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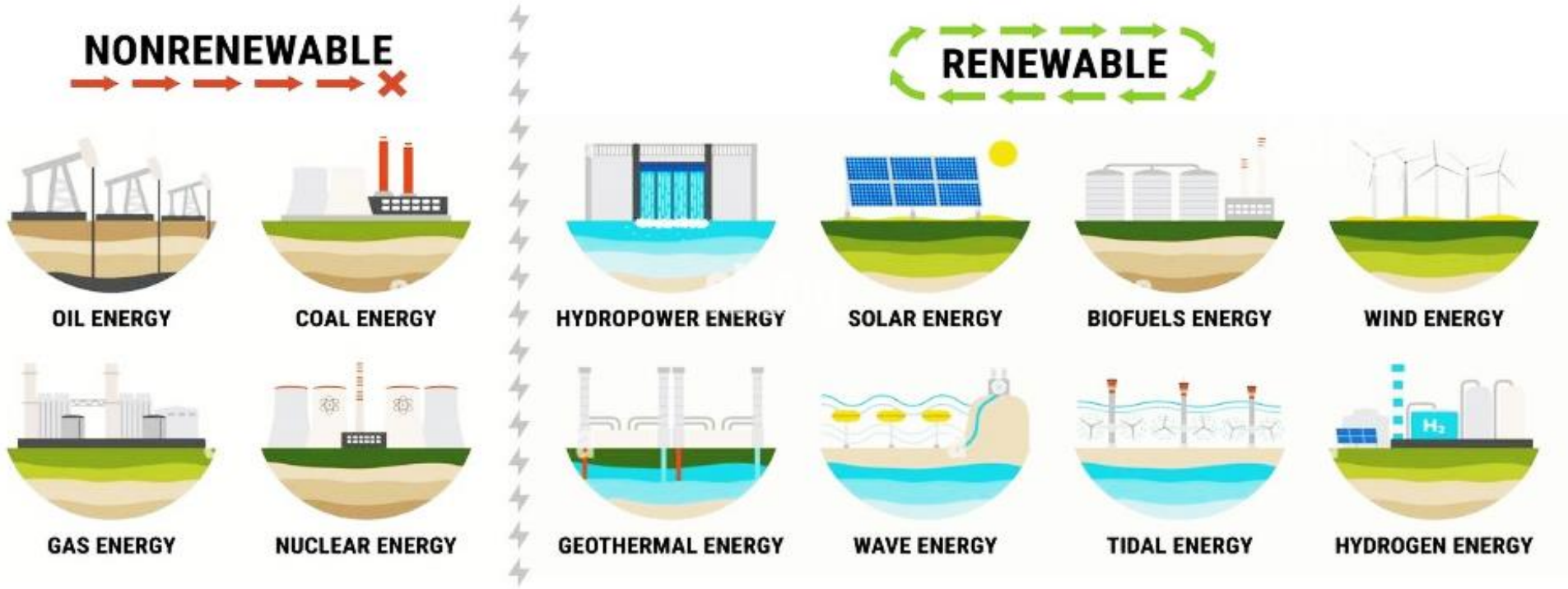
National Research University

SMALL HYDROPOWER PLANT. IMPACT OF WATER RESOURCES ON THE POWER GRID



Dilshod KODIROV
Professor, Doctor of Science

Head of the Department of Power Supply and Renewable Energy Sources

kodirov.dilshod@gmail.com
d.kodirov@tiiame.uz

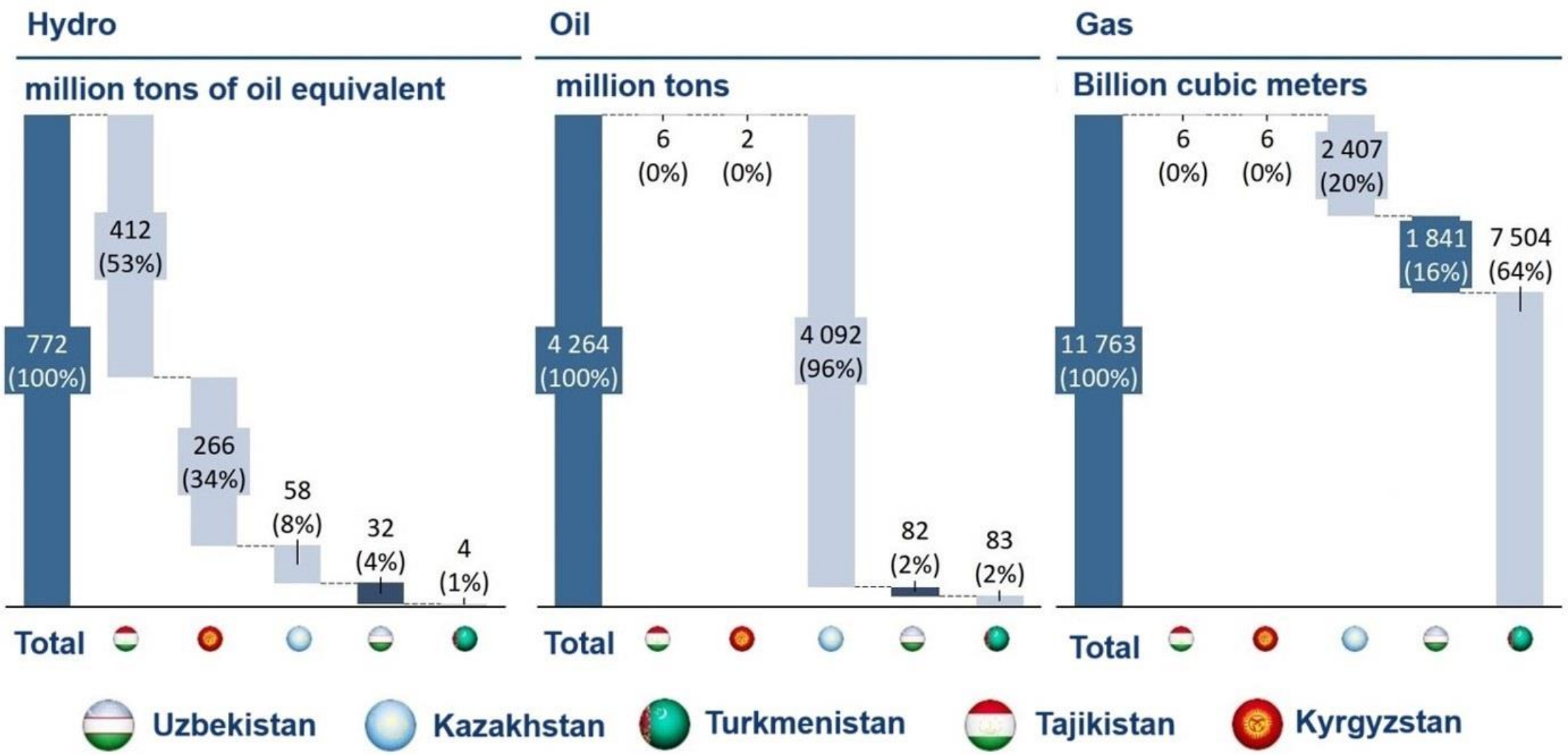
THE SIGNIFICANCE OF THE TOPIC

In Uzbekistan, which has chosen the path of modern development, the hydropower sector, considered a vital energy source for the economy, is undergoing consistent growth alongside large-scale reforms. In recent years, significant progress has been made in constructing new hydropower plants and modernizing existing ones in accordance with contemporary demands.

The development of hydropower not only ensures a stable supply of electricity to the population but also plays a crucial role in preserving the natural environment and ecology. In recent years, Uzbekistan has adopted one Presidential Decree, seven resolutions, and two decisions of the Cabinet of Ministers aimed at reforming the hydropower sector.

The total number of hydropower plants increased from 37 in 2017 to 58, while their production capacity rose from 1,856 MW to 2,233 MW. Additionally, approximately 400 MW of extra capacity was created.

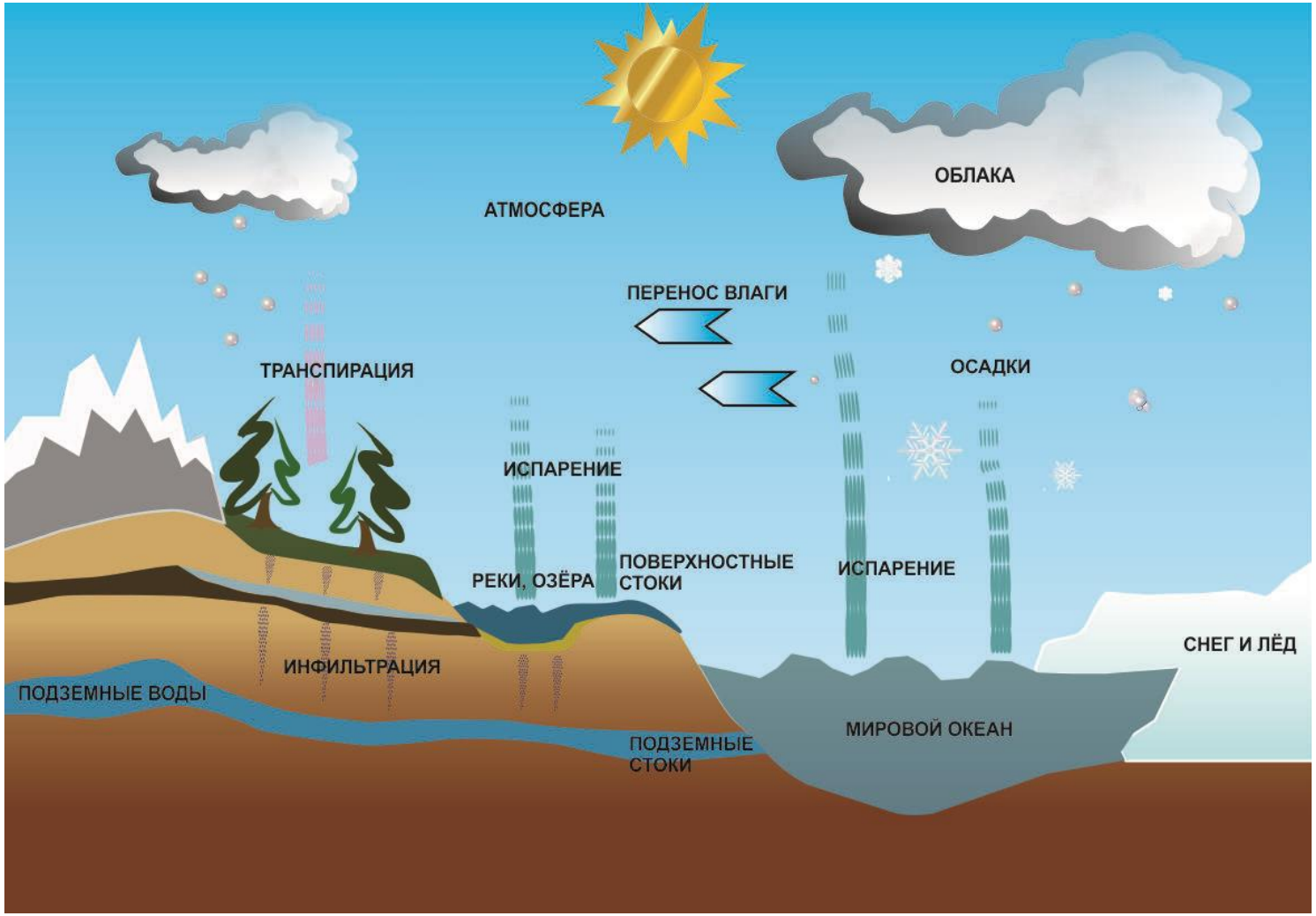
THE ENERGY RESOURCE POTENTIAL OF CENTRAL ASIAN COUNTRIES



THE WATER CYCLE IN NATURE

The Earth's water resources form a single complex in constant dynamic equilibrium, referred to as the water cycle in nature. Their total volume amounts to 1,351,421 thousand km³, of which:

- All oceans: 1,350,000 thousand km³
- Oceans, rivers, lakes, and surface evaporation: 452 thousand km³
- Precipitation: 385 thousand km³
- Snow and ice: 250 thousand km³Clouds: 111 thousand km³
- Groundwater: 84 thousand km³
- Transpiration (water evaporation by plants): 71 thousand km³
- Atmospheric moisture: 13 thousand km³
- Surface water sources (rivers, lakes, swamps, etc.): 2 thousand km³



WATER RESOURCES

Currently, there are more than 30,000 reservoirs worldwide with a total volume of approximately 2,000 km³. Their useful volume is estimated to be nearly 1,500 km³, which accounts for about 10% of the average annual flow of all rivers in the world.

The total surface area of the world's reservoirs is between 600,000 and 620,000 km².

In Uzbekistan, there are more than 55 reservoirs with a total volume of 19.2 billion m³.

Reservoirs perform the following important economic functions:

Hydroelectric power stations

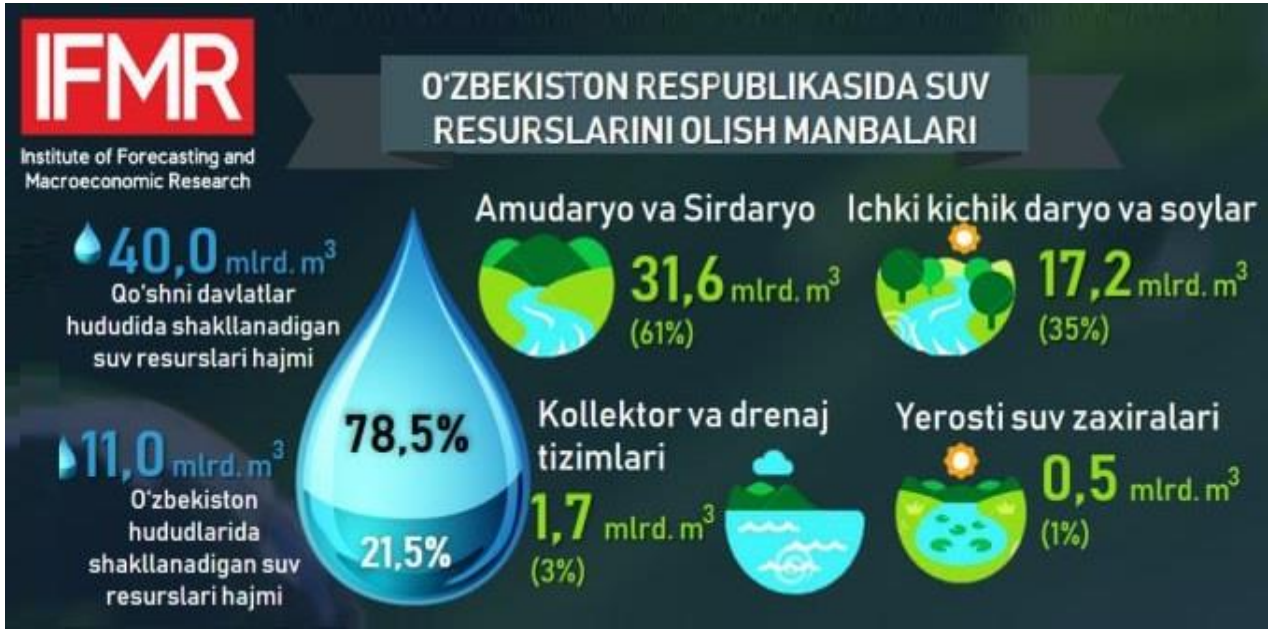
Water supply

River transport

Recreation in water

Fishing, and others.

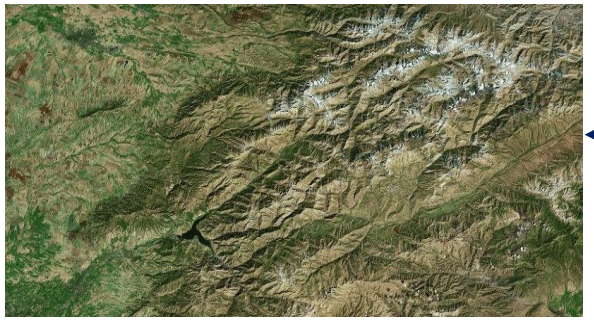
WATER SCARCITY

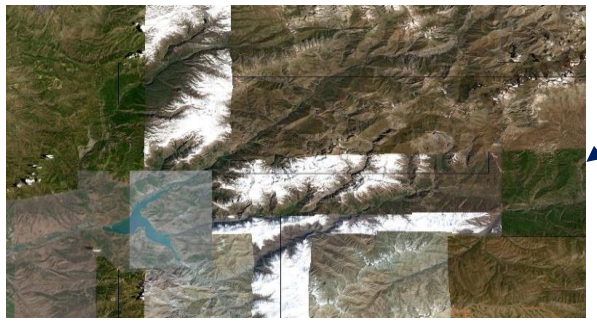


According to research by the World Resources Institute (WRI) and the UK-based "Economist Intelligence Unit", among the 33 countries expected to face the most significant water scarcity by 2040, Central Asian countries, including Uzbekistan, are listed.

Experts suggest that in Uzbekistan, water scarcity is expected to reach 7 billion cubic meters in the near future, and by the 2050s, it could rise to 12-13 billion cubic meters. Given this situation, the importance of water conservation will become even more critical.

WATER RESOURCE GENERATION





START

Taking pictures via satellite or drones

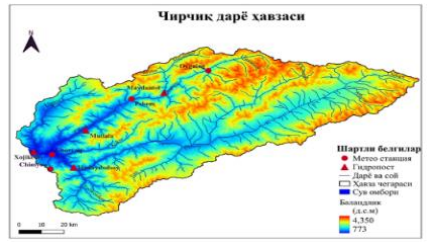
Processing based on the Modsnow program

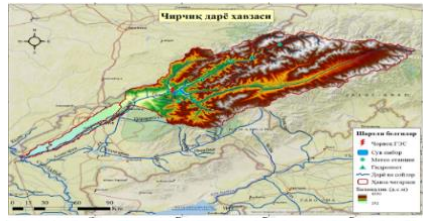
Determining the boundaries of an area covered by snow based on geoinformation technology

Hydrometeorological factors

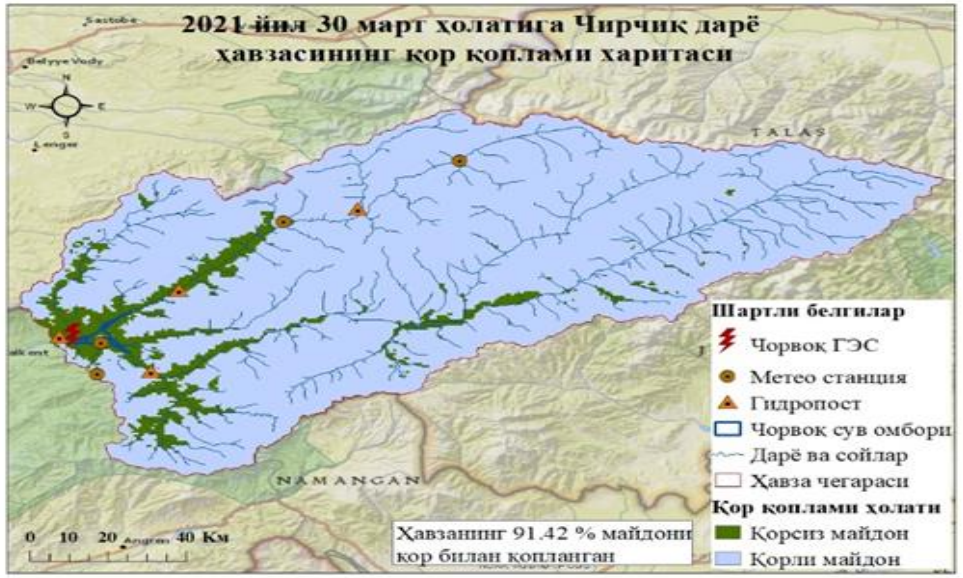
- Precipitation, (mm)
- Snow depth (cm)
- Air temperature, (°C)
- Snow density, kg/m³
- Wind speed, m/s
- Atmospheric pressure, Pa

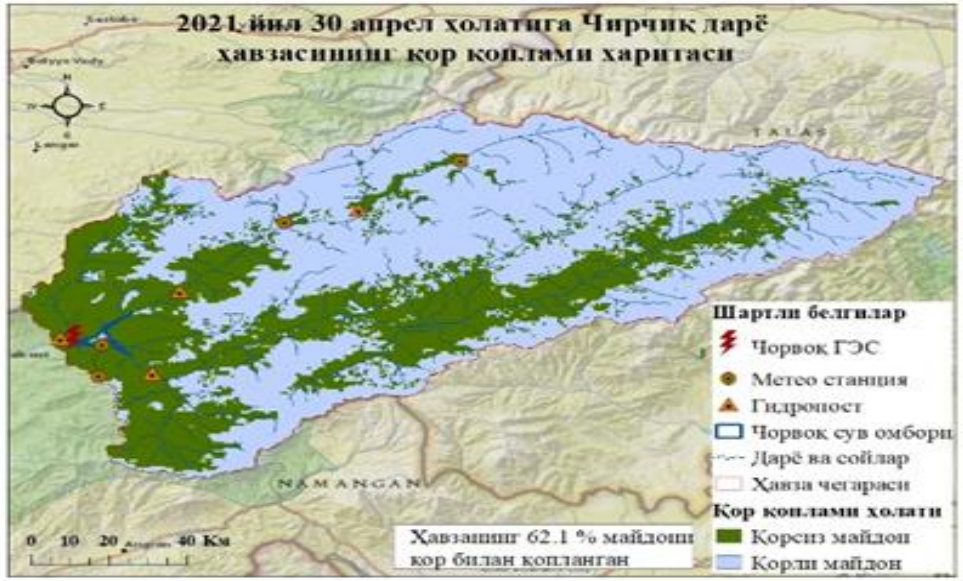
WATER BALANCE GENERATION

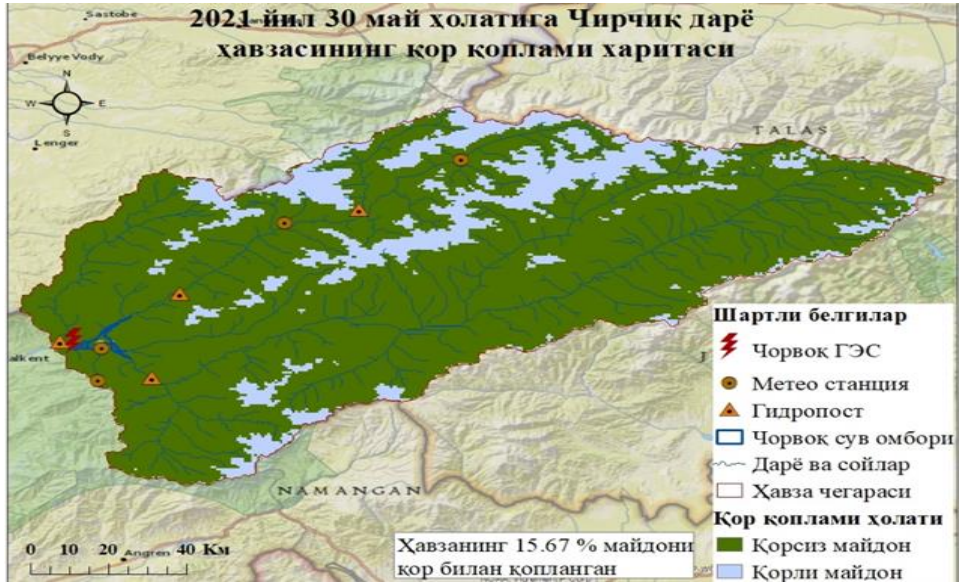


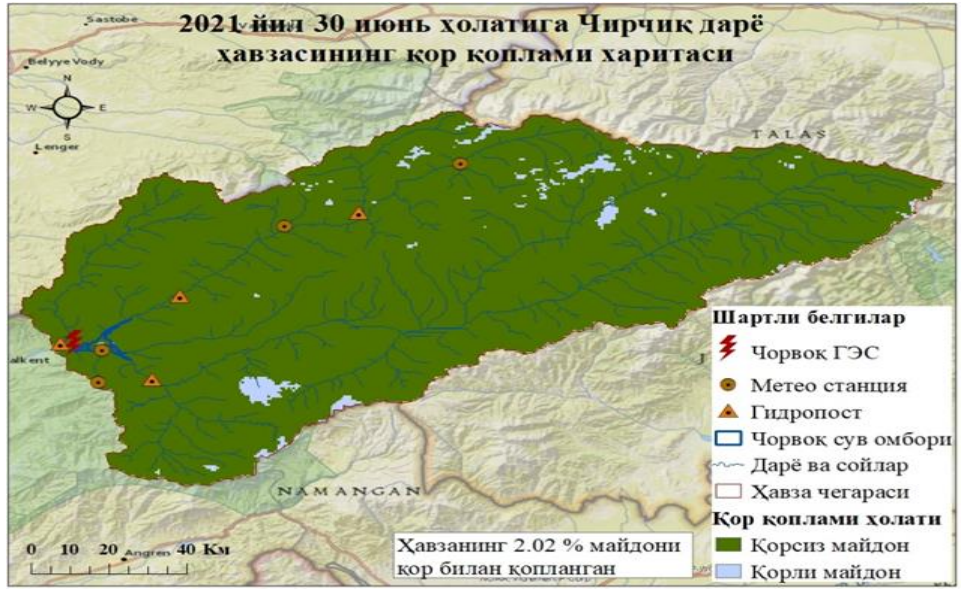


THE RELATIONSHIP BETWEEN SNOW COVER AND WATER FLOW

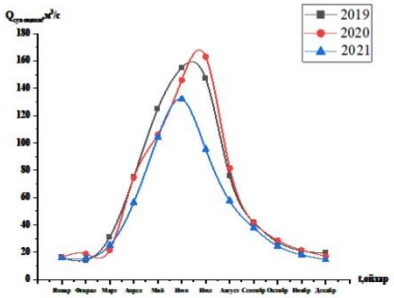




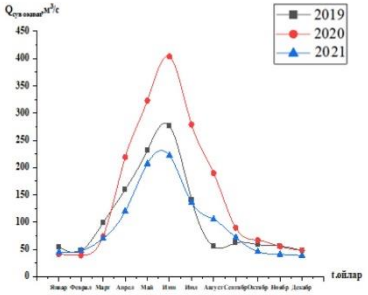




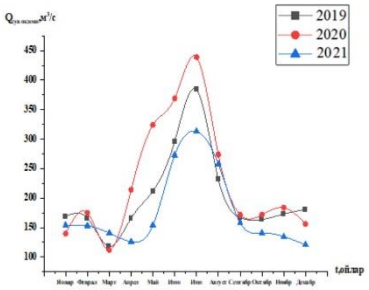
Пскем дарёси сув ўлчаш жойидаги сув оқими



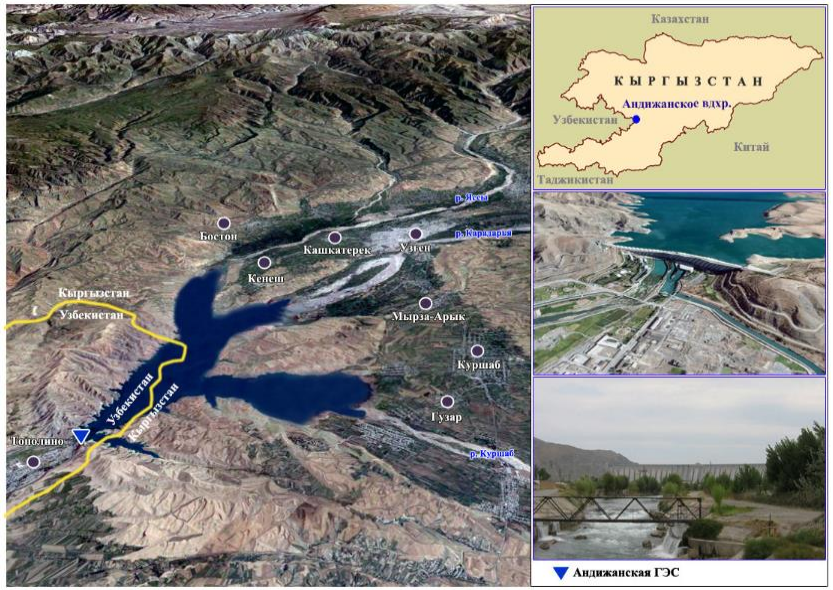
Худойдодсой сув ўлчаш жойидаги сув оқими



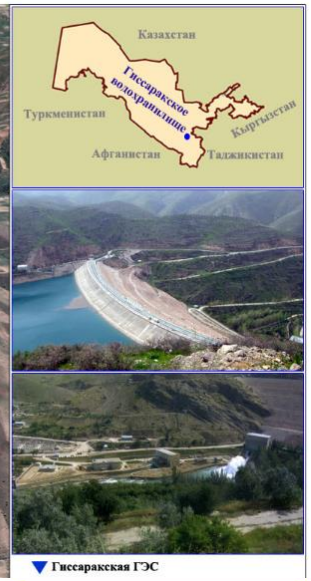
Чирчиқ дарёси Ғазалкент сув ўлчаш жойидаги сув оқими



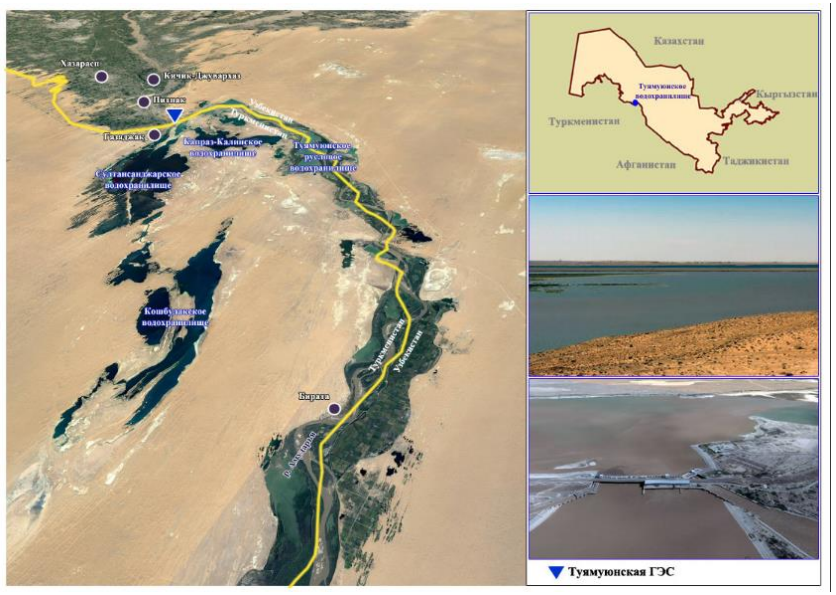
LARGE RESERVOIRS IN UZBEKISTAN



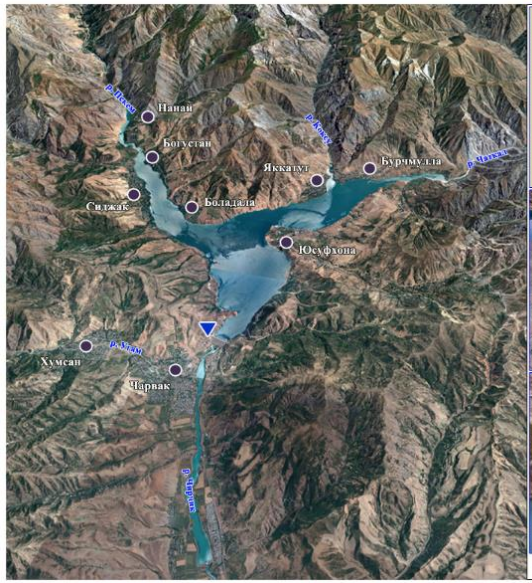
Andijan Water Reservoir and Hydroelectric Power Station
Purpose: Irrigation, Energy
Height: 121 m
Length: 850 m
Capacity: 190 MW
Average annual electricity production: 171.5 million kWh



Khisorak Water Reservoir and Hydroelectric Power Station
Purpose: Irrigation, Energy
Height: 138.5 m
Length: 660 m
Capacity: 45 MW
Average annual electricity production: 80.9 million kWh



Tuyamuyin Water Reservoir and Hydroelectric Power Station
Purpose: Irrigation, Energy
Height: 34 m
Length: 900 m
Capacity: 150 MW
Average annual electricity production: 1.0 billion kWh

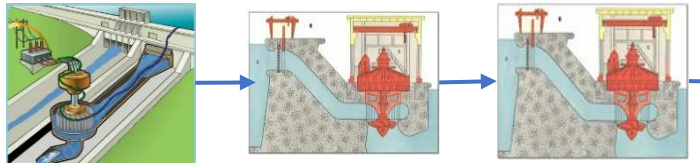


Chorvoq Water Reservoir and Hydroelectric Power Station
Purpose: Irrigation, Energy
Height: 168 m
Length: 764 m
Capacity: 666 MW
Average annual electricity production: 2.0 billion kWh

HYDROELECTRIC POWER STATIONS LOCATED IN THE CHIRCHIK RIVER BASIN

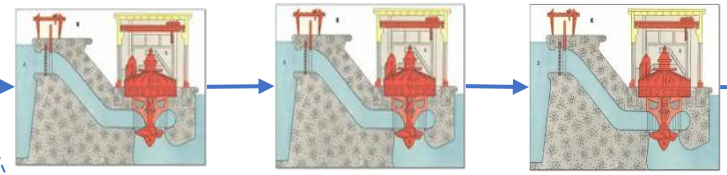
Middle Chirchik Hydroelectric Power Station Cascade

HPP-6 666 MW → HPP-27 165 MW → HPP-28 120 MW



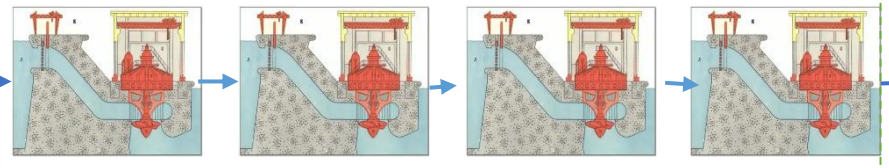
Chirchik Hydroelectric Power Station Cascade

HPP-8 72 MW → HPP-7 84 MW → HPP-10 34,7 MW



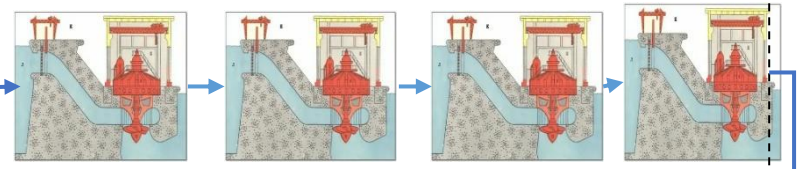
Kodirya Hydroelectric Power Station Cascade

HPP-15 9 MW → HPP-11 11,2 MW → HPP-3 13,2 MW → HPP-12 11,2 MW



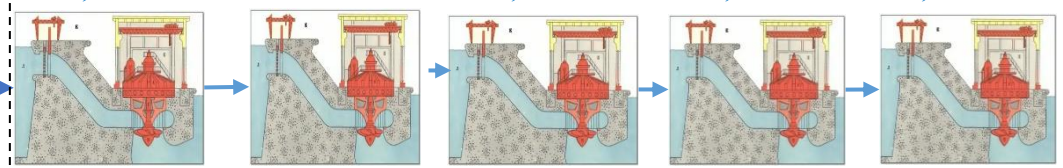
Tashkent Hydroelectric Power Station Cascade

HPP-1 4MW → HPP-21 3,6 MW → HPP-4 6,4 MW → HPP-9 16,6 MW



Lower Bozsuv Hydroelectric Power Station Cascade

HPP-14 10,7 MW → HPP-18 7 MW → HPP-19 15,4 MW → HPP-23 17,6 MW → HPP-22 4,4 MW



CLASSIFICATION OF HYDROELECTRIC POWER STATIONS

According to the Decree No. ПҚ-44 of the President of the Republic of Uzbekistan dated December 10, 2021, hydroelectric stations are classified by their installed capacity as follows:

- Micro HPPs: Hydro power stations with a capacity of up to 0.5 MW
- Small HPPs: Hydro power stations with a capacity of up to 5 MW
- Medium HPPs: Hydro power stations with a capacity of up to 30 MW
- Large HPPs: Hydro power stations with a capacity of over 30 MW

These hydroelectric stations are considered renewable energy sources.

According to water transmission capacity, channels are classified into the following types:

- Small: up to 5 m^3/sec
- Medium: from 5 m^3/sec to 35 m^3/sec
- Large: from 35 m^3/sec to 350 m^3/sec
- Very large: from 350 m^3/sec to 800 m^3/sec
- Extremely large: over 800 m^3/sec

Main Structural Elements of a Hydroelectric Power Station

- Hydrotechnical Structures of Hydroelectric Power Stations
- Water Supply Structures
- Hydroturbine
- Generator
- System for Stabilizing Electrical Energy Output Parameters

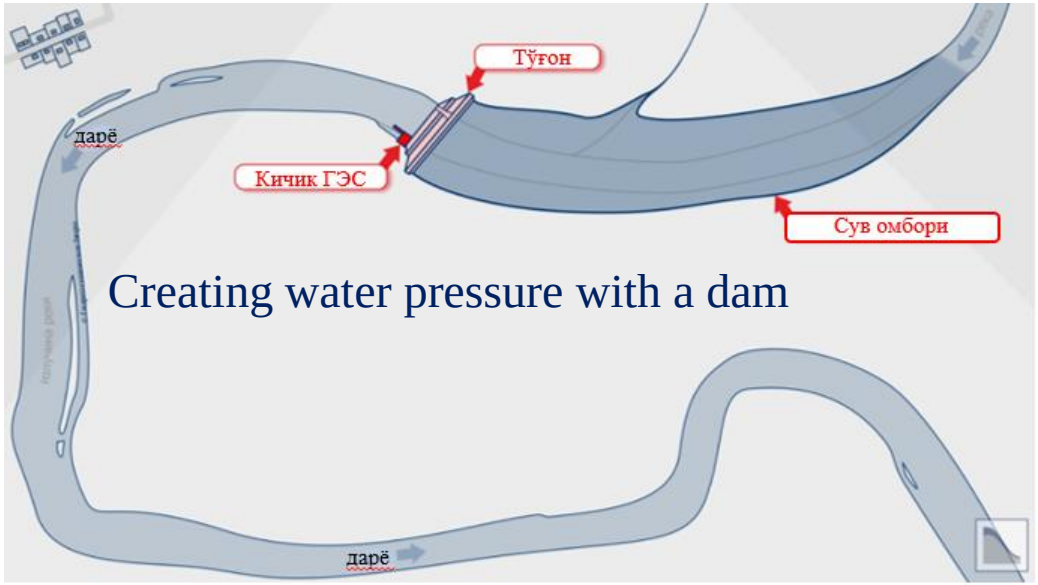
СУВ ЭНЕРГИЯСИДАН ФОЙДАЛАНИШ СХЕМАЛАРИ

A hydroelectric power station is a complex of hydrotechnical structures that converts water energy into mechanical energy with the help of a hydroturbine, and then into electrical energy using a generator.

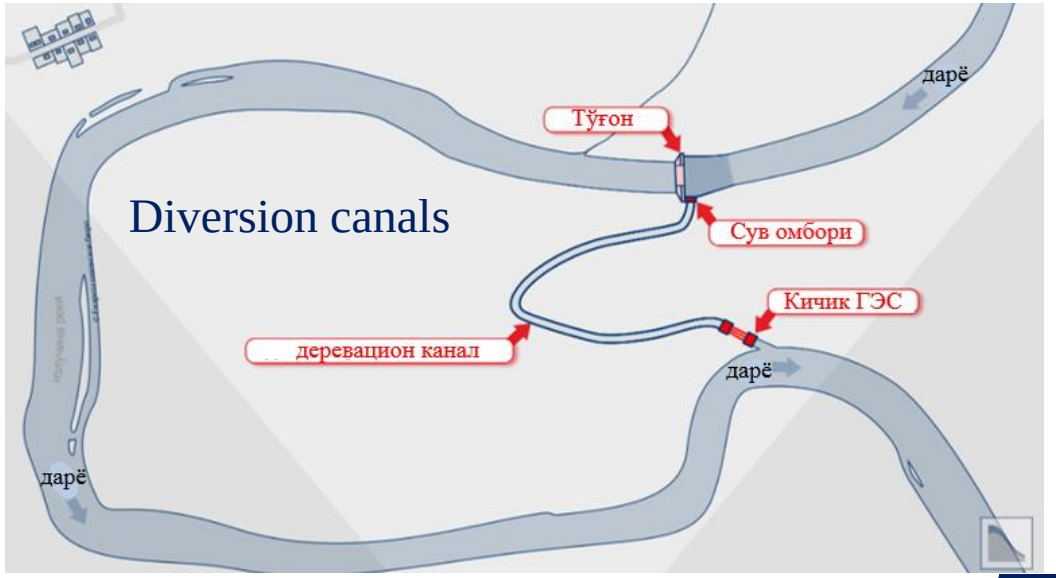
Hydroelectric power stations operate according to the following schemes:

a)with a dam;

b)b) without a dam.

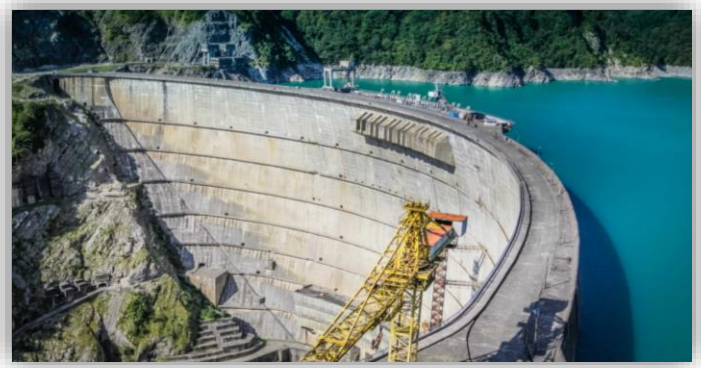


Creating water pressure with a dam

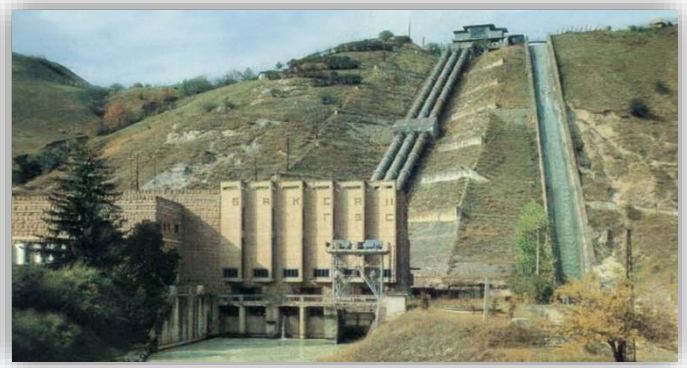


Diversion canals

Dam



Without a dam



SELECTION OF THE LOCATION FOR INSTALLING A HYDROELECTRIC POWER STATION

Water flow rate

There must be a sufficient water flow at the installation site to ensure the stable operation of the hydroelectric power station.

Geography

The geographical location, relief, level of precipitation, and water flow must be taken into account.

Environmental aspects

The impact on the local ecosystem and the river's fish resources must be taken into account.

DESIGNING HYDROELECTRIC POWER STATIONS

Preparing Technical Drawings

Drawings for the placement of equipment for the planned hydroelectric power station will be prepared.

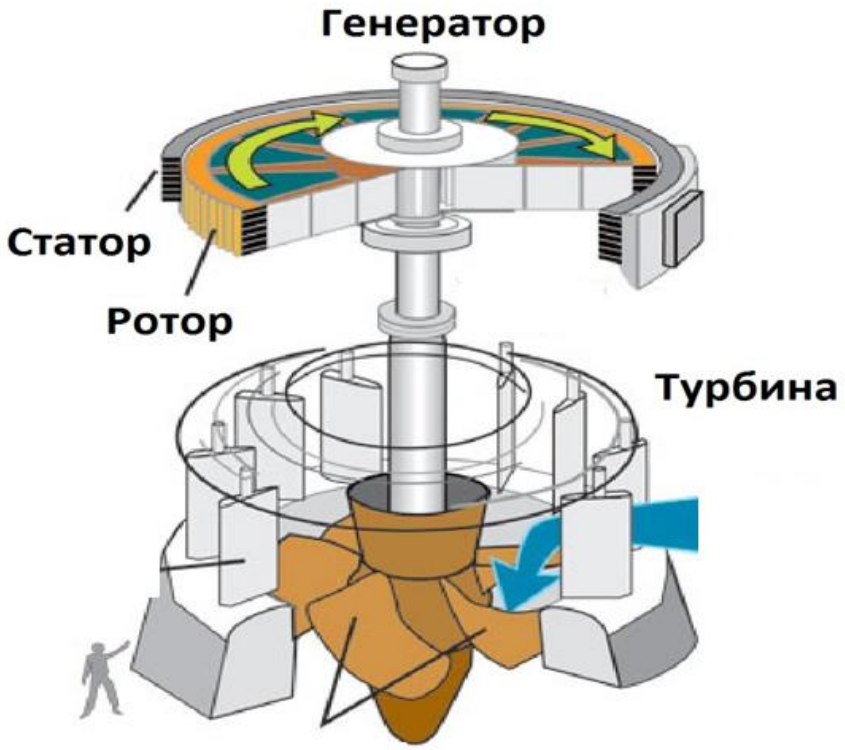
Environmental Impact Assessment

The impact of the future hydroelectric power station on the surrounding areas and ecosystem will be analyzed.

Project Development

At this stage, a complete project is created, which includes the preparation of all necessary documents and calculations.

THE OPERATING PRINCIPLE OF A HYDROELECTRIC POWER STATION



Hydraulic Turbine – Converts kinetic energy into mechanical energy.

1

Utilization of the potential energy of water

The potential energy of the water accumulated in the upper reservoir is used to rotate the turbine blades through a water conduit.

2

Electricity generation

As a result of the turbine's rotation, kinetic energy is converted into mechanical energy, which is then converted into electrical energy with the help of a generator.

3

Return of water

The used water is returned to the river or reservoir for reuse in hydroenergy.

TECHNICAL AND FINANCIAL ASPECTS

Hydroturbine

Depending on the parameters of the water flow, there are different types of turbines, namely: Kaplan, Francis, and Pelton.

Electric Generator

It is necessary to convert the mechanical energy produced by the turbines into electrical energy.

ТРАНСФОРМАТОР

It is necessary to transfer the produced electrical energy to the power grid and distribute it to consumers.

Investment costs

All costs incurred for the construction of hydroelectric power stations.

Operating costs

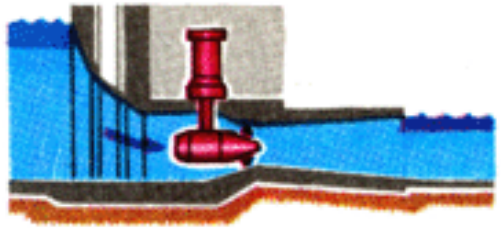
Maintenance and repair costs for equipment during operation.

Cost recovery period

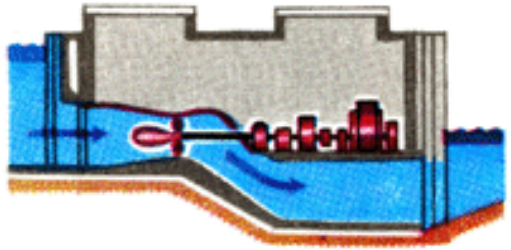
The payback period of the hydroelectric power station based on the electricity production forecast.

HYDRAULIC TURBINES

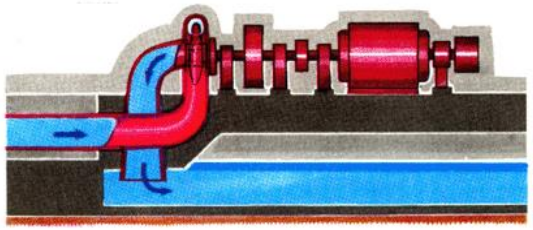
Horizontal



Pressure: 5-10(15) m,
Water flow: high and medium,
Turbine: capsule type

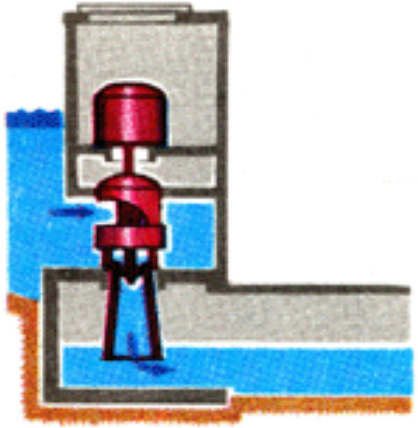


Pressure: 5-40 m,
Water flow: any,
Turbine: Kaplan and Banki



Pressure: 40 m and above,
Water flow: small and medium,
Turbine: Francis, Banki, Bucket turbine

Vertical



Pressure: 20 m and above,
Water flow: small and medium,
Turbine: Rotating-blade turbines

Pressure: 40 m and above,
Water flow: large,
Turbine: Bucket, Francis, and Banki turbines

INNOVATIONS AND TECHNOLOGIES

1 Hydrodynamic conditions

It is necessary to consider the speed of the water flow, its variability, and other factors that affect the operation of the generator.

2 Electrical technical parameters

Based on technical parameters such as voltage, frequency, and station capacity, it is necessary to select a specific type of generator for the hydroelectric power station project.

3 Reliability requirements

To ensure the continuous operation of the generator, the hydrodynamic conditions and electrical technical parameters must be compatible.

4 Integration into the green grid

By integrating hydroenergy systems into the green energy infrastructure, it is possible to provide regions with sustainable electricity supply.

5 Development of an energy-saving model

Innovations in the field of hydroenergy, the development of energy-saving solutions, and the creation of modern technologies for electricity generation.

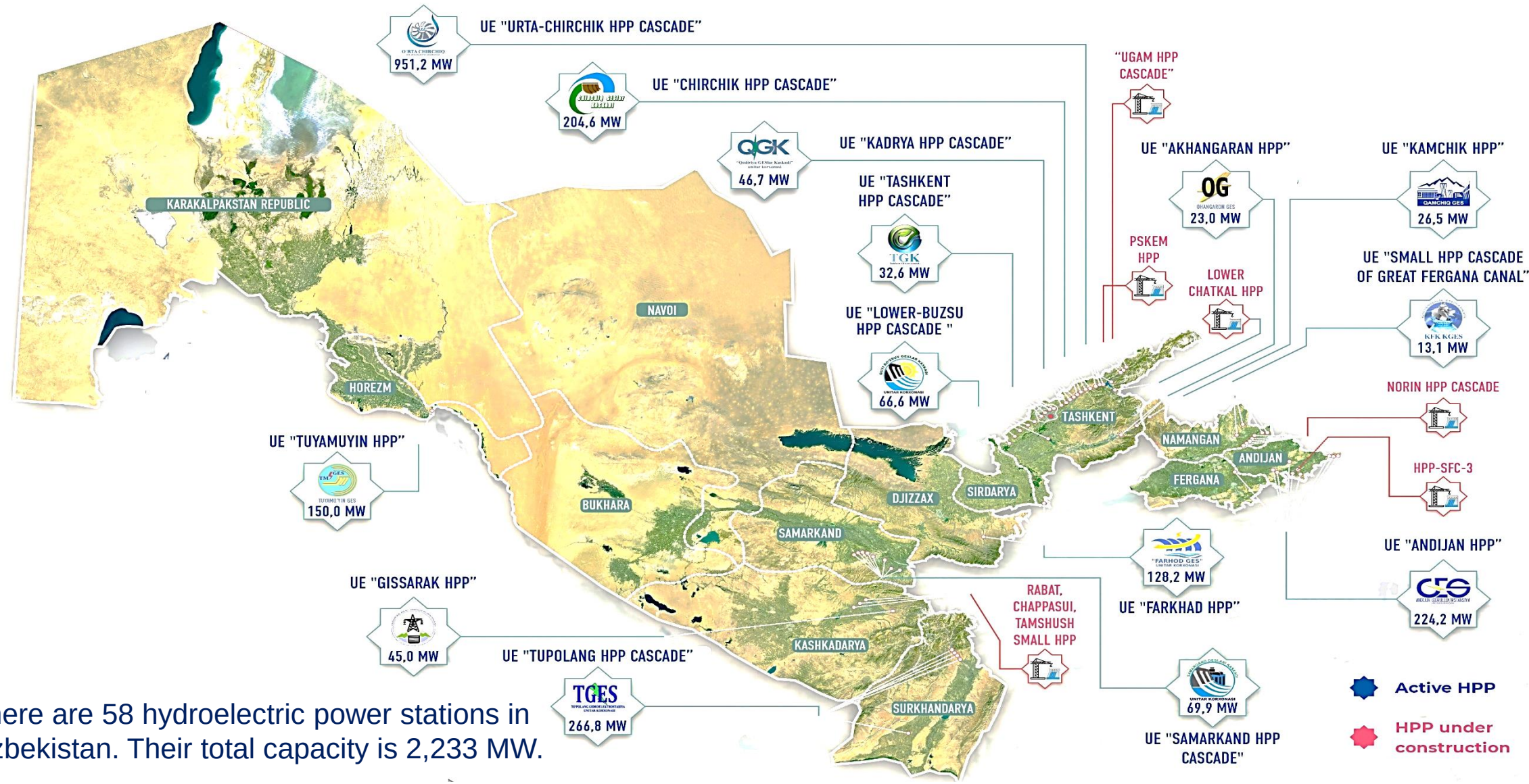
6 Integration with intelligent systems

The implementation of modern technologies for automating, managing, and monitoring processes to ensure efficient operation.

ADVANTAGES OF SMALL HYDROELECTRIC POWER STATIONS

- ✓ It is possible to set up local or regional electricity supply in areas far from power stations and difficult to access.
- ✓ The construction of small-capacity hydroelectric power stations is relatively simple, inexpensive, and does not require a long period for construction.
- ✓ During construction and operation, there is minimal disruption to the natural landscape and the environment.
- ✓ Like other renewable energy sources, it is not directly dependent on weather conditions.
- ✓ It is not dependent on the price of centrally supplied electricity.

INDICATORS OF THE USE OF HYDROPOWER PLANTS IN UZBEKISTAN



There are 58 hydroelectric power stations in Uzbekistan. Their total capacity is 2,233 MW.

HOW DOES IT WORK?

TOP 10 LARGEST HYDROELECTRIC POWER STATIONS IN THE WORLD

CONCLUSION

President of the Republic of Uzbekistan Shavkat Mirziyoyev, during his meeting with leading scientists of our country on December 30, 2016, expressed his views on the development of renewable energy sources, especially small and micro hydropower stations in our republic. He stated: '... It is necessary to ensure that 32% of the electricity produced in our country comes from hydropower stations. If we work in this area, we can obtain environmentally friendly and affordable energy.'

Thank you very much for your attention!

Dilshod KODIROV
Professor, Doctor of Science

Head of the Department of
Power Supply and Renewable Energy Sources
“TIIAME” National Research University

kodirov.dilshod@gmail.com
d.kodirov@tiiame.uz