ҚАЗАҚСТАН РЕСПУБЛИКАСЫ ҒЫЛЫМ ЖӘНЕ ЖОҒАРЫ БІЛІМ МИНИСТРЛІГІ
Л.Н. ГУМИЛЕВ АТЫНДАҒЫ ЕУРАЗИЯ ҰЛТТЫҚ УНИВЕРСИТЕТІ

МИНИСТЕРСТВО НАУКИ И ВЫСШЕГО ОБРАЗОВАНИЯ РЕСПУБЛИКИ КАЗАХСТАН
ЕВРАЗИЙСКИЙ НАЦИОНАЛЬНЫЙ УНИВЕРСИТЕТ ИМЕНИ Л.Н. ГУМИЛЕВА

MINISTRY OF SCIENCE AND HIGHER EDUCATION OF THE REPUBLIC OF KAZAKHSTAN
L.N. GUMILYOV EURASIAN NATIONAL UNIVERSITY

"ЖАСЫЛ ЭКОНОМИКАҒА" КӨШУ ЖАҒДАЙЫНДА ҚАЗАҚСТАН РЕСПУБЛИКАСЫНЫҢ ТҰРАҚТЫ ДАМУЫ: ЕУРОПАЛЫҚ ОДАҚ ЕЛДЕРІНІҢ ТӘЖІРИБЕСІН ҚОЛДАНУ"

ХАЛЫҚАРАЛЫҚ ҒЫЛЫМИ-ТӘЖІРИБЕЛІК КОНФЕРЕНЦИЯСЫНЫҢ
ЕҢБЕКТЕР ЖИНАҒЫ

СБОРНИК ТРУДОВ
МЕЖДУНАРОДНОЙ НАУЧНО-ПРАКТИЧЕСКОЙ КОНФЕРЕНЦИИ

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АСТАНА, 2022
ASTANA, 2022

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Халықаралық ғылыми-тәжірибелік конференциясының
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Международной научно-практической конференции

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АСТАНА
28.10.2022

ӘОЖ 338 (574)
КБЖ 65.9 (5Каз)
Ж 33

ISBN 978-601-337-777-3

Ж 33
«Жасыл экономикаға" көшу жағдайында Қазақстан Республикасының тұрақты дамуы: еуропалық одақ елдерінің тәжірибесін қолдану» халықаралық ғылыми-тәжірибелік конференциясының еңбектер жинағы. – Астана: "Л.Н. Гумилев атындағы Еуразия ұлттық университеті"КЕАҚ, 2022. – 484

Сборник трудов международной научно-практической конференции «Устойчивое развитие Республики Казахстан в условиях перехода к «зеленой экономике»: применение опыта стран европейского союза». – Астана: НАО «Евразийский национальный университет имени Л.Н. Гумилева», 2022. – 484

Works of the International scientific and practical conference «Sustainable development of the Republic of Kazakhstan in the conditions of transition to a "green economy": application of the experience of the countries of the European Union». – Astana: NAO "L.N. Gumilyov Eurasian National University", 2022. – 484

ISBN 978-601-337-777-3 **УДК 338 (574)**
ББК 65.9 (5Каз)

распространенному мнению, солнечная энергетика может быть конкурентоспособнойуже сейчас.

Опыт использования солнечной энергии в Республике Казахстан показывает возможность выработки электрической энергии на солнечной электростанции. При этом выработанная электроэнергия подается в энергосистему, что исключает накопителей энергии и вся выработанная энергия фотоэлектрическими установками передается в электрическую сеть. В совокупности повышается эффективность солнечной электростанции.

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DEVELOPMENT OF ECONOMICALLY AND ENERGY EFFICIENT NANOFILTRATION TECHNOLOGY FOR DRINKING WATER TREATMENT

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1. Introduction

Water is essential for our survival. Water resources management is facing challenges in the field of water allocation [1]. The growing impact of climate change and management actions brings more uncertainties [2]. As a result, the allocation of water resources requires alternative and innovative strategies and technologies to solve these problems. Moreover, one in three people globally does not have access to safe drinking water according to a comprehensive data analysis conducted in 2017 conducted by the World Health Organization and United Nations Children's Fund. Water scarcity affects the largest part of the global population [3]. Therefore, the sustainability of current and future water resource allocation is one of the biggest concerns. To solve these challenges, many researchers and companies are developing new innovative technologies to provide every person in the world with water [4; 5; 6]. Every year various innovations simplify and reduce the cost of these processes. In this study, the potential of an integrated water treatment technology nanofiltration and UV energy-saving LED lamps is presented. The proposed treatment technology is studied in terms of operating cost and climate impact.

2. Product and technology

The technology offered represents a water treatment installation to provide clean and safe drinking water. The main units of water treatment installation include: 1) course filter, 2) ultrafiltration, 3) nanofiltration, 4) UV energy-saving LED lamp. This product allows the provision of drinking water according to the Sanitary Norms and Regulations of Kazakhstan.

3. Water characteristics and treatment plant setup

The plant consists of electrolysis, nanofiltration, and ultraviolet LED energy-saving lamp disinfection unit as the main components. There are also several other sub-units supporting the system including storage tanks, feather and fat catchers, coarse mechanical filter, and ultra-filtration. The process of electrolysis in the treatment system begins with applying a unipolar voltage to the metal plates-electrodes from a power unit. The mechanical ultra-filtration plays an important role in preparing the water for nanofiltration to remove pollutants escaped from the previous units. Table 1 provides an overview of the groundwater characteristics from the Izhevski poultry farm in Kazakhstan as well as the Kazakhstani drinking water quality standards.

Table 1. Groundwater characteristics before treatment

Parameters	Well water analysis	Guidelines	Unit
pH	7.18	6.0-9.0	pH
Turbidity	0.1	1.5	mg/dm^3
Colours	20	20(35)	degree
Suspended substances	0	0	mg/dm^3
Chlorine free	0.15	0.3-0.5	mg/dm^3
Chlorine total	0.1	0.8-0.12	mg/dm^3
Nitrite nitrogen	0.2	3	mg/dm^3
Nitrate nitrogen	11.8	45	mg/dm^3
Phosphates	0.01	3.5	mg/dm^3
Ammonium	1.05	2	mg/dm^3
COD	1.1	5	mg/dm^3
BOD_5	0	0	mg/dm^3
Manganese	0.04	0.1	mg/dm^3
Nickel	0.01	0.1	mg/dm^3

4. Customer value proposition

As new innovative technologies at the beginning stages are unknown to potential customers, the product or idea must bring value and benefits to potential buyers. There are different ways to create value for customers. The product might decrease costs for customers. Or product increases value, allowing the customer to sell their products for a higher price or capture a larger portion of the market. Different options need to be explored and identify types of customers to gain insight into the total addressable market. The customer value proposition is a unique offering that will make customers willing to buy your product. What exactly is the customer's problem and how does your product solve it? Are they even aware of the problem? If so, why haven't they solved it yet? The best potential customer is one who is aware of the problem, has an urgent need to solve it, but is unable to do so internally. Potential economic effects can be from the reduction of maintenance costs or lower cost of the product compared to other competitors. You need to quantify the increase in profit will realize for your customer. This will allow you to sell effectively. You also need to understand your ultimate price point.

The proposed technology is a climate-friendly cost-efficient water treatment solution. In order to quantify the proposed value to the customers, we need to understand what is the current product/solution used by the customers or alternative competing products that the client has the option to purchase. Currently, the villagers that have limited access to safe and clean drinking water in Kazakhstan usually may get water from wells, open waters, rivers, lakes, buy bottled water, buy truck delivered water. This water in most cases is not safe for human health. Villagers rely heavily on boiling as a way of water treatment. As our potential customer, governmental entities, are planning to purchase water treatment modules, in our customer value proposition analysis, we have made a competitive mapping of alternative water treatment technologies that the customer has the option to purchase.

5. Results and discussion

After the treatment process of the groundwater using the proposed technology, the results were compared with drinking water quality standards set by the government of Kazakhstan as summarized in Figure 1.

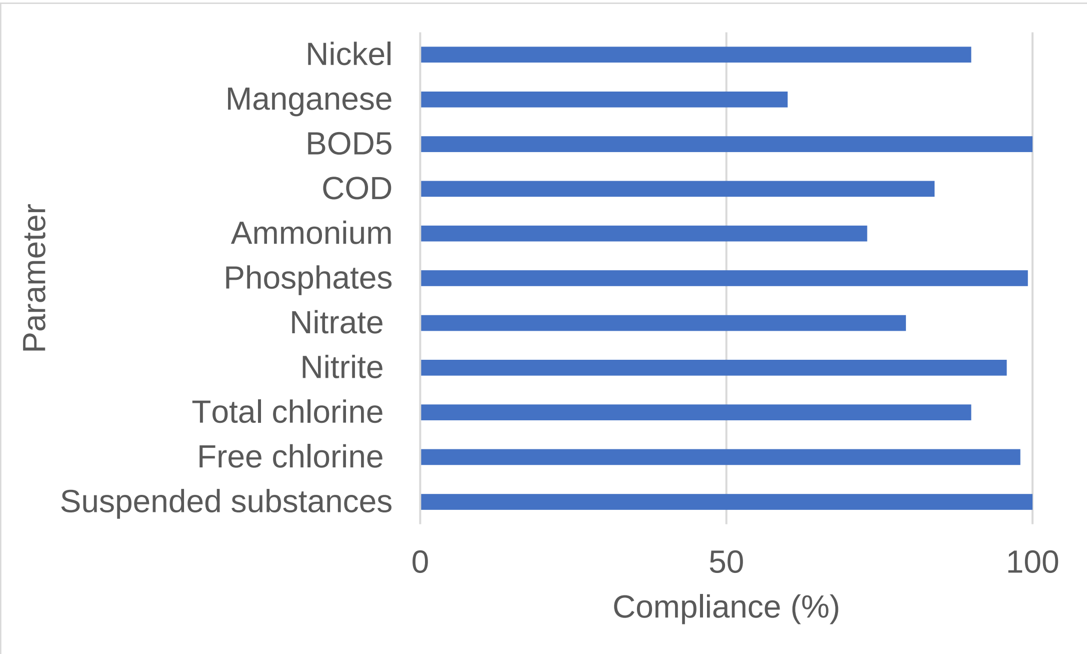

Figure 1. Percent compliance with drinking water quality standards

5. 1 Operating cost in comparison to reverse osmosis systems

The estimation of the operating costs relies more on the energy consumption from each sub-unit as well as maintenance costs (Tables 2 and 3). In general, the proposed treatment system is observed to be more cost-effective in comparison to some existing water treatment technologies such as reverse osmosis systems (Figure 2).

Table 2. Operating costs from proposed treatment plant

Equipment	Capacity N, kWt·h/m³	Electricity cost, USD/m³	Other expenditures	USD/m³
Course filter (pump with P = 16 atm)	0.513	0.016145	Cartridge change once in 6 months	0.011
Mechanical fine filter (pump)	0.56	0.017627	Change of cartridge once in 2 months	0.02
Nano filter (pump)	0.16	0.005036	Membrane change after each 5000 m³	0.023
UV Led lamp	0.0064	0.000201		–
Total	**1.239**	**0.039**		**0.054**

Table 3. Operating costs from existing technologies (reverse osmosis)

Equipment	Capacity N, kWt·h/m³	Electricity cost, USD/m³	Other expenditures	USD/m³
Course filter (pump with P = 16 atm)	0.513	0.016145	Cartridge change once in 6 months	0.01121
Mechanical fine filter (pump)	0.56	0.017627	Change of cartridge once in 2 months	0.020178
Reverse osmosis (pump)	1.2	0.037772	Membrane change after each 5000 m³	0.09201
UV lamp	0.032	0.001007		–
Total	**2.305**	**0.07**		**0.12**

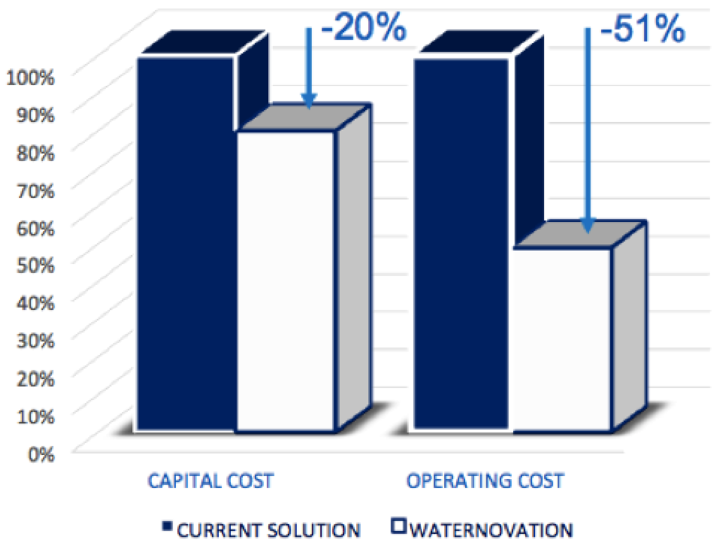

Figure 2. Cost comparison between presented and existing technologies

5.2 Climate impact

The proposed product is more climate-friendly than current solutions in the villages (Figure 3). Based on our estimations, the proposed project allows to reduce 122.388 tons of carbon dioxide emissions. We compare CO_2 emissions from current water treatment solutions (boiling and treatment plants) with our proposed technology.

5.2.1 Current treatment technologies

(a) Boiling

i. Coal
ii. Electricity

(b) Treatment plant

i. Reverse osmosis
ii. Conventional UV lamps

Total CO_2 emission from boiling and treatment plant=122.6tons/year

5.2.2 Proposed treatment technology

i. Nanofiltration
ii. UV-LED lamps (energy-saving)

Total CO_2 (nanofiltration+UV LED) =197.1+14.5=211.6kg/year

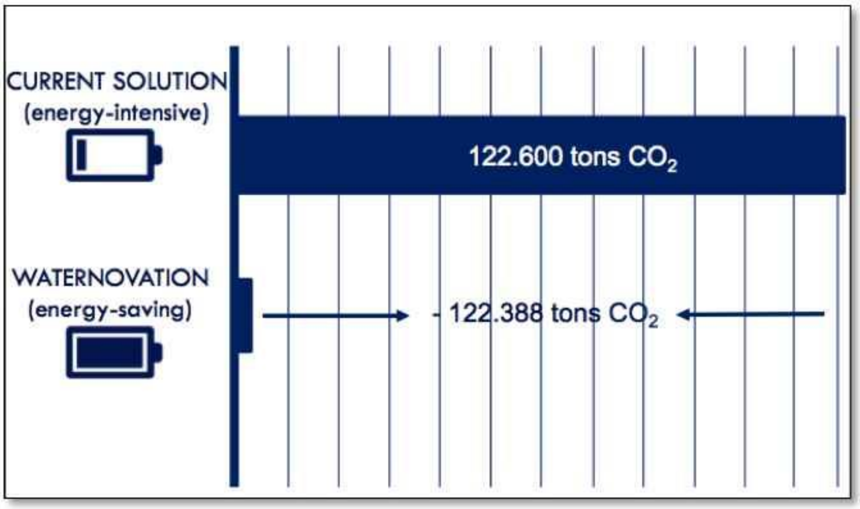

Figure 3. Climate impact

6. Conclusion

In this study, an innovative water treatment technology was analyzed. The treatment approach that allows to improve public health in a more economically efficient way and more conscious of climate change. The use of a complex of modern innovative technologies improves not only the ecological and epidemiological situation, but also increases the productivity of the population, regions, improves economic performance and the welfare of countries. Innovation is about generating ideas and creating technology. However, even the best ideas will be lost if they never turn into a product or service. In this regard, the innovation process must include transformation, implementation, distribution, commercialization, and scaling. Generally, the proposed water treatment system was observed to be more cost-effective in comparison to some existing water treatment technologies such as reverse osmosis systems.

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ZALEŻNOŚĆ ENERGETYCZNA EUROPY

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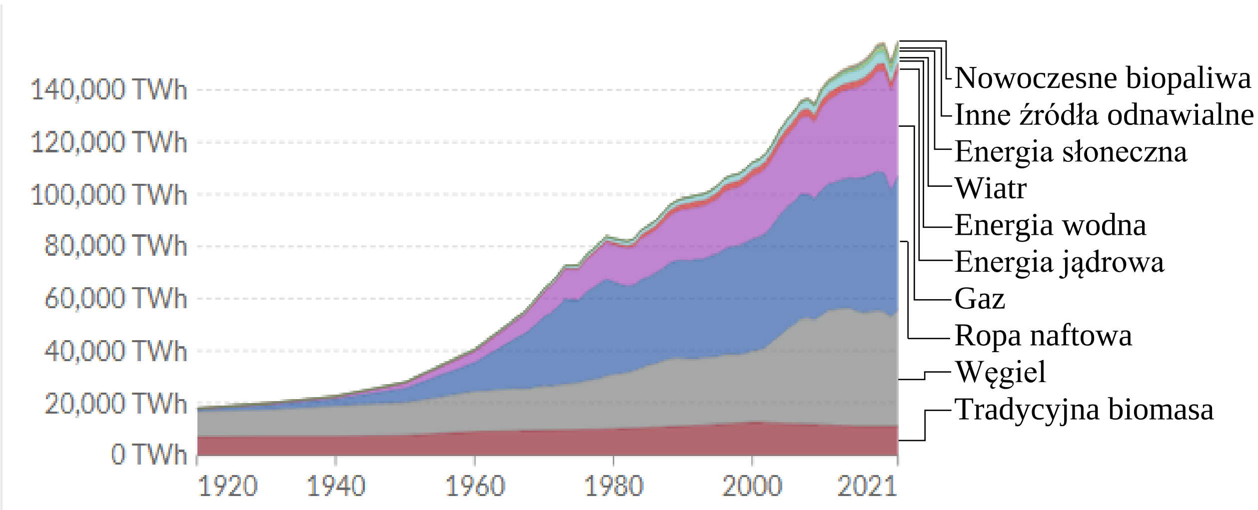
Zapewnienie bezpieczeństwa energetycznego jest niezwykle ważne dla funkcjonowania współczesnych gospodarek i społeczeństw. Energia jest produktem podstawowym, który napędza całą gospodarkę. Od stabilności i przystępności cenowej jej dostaw zależą dobrobyt i bezpieczeństwo całego świata. Zaopatrzenie gospodarki w nośniki energii stanowi strategiczny priorytet dla krajów i jest coraz częściej postrzegane jako środek wspierania konkurencyjności branż.

Ponadto część ekonomistów uważa, że jako alternatywny sposób pomiaru PKB można wykorzystać ilość wyprodukowanej energii elektrycznej, ponieważ im [7].

Do XX wieku globalne zużycie energii pierwotnej rosło powoli. Jednak według informacji zawartych w zasobie Our World in Data [5], w ciągu ostatnich 100 lat nie tylko znacznie wzrosło zużycie energii w skali globalnej, ale także znacznie zróżnicowały się rodzaje zużywanych zasobów. Rysunek 1 pozwala stwierdzić, że we współczesnym świecie najczęściej używa się węgla, ropy naftowej oraz gazu.



Rys. 1. Globalne bezpośrednie zużycie energii pierwotnej
Źródło: https://ourworldindata.org [data dostępu: 9.10.2022]