HYDROPOWERED WATER SUPPLY

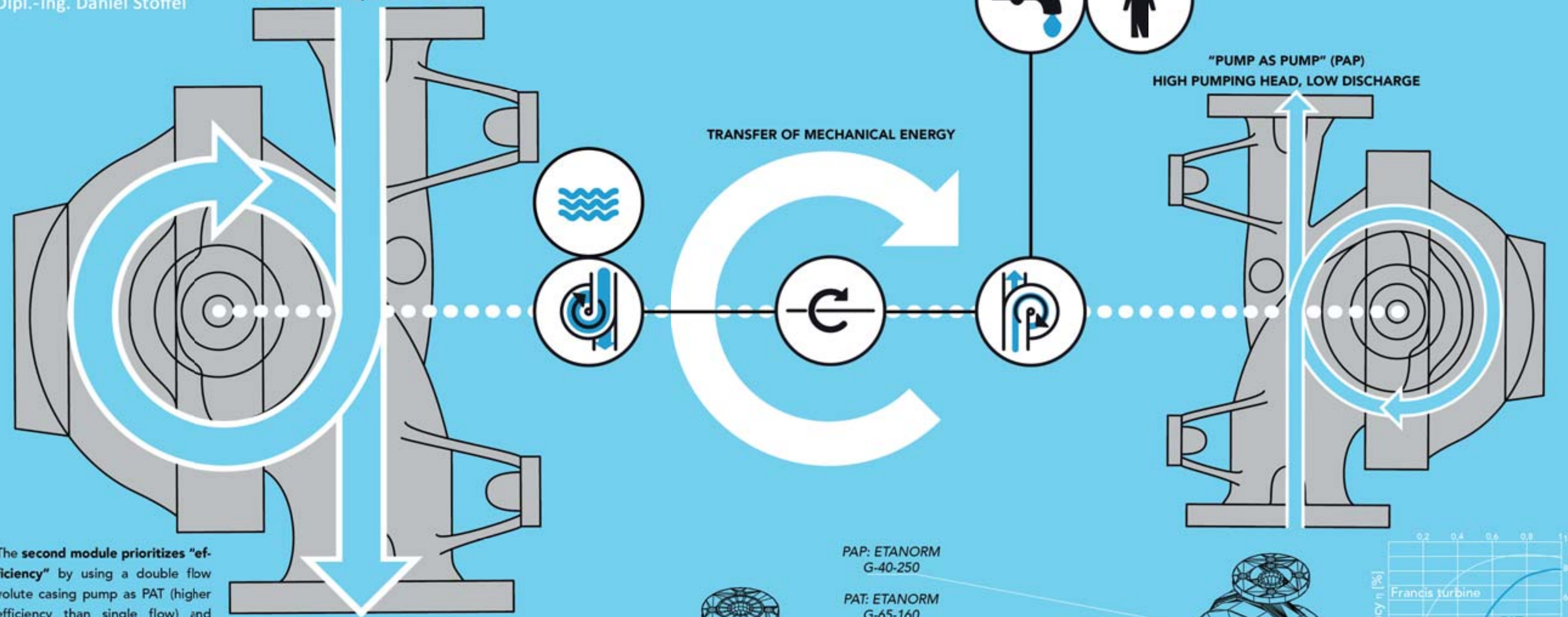
BY OPERATING A PUMP IN REVERSE, IT CAN BE USED AS A TURBINE FOR GENERATING POWER. THROUGH A MECHANICAL COUPLING OF THIS "PUMP AS TURBINE" (PAT) WITH A REGULAR PUMP, WATER CAN BE SUPPLIED WITHOUT THE NEED OF ANY ADDITIONAL SOURCE OF ENERGY. THIS EASY-TO-LEARN TECHNOLOGY IS ESPECIALLY SUITABLE FOR AREAS WITH POOR INFRASTRUCTURE.

INSTITUTE FOR WATER AND RIVER BASIN MANAGEMENT
Prof. Dr.-Ing. Franz Nestmann, Dr.-Ing. Peter Oberle
Dr.-Ing. Muhammad Ikhwan, Dipl.-Ing. Daniel Stoffel

A sustainable water supply has **three essential requirements**: the **existence of water resources**, the **availability of appropriate technologies** suited for the local boundary conditions and the provision of **operating energy**. Regarding the provision of energy, the utilization of a **hydropower potential as drive of a pumping system** is a technically, economically and ecologically reasonable solution: a **field-approved concept** with no need for fuel leads, low maintenance costs, and based on renewable energy with no emissions. This utilization can be realized through conventional turbines or **reverse driven pumps** (pump as turbine, PAT). The latter excel thanks to a simple structure that leads to high robustness, low investment and low maintenance costs. These machines are thus **predestinated for application in poorly developed and remote areas.**

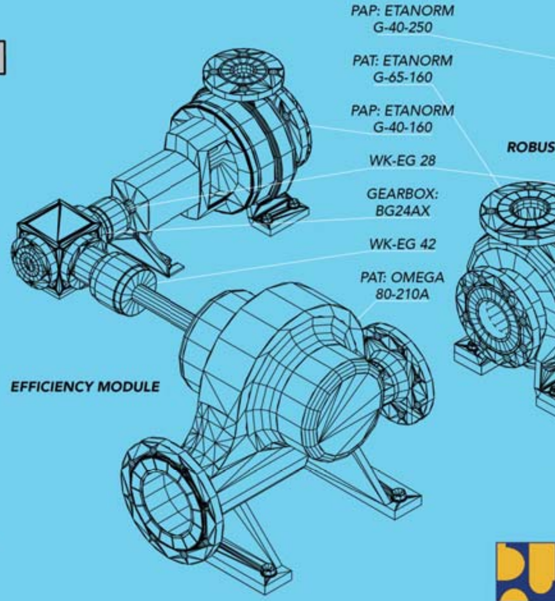
By **coupling a PAT mechanically with a feed pump** (the conveying module), water can be supplied without **the need for electricity**. Regarding the construction of the conveying module, the machine is selected based on local boundary conditions such as the fall head, discharge, pump head and flow rate. Since the efficiencies of both PAT and feed pump depend on the specific rotation speed, the necessity of interposing a gearbox has to be analyzed for each application. Despite energetic losses by the gearbox, its utilization might increase the overall efficiency of the module if the speed transmission leads to higher single efficiencies of PAT and feed pump.

The **first module** of the UGM model plant **prioritizes** the properties **"robustness"** by using two single flow volute casing pumps of the same machine type without speed adaption by a gearbox.



The **second module prioritizes "efficiency"** by using a double flow volute casing pump as PAT (higher efficiency than single flow) and speed adaption through a gearbox. The two conveying modules of UGM model plant have been evaluated through test rig runs by KSB AG Germany.

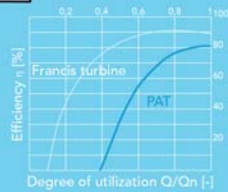
Parameter		*ROBUSTNESS MODULE*		*EFFICIENCY MODULE*	
Manufacturer		*KSB AG*	*KSB AG*	*KSB AG*	*KSB AG*
Type		*ETANORM G-65-160*	*ETANORM G-40-250*	*OMEGA 80-210A*	*ETANORM G-40-160*
Function		*PAT*	*PAP*	*PAT*	*PAP*
Hydraulic head	*[m]*	*8-10*		*8-10*	
Pressure head	*[m]*		*13*		*13*
Discharge	*[l/s]*	*16,7 - 19,4*	*4.6 - 6.8*	*16.4 - 22.5*	*4.7 - 7.5*
Rotation speed	*[min⁻¹]*	*1.180*	*1.180*	*1.100*	*1.700*
Max. efficiency	*[%]*	*75*	*58.5*	*76.9*	*66.3*
At conditions	*[min⁻¹]*	*1.515*	*1.450*	*1.515*	*1.450*
Manufacturer				*Walther Flender GmbH*	
Type				*BG24AX*	
Transmission				*1.55*	
Efficiency	*[%]*			*91*	
Manufacturer		*Walther Flender GmbH*		*Walther Flender GmbH*	
Type		*WK-EG 28*		*WK-EG 42*	*WK-EG 28*
Function		*PAT-PAP*		*PAT-PAP*	*gearbox-PAP*
Efficiency	*[%]*	*99,9*		*99,8*	*99,9*
System efficieny	*[%]*	*42*		*45*	



A PUMP BECOMES A TURBINE

The **operating principle of a pump** (conversion of mechanical energy to kinetic energy) can be seen as the **reversal of a turbine's function** (kinetic energy to mechanical energy). Thus, by operating a pump reversely it can **substitute a turbine for power generation** whereby the comparatively simple hydraulic design of a PAT leads to the following advantages:

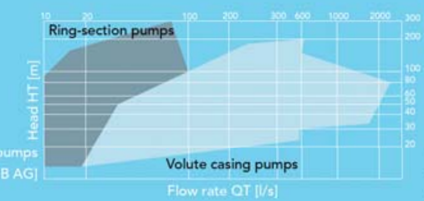
- Adjustment devices are not necessary
- Operation of multiple machines meets fluctuating conditions
- Low maintenance effort
- Low investment and maintenance costs
- High robustness



Degree of divergent courses for a PAT and an exemplary Francis turbine, which differ especially in the lower partial load range

The different performances of a PAT and a common turbine can be highlighted by examining the characteristic efficiency curves for both machines. As opposed to a PAT, a common turbine is equipped with an adjustment device, leading to a better **partial load behavior**. This **can be compensated** for by **setting up various machines in parallel**, allowing individual machines to be started or stopped depending on the respective conditions.

This technology applies potentially well in **drinking water supply systems**, for **retrofitting of small hydropower systems** and in **multiple industrial applications**. Potential fields of application as well as the corresponding machine types can be seen in the image to the left. Regarding low flow rates ring-section pumps might be applied, with increasing flow volute casing pumps can be the alternative.



Operational areas for pumps used as turbines [KSB AG]