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KARAKALPAK STATE UNIVERSITY
QDU

Conference on Sustainable Development and Renewable Energy Resources in Uzbekistan

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Proceedings

Introduction

Lars Rydén, Prof. Uppsala University, Swedish Aral Sea Society

1. Organization of the conference

The conference was organised as a common effort among the Uzbek universities taking part in the master level course on Sustainable Development and Sustainability Science during February to June 2022 organised by the Swedish Aral Sea Society and Karakalpak State University. The topic chosen for the conference was a key question for achieving a sustainable society, energy, especially in the present situation of global warming in which the Central Asian republics are especially hard hit. Although as expected most participants were from the universities involved in the master level teaching, the invitation to take part was distributed freely and several others thus have contributed to the conference.

The design of the conference was simple as it was half a day meeting on-line using Zoom. Thus, nobody had to travel, and all papers and presentations were simply emailed as requested. A few individuals who did not present papers took part.

2. Why Renewable Energy is important

There are several reasons to address the difficult question of renewable energy, especially in a country like Uzbekistan, which since long is heavily dependent on fossil carbon, especially natural gas. From the perspective of sustainable development, one needs to emphasize:

- Fossil energy is not renewable and thus a limited resource which finally will be exhausted.

- Burning of fossil carbon causes emission of Green House Gases (GHG) mostly carbon dioxide CO2, but also methane, which cause climate change.

- Burning of fossil carbon produces serious air pollution.

- Fossil energy is politically problematic and creates political dependence.

It is true that it will take a long time before all available fossil energy resources have been emptied. This time is so long that the first argument is close to irrelevant. But as with all non-renewable natural resources the accumulation of biproducts causes problems long before the resource is finished. The most serious byproduct here is carbon dioxide, causing global warming. The second argument about climate change is therefore very important and the reason why the whole world now is looking for ways to get out of its dependency on fossil energy. To get out of this dependency is especially difficult for countries which are almost 100 % relying on fossil energy, such as Uzbekistan. The question thus needs to be addressed and here universities have a special responsibility.

The burning of fossil carbon, especially back coal, gives rise to many pollutants, such as mercury, and other toxic metals, sulfur oxides, nitrogen oxides, toxic volatile organic compounds, ozone and aerosols. In many cases the flue gases are not purified properly and thus cause significant harm among both humans and nature. It is especially relevant in traffic when car exhaust pollutes streets and the environment with many children.

The large volumes of fossil energy are produced by only a few, about ten, countries, including Saudi Arabia, and other middle east countries, Russian Federation, and Venezuela. These are all autocratic states and have repeatedly used their energy production as agents for political pressure. Renewable energy resources on the contrary are typically locally produced and can not be means for political influences. Exceptions may be some large hydropower plants where the electricity produced is distributed internationally.

3. The range of renewable energy resources

The traditional renewable energy resource is *bioenergy*, in most cases wood, but also other forms of bioenergy, such as ethanol from different forms of cultivated crops. It is interesting to note that (the rather few) smaller communities, towns and villages, which today are energetically self-sufficient, typically rely on their own bioenergy resources. The burning of bioenergy of course causes as much carbon dioxide emissions as burning fossil energy, in fact typically more, per kWh. This carbon is, however, part of the natural cycle of carbon and will eventually, typically after many years, be returning to become biomass in the process of photosynthesis and carbon fixation. With the present urgency to address global warming the use of biomass thus has its drawbacks.

A second since long established renewable energy resource is *hydropower*. Modern large hydropower plants exist since the beginning of the 20th century and in most countries the existing resources of streaming water has been used in hydropower and a large expansion of this source of energy is no longer feasible. Hydropower has however in many cases a key role in the energy system as their reservoirs allow electricity to be produced by demand. In fact the hydropower plant can even be used as a kind of battery as pumping of water to refill the reservoirs can be made with a decent energy return. More recently small hydropower plants, sufficient for a few households or a small community, are being built in many countries and then in large numbers. A drawback which needs to be mentioned is the negative impact which hydropower has on the ecosystems which originally existed in the streaming water, such as migrating fish. There are now various methods to diminish these damages.

More recently *wind energy* has become a very important renewable energy resource. Through technology innovations and economies of scale, the global wind power market has nearly quadrupled in size over the past decade and established itself as one of the most cost-competitive and resilient power sources across the world (https://gwec.net/global-wind-report-2021). Denmark was very early in establishing wind power and is in the forefront with 2 738 kWh/capita wind power electricity. Presently Sweden and Germany are second and third. Total largest wind power installed have, however, China and the USA: Drawbacks of wind power includes intrusive on the landscape which can be seen from far away - a modern wind power turbine has a height of 300 meters - the noise which the wind power turbines generate, and in some places serious impact on birds. The installations require some rare earth metals which is key resource.

Also *solar photovoltaic electricity* has increased dramatically over the recent years. Solar PV generation increased by a record 179 TWh (up 22%) in 2021 to exceed 1 000 TWh. It demonstrated the second largest absolute generation growth of all renewable technologies in 2021, after wind. Solar PV is becoming the lowest-cost option for new electricity generation in most of the world (https://www.iea.org/reports/solar-pv). Solar PV is still in general only a small part of the electricity generation, but the potential is considered to by large. The International Renewable Energy Agency (IRENA) has reported that solar photovoltaic (PV) module prices have fallen 80% in the last decade, while installed capacity has grown from 40 GW to over 600 GW in the same period. These trends are set to continue with new global solar installations of over 140 GW expected in calendar year 2020. (https://now.solar/2020/08/12/global-photovoltaic-power-potential-by-country-2020/). The drawback of PV is again the requirement of rare earth metals for the solar cells. However technology development is rapid and new types of cells without need for rare earth metals and as well higher productivity are expected.

Geothermal energy was originally typical for countries close to or on a boundary between two tectonic plates, such as Iceland, where hot water was available immediately below the surface. By going beyond the immediate boundaries the installed capacity of geothermal energy has gradually increased worldwide over the last decade, reaching some 15.6 gigawatts in 2021. (https://www.statista.com/statistics/476281/global-capacity-of-geothermal-energy/). By using geothermal heat pumps, earth-coupled, ground-source, or water-source heat pumps, the capacity for geothermal heat has increased considerably. Heat pumps use the relatively constant temperature of the earth as the exchange medium instead of the outside air temperature. Thus even if the country experience seasonal temperature extremes -- from scorching heat in the summer to sub-zero cold in the winter— a heat pump can use the relatively constant temperature a few feet below the earth's surface. (https://www.energy.gov/energysaver/geothermal-heat-pumps). By a widespread use of heat pumps Sweden is now globally second, after Iceland, in use of geothermal energy.

Energy in form of heat may be both non-renewable – from burning fossil fuels – or renewable. Heat from burning biomass has been mentioned. Heat may also be extracted from solar panels, today also in combination with photovoltaic cells. This is very common in southern Europe. Heat is also produced in concentrated solar power, then mostly with the intention to produce electricity using generator technology.

4. Storing energy

Fossil energy constitute an extremely comfortable and concentrated form of stored energy, which as well can be distributed easily. When abandoning the use of fossils in the energy system the storing of energy, especially electricity, becomes a dilemma. In the renewable energy system bioenergy and hydropower, sometimes also geothermal energy, offers ways to store energy. Electricity from wind power and photovoltaic cells needs however to be used immediately if not stored in battery.

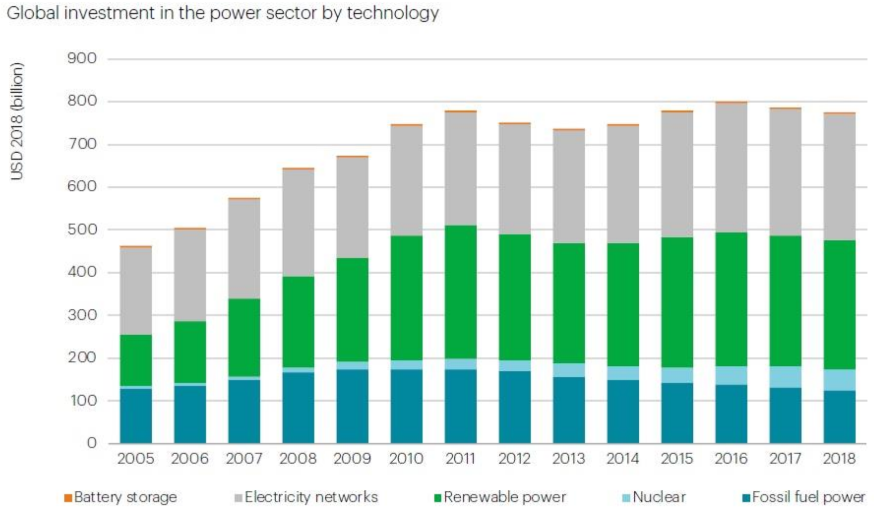
Battery technology is under rapid development but. Presently lithium-based batteries it is used in electric cars and in households, but with a limited capacity and comparatively costly.

Electricity from e.g. photovoltaic cells and wind power is today often turned into hydrogen gas by using an electrolyzer to split water into hydrogen and oxygen. Hydrogen may be stored under pressure and used to produce electricity in a fuel cell. Hydrogen may also be further processed to form ammonium or other compounds, such as methane or methanol. These are less problematic to store, but the energy losses in these conversion steps are considerable. Bioenergy in different forms is of course easily stored but less easy to distribute.

5. The cost of renewable energy - investments

The cost of renewable energy has fallen dramatically over the last 10 – 30 years. It is today on a level which makes investments in renewables most often economically better than investments into fossil fuel production. The global average of newly commissioned solar PV projects declined by 88% between 2010 and 2021, that of onshore wind fell by 68%, CSP by 68% and offshore wind by 60%. And this steep decline continues. The global average levelized cost of electricity of new onshore wind projects added in 2021 fell by 15% (Renewable Power Generation Costs in 2021 (irena.org)). The threat to this development is the increased concern over the rare earth metals used in these technologies, both PV and wind power.

The level of investments in renewable electricity is for this reason high and continues to be high. (See diagram) https://www.iea.org/reports/world-energy-investment-2019/power-sector.



6. Energy use and cooperation in Central Asia

Bo Libert, consultant, bocarl.libert@gmail.com

Universal access to affordable and clean energy by 2030 is no 7 of the United Nations' Sustainable Development Goals (SDGs). Universal energy access is considered as one of the most crucial targets. Other targets are to increase substantially the share of renewable energy and to improve energy efficiency.

Central Asia is endowed with abundant and diverse energy resources. These are fossil fuel-based resources such as natural gas, oil, coal, but there are also largely untapped renewable energy resources such as hydro, solar, wind, and biomass energy. This brief paper outlines the energy situation, policies, potential and challenges for the future in the five Central Asian countries.

1. Country energy profiles

Kazakhstan has abundant hydrocarbon resources with the fourth largest coal reserve in the world. Oil and gas resources are also very rich, and there is a potential for developing hydropower further. Coal, oil and natural gas dominates the energy use. More than 80% of its electricity is generated by coal-fired power plants.

The main potential and actual source of energy in *Kyrgyzstan* is hydropower. More than 90% of the electricity comes from hydropower. Coal and oil are also important sources of energy.

The main internal source of energy in *Tajikistan* is hydropower but there are also some coal reserves. Almost all electricity is generated by hydropower. Coal and oil are important for energy production.

In *Turkmenistan* natural gas is the first and foremost internal source of energy and its natural gas resources are the sixth largest in the world. Gas and oil are the main sources for energy generation.

Coal is available in *Uzbekistan*, but the main internal source of energy is natural gas. Natural gas and, to some extent, oil and coal provide the energy needed.

2. Electricity and energy infrastructure

A power grid linking the republics of Central Asia was set during the Soviet Union period in the 1980s. This interconnection allowed power to flow across the republics. However, after Soviet dissolution and state independence in 1991, the energy interests of independent Central Asian countries diverged, and the joint energy grid fell apart. It is very positive that due to better political relations the joint energy grid is presently being re-established.

The infrastructure of the Central Asian power sector is, however, in many places outdated and it is sometimes difficult to meet a growing energy and electricity demand in the individual countries. This is particularly the case in the countryside.

3. Energy for heating and low housing standard

The majority of housing in Central Asia is built without building codes taking into account energy efficiency which is a key reason for the high energy utilization in the residential sector for heating.

The absence of modern heat energy supply services, low income and high heat demand of low energy-efficient building stocks in rural localities promote the use of solid fuel for house heating. This contributes to pollution of air including in-doors. Tajikistan and Kyrgyzstan have high death rates from indoor pollution.

4. Energy tariffs and lack of incentives for investments

Too low tariffs decrease the incentive for investments in energy generation and for energy savings. In Kyrgyzstan a differentiated electricity tariff was introduced where households had a low price up to 700 kWh and beyond three times higher[1]. This impacted positively on the energy use in the country.

The best investment is to make sure that energy is used as efficiently as possible, but the low tariffs decrease the focus on energy savings. The electricity tariff is generally significantly below the estimated cost of energy generation from alternative sources. Therefore, investors are not motivated to invest in energy generation, including in renewables.

Increasing energy prices is a politically very sensitive issues and may lead to significant protests in the worst case. This was recently the case in Kazakhstan as a result of increased fuel prices.

5. Hydropower-irrigation trade-offs

A water cooperation agreement between the five Central Asian states from 1992 did not refer to energy cooperation. This is one reason of the current water problems in Central Asia. As Kyrgyzstan and Tajikistan lost the previously delivered winter supplies of energy allotted by Moscow, their only option was to rely on hydropower. To generate electricity in their hydropower stations, in particular Kyrgyzstan started to release more water from the Toktogul reservoir during the cold season. With increased winter water releases, less water was available during the spring and summer irrigation season in the downstream countries Uzbekistan and Kazakhstan.

It is a positive development during the past couple of years that upstream countries have agreed with downstream countries on energy exchanges. For example, Kyrgyzstan is releasing water during the vegetation period in exchange of energy deliveries from Kazakhstan and Uzbekistan during the cold season. There is also a commercial trade of electricity between countries.

[1] https://www.iea.org/reports/kyrgyzstan-energy-profile/national-market-structure

6. Renewable energy and lack of climate change mitigation

Central Asia is one of the regions in the world suffering the most from increasing temperatures and climate change. At the same time, they are large emitters of greenhouse gases, especially from use of fossil fuels. While the Central Asian governments are trying to show their commitment to renewable energy (RE) and climate change mitigation, there are financial and political bottlenecks to what is being achieved. Apart from hydropower in Kyrgyzstan and Tajikistan, renewable energy sources play a very marginal role in energy generation. But the Central Asia republics have a high potential for RE. The river networks in Tajikistan and Kyrgyzstan make them superior for hydro energy. Both countries also have a high potential for solar energy. The large potential for solar energy is available in Kazakhstan, Uzbekistan, and Turkmenistan as well. Considerable wind energy potential is found in Kazakhstan and Turkmenistan.

7. Difficulties for investments in renewable energy generation

In the countries endowed with hydrocarbon resources the political will to invest in renewable resources may be limited. Current energy policies, legislative framework and energy tariffs are barriers to producing electricity with RE sources. Some solar and wind energy projects are however being planned. Kazakhstan is possibly the country progressing the most including the development of solar power.

In Kyrgyzstan and Tajikistan, plans for more hydropower are in place. In Tajikistan, the major Rogun dam is being constructed and in Kyrgyzstan the Kambarata 1 and 2 and other hydropower cascades are on the agenda and discussions on-going with tentative international investors including downstream countries.

8. Reference

More specific information on several of the issues raised in this paper can be found in:

*Mehta, K.; Ehrenwirth, M.; Trinkl, C.; Zörner, W.; Greenough, R. The Energy Situation in Central Asia: A Comprehensive Energy Review Focusing on Rural Areas. Energies 2021, 14, *2805. https://doi.org/10.3390/en14102805*

The development of bioenergy is a step towards sustainable development

Bezzubko Larysa, Doctor of Sciences in Public Administration, Professor, Donbas National Academy of Civil Engineering and Architecture, Kramatorsk, Ukraine;

Eshniyazov Rustam, Karakalpak State University, Nukus, Uzbekistan

1. Introduction

Currently, the transition to renewable energy sources is an urgent task for every state (figure 1).

It is possible to put forward both global causes of this phenomenon (the need to mitigate the negative effects of climate change), and regional (as an example, we can note the need for European countries to solve the problems of "energy security" of the European Community as a result of the gradual abandonment of gas consumption from Russia), local (such problems within a single country may be development of state policy measures in the field of energy conservation and energy efficiency improvement at the national and regional levels).

Figure 1. Sustainable development is a condition for the survival of mankind

2. Sustainable Development Goals

At the United Nations Summit on Sustainable Development in 2015, the Sustainable Development Goals until 2030 were adopted, among which the tasks of ensuring universal access to affordable, reliable, sustainable and modern energy supply were noted (figure 2).

According to the World Bank, 2.6 billion people in developing countries use traditional types of biomass for cooking and heating [1]. The development of bioenergy in various countries is an important step towards creating a system of sustainable development (figure 3).

Figure 2. Sustainable Development Goals

Figure 3. Humanity and bioenergy

3. The national programmes in Uzbekistan and Ukraine

In 2020, Uzbekistan adopted a program of comprehensive measures for the development of biotechnologies and improvement of the country's biological security system in 2020-2024. Uzbekistan has also approved Strategies for the transition of the Republic to a "green" economy for the period 2019-2030."

Ukraine has signed several international documents that record the gradual abandonment of coal-based energy production until 2030 and the fastest possible transition to renewable energy (solar, wind, biomass). Ukraine has developed a Concept for the development of bioenergy in Ukraine for the period up to 2035. All this testifies to the attention of the national authorities of different countries to the problems of bioenergy development.

4. Interest in bioenergy

The interest in various problems of bioenergy (technical, organizational, economic, legal and environmental, and others) is huge. According to the research data, 124,285 articles were published on this topic only for the period 2000-2018 [2]. High greenhouse gas emissions, deadly air pollution, unstable prices for fossil energy carriers stimulated active research in the field of bioenergy development. But it is time to move from theoretical research to the mass use of bioresources, the formation of a bioenergy market at the national level. This requires the application of a systematic approach and recommendations to the development of state policy measures in the field of energy conservation and energy efficiency at the national and regional levels; in assessing the scale and structure of the bioenergy market. It is important to

1. Determine of the region's need for biofuels.
2. Determine the potential of biological resources at the national, regional and local levels.

It is necessary to develop national and regional programs aimed at the development of bioenergy.

5. Sources of bioenergy

In industrialized countries, there is an abundance of a wide range of raw materials to produce biofuels, including agricultural and forest waste, construction and industrial waste, as well as solid household waste (MSW).

Uzbekistan has a great potential for renewable energy sources, which, according to experts, exceed the resources of organic fuel by an order of magnitude. In Uzbekistan, the use of the organization of the use of the second and third generation of biofuel production from plant stems and microalgae (aquatic plants) is promising. Currently, in the republic, stems and tops (root crops) of crops such as cotton, cereals, rice and potatoes are used as livestock feed and as fuel.

In different regions of the republic, it is necessary to determine the most efficient bio-raw materials for energy production. An example is the use of algae as a raw material for biofuels of the third generation. This type of resource is suitable because of the high ability of algae to produce a large amount of lipids suitable to produce biodiesel [3]. In addition, this fast-growing biomass can be used directly to produce a wide range of biofuels.

6. References

1.Saghir J. Energy and poverty: myths, links, and policy issues. *Energy working notes.* 2005. № 4. URL: http://siteresources.worldbank.org/INTENERGY/Resources/

2. Welfle A., Thornley P., Röder M. Review of the role of bioenergy modelling in renewable energy research & policy development. *Biomass and Bioenergy* Volume 136, May 2020, 105542.

3. Biofuels from industrial/domestic wastewater.. *Archived from the original on 18 February 2009.*

Concentrated Solar Power (CSP) as a source of renewable energy in sunshine-rich countries

Lars Rydén, Prof. Uppsala University, Swedish Aral Sea Society

1. Background

Concentrated Solar Power CSP is a system in which mirrors or lenses are used to concentrate a large area of sunlight onto a small receiver. It causes a very high temperature of the receiver, which is used to heat a liquid usually thermal oil. The liquid is circulating to a steam engine which is connected to an electric power generator to produce electricity. One may also use the heat directly mostly for district heating. In Europe, since the mid-1990s about 125 large solar-thermal district heating plants have been constructed.

The use of solar collectors to generate heat (or intense light) is very old. A first well-known case is the solar collector built by Augustin Mouchot at the World Exhibition in Paris in 1878. He used it to run a cooling engine to make ice cream (!).
https://alternativeenergy.procon.org/historical-timeline/

The topic of CSP is introduced here as a possible future way to large scale production of solar electricity in Uzbekistan.

2. The technology

There are two different well-established technologies (https://en.wikipedia.org/wiki/Concentrated_solar_power). In the parabolic trough technology (Figure 1) linear parabolic reflectors concentrate light onto a receiver positioned along the reflector's focal line. Temperatures achieved is about ca 400 °C. Trough systems are the most developed CSP technology. Thermal oil or molten salts are used as thermal fluids.

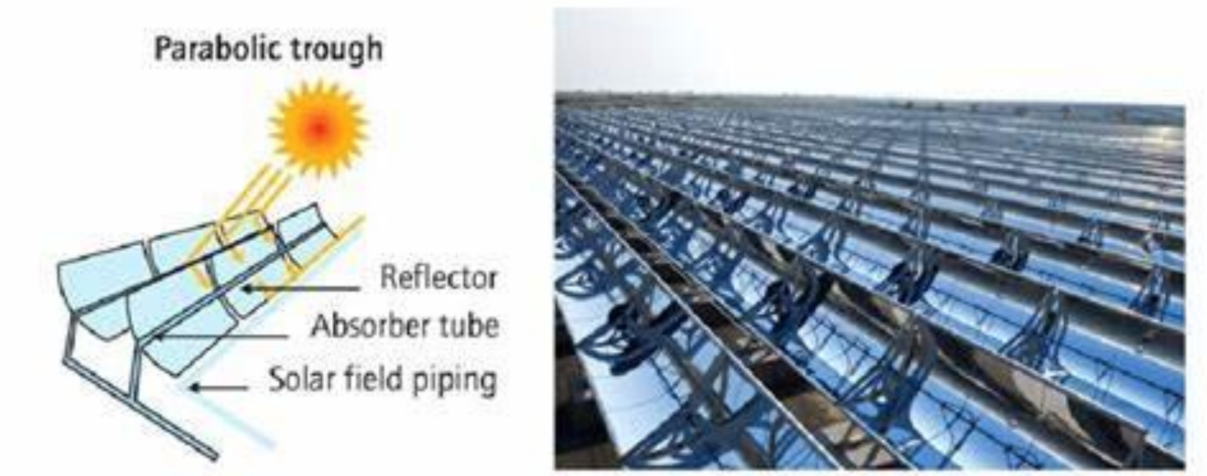


Figure 1. parabolic trough technology (https://www.researchgate.net/publication/306279260_InTech-Aluminium_alloys_in_solar_power_benefits_and_limitations/figures?lo=1)

In the Heliostat power plant technology a solar power tower consisting of an array of dual-axis tracking reflectors (heliostats) concentrate sunlight on a central receiver atop a tower. Temperature achieved are about 600 ^{o}C. Mostly molten salts are used as thermal fluids.

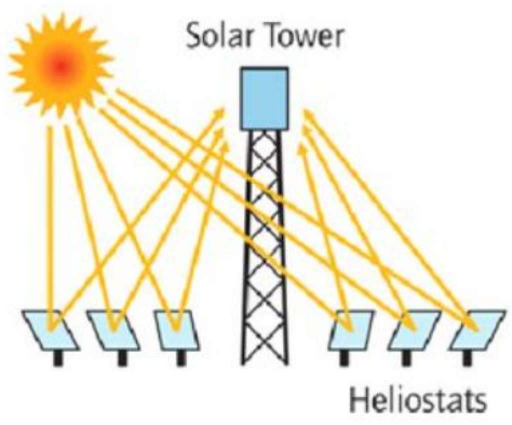


Figure 2. Heliostat power plant technology. (wikipedia.org/wiki/Concentrated_solar_power)

Figure 3. Left. Parabolic trough at a plant near Harper Lake, California (https://en.wikipedia.org/wiki/Concentrated_solar_power#/media/File:Parabolic_trough_at_Harper_Lake_in_California.jpg)
Figure 3 Right. The PS10 solar power plant in Andalusia Spain concentrates sunlight from a field of heliostats onto a central solar power tower. (https://en.wikipedia.org/wiki/Concentrated_solar_power#/media/File:PS10_solar_power_tower.jpg)

3. A CSP plant can store heat

A CSP plant can store the heat to be used when the sun is not shining. It can be done either as sensible heat or as latent heat, for example, using molten salt.

The most direct way to store heat is called *sensible heat storage (SHS)* (Figure 4). It is based on raising the temperature of a liquid or solid to store heat and releasing it when required. Materials used in sensible heat storage must have high heat capacity and also high boiling or melting point. Although this method of heat storage is less efficient, it is not complicated and inexpensive.

Latent Heat Storage (LHS) use materials which store heat when the material undergo a phase change, most often solid-to-liquid. The comparison between latent heat storage and sensible heat storage shows that in latent heat storage, storage densities are typically 5 to 10 times higher than in sensible heat storage. (https://www.thermal-engineering.org/what-is-sensible-heat-storage-shs-definition/) (https://www.thermal-engineering.org/what-is-latent-heat-storage-lhs-definition/)

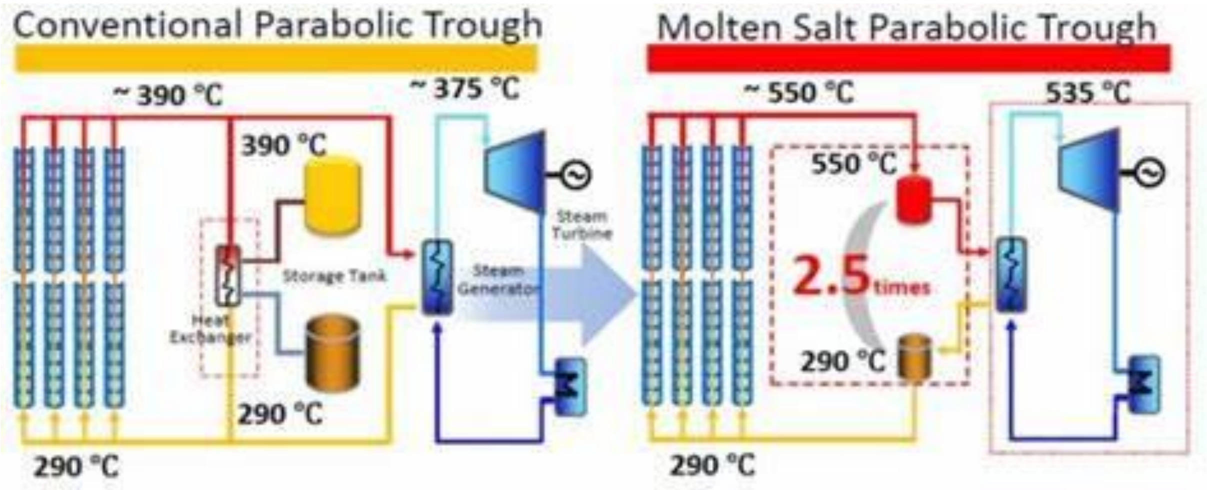


Figure 4. Left. Conventional parabolic trough using *sensible heat storage (SHS).* Right using *Latent Heat Storage (LHS)*.

4. DEWA project in Dubai

As an example Dubai Electricity Water Authority (DEWA) built a combined trough and tower CSP plant in the Dubai desert in 2019. The capacity is 700 MW with a price of US$ 73 per MWh . It has 15 hours of thermal energy storage daily. (https://helioscsp.com/worlds-tallest- Concentrated-solar-power-tower-completed/)

The DEWA concentrated solar power plant reached a major milestone on 14 July 2022: the first salts were injected into the receiver in order to reach 565°C at the receiver outlet.

The project today also includes PV electricity production. (https://helioscsp.com/tag/dubai/)

Another case is the CSNP Royal Tech Urat 100MW Parabolic Trough CSP Project in China. It was successfully connected to the grid on January 8th, 2020. (http://www.cspfocus.cn/en/market/detail_2597.htm)

5. Amount and cost of installed CSP in the world

The installation of CSP plants in the world is increasing (Figure 5). The global total installed capacity in 2021 was 6,800 MW. Spain accounted for almost one third (2,300 MW) while United States had a total of 1,740 MW installed. A recent report in Energy & Environment (July 2022) accounts of CSP in 10 countries.

From 2019 CSP with thermal energy storage cost 50 - 70 € / MWh depending on the solar radiation received. DEWA project reports US$ 73 (72 €) per MWh. Generally speaking a typical (PV) solar system in the U.S. can produce electricity at the cost of 60 - 80 € / MWh https://www.electricrate.com/solar-energy/price-per-kwh/. Investments are paid back in some 9 years. Clean solar energy has become cheaper than coal or natural gas.

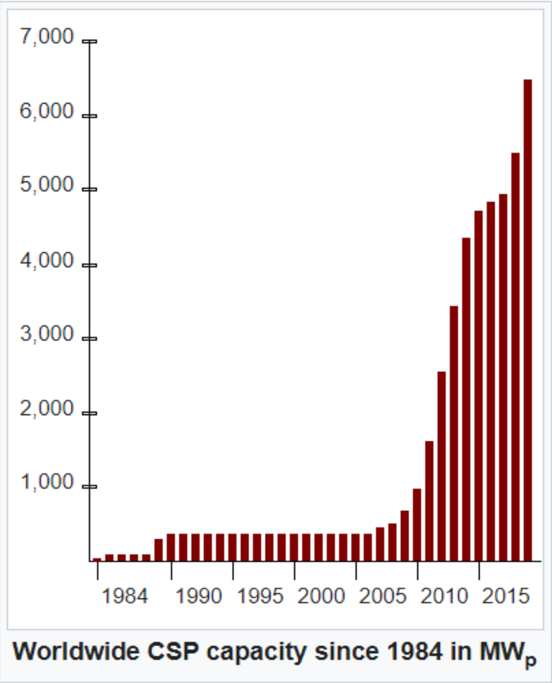


Figure 5. installation of CSP plants in the world.
(https://en.wikipedia.org/wiki/Concentrated_solar_power)

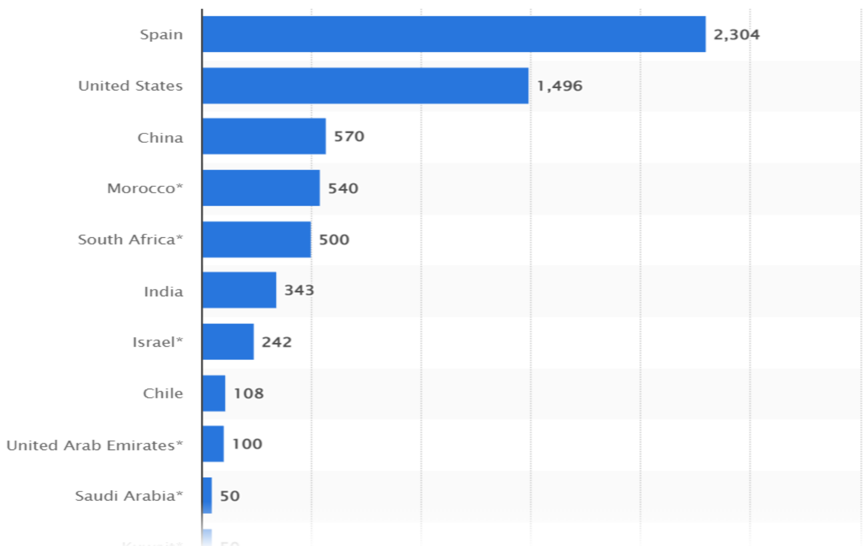


Figure 6. Global installed concentrated solar power capacity by selected countries 2021 (Energy & Environment July 2022)

Experiences of Renewable Energy Development in Lithuania

Linas Kliučininkas, Prof. Department of Environmental Technology, Kaunas University of Technology, Kaunas, Lithuania. linas.kliucininkas@ktu.lt

1. Early efforts to introduce RES

After the closure of the Ignalina (Lithuania) nuclear power plant (NPP) in 31 December 2009, Lithuania switched from being a net exporter to being a net importer of electricity. Currently, Lithuania imports about 70 % electricity.

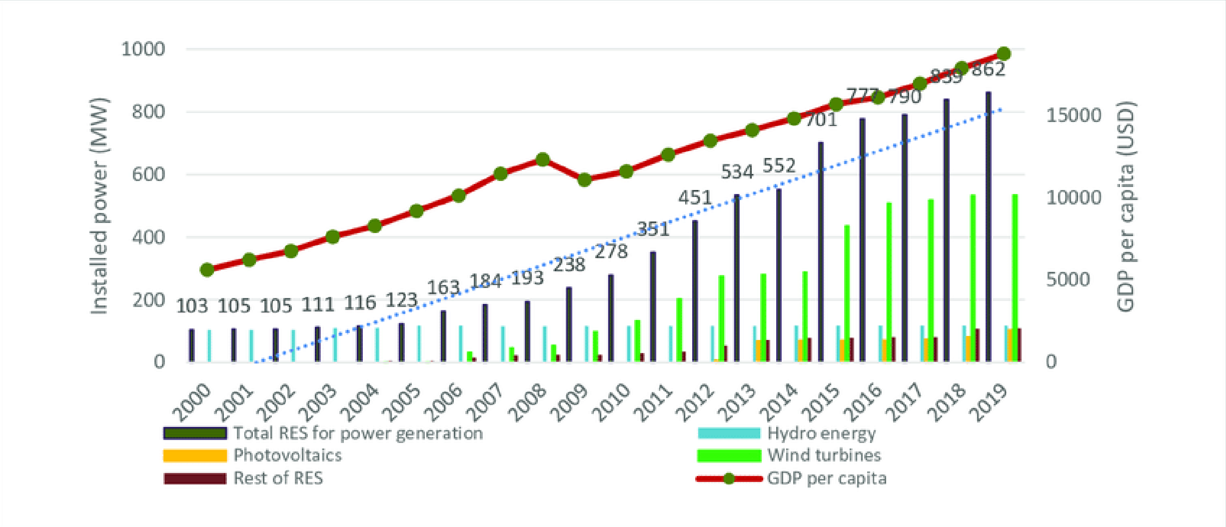


Fig. 1. Installed power of renewable energy sources and GDP in Lithuania 2000–2019 (Statistics Lithuania, 2021; Eurostat, 2021)

During the last two decades, installed power from renewable energy sources (RES) grew more than 8 times from 103 MW in the year 2000 to 862 MW in 2019. Significant growth of RES started with the development of largescale wind turbines in 2009 with added 44 MW wind power capacity. Significant wind power growth continued until 2016. In terms of solar energy, substantial growth was recorded in 2013 with added 61 MW installed power of photovoltaics. However, later this growth was very slow due to decreased feed-in-tariffs for electricity production from photovoltaics.

Table 1. Electricity capacity and generation [Official Statistics Portal of the Republic of Lithuania, 2020].

Technology	Capacity in 2020, MW	%
Non-renewable	**2493**	**73**
Renewable	**922**	**27**
Hydropower plants	117	3.4
Solar power plants	148	4.3
Wind farms	539	15.8

Bioenergy (biofuels, biogas) power plants	118	3.5
Geothermal	0	0
Total	**3415**	**100**

2. Wind energy

Electricity generated in wind farms accounts for more than a half of all electricity generated from renewable energy sources in Lithuania. The amount of electricity that the wind turbine can generate under optimal wind conditions, of 1 kW wind power plants produced an average of 2050 kWh of electricity, while in all EU countries this total indicator is 3200 kWh/kW. This means that a wind power plant of the same capacity in the EU produces on average 1.56 times more electricity than in Lithuania; at the same time—the cost of electricity produced by Lithuanian wind power plants is higher.

Another important factor in the development of wind energy is the possibility of wind power plants to be connected to the electricity grid. Nevertheless, wind is currently the most efficient renewable resource. According to the goals set in the Lithuanian National Strategy, wind generation should triple by 2030, and in the long run, wind farms should produce more than 50% of Lithuania's electricity needs.

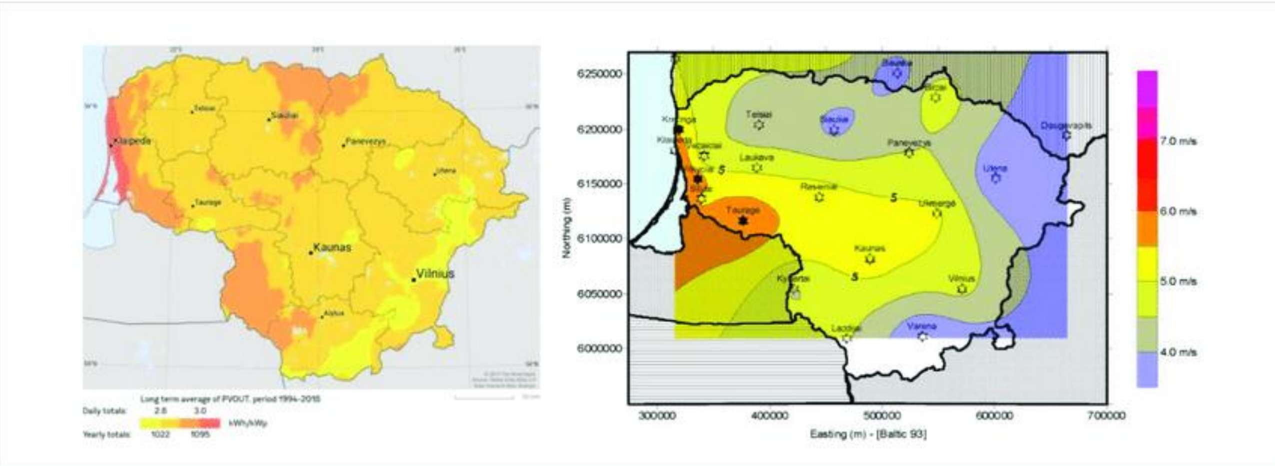


Fig. 2. Solar irradiation (kWh/m^2) and wind energy potential (m/s) in Lithuania (Solargis, 2021; UNDP, 2003)

3. Solar energy

Solar irradiation in Lithuania varies from 1,000 to 1,200 kWh/m^2 per year. Higher solar energy potential is fixed in the western part of the country and, on the contrary, lower in eastern part of Lithuania. The central and the remaining part of the country indicates a solar radiation parameter to be around 1,100 kWh/m^2 per year.

It is often assumed that there are very few solar energy resources in Lithuania, and that they are insignificant. Recently, however, the popularity of solar energy, especially in households, has been growing rapidly due to favourable government decisions. The legalization of remote solar power plants and the planned financial support for their installation paved the way for such a breakthrough. Efficient solutions for the interaction between solar power plants and geothermal heating are particularly popular among household owners. Residents who produce electricity from the sun pay less for it, and the increase in the number of consumers producing nationwide will have a tangible impact on the growth of Lithuania's energy independence. Solar power plants are predicted to continue to play a key role in the use of renewable energy sources in households in the future.

4. Biomass

The use of biomass in the district heating sector increased from 2 % to 65 %, thus surpassing the biomass used in district heating to imported gas. The main reason for this change is the huge renewable energy resources in Lithuania where the forests cover 33,2 % from the country (2,2 M ha). The price of using biomass for heating was up to 3 times less than the price of natural gas, however in 2022 when Russia started massive war in Ukraine the situation has changed considerably. The amount of biomass per capita in Lithuania is one of the highest in the European Union.

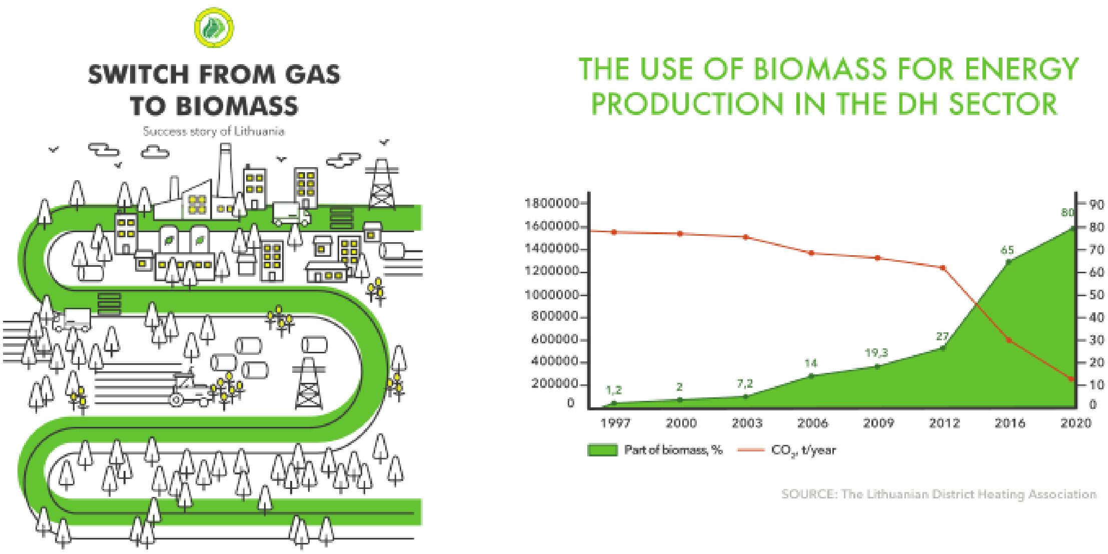


Fig. 3. District heating from solid biomass in Lithuania 1997-2020 (The Lithuanian District Heating Association)

5. Summary

In summary, solid biomass has the leading share among renewables, more than 80%, in Lithuania. The proportion of forest biomass used in final primary energy consumption has increased rapidly since about 2010. However, renewables for energy production sometimes face market barriers such as high initial investment cost and low competitiveness, in the long term, its usage should give economic and ecological benefits.

The peak in prices for natural gas in 2007–2012 and the EU's policy of greater use of renewables have led to the rapid construction of biomass-fired boilers and cogeneration plants in Lithuania. The result of state aid and incentive regulation was that already in 2017 about 70% of the total district heat production was from renewables.

Russian invasion to Ukraine (2022) and energy blackmailing changed the situation dramatically. In this context, the expansion of renewable energy generation is one of the key factors in the development of cheap and sustainable energy in Lithuania.

6. Literature sources

1. Baskutis, S.; Baskutiene, J.; Navickas, V.; Bilan, Y.; Cieśliński, W. Perspectives and Problems of Using Renewable Energy Sources and Implementation of Local "Green" Initiatives: A Regional Assessment. *Energies* 2021, *14*, 5888. https://doi.org/10.3390/en14185888
2. Gecevicius, G.; Kavaliauskas, Z. Development of Renewable Energy in Lithuania: Experience, State and Trends. Environmental Reserach, Engineering and Management, Vol. 77, 4, 2021. https://erem.ktu.lt/index.php/erem/article/view/29902
3. Official Statistics Portal of the Republic of Lithuania. Environment Protection and Energy. 2020. https://osp.stat.gov.lt/statistiniu-rodikliu-analize#/
4. The International Renewable Energy Agency (IRENA). Renewable Energy Statistics 2021; The International Renewable Energy Agency: Abu Dhabi, United Arab Emirates, 2021; 460p.
5. Lithuania, switching from gas to biomass. https://www.expobiomasa.com/en/bioenergy-renewable-energy/lithuania-changing-biomass-from-gas
6. Varnagiryte-Kabasinskiene, Iveta; Lukmine, D.; Mizaras, S.; Beniusiene, L.; Armolaitis, K. Lithuanian forest biomass resources: legal, economic and ecological aspects of their use and potential. Energy, Sustainability and Society 9, 41, 2019. https://energsustainsoc.biomedcentral.com/articles/10.1186/s13705-019-0229-9

Current state of the use of solar energy in Uzbekistan

Eshkuvat Arzikulov Prof. Samarkand State University, Samarqand, Uzbekistan

1. Electricity production in Uzbekistan

Development in any society in the modern world is determined by its energy capabilities and the degree of use of various energy sources. It is also known that the more a society develops, the more it uses energy. The Republic of Uzbekistan, after the election of the second President, has dramatically changed the course of development, it has become more open to the whole world, there has been and is a sharp increase in all areas of activity, which required a large amount of energy (especially electricity). The new government in the republic pays close attention to the development of the energy sector in order to fully provide electricity to all sectors of the economy.

The annual volume of electricity production in our economy in 1991 was 54.2 billion kWh, by 1996 this figure had significantly decreased and amounted to 45.4 billion kWh [1]. The main reason for this decline in electricity generation is outdated power units built 30-40 years ago at the largest power plants in the country. As a result of the modernization and commissioning of new power units in 1996-2018. there is a steady increase in production.

The total electricity generation capacity in the country is 14.1 GW, of which 85.8% comes from thermal power plants [2]. With the growth of GDP and population in our country, the demand for electricity and its production is also growing.

According to the forecast, electricity production in Uzbekistan for 2019-2025 will increase by 40% by 2025, compared to 2018, and will reach 84.9 billion kilowatt-hours. It is planned to increase the existing power generation capacity by 2.5 times, which will double the annual volume of electricity production by 2030 [3].

2. Renewable energy sources

Although the Republic of Uzbekistan has significant natural energy resources (fossils) to meet the needs of the current economic growth rates, according to experts, it is enough for about 40-50 years, which requires the use of renewable energy sources (RES). In the table below, the RES data of the republic [4].

Renewable energy sources	Gross potential	Technical potential
Hydropower	9.200 Mtoe	2 Mtoe
Wind power	2.200 Mtoe	0.4 Mtoe
Solar	50,973 Mtoe	177 Mtoe
Geothermal energy	67,000 Mtoe	0.3 Mtoe
General alternative energy sources	117,984 Mtoe	179.3 Mtoe

To date, the prevalence of RES in Uzbekistan, as well as in many countries, although growing over time, remains relatively low. Meanwhile, the volume of consumption of primary energy resources in 2010 amounted to 58.3 million tons of oil equivalent (toe), 91.8% of which was provided by natural gas, the contribution of oil and gas condensate was 7.0%, hydropower - 1.3%, coal and other sources - 0.004% [4]. Up to 20% of natural gas is used in the production of electricity, about 30% of energy resources are used for the production of heat, hot water and cooking.

The power industry is in the process of deep modernization, the purpose of which is to increase the efficiency of generating capacities, develop electric networks, increase the contribution of coal and hydro resources to electricity generation, increase the energy supply of the economy, i.e. the amount of energy consumed per capita. The analysis shows that in order to ensure energy sustainability in the republic after 2030, it will be necessary to produce additional energy resources in the amount of up to 13 million toe / year [1].

3. The potential of PV energy

The combined technical potential of wind energy, small hydropower and geothermal energy in the country is small compared to this value, while the technical potential of solar energy (180 million toe) is three times the amount of energy consumption in the country. The question is how to use this potential in an economically justified way in the short term. This requires a system of organizational, financial, economic and social support measures that only the state can implement; it should increase the attractiveness of RES for producers and users, equalize their chances with energy from fossil fuels, and promote their integration into the existing energy sector.

How much should the installed capacity of solar installations grow so that in 20 years' solar energy can replace fuel in the amount of, say, 10 million toe? Can we hope that this will increase the power supply of the country's population? We will assume that we are talking about photovoltaic plants, although in the long term for the centralized production of solar electricity, mirror-concentrating systems will apparently be more profitable.

For calculations, we assume that solar power plants have an efficiency factor = 0.18, the number of sunny days in a year is 300-320, the average solar radiation flux is 700 W/m² for 7 daytime hours. We will assume that a solar power plant with an area of 1 m² corresponds to an installed capacity of 1 kW. If we assume that solar power plants with a total capacity of 100 MW will be installed annually, in 20 years this will be 2 GW, which corresponds to 2 km² of the earth's surface covered with photovoltaic panels. These solar power plants can generate electricity equivalent to about 45 thousand toe annually.

If we assume that the installed capacity grows exponentially with a factor of 1.5 from the initial value of 1 MW, then in 20 years it will be more than 6 GW having, however, real meaning. This is not our goal at all. We only want to show that the transition to renewable energy requires a high level of organization of the economy, an important role in which should be occupied by market mechanisms and properly organized marketing, a huge amount of technical work, as well as a huge amount of investment, which can be easily estimated from the above data on the cost of each Watt. installed capacity of FES. Thus, for the annual production of solar electricity in the amount equivalent to 10 million toe, it will be necessary to cover with photo converters about 440 km.² of area, which seems to be a difficult and extremely expensive task. Here, of course, we must take into account our remark about more economical and, in the future, technologically more advanced mirror-concentrating systems for generating heat and electricity.

4. Thermal energy

If we talk about thermal energy, we must keep in mind solar collectors, the efficiency of which in terms of hot water can reach 70% and which are quite competitive in cost with other sources of heat and hot water, which has led to their widespread use in the world. Installation of 30 million m² of solar collectors in Uzbekistan, i.e. 1 m² for each inhabitant of the country can save fuel in the amount of about 3 million toe. Low potential heat has disadvantages, in particular it is poorly converted into other types of energy; in addition, solar collectors make serious demands on the quality of water supply, which cannot be provided everywhere. Nevertheless, in the short term, solar collectors, especially in combination with heat pumps, represent one of the most promising areas for using solar energy.

5. Conclusions

Thus, although solar energy has no alternatives in the long term, it is unlikely that it will be able to solve all the energy problems of the republic in the short term. Nevertheless, it is necessary to deal with the issues of introducing solar energy into the economy and everyday life, paying special attention to the issues of distributed generation of solar electricity and heat and the creation of hybrid power plants, such as solar thermal power plants. The potential of these niches of the energy market in Uzbekistan is very high, it requires early study and wide exploitation, which poses serious challenges for the marketing services of energy companies involved in the use of solar energy.

Today, the share of RES in world energy consumption is 19.3%, fossil fuel and energy resources - 78.4% and nuclear energy - 2.3%. [5]. The global share of renewable energy in electricity generation in 2018 was 26%. The total capacity of renewable energy sources in our country was 1844 MW in 2018, which is about 3% of the total energy consumption of this type of energy [6]. On average, 10-12% of the total electricity is generated from renewable energy sources.

6. References

1. http://energo-cis.ru/wyswyg/file/news/
2. https://stat.uz
3. https://minenergy.uz/ru/news/view/1063
4. 4. Nasyrov T., Vasikov A., Bjarne J.-K., Zavyalova L., Pozychanyuk P. Prospects for the development of renewable energy in Uzbekistan. UNDP Publication, Uzbekistan, 2007. 95 p.
5. 5. Saidova G.K., Salikhov T.P., Kabulova Kh., Elisov A., Shadybaev T. Alternative Energy Sources: Scientific Report of the Center for Economic Research 2011/03, Tashkent, 2011. 74 p.
6. 6. Gulamov M.K., Zainutdinova H.K. Renewable energy sources and energy efficiency in Uzbekistan.// Economy and Finance 2013, No. 5, P.31-38.

Local renewable energy supply as a key component in climate transformation within agriculture and forestry – the Fräkentorp example in Malmköping, Sweden

Björn Frostell, Eva von Heideken, Tomas von Heideken, Peter Hörmander

Figure 1. The main barn at Fräkentorp Manor has room for 75 cows, with a 125 kW photovoltaic solar plant installed on the roof and with a 300 m^3 biogas plant main digester under installation.

1. The Vision of JOSE (Center for Agricultural and Forestry Economics)

The Center for Agricultural and Forestry Economics (JOSE=Jord- och SkogsbruksEKOnomi) wants to bring together farmers and foresters and others with an interest in developing and implementing organic cultivation systems and technology solutions for the production of food, forest raw materials and ecosystem services. This also includes contributing to maintaining and developing socially sustainable working conditions with high animal ethics. In a first step, JOSE focuses on bringing together agricultural and foresters in Södermanland province and the Mälardalen region (Södermanland, Örebro, Västmanland, Uppland and Stockholm) in Sweden. The Center is also interested in a broader cooperation at the national and international level.

2. Why JOSE

• More and more signs indicate that climate change is beginning to pose a real and immediate threat to humanity and that urgent action is needed;

• Climate change is only part of a much larger ecological challenge which means that man as an ecological being is beginning to take up too much space on earth;

• The current development in agriculture and forestry is based on a philosophy that has been valuable in the short term (increased output and financial return), but which has come at the expense of both increased ecological impact and reduced social sustainability;

• An important sub-problem in the current development is a continuous ongoing linear upscaling and a continuous mechanization (more dairy cows, more meat animals, larger cultivation areas, larger cultivation facilities, larger private forest areas, automated and digitalized systems). The industrialization of agriculture and forestry has important ethical drawbacks, the most important perhaps being that human and soil health as well as animal welfare become more difficult to maintain;

• Sweden has approx. 60,000 agricultural and forestry companies and together approx. 300,000 private forest owners. Many of these have a great commitment and interest in environmental and sustainability issues;

• Farmers and foresters work daily with living materials and are therefore closer to the basics of life and closer to a fundamental way of thinking than many other professional groups;

• Agriculture and forestry have a decisive opportunity to contribute to improved and ecologically more sustainable resource flows (in the short term important climate measures) and in the long term an ecologically based supply of food, renewable raw materials and energy.

3. Energy Supply at Fräkentorp Manor August 2022

The energy supply currently is based on the following sources:

• Two photovoltaic solar energy plants with together 160 kW installed maximum capacity;

• Two wood chips fired incineration plants - each with 80 kW installed capacity – for heat energy supply to buildings and for hot water supply. One of them designed for simultaneous production of heat and biochar (as a cultivation substrate and carbon storage mechanism);

• 15 m3 of diesel for different engines in the operations:

• Electricity supply from the main national electricity grid.

A 300 m3 biogas plant is in the phase of being added to the Manor energy supply. Biogas will add a renewable fuel energy source and increase the flexibility of the local energy system. At present, the Fräkentorp Manor is self-supported with energy (heat and electricity) and serves as an energy supplier to society during 8-9 months per year. A main remaining challenge is energy supply during wintertime (November-January), when solar radiation is very limited in Sweden.

4. Results for the year 2021

The energy metabolism at Fräkentorp for the year 2021 is summarised in Table 1. This is the very first overall compilation of data that has been done and must be regarded as preliminary. It is based on the following sources of information (cf. Table 1):

- Consumed electricity (measured) in the Fräkentorp main buildings (main house plus three rental houses plus five economy buildings);
- Electricity consumption in the family house at the Bjursätter farm (estimated), a smaller farm belonging to the Fräkentorp Manor;
- Total quantity of wood chips (measured) consumed in the two wood chips incineration plants for heat production at Fräkentorp;
- HVO diesel consumption in the Fräkentorp own tractors and machinery (measured);
- Estimated diesel use in lego work performed at Fräkentorp and assuming it is non-renewable;
- Estimated gasoline use in own non-electric cars used at Fräkentorp (the family has also 2 fully electric cars since 2021).

Table 1 shows that Fräkentorp has been successful in transforming its energy use almost entirely to renewable energy (indicatively 98,5 % renewable). Remaining challenges and ambitions are (i) to be even more self-supported with energy (biogas production plus energy storage) and (ii) to lower the use of wood chips by improving the thermal efficiency of especially the earliest installed wood incineration furnace.

Table 1. The energy metabolism at the Fräkentorp manor during 2021 from measured and estimated energy production and consumption (*=total electricity use in the buildings belonging to the main Fräkentorp manor incl. family home, 3 rental homes and five economy buildings; **= estimated energy use in the family home at Bjursätter farm family home and in the aquaponics demonstration plant at Bjursätter).

Energy metabolism for the Fräkentorp Manor, Malmköping Sweden						
Energy type	**Energy use**	**MWh/år**	**Renewable, %**	**Renewable, MWh/yr**	**Own prod., MWh/yr**	**Purch. prod., MWh/yr**
Electricity	Electricity Fräkentorp*	122	100	122	46	76
	Ekectricity Bjursätter**	35	100	35	10	25
	Total electricity	156	100	156	56	101
Heat	Heating of all buildings	800	100	800	800	0
Fuels	Own vehicles (HVO diesel)	169	100	169	0	169
	Vehicle fuel lego-work (diesel)	15	0	0	0	15
	Vehicle fuel (gasoline)	2	0	0	0	2
	Total energy use	**1142**		**1125**	**856**	**287**
	Sum total renewable	**1125**				
	Sum total non-renewable	**17**				
	Energy use and production					
	Renewable energy use, %	**98,5**				
	Non-renewable energy use, %	**1,5**				
	Own production, %	**75,0**				
	Purchased productionm, %	**25,1**				

5. Further information

Fräkentorp Säteri 64296 MALMKÖPING, SWEDEN Phone: Eva von Heideken: +46-70-594 4118 E-mail: eva@frakentorp.se

Peter Hörmander, Energía y Ambiente, S.A. 2a Ave, 12-33, Z10 Edificio CANAMCO, Apt 12C Guatemala City, GUATEMALA C.A. Phone: +502-4247 1307 E-mail: peterhormander@gmail.com

Björn Frostell Åbergssons väg 1 170 77 SOLNA, SWEDEN Phone: +46-70-639 4100 E-mail: bjornfrostell@gmail.com

Green production of ammonia for energy, fertilizer and feed.

Lars Hylander, Kungsgarden@telia.com

1. Storing the energy from the sun as liquid hydrogen

The sun is the prerequisite for all life on earth. Without the sun we would have no flowers, animals nor heat. But now it's getting too hot because humans have burned too much oil, gas and coal. Therefore, we must obtain energy in other ways than from oil in a sustainable and safe way.

We may start at the mother of life - the sun. The sun is allowed to shine on solar cells that convert light into electricity, which may be stored in batteries from day to night. Storage losses at prolonged storage may be reduced by producing an energy dense storage media such as liquid hydrogen, which is stored until electricity is needed, when the hydrogen is fed to fuel cells, generating electricity.

2. Ammonia as an alternative form of energy storage

A better option is to feed fuel cells with liquid ammonia, having no risk of explosion, having higher energy density than liquid hydrogen and smaller losses at production and storage. Ammonia may be produced environment friendly by using electricity to split water (H_2O) into oxygen and hydrogen (H_2) and then let the hydrogen react with the nitrogen (N_2) of the air to form ammonia (NH_3). There will be some oxygen left over but it will not harm anyone. Newly invented machines mean that this can be done locally with electricity from a standard photovoltaic system.

3. Ammonia provides also fertilizers

Ammonia can do much more than storing energy and provide electricity. If another hydrogen atom connects with ammonia, an important nutrient, ammonium (NH_4), is formed. Ammonium is needed in large quantities by all plants to synthetize proteins, being essential for humans and animals. By treating straw with ammonia, ruminants can obtain more energy and proteins from the straw being fed.

In conclusion, ammonia, produced locally with renewable energy sources, have the potential to be a key component in the transition to a sustainable society with reduced effects on the climate.

The use of fresh groundwater is the base for sustainable development of Ustyurt

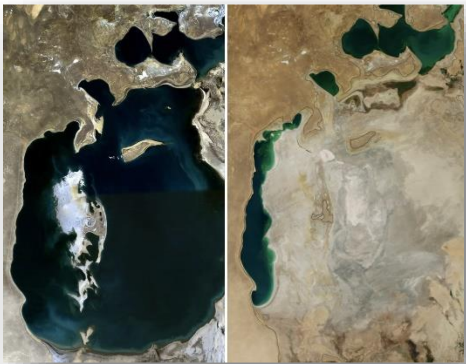
Zakirov M.M. - d.g.-m.s., Professor, Tashkent State Technical University named after I.A. Karimov, Tashkent, Uzbekistan

Dzhaksymuratov K.M., Ph.D., Associate Professor, Deputy Director for Research and Innovation, Nukus branch of the Navoi State Mining Institute, Nukus, Uzbekistan

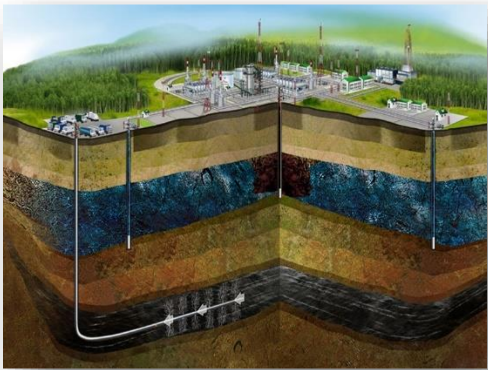
Embergenov A.P., 3rd year student, Nukus branch of the Navoi State Mining Institute, Nukus, Uzbekistan

1. Creation of freshwater in the Ustyurt region

In the zone of the Aral Sea ecological crisis, the provision of drinking and technical water to the population and industrial facilities is currently very important. The Ustyurt region is a vast, relatively flat geological structure, where the formation of groundwater is closely related to its structure and terrain. In recent years, the need to find new ways of water supply to the region has increased. By applying innovative methods it has been possible to create artificial reserves of fresh groundwater in the region. It includes the replenishing and desalination of brackish waters of the lower horizons, as well as concentrated immersion of atmospheric precipitation falling on takyr areas.



a



b

Figure 1 a) The former and current state of the Aral Sea
https://en.wikipedia.org/wiki/Aral_Sea
b) Groundwater structure and use
https://www.gazeta.uz/oz/2018/07/25/yer-osti-suvlari/

2. Artificial freshwater

In Ustyurt (Eastern part), we made hydrogeological studies on the artificial creation of freshwater reserves and their replenishment by temporary surface runoff of atmospheric precipitation. We found out that this will create a fundamental possibility of collecting and preserving fresh surface water in conditions of fractured and karst reservoirs. Thus modern hydrogeological studies of the role of groundwater in the development of Ustyurt are very relevant. They require, however, innovative approaches in order to solve these important national economic problems.

An innovative and technological solution to the problems of water supply in Karakalpak Ustyurt is possible, in our opinion, only with the use of groundwater by storing or replenishing it in aquifers or takyrs. This is a complex of hydrogeological and engineering measures that provide additional artificial nutrition, where their reserves are regulated. This makes it possible to obtain the required amount of water, and most importantly, in case of its deficit, to preserve the aquifer from depletion. Hydrogeological conditions of storage of surface runoff of atmospheric precipitation occur first from the surface of the aquifer, where we lower the dependencies on the geological structure into aquifers.

a b

Figure 2. a and b Groundwater extraction.
https://kun.uz/uz/49361744?q=%2F49361744

3. The geology of the Ustyurt region

In tectonic terms, in Ustyurt, the study area (Uru site) is located within the North Ustyurt depression in the third-order tectonic structure of the Kosbulak trough, on the surface of the Karakidyr karst valley. Of greatest interest to us are the Upper Miocene deposits, represented mainly by limestone-shell rocks with interlayers of dolomitic limestones, loose marls and weakly gypsum clays. The regional impermeable roof separating them from the upper horizon of (non-pressure) groundwater is a thick layer of Paleogene clays. Only on the arch of the Central Ustyurt uplift and in the southern part of the Karakalpak Ustyurt are Paleogene deposits completely absent. In these areas, groundwater in the sediments of the upper part of the Cretaceous has the character of groundwater and, with the groundwater of the Miocene, constitutes a single aquifer. Promising is the aquifer of the Sarmatian deposits developed in most of this region. (Fig. 3).

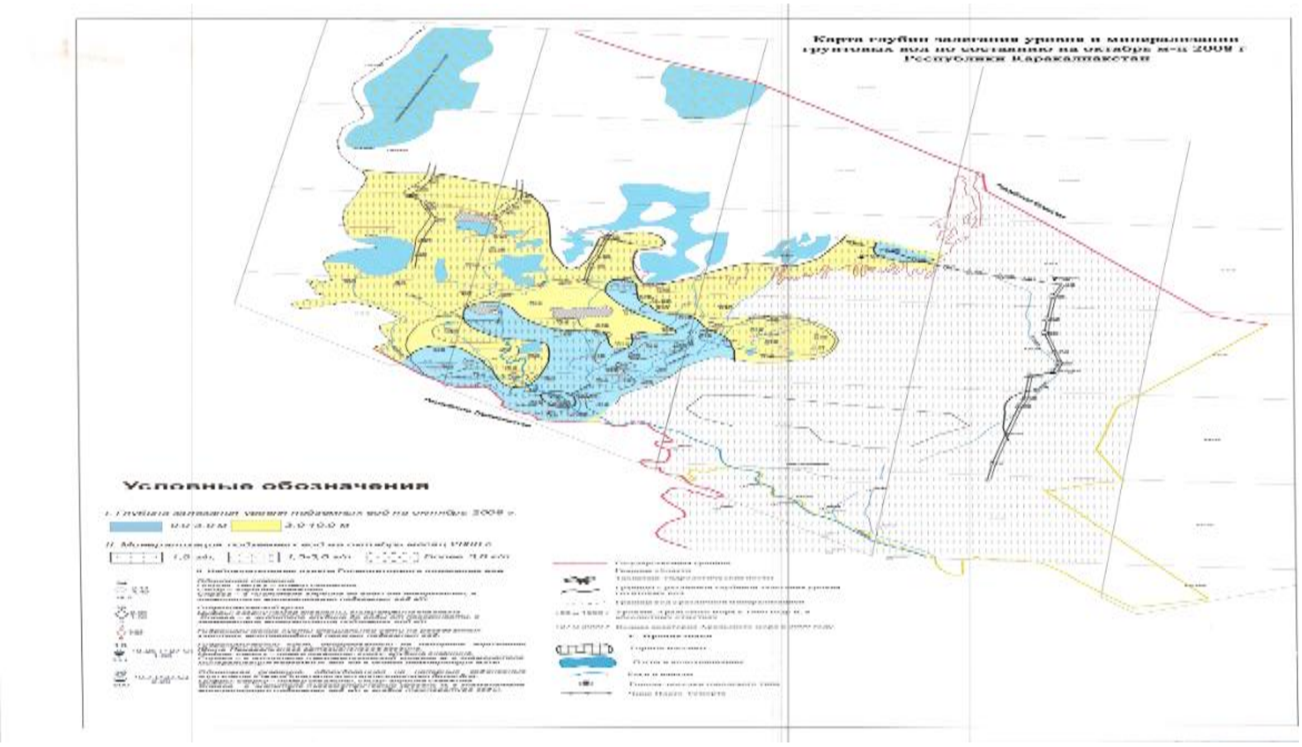


Figure 3. Hydrogeological map of the region

4. Building an artificial pool of fresh groundwater

We thus studied the conditions for the formation of takyr lenses of fresh groundwater artificially on the Ustyurt plateau. An experimental site was made by a directed explosion in the western part of the Uru takyr. In this way an absorbing pool with a capacity of 8000 m^3 was built in the Sarmatian fractured limestones, where 35.9 thousand m^3. As a result, a lens of fresh groundwater with mineralization up to 2 g/l was formed. Its length was 410 m, the average width was 100 m, and the maximum thickness was 28 m. The volume of the lens in the specified parameters was 13 655 m.

In the process of work, the important role of the turbidity of the infiltrate was revealed. In the conditions of fractured and karst rocks, suspended sediments brought with surface waters reduced the permeability of rocks in the saturation zone and contributed to the accumulation of fresh water. At the same time, they reduced the return of the infiltration basin.

On the Uru experimental site, 16 observation wells were drilled along two mutually perpendicular beams with an intersection point in the infiltration basin at a distance of 30, 70, 130 and 200 meters from the center of the basin. Due to the fact that the level of groundwater is revealed at a depth of 12-13 m from the earth's surface, the depth of observation wells was from 15 to 30 m with the installation of filters in the intervals of 27.5-29.0 m, 22.5-24.0 m, 17 .5-19.0 m, 12.5-14.0 m.

Surface runoff at the Uru site was carried out through a hydraulic structure into an infiltration basin, which was previously cleared of silt deposits. To increase the volume of infiltration next to the basin, limestone overburden was cleaned on an area of 625 m^2, and a hydraulic structure was built through which water was supplied to the newly built infiltration basin after sedimentation from the takyr.

Figure

Figure 4. Groundwater extraction process.
https://xs.uz/uzkr/post/qaqror-erlarga-suv-chiqarildi

5. Conclusions

The studies carried out gave us both field and scientific-experimental information on the assessment of the hydro-geological conditions of Ustyurt when using the method of artificial groundwater reserves. We see this as an important part for sustainable development of the region. In further research it is necessary to identify promising areas for the application of the method of storage and desalination, as well as examining further the issues of the integrated use of Ustyurt groundwater reserves.

6. Literature:

1. Zakirov M.M., Yusupov Sh.S. Results of a study of helium propagation in groundwater (on the example of the Pritashkent artesian basin) // Reports of the Academy of Sciences of the Republic of Uzbekistan. - 2017. - No. 4. - P. 55-58 (04.00.00; No. 5).

2. B.Janibekov B. O., M.Turapov M. K., B.Toshmuhamedov, O.Khaitov, Djaksimuratov K.M., Study of Ore's Geodynamic Position Formation of Ore Deposits. International Journal of Innovative Analyses and Emerging Technology. ISSN 2792-4025 (online), Published under Volume: 1 Issue: 7 in December-2021 Copyright (c) 2021, http://openaccessjournals.eu/index.php/ijiaet/article/view/799

Strategic approach to the training of specialists in sustainable development

Rustam Eshniyazov, Karakalpak State University, Nukus, Uzbekistan

Borys Bezzubko, PhD in Public Administration, Associate Professor, Donbas National Academy of Civil Engineering and Architecture, Kramatorsk, Ukraine

1. Training specialists in the field of SD

The course on sustainable development requires the training of specialists in this field, specialists which are in demand all over the world. Thus the market of education in the field of sustainable development is just being formed. The term "Environmental, Social and Corporate Governance" (ESG) has become widely used as a direction of training specialists capable of systematically solving theoretical and practical problems of sustainable development at the corporate and state levels.

A Russian consulting integrator in the field of education, called "You Social" has analyzed the practices of sustainable development to transform companies taking into account the modern requirements of society, consumers, employees, etc. It has reported on more than 200 programs on sustainable development at various levels from bachelor's degree to MBA programs at leading universities in the world [1]. The leading countries in terms of the number of educational courses in this area are Great Britain, Sweden, Finland, Norway and Denmark. It should be noted that the training of specialists in the field of sustainable development takes place within the framework of training specialists in various fields, such as architecture and design, design of green cities or sustainable design, engineering, and media. In the future, it will be necessary to develop a strategy for training specialists in the field of sustainable development in all countries, taking into account national, regional and local characteristics.

2. Implementing Education for SD (ESD) in Uzbekistan

Several measures are taken by the Republic of Uzbekistan to implement the Strategy of the United Nations Economic Commission for Europe (ECE) on Education for Sustainable Development (ESD). These include the consistent improvement of the level and quality of continuing environmental education in the country, supported by a strong and targeted social policy. The defining idea of ESD is the development of skills and abilities, the deepening of knowledge focused on the prevention and solution of social, economic and environmental challenges and threats of the present and the future, including the Aral crisis.

Among the indicators and sub-indicators of countries' reporting on the implementation of the ECE strategy for 2020-2025, there are the following:

1) the availability of formal, informal and informational training in this area;
2) inclusion of ESD in national curricula and/or national standards, regulations or requirements at all levels of formal education; and
3) allocations from the state budget and/or whether economic incentives are provided directly

to support ESD and others.
All this makes the issues of developing strategies for training specialists in sustainable development relevant, integrating ESD into curricula and courses as an independent academic discipline and integrated into other traditional academic disciplines [2].

3. Principles of training SD specialists

The main principles of training specialists in sustainable development include the following:
- continuity, consistency and systematicity.
- education of understanding of the integrity, unity of the environment, the inseparable connection of its components, the interdependence of natural processes;
- interdisciplinary approach to the formation of ecological culture;
- coverage of environmental problems at the global, national and local levels;
- orientation of training on the development of value-motivational spheres of personality.

4. Specialists in energy management

Within the framework of this conference, it is necessary to note the relevance of the task of training specialists in the field of energy green management development. This type of management is located at the junction of environmental and energy management. Energy management is a set of organizational and technical measures aimed at improving the efficiency of the use of fuel and energy resources.

The purpose of training specialists in the field of energy management is to gain knowledge and practical skills in the field of efficient use of energy resources at all stages of production, transportation and consumption. This assumes that future specialists will have practical skills in conducting energy conservation policy, energy management and energy audit at the macro and micro levels. Macro-level energy management includes management of rational use of fuel and energy resources at the interstate, intra-state, regional, district, city, and industry levels. Micro-level energy management corresponds to management at the level of an enterprise, institution, firm, organization.

5. Future development of ESD

To further improve the educational process in the field of sustainable development, it is proposed:
1) introduction of the discipline "Sustainable Development and Sustainability Science" into the educational process, during the preparation of bachelors and masters of various specialties;
2) Inclusion of issues of sustainable development in the work programs of academic disciplines of the cycle of engineering, humanitarian and socio-economic training;
3) improve energy management training;
4) consider the issues of training specialists in the field of sustainable development.

6. References

1. ESG education. https://yousocial.ru/
2. The concept of the Republic of Uzbekistan on education for sustainable development. https://sreda.uz/rubriki/study/koncepciya-respubliki-uzbekistan-po-obrazovaniyu/