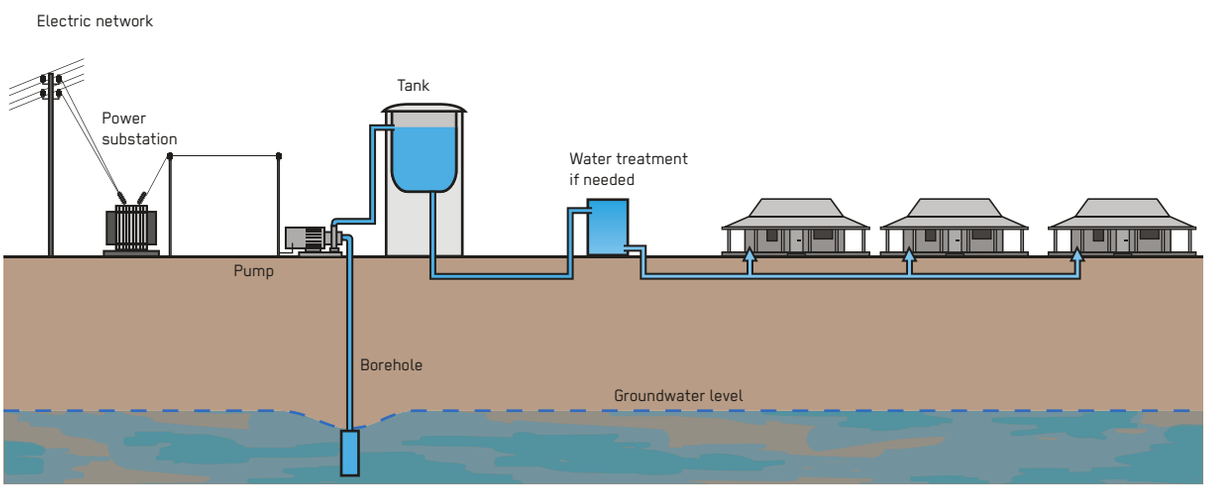
Electric-Powered Energy System

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



Electric-Powered Energy Systems use electricity from a grid to power water pumping, transport or treatment. It is an energy source suited for all phases of an emergency, but it may not always be available (e.g. in the acute phase after a natural disaster).

On a small local scale, electricity produced by a set of solar panels **(see S.10)** or one diesel generator **(see S.12)** can power a simple water system, such as a pump in a borehole. Electricity at a larger scale is generally centrally produced and fed into transmission lines. Whilst this electricity may still be produced by a set of diesel generators or other means (e.g. solar, wind or hydropower), the O & M is centralised, and the power is fed into a grid to be used over a wide area.

Design Considerations: For water supply, electrical energy is mostly used for pumping, though it can also be used for other processes, such as water treatment **(see chapter T)**. Key considerations for the design of Electric-Powered Energy Systems relate to whether the required supply is direct current (DC) or alternating current (AC), and for the latter whether it is single-phase or three-phase. All supply types can be used for water systems, and the choice depends on the context and power requirements. For example, DC power provides electric charge (current) in only one direction, and is the type of power produced by a solar panel to efficiently run a DC pump. However, DC supplies are limited by the distances the energy can be conveyed without prohibitive energy losses, so cable sizing is important.

With AC power, the current and voltage change direction periodically, and is the type of energy from the grid that operates the more commonly available AC pumps. This change in direction creates a wave which can have differing heights (called amplitude, a measure of how much voltage occurs at the top or bottom of each wave) and frequency (number of waves per second). In addition, the number of waves at any moment in time is termed the phase. Single phase is produced using one

live wire to create one wave (230 volts), whereas three phase is produced using three live wires to create three waves simultaneously that are offset in time (415 volts). Three-phase current is used when more power is needed, such as supplying power for transmission lines, as well as for large motors and heavy loads. AC is the mode used for transporting electricity across long distances, as at high voltages (over 110,000 volts) less energy is lost in transmission. Higher voltages mean lower currents, and lower currents generate less heat in the power line due to decreased resistance. AC is converted from these high voltages using transformers at the destination before the power is used. Energy can be stored using batteries, but it is generally better to avoid this due to the cost, short lifespan and inherent energy losses that occur during battery storage through a well-designed pumping system together with adequate storage.

Materials: The type of power supplied should be matched to the operating requirements of the equipment at a location. For example, a large pump motor with a voltage of 415 volts will require a three-phase supply.

Applicability: Grid electricity is suitable for all response phases, though may not always be available in the acute phase if power lines or power stations are affected or in areas with frequent and prolonged power cuts. For emergency response and in certain non-emergency contexts, alternative sources of power could prove a better choice.

Operation and Maintenance: Electric pumps can operate with little maintenance, but regular checks of current, voltage and frequency are needed to warn of potential problems. If readings are higher or lower than normal, appropriate steps need to be taken with the power supply or the pump. Where electricity is produced by a local generator, maintenance burden and cost will increase significantly **(see S.12)**. A voltage regulator needs to be installed to protect the system against variable voltages and blackouts, and access to alternative power sources will also be useful at the time of such blackouts.

Health and Safety: Electricity can be dangerous. Only trained personnel should work with mains supply, and all health and safety rules regarding electricity must be followed. If work is remote from a distribution board, then supply should be disconnected at the isolator, the fuses should be removed, wires should always be assumed to be live until tested, hands should be kept dry, everyone must verify that they have finished working and are aware before switching back on, cables should be properly insulated and earthed, and fuses and circuit breakers should not be overridden. If battery systems are used, access should be restricted to avoid electrocution risks.

Costs: In addition to the costs per kWh, the actual maintenance costs for grid electric systems are moderate (0.8–1.5 USD/person/year) and comparable to Wind-Powered Energy Systems **(S.9)**. However, if using Diesel **(S.12)** directly to produce power, the ongoing costs are significant. Apart from financial costs, the high environmental costs from energy produced using non-renewable sources should be considered at the design stage when choosing a power supply.

Social and Environmental Considerations: Grid electricity as an energy source is very common and is well accepted by people.

Strengths and Weaknesses:

⊕ Can be produced using renewable energy, a low-carbon energy option

⊕ Relatively low maintenance and therefore low overall cost to users when electricity is supplied through the grid (maintenance is done further away in centralised location)

⊖ May not be useful in certain contexts where power is unreliable

⊖ Requires specialised technical O & M at centralised level

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