

Kick-off Meeting

Conducting a Pre-Feasibility Study – the first step to develop
Small Hydropower projects
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Electrical & Mechanical equipment for small hydropower plants – best international practices

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Small Hydropower Plants: A Comprehensive Overview



Small hydropower plants are a crucial source of renewable energy. Technological advancements are transforming these facilities, while new challenges are emerging. This presentation will delve into the world of small hydropower plants, exploring their electrical and mechanical components, best international practices, and the advantages and challenges of implementing these practices. Also, This presentation will describe the role of electromechanical equipment's in the hydropower plants, the latest innovations in hydropower units, the evolving landscape of efficiency and reliability, and the crucial considerations of environmental sustainability.

Principles of hydroelectric power plant operation



- Water from a natural water body like a river is stored in the reservoir. This reservoir is built at a level higher than the Powerhouse.
- Water from the reservoir flows through the penstock to the powerhouse and the potential energy of water stored in the dam is converted into kinetic energy.
- In the powerhouse the hydraulic turbine converts the energy of flowing water into mechanical energy, and a hydroelectric generator converts this mechanical energy into electricity. The electricity produced is then transmitted to the power grid.
- The main elements of a hydroelectric power plant include Water Turbines, Generators, Switchgears, Excitation system, Control&Protection system, HPU (Hydraulic pressure unit), Lubrication System, Cooling System and MIV (Main Inlet Valve).

Hydromechanical Equipment's and Main Structures



➤ Intake

The intake structure collects water from the river, filtering out debris and directing it towards the penstock for optimal performance.

➤ Penstock

The penstock is a pipe that carries water from the intake to the turbine, ensuring efficient water flow and minimal energy loss.

➤ Powerhouse

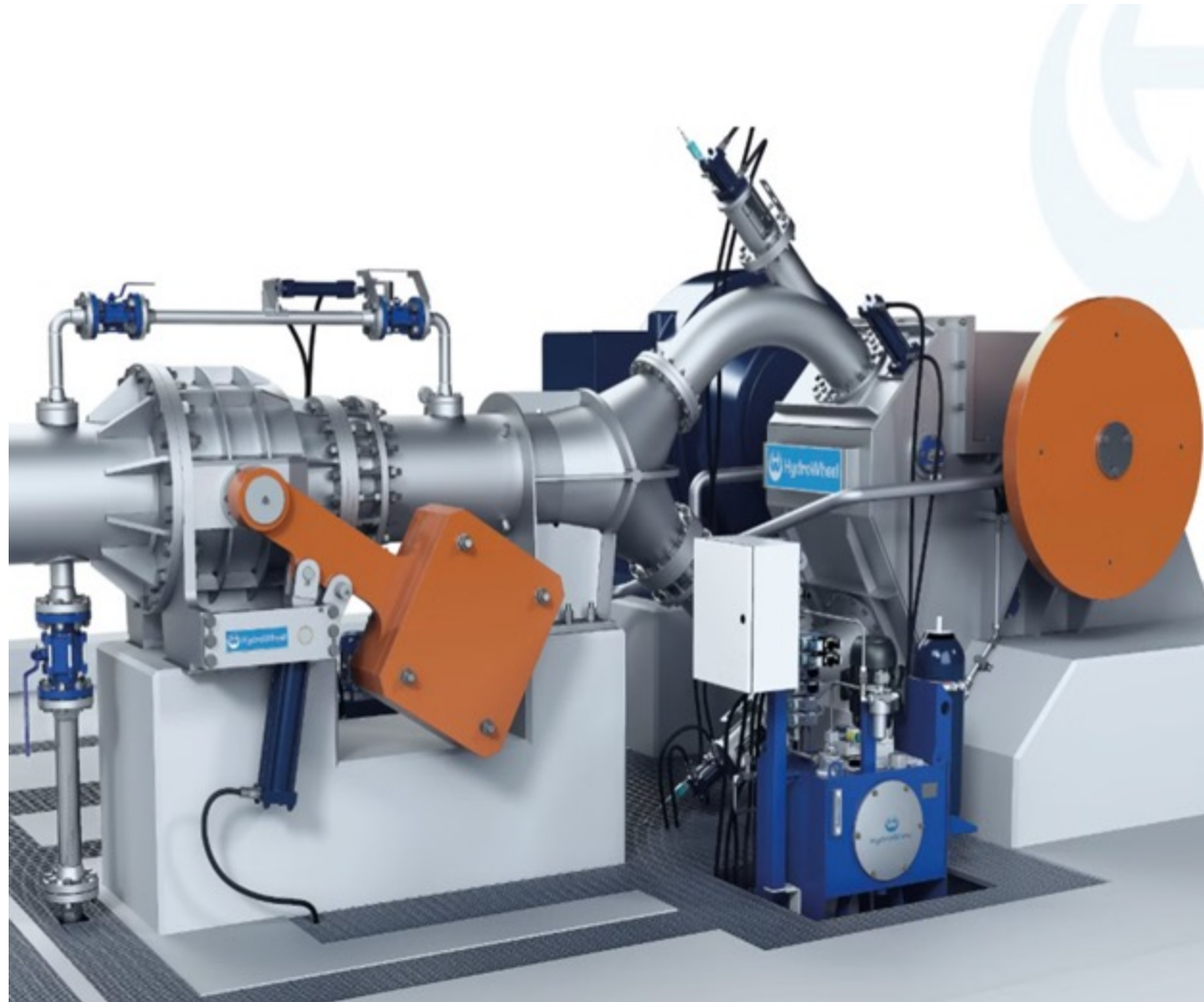
Powerhouse is a building provided to protect the hydraulic and electrical equipment.

➤ Outlet

The outlet structure releases water back into the river after it has passed through the turbine, minimizing environmental impact and maintaining river flow.



Role of Electromechanical Devices



➤ Turbines

Hydro turbines are devices used in hydroelectric generation plants that transfer the energy from moving water to a rotating shaft to generate electricity. These turbines rotate or spin as a response to water being introduced to their blades.

➤ Generators

Synchronous machines use electromagnetic induction to convert mechanical energy into electrical energy.

➤ Transformers

These devices step up the voltage level of the generated electricity for efficient transmission.

➤ Switchgear

These electrical components control the flow of electricity and protect the system from faults

➤ Control System

The control system monitors and regulates the plant's operation, ensuring optimal performance and safety, often utilizing advanced automation technology.

Hydropower Units: Technological Advancements



➤ Turbine Efficiency

Advances in turbine design, such as the use of variable-speed turbines, have significantly increased efficiency, maximizing energy generation.

➤ Digital Control Systems

Advanced control systems, equipped with AI and machine learning, optimize plant performance, enhance reliability, and reduce downtime.

➤ Automated Operations

Increased automation streamlines operations, minimizing human intervention and improving overall efficiency and safety.

➤ Remote Monitoring

Real-time data monitoring from remote locations allows for proactive maintenance and ensures the optimal performance of hydropower units.

Turbine Design and Operation



Common Types of Turbines

- Francis turbines
- Kaplan turbines
- Pelton turbines
- Ossberger turbines
- Turgo turbines
- Bulb turbines

Design Considerations

Turbine design is crucial to optimize efficiency and reliability, considering factors like water flow, head, and power output.

Operating Principles

Turbines operate by converting the potential energy of the water into mechanical energy, through a combination of pressure and velocity changes.

Innovative Hydro Turbines: StreamDiver Turbines



The StreamDiver is a turbine eco-friendly turbines where simplicity is the key principle. It runs completely submerged, the housing is flooded, and the bearings lubricated with water. There is no risk for oil spills and no complex seals are needed. The direct-driven permanent magnet generator makes a gearbox redundant of efficiency and reliability, and the crucial considerations of environmental sustainability. All of the above provides an opportunity to reduce civil costs with an innovative layout of plants.



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Generator Systems and Synchronization



1

Generator Design

Generators are typically synchronous machines, producing alternating current (AC) electricity.

2

Synchronization

The generator's output must be synchronized with the power grid to ensure stability and proper power flow.

3

Voltage Regulation

Generators have control systems to regulate voltage output, maintaining a consistent supply.

Transformer and Switchgear Components



Component

Function

Transformers

Step up voltage for transmission

Circuit Breakers

Protect the system from faults by interrupting the flow of electricity

Relays/Protection devices

Monitor electrical parameters and activate trip command to Circuit breakers

Insulators

Prevent electrical current from flowing to ground

Monitoring and Control Systems



Data Acquisition

Sensors gather data on various parameters, including water flow, turbine speed, voltage, and current.

Control Systems

Control systems use data from sensors to adjust turbine operation, voltage regulation, and protection mechanisms.

Remote Monitoring

Modern hydroelectric plants often use remote monitoring systems for real-time oversight and remote-control capabilities

Best International Practices: Electrical Equipment



1

Efficiency

Optimizing energy conversion efficiency through advanced generator design, efficient power transmission, and minimal energy loss in the system.

2

Reliability

Ensuring reliable operation with robust electrical components, redundant systems, and regular maintenance to minimize downtime.

3

Safety

Prioritizing safety with proper grounding, insulation, and protective devices to prevent electrical hazards and ensure worker safety

4

Environmental Impact

Minimizing environmental impact by using sustainable materials, reducing electromagnetic interference, and adhering to environmental regulations.

Best International Practices: Mechanical Equipment



1

Turbine Selection

Choosing the most efficient turbine type based on flow, head, and environmental factors.

2

Penstock Design

Optimizing penstock diameter and material to minimize friction losses and maximize water flow.

3

Intake and Outlet

Designing intake and outlet structures that minimize environmental impact and maintain river flow.

4

Maintenance

Implementing regular maintenance schedules to ensure optimal performance, identify potential issues, and extend equipment lifespan.

Advantages of Adopting Best Practices



1 — **Increased Efficiency**

Best practices optimize energy conversion and transmission, maximizing energy output and reducing energy waste.

2 — **Reduced Operational Costs**

Efficient equipment and minimal downtime contribute to lower operating costs, increasing the plant's profitability.

3 — **Improved Reliability**

Robust equipment, regular maintenance, and redundancy lead to reliable operation, ensuring consistent energy generation.

4 — **Minimal Environmental Impact**

Best practices minimize environmental impact through sustainable design, efficient operation, and adherence to environmental regulations.

Challenges in Implementing Best Practices

1

Cost

Implementing best practices may require significant upfront investment in advanced equipment and technologies.

2

Technical Expertise

Specialized skills are needed to design, install, and maintain equipment according to best practices, requiring qualified personnel.

3

Regulation

Navigating complex regulations and obtaining permits can be time-consuming and challenging, requiring extensive planning and documentation.

Improving Efficiency and Reliability



1 Predictive Maintenance

Data analytics and machine learning predict potential issues before they occur, minimizing downtime and ensuring a consistent energy supply.

2 Advanced Monitoring Systems

Comprehensive monitoring systems track key performance indicators, providing insights into plant health and optimizing operations.

3 Adaptive Control Strategies

Intelligent control systems adjust to varying water flow conditions, maximizing energy generation and ensuring optimal plant performance.

4 Redundant Systems

Backup systems and fail-safe mechanisms ensure uninterrupted power generation, even during unforeseen events or maintenance activities.

Conclusion and Key Takeaways



Sustainability

Small hydropower plants are a sustainable and environmentally friendly source of renewable energy.



Efficiency

Adopting best practices maximizes energy efficiency, reducing energy waste and minimizing environmental impact.



Global Impact

Best practices are essential for maximizing the benefits and minimizing the risks of small hydropower plants worldwide.