**Hydropower Plants:
Achieving Maximum Output**

**With its application-specific seals and materials, Freudenberg Sealing Technologies enables high and sustainable yields in hydroelectric power generation.**

Weinheim, August 28, 2025. The safe, stable and efficient operation of hydropower plants is a cornerstone of the future net-zero energy mix. Depending on regional and climatic conditions, hydropower generated from flow energy can account for more than 80 percent of the electrical energy produced in a given country. In this area, Norway currently leads with 89 percent, followed by Canada with 62%, Brazil with 60% and Switzerland with 55%. Freudenberg Sealing Technologies understands the challenges of operating energy systems that must deliver reliable, round-the-clock performance. Avoiding downtime is critical and one thing is certain: Neither turbines nor valves can function without precision-fit seals. The sealing materials from Freudenberg Sealing Technologies form seamless connections between the systems’ mechanical components. They can withstand freezing water and fluctuating pressures as well as saltwater while retaining their shape.

**Types of hydropower plant: an overview**

Humans have harnessed and used the immense energy of flowing water for thousands of years – to irrigate fields and drive millstones, for example. In the past, swollen wood or leather straps served as makeshift seals. Today, far more efficient sealing materials are available for converting the power of water into usable energy. Each type of hydropower plant has specific requirements that must be considered when choosing the proper material. On land, we distinguish between run-of-river power plants and diversion power plants, which are installed in streams and on rivers. Pumped storage and cavern power plants, in contrast, are primarily used as energy reservoirs. And to capture the endless energy of the oceans, tidal power plants along coastlines have now reached market maturity. To get a sense of the extreme environments in which sealing materials must function with top efficiency, it is essential to take a closer look at the turbines that are powered by the masses of water.

**Turbines: The heart of hydropower utilization**

At what angle and from what drop height will the water strike the turbine? At which volume and average flow pressure? These are the key variables when determining which turbine will deliver the highest efficiency for the hydropower plants. A basic distinction is made between equal pressure turbines and overpressure turbines. Equal pressure turbines are designed so that the flow pressure upstream and downstream of the turbine remains constant. They are ideal for high drop heights and low water volumes. A Pelton turbine is an example. In contrast, overpressure turbines use the pressure differences before and after passing through the turbine to generate energy. They work efficiently across a wide range of drop heights and water volumes. Kaplan, Francis and propeller turbines have proven effective in this area. Together, these four types of turbines account for up to 80 percent of the global market. All turbine models have one thing in common: they can only withstand harsh environmental conditions if they are equipped with sealing materials that have been perfectly selected.

**Fact check: Focus on seals**

Considerable expertise is required when selecting the right sealing materials, as the different flow angles and velocities, the expected pressure distribution and water properties all need to be taken into account. This is exactly the kind of materials know-how that Freudenberg Sealing Technologies has been developing and refining for decades. Octavia Ohr, Head of R&D, Freudenberg Xpress® Customized Solutions, explains: “It’s fascinating to see how these relatively small seals play such a crucial role in maximizing the energy output from hydropower. Each seal has a specific shape and not every material works in every application. But I welcome each new request. When we combine our materials expertise with the Freudenberg Xpress® product line, we can match the right compound to each environment and manufacture customer-specific profiles.”

**Sealing properties: High-performance materials for turbulent environments**

Every hydropower plant site has its own set of environmental conditions that place high demands on all components – so there is a lot to consider. At dynamic sealing points exposed to fresh water, materials must offer high adaptability and deliver a well-balanced combination of water compatibility, wear resistance, and sealing performance. Commonly used materials include polytetrafluoroethylene (PTFE), polyurethane (PU) and nitrile rubber (NBR). These material groups have stood the test even under high flow velocities. In extremely turbulent environments, however, the priorities for the required material properties shift to high mechanical strength and vibration resistance. For these conditions, high-performance thermoplastics such as polyetheretherketone (PEEK) are ideal. In icy environments, materials must primarily offer excellent cold resistance and withstand increased ozone exposure. This is where ethylene propylene diene monomer (EPDM) is the material of choice – these seals remain flexible even after long periods in frosty conditions. Wave or tidal power stations present a different challenge: saltwater is highly corrosive, which makes chemically inert and corrosion-resistant materials absolutely essential. In such cases, EPDM can be used, for example. This group of materials can withstand saltwater and unprotected exposure to sunlight over a long period of time. The bottom line: Only perfectly selected materials and custom-engineered seals can reduce wear in hydropower systems and enable low-maintenance and long-lasting operation.

**Maintenance: Global modernization of hydropower plants**

The development of new hydropower plants is currently focused on Asia, Africa and South America. Among these, Brazil stands out. For decades, its existing hydropower plants have relied on particularly large turbines to generate energy. This means that large-format, high-performance seals are also required as part of the maintenance cycles. This is where material and manufacturing expertise counts, which is exactly what Freudenberg Sealing Technologies provides. Thanks to its international production and logistics network, it can quickly produce and deliver custom-fit seals.

If we look at hydropower in Europe, we see that the majority of power plant potential has already been tapped. This is due to strict environmental regulations and to widespread existing infrastructure already installed along European rivers and streams. As a result, Europeans are currently focusing on modernizing existing systems, some of which have been in operation for more than 100 years. The same is true for North America. In both Canada and the U.S., large-scale modernization programs are currently creating a new wave of hydropower development. Even in the absence of political planning certainty, there is an acknowledged need to bring hydropower plants to the state of the art, which is resulting in a growing number of maintenance contracts.

**Energy strategies: Diversifying the energy mix**

In the coming years, the global hydropower sector is expected to see a surge in wave and tidal power plant installations, as well as the development and expansion of pumped power plants as energy storage systems. On June 25, 2025, the International Hydropower Association (IHA) published its annual “2025 World Hydropower Outlook” in London. The press release states: “Pumped storage hydropower plants (PSH), the world’s most proven technology for large-scale electricity storage, are drawing increased attention from policy makers and investors in times of market volatility and system stress. With major policy reforms and over 60 GW of PSH projects in the pipeline, Europe has a clear opportunity to use this momentum for the implementation.” Scott Sharpless, Global Key Account Manager, Power/Energy at Freudenberg Sealing Technologies, observes: “Hydropower is one of the oldest and most sustainable forms of renewable energy. It doesn’t produce direct emissions and helps to reduce our environmental footprint while securing our energy supply. With our competent materials expertise, we can shape the perfect material into customized seals for every environmental requirement, which takes us one step closer to carbon neutrality.”

Detailed information on the range of services offered by Freudenberg Sealing Technologies in the field of hydropower is available here.

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**About Freudenberg Sealing Technologies**

Freudenberg Sealing Technologies is a long-standing technology expert and global market leader for sophisticated and innovative applications in sealing technology and electromobility. With its unique materials and technology expertise, the company is a proven supplier of sophisticated products and applications as well as a development and service partner for customers in the automotive industry and general industry. In the 2024 financial year, Freudenberg Sealing Technologies generated sales of around €2.5 billion and employed around 13,000 people. Further information at [www.fst.com](http://www.fst.com/).

The company is part of the global Freudenberg Group, which generated sales of almost 12 billion euros in the 2024 financial year with its Seals and Vibration Control Technology, Nonwovens and Filtration, Household Products and Specialties divisions and employed around 52,000 people in some 60 countries. Further information at [www.freudenberg.com](http://www.freudenberg.com)

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