

JACOB ARNOLD ■ TIDAL POWER STATIONS WERE INSTALLED IN SEVERAL PLACES IN THE NETHERLANDS MANY DECADES AGO, BUT BECAUSE OF THE ADVANCE OF NUCLEAR POWER, INVESTMENT IN THIS FORM OF FREE AND CLEAN ENERGY STAGNATED. NOW, DUE TO THE ENVIRONMENTAL EFFECTS OF CONVENTIONAL POWER PLANTS, RENEWED ATTENTION IS BEING GIVEN TO THIS FORM OF ENERGY.

Low pressure pump-turbines provide **energy** from tides

To protect land regained from the sea, the Netherlands has developed a multitude of dams and levees (dykes), frequently incorporating sluices to facilitate navigation of channels and rivers. To control the levels of inland water, a large volume of water must be dumped daily during low tides. This presents opportunities to generate tidal energy. Frequently, it is also required to pump during high tide. This calls for the application of a low pressure pump-turbine as a sustainable solution. To ensure the free passage of migrating fish, features of the recently developed and patented fish-friendly pump by Norit Nijhuis and FishFlow Innovations are incorporated in the low pressure pump-turbine development program.

An example of a possible application of these machines is Lake Grevelingen in the Dutch Delta. This lake is blocked off from the sea by two dams and contains stagnant brackish water. In order to revive this lake, the intention is to partially open up the dams to refresh the water and also restore some tide. Norit Nijhuis was asked by Delta Energy to perform a feasibility study on the generation of tidal energy utilizing these openings. The study showed that generation of tidal energy is a feasible option, and as much as an average of 60 megawatt can be produced on a daily basis. This was also shown by a study performed by Delft University, that considered the aspects concerning the required civil construction in more detail. Recently, the Dutch Water Board approached Norit Nijhuis to investigate the feasibility of including a pumping function in the proposed tidal energy plant for this location.

Preliminary studies and experimental measurements by Norit Nijhuis have shown that with level differences as low as 20 centimeters, power can effectively be extracted from water, of which the magnitude is proportional to the flow rate available. These tests were done on a bi-directional turbine. Tests performed on a low pressure axial flow pump revealed that it can also effectively act as a low pressure turbine. This technology, which Norit Nijhuis developed and tested as pump-turbines, will be applied in the South-to-North Water Diversion Project in Han Zhuang, China for the first time.

Low pressure turbines as well as low pressure pumps operating as turbines can develop a substantial amount of power, even at very low level differences. If shaft power is converted to electrical energy, the cost per kilowatt-hour can compare favorably to that of generating wind energy, with the additional advantages of availability, predictability, durability, and stealth. The application of low pressure turbines presents a sustainable option for generating clean energy.

