Human-Powered Energy System

Response Phase	Application Level	Management Level	Objectives / Key Features
* Acute Response ** Stabilisation ** Recovery	** Household * Neighbourhood City	** Household ** Shared ** Public	Abstraction and transport of water using human power
Local Availability	**Technical Complexity**	**Maturity Level**	
*** High	* Low	*** High	

Human-Powered Energy Systems are based on the use of human force. In the acute response phase, Human Power is often limited to transporting water, while supply and treatment are managed centrally to ensure adequate water quantity of the desired quality can be delivered. Human-Powered abstraction, transport and treatment can be used in all response phases and is common during acute emergencies, especially in natural disasters where it might be the only energy source available for a period of time.

Human Power, estimated at around 70 Watts (for an adult male) over a longer duration (e.g. 8 hours), is a free power source that can reduce ongoing financial costs of a water system. Women and children are most often the ones powering these systems (e.g. for water collection and transport), and technologies should be designed with these two groups in mind. The cost of Human-Powered Energy Systems is principally measured in the time and the physical cost, particularly for women and children. For water supply, human energy is most commonly used for pumping water for drinking and irrigation purposes, as well as for transporting water and treating it at household level **(see chapter H)**.

Design Considerations: The design of any Human-Powered System is limited by the fact that it will use only human energy, and design considerations tend to focus on water abstraction technologies **(see chapter A)**. Protected Wells **(I.7)** and Protected Boreholes **(I.8)** are by definition capped with a pump, reducing the potential for contamination. Where this pump is manually operated, the design must ensure that the water can be lifted using human energy alone. The key criteria is whether it is possible to operate the pump with only one person or sometimes two (e.g. in the case of a rope pump).
There are design parameters that can facilitate Human-Powered pumping from different depths (e.g. having smaller pipe diameter, or levers for mechanical advantage) and for giving different flow rates (e.g. hand pumps versus foot pumps). Where higher volumes of water are required, foot pumps may be preferred as they are usually less tiring to use since they make use of larger body parts (legs). Suction pumps are suited to shallow groundwater up to six or seven metres in depth, and include both foot and hand-operated types **(see A.2)**. Beyond suction depth and up to a depth of around 15 metres, the water column in the pipe can be lifted directly by the user using Direct Action Pumps **(A.3)**. For depths of more than 15 and up

to 45 metres, mechanical levers must be added to make the work easier, while gearing mechanisms can enable pumping from depths greater than 45 metres and up to 90 metres **(see A.4)**. This is considered the limit for Human-Powered abstraction. Design considerations can also be applied to water transport and treatment, but here it can be that the users themselves modify the design. For example, round jerrycans are modified to be rolled along the ground, or water is transported in wheelbarrows or carts or by Water Vendors **(D.1, D.2)**.

Materials: The needed materials depend on what Human-Powered method is to be used (e.g. what type of pump or water container).

Applicability: Human Power can be appropriate for water abstraction, transport and treatment. It is often more viable at the household level and in the context of rural communities, where there is limited access to other energy sources, limited financial resources, and where water demands tend to be lower. In contrast, in acute emergencies and/or urban settings, populations are often much denser. Here, human energy is mainly used for transporting water from a source (e.g. water at tapstands), while the water supply and treatment is handled at a central location where water quantity and quality can be assured. This centralised treatment and supply is necessary because in these situations there is often a limited number of actual water points (such as wells or handpumps) that are available compared to the population density, and also the flow from Human-Powered sources is extremely limited. To avoid queues and conflict, a single handpump should serve no more than 500 people during the acute response, and given that one handpump might typically extract only 1 m^3/hour. Additionally, high density populations can pose a significant contamination risk, particularly for shallow groundwater sources. However, context is important, and there are situations where handpumps do form a part of the emergency water supply strategy in acute phases.

Operation and Maintenance: Use of human energy ultimately depends on the nutrition and health status of the population, so a lot of the inherent O & M will revolve around the health of those operating the system. In terms of Human-Powered equipment, the level of O & M will vary according to the type of system in use, which most often involves manually operated pumps. Although the energy source in this case is finance-free, over one-fifth of manually operated pumps do not remain functional over time. There is a broad range of reasons for this, including technical issues regarding the groundwater or borehole (e.g. corrosive groundwater or poor borehole design) or with the pump itself (e.g. quality of pump materials or pump age) or various other reasons (e.g. issues to do with management, monitoring, finances, corruption, access to hardware or having the skills needed for repair). This is a similar level of functionality as other types of water systems but illustrates that a free energy source does not necessarily equate with better functionality.

Health and Safety: Health and safety concerns of using Human Power as an energy source can include over-exertion (especially for women and children) due to the excessive energy needed to lift water from deeper wells, which is a greater risk in hotter and/or more humid environments. Transporting water can also be physically hazardous, especially near open water or on paths that are steep or slippery, and there may be safety risks for women if the source is remote and insecure. In these cases, it is important to consider whether all members of a society are able to use the water systems, irrespective of their power capacities **(see X.15)**. Transporting water by hand requires filling and emptying small Household Water Containers **(see D.1)**, and this process may contaminate the water.

Costs: The use of human energy can positively impact recurring financial costs. This does not mean that these systems are without recurring energy costs, as labour has an intrinsic cost to the one providing it, which also ends up providing value to both households and the wider community.

Social and Environmental Considerations: Human Power as an energy source is well understood and accepted by users. However, there is a non-financial cost to using human energy that must be accounted for, as much of the water abstraction and transport is carried out by women. While there may be social benefits to the women-only interactions at water points, this unequal gender role also leads to possible physical risks as well as economic and educational effects, where less time is spent on more productive uses (e.g. school, work). Due attention is needed to assure protection measures are in place so that women can safely use water supply facilities.

Strengths and Weaknesses:

(+) Has lower recurring financial costs
(+) Tends to be used with lower-technology infrastructure, which has a lower investment cost
(+) Low carbon footprint

(−) Energy produced is limited, which in turn limits the amount of water that can be abstracted or transported
(−) Has inherent health risks, such as over-exertion, physical and protection hazards
(−) Can contribute to gender inequality

→ **References and further reading material for this technology can be found on page 213**