsyst software package is obtained from NASA-SSE and Meteonorm meteorological sources. The Meteonorm database collects weather data from over 1200 weather stations worldwide, with monitoring periods ranging from 10 to 30 years. To achieve the highest accuracy in data approximation, Meteonorm interpolates values from the three nearest weather stations located at the point of interest. PVsyst allows you to add data to its database, providing flexibility and customization options [12,22].

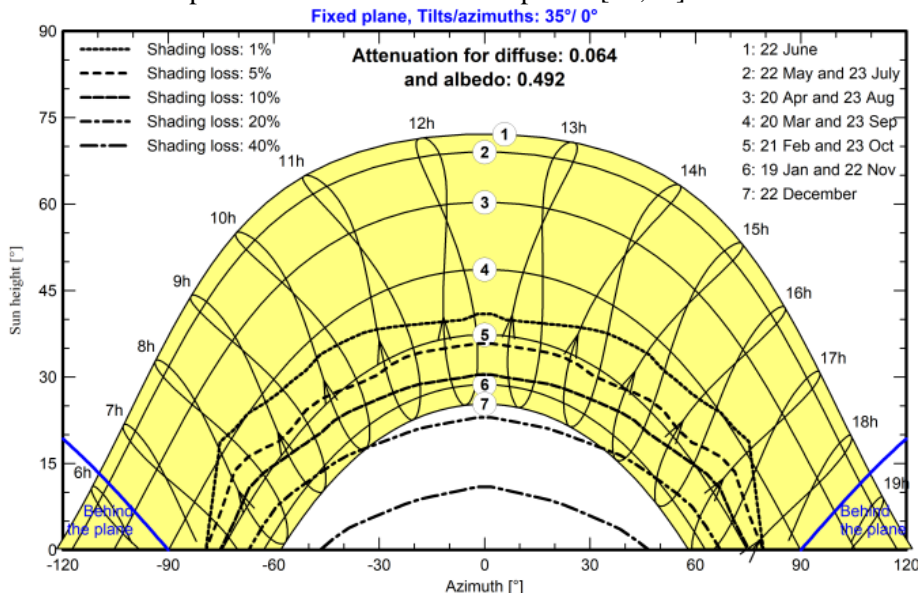


Fig. 4 Sun paths (Height/Azimuth diagram)

According to the Sun path diagram (Height/Azimuth diagram), polycrystalline silicon photovoltaic panels are installed at a fixed inclination

angle of 35° relative to the horizon, with a precise orientation towards the azimuth.

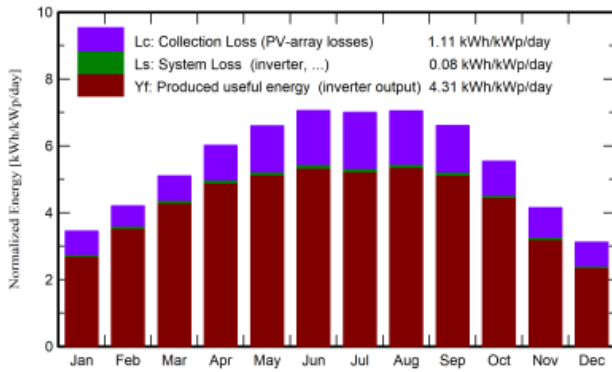


Fig. 5 Normalized productions (per installed kWp)

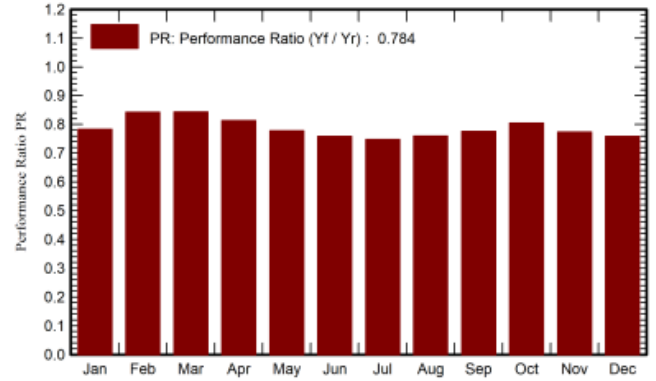


Fig. 6 Performance Ratio PR

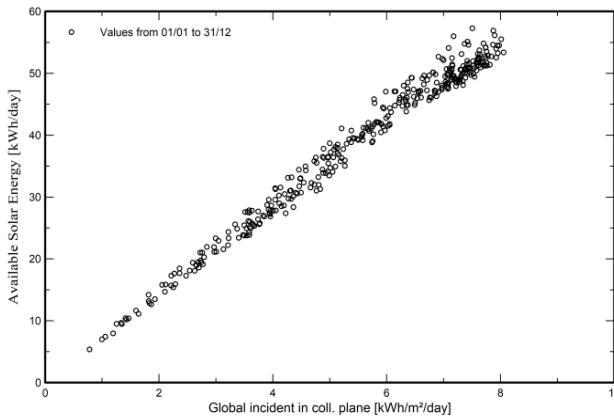


Fig. 7 Daily Input/Output diagram

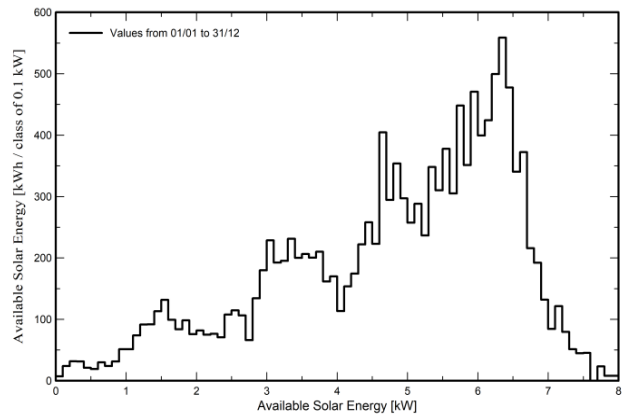


Fig. 8 System Output Power Distribution

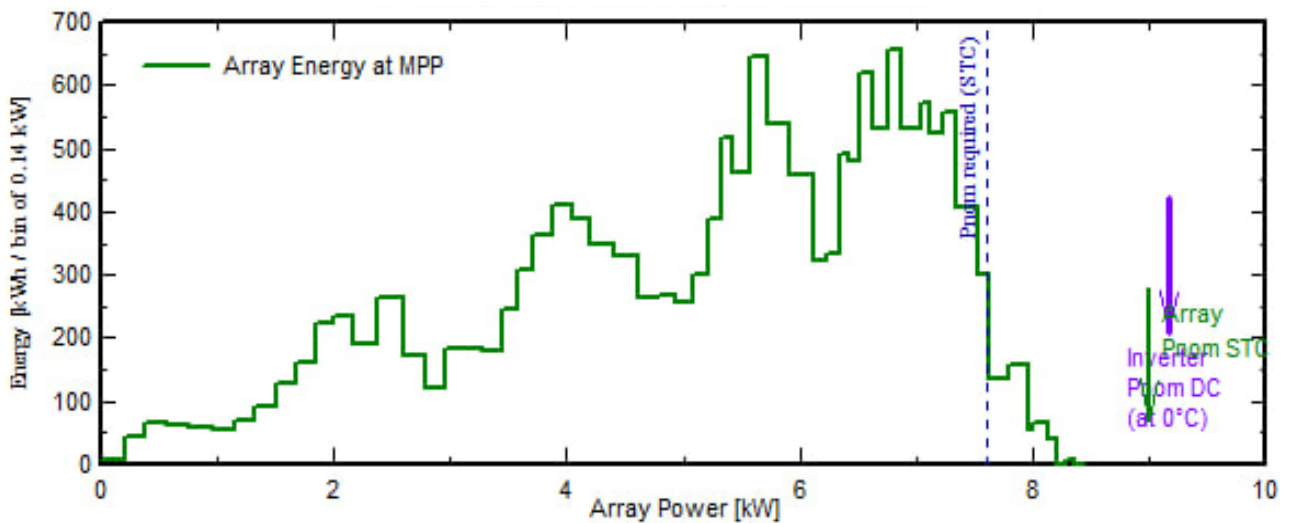


Fig. 9 Power sizing: Inverter output distribution

	GlobHor kWh/m ²	DiffHor kWh/m ²	T_Amb °C	GlobInc kWh/m ²	GlobEff kWh/m ²	EArray kWh	E_User kWh	E_Solar kWh	E_Grid kWh	EFrGrid kWh
January	58.0	22.60	-3.00	107.0	86.4	769	5654	754	0.000	4900
February	75.6	28.60	-2.00	117.8	104.0	910	5107	893	0.000	4214
March	121.8	44.00	5.00	158.2	146.3	1224	5654	1200	0.897	4455
April	161.1	53.40	12.60	180.5	167.4	1348	5472	1322	0.158	4150
May	206.1	62.00	20.50	204.5	189.1	1460	5654	1432	0.000	4222
June	226.2	58.50	25.40	211.6	195.3	1472	5472	1443	0.000	4029
July	226.9	58.00	27.20	217.1	200.3	1489	5654	1460	0.000	4194
August	204.9	48.70	25.20	218.5	203.0	1522	5654	1495	0.000	4160
September	158.7	37.80	20.20	198.3	184.6	1410	5472	1384	0.000	4088
October	114.1	30.40	11.70	171.7	156.4	1266	5654	1244	0.000	4410
November	69.6	22.80	5.80	124.4	103.8	883	5472	866	0.000	4606
December	50.5	20.10	-1.00	96.5	76.0	673	5654	659	0.000	4996
Year	1673.5	486.90	12.38	2006.1	1812.8	14424	66576	14151	1.054	52425

Legends

GlobHor	Global horizontal irradiation	EArray	Effective energy at the output of the array
DiffHor	Horizontal diffuse irradiation	E_User	Energy supplied to the user
T_Amb	Ambient Temperature	E_Solar	Energy from the sun
GlobInc	Global incident in coll. plane	E_Grid	Energy injected into grid
GlobEff	Effective Global, corr. for IAM and shadings	EFrGrid	Energy from the grid

Fig. 10 Balances and main results

Conclusion

As a summary, it is important to emphasize that renewable energy sources, based on recurring energy sources, provide a significantly lower environmental impact compared to non-renewable sources. They are also considered cost-effective in terms of operation. Utilizing drip irrigation systems in countries under arid conditions is being considered to conserve water resources. With this method, it is possible to reduce water wastage by 40-45% in our Republic. Most of the pumps used for water collection in drip irrigation systems operate directly from the grid. The recommended solar power station with a 9 kW hourly energy consumption perfectly meets the demand for electrical energy in irrigation fields. The installation of photovoltaic panels at an optimal tilt angle of 35° in two rows, with a distance of 1.5 meters between rows, reduces solar radiation losses by less than 8.2%. The electricity generation from photovoltaic panels installed in agricultural fields increases by 3%. The construction of the solar power station results in an annual surplus of approximately 3,193 kW of energy, with an annual transmission of around 16,517 kW of electrical energy to the grid. The short payback period of the investment ensures the growth of these values.

Reference:

1. Solar energy training manual: Yuldoshev I.A., Tursunov M.N., Shogochkarov S.Q., Jamolov T.R., - Tashkent "Sano-standart" publishing house, 2019, 45-47
2. "Solar energy" subject: [Text] textbook/. Yuldashev I.A., Sultanov M.Q., Yuldashev F.M.- Tashkent: "Bookany print," 2022, p. 55-56.
3. Vissarinov V.I., Derugina G.B., Kusnetsova V.A., Malinin N.K., "Solnechnaya energetika", Uchebnoe

posobie dlya Vuzov. Moscow. Izdatelsky dom MEI. 2008 35-40 p.

4. Irrigation melioration, study guide for higher educational institutions. - T.: TIQXMMI, 2019: 4-5

5. Methodological instructions for performing laboratory exercises in the subject "Solar energy". Yuldoshev I.A., Shoguchkarov S.Q., Jamolov T.R., Gafurov D.S., Karshiyeva N.H., Jurayeva Z.I. - Tashkent: ToshDTU, 2019. 5-10 .

6. E. B. Saitov Photoelectric batteries and device technologies science. T: ToshDTU, 2019, 85

7. Hydraulic energy storage of wind power plants, B. Urishev, F. Nosirov, N. Ruzikulova: E3S Web Conf. 383 04052 (2023) DOI: 10.1051/e3sconf/202338304052

8. A. D. Jones and G. Ejeta, "A new global agenda for nutrition and health: The importance of agriculture and food systems," Bulletin of the World Health Organization, vol. 94, no. 3, pp. 228229, 2016. Available: <https://www.who.int/bulletin/volumes/94/3/15-164509/en/> [Accessed Sep. 20, 2019]

9. M. Mukhammadiev, B. Urishev, A. Abdulaziz uulu, U. J. Kuvatov, H. Murodov, Solar energy application for power supply of pump installations for irrigation of agricultural plants "Alternative and renewable energy development trends: problems and solutions" 2021: 265-267

10. Akbar Sarvar Ogli, U., Javakhir Sherzod Ogli, A., & Shahista Qahramonovna, Z. (2024). Use Of Biological Factors In Protecting The Panels Of Photoelectric Stations Against Dust. Horizon: Journal of Humanities and Artificial Intelligence, 3(1): 60–65 <https://univerpubl.com/index.php/horizon/article/view/3085>

11. Kabbaj, M. N. (2022). A novel algorithm for optimal sizing of stand-alone photovoltaic pumping systems. International Journal of Power Electronics and Drive Systems. 50-52

12. "Determining the solar potential for the design of solar photovoltaic devices using complex software" Orinbaev Bakhtiyar Barlikbaevich, Izzatillayev Jo`rabek Olimjonovich International scientific and practical conference "Prospects of the development of science in Uzbekistan" November 30, 2022. 150-151 p <https://doi.org/10.5281/zenodo.7346103>
13. Boboraim Urishev, Muradilla Mukhammadiev, Abdurauf Abduaziz uulu and Hojiakbar Murodov E3S Web Conf., 264 (2021) 04057 DOI: <https://doi.org/10.1051/e3sconf/202126404057>
14. Solar system design for water pumping Hadidi Abdelkader and Yaichi Mohammed E3S Web Conf., 37 (2018) 06001 DOI: <https://doi.org/10.1051/e3sconf/20183706001>
15. Photovoltaic Plants for Water Lift Systems // Mirzabaev, A.M., Sytdykov, O.R., Makhkamov, T.A., Verchenko, P.E., Mirzabekov, S.M. // Applied Solar Energy (English translation of Heliotekhnika), 2018, 54(5),: 346–349. <https://www.scopus.com/record/display.uri?eid=2-s2.0-85061633908&origin=resultslist>
16. Ismailov, Sarvar & Oybek ogli, Ezoz. (2020). Organization of autonomous systems for drip irrigation systems.
17. A Mirzabaev et al 2020 IOP Conf. Ser.: Earth Environ. Sci. 614 012016 DOI 10.1088/1755-1315/614/1/012016
18. Increase the efficiency of irrigation pumping stations: Ozbekiston qishloq xojaligi. - Tashkent, 2009. - №11. C.25-26.
19. Fakhridin Jaylavovich Nosirov, Urishev B.U, Bozor Djumayevich Ulugov, Jakhongir Mir-zoaliyevich Dust-murodov, Panji Azamo-vich Khaliyarov. "Reduced Pump Power Consumption Micro Accumulating Power Plants" International journal of Advanced Science and technology - IJAST. Publisher: Science and engineering research support society. Colorado Technical University – USA, 2020. <http://sersc.org/journals/index.php/IJAST/article/view/17478>. ISSN: 2005-4238.
20. <https://kun.uz/uz/news/2022/08/09/ozbekistondagi-suv-taqchilligi-ehitimoliy-qurgoqchilik-va-keskinlashayotgan-ekologik-muammolar>
21. <https://kun.uz/uz/news/2019/09/27/ozbekistonda-bir-yilda-ortacha-qancha-suv-ishlatilishi-malum-boldi>
22. <https://www.pvsyst.com/>

ELECTROMAGNETIC FIELD MODEL AS A SOURCE OF WATER CAVITATION ENERGY

M.O.GAFUROVA, K.G.ABIDOV (Tashkent State Technical University, Tashkent city, Republic of Uzbekistan)*

Received: September 30, 2023; Accepted: Aprilr 02, 2024; Online: Aprilr 08, 2024;

Abstract: *The article investigates numerical models of cavitation processes in water, fluid flow taking into account process to determine the optimal parameters for the operation of the device. A mathematical model of a rotating electromagnetic field for designing a rotary vortex generator based on cavitation processes in water is considered. The interaction of charged particles is considered in the article, which made it possible to determine the types of oscillatory processes. The study of the rotating electromagnetic field made it possible to determine the vibrationally rotational motion of molecules, which are the basis for obtaining thermal energy. In addition, describes electromagnetic methods of wastewater treatment, which showed that electromagnetic waves change the structure of hardness salts to form a brittle aragonite form of calcium carbonate. At the same time, a strong mixture of amorphous deposits of hardness salts is not formed, and previously formed deposits are destroyed and carried away with the flow of water.*

Keywords: *electromagnetic field, model, decontamination, energy source, boundary conditions.*

Annotatsiya: *Maqolada qurilmaning ishlashi uchun maqbul parametrlarni aniqlash uchun jarayonni hisobga olgan holda suvdagi kavitatsiya jarayonlarining raqamli modellari, suyuqlik oqimi o'rganiladi. Suvdagi kavitatsiya jarayonlariga asoslangan aylanma vorteks generatorini loyihalash uchun aylanadigan elektromagnit maydonning matematik modeli ko'rib chiqiladi. Maqolada zaryadlangan zarrachalarning o'zaro ta'siri ko'rib chiqiladi, bu tebranish jarayonlarining turlarini aniqlashga imkon berdi. Aylanadigan elektromagnit maydonni o'rganish issiqlik energiyasini olish uchun asos bo'lgan molekullarning tebranish harakatini aniqlash imkonini berdi. Bundan tashqari, elektromagnit to'lqinlar qattiqlik tuzlarining tuzilishini o'zgartirib, kalsiy karbonatning mo'rt aragonit*

*Gafurova Mexrnoz Odiljonovna – Doctoral Student, gafurova.mexrnoz@mail.ru, <https://orcid.org/0009-0006-7612-8221>;
Abidov Kudrat Gayratovich – DSc, Associate Professor, abidoff@rambler.ru, <https://orcid.org/0000-0001-8315-0351>.