Hydropower

Hydroelectric power is generated by capturing the kinetic energy or motion in free-flowing or falling water, waves, currents or tides, and converting it into electric current. The Massachusetts Class I Renewable Portfolio Standard (RPS) differentiates between **hydroelectric power**, which captures energy from flowing freshwater with or without the use of a dam structure; **ocean thermal, wave or tidal energy,** which is strictly derived from marine resources including differentials in ocean water temperatures ("ocean thermal"); and **marine or hydrokinetic energy,** which encompasses both categories but excludes facilities that dam or impound the flow of water.

The most common hydropower facility is an **impoundment,** or dam, which stores river water in a reservoir. Water being released from the reservoir has potential energy, and when it falls it spins a turbine, generating electrical current. Large-scale (over 100 MW) hydroelectric dams, such as China's Three Gorges Dam, have become notorious as harbingers of environmental devastation and human displacement. Riverside ecosystems tend to be rich in biological diversity, and damming a free-flowing stream often leads to the flooding and destruction of these communities. The erratic flow of water periodically released from a dam, in addition to its lack of sediment, leads to erosion and loss of riverbeds and banks. Ecosystems previously adapted to a cyclical pattern of inundation and drought can also suffer as a result of large-scale dams.

The alternative to an impoundment is a **diversion** facility, which channels a portion of the flow of a river through a canal and uses that current to spin a turbine for electrical generation. Diversion facilities do not necessarily require a dam, but still rely on the potential energy of falling water to drive turbines.

Pumped-storage facilities are another type of hydropower, although they do not qualify as renewable generation units. Pumped-storage is a mechanism for balancing electrical production and demand: when electrical production is high, water is pumped from a lower reservoir to a higher reservoir. This effectively converts electrical energy into potential energy. When electrical demand is high, the water from the higher reservoir flows back into the lower reservoir, spinning a turbine and generating electricity. Although no net energy is produced through pumped-storage, these facilities can help level out peak load and offset the instability introduced into the grid by variable power sources, such as wind turbines.

The Low Impact Hydropower Institute in Portland, Maine identifies eight criteria for hydropower dams with low environmental impact, independent of their size. These include:

- **River Flows** – The dam and powerhouse should provide river flows that promote fish, wildlife, and water quality health, including seasonal fluctuations if applicable to the region.
- **Water Quality** – The facility is required to demonstrate that the state has not found it to have impaired water quality.
- **Fish Passage** – There must be provisions for the passage and protection of fish, such as a fish ladder (when appropriate).
- **Watershed Protection** – The facility must be in compliance with federal license terms regarding watershed protection and enhancement.
- **Threatened and Endangered Species Protection** – No negative impacts on endangered species can be caused by the facility, and it must be in compliance with species recovery plans.
- **Cultural Resources Protection** – The facility must protect cultural resources, through compliance with either its federal license or a plan developed with a local or tribal agency.
- **Recreation** – Free access to the water and accommodations for recreational activities on the public's river must be given by the facility.
- **Facilities Recommended for Removal** – If a resource agency has recommended that a dam associated with the facility should be removed, it will not qualify for certification.

What is the status of hydroelectric power in Massachusetts?

In order to qualify as a Class I Generation Unit under the Massachusetts RPS, hydroelectric facilities cannot have been built recently (after 1997) or be larger than 25 MW in capacity. They are also required to meet certain environmental standards, such as fish passage and watershed protection measures. As of October 2013, there are 23 hydroelectric generation units that qualify under RPS Class I, 8 of which are in MA. Within the MAPC region, the Deer Island hydro project has a generating capacity of 2 MW and has been certified by the Low Impact Hydropower Institute.

How can I develop hydropower in my community?

MassCEC offers a Commonwealth Hydropower program, which "seeks to increase the output of the Commonwealth's hydropower assets by providing grants for ecologically appropriate projects that can be implemented quickly and efficiently." Priority is given to projects that will qualify for Class I RPS. Funding will be available for both existing facilities that will increase their

generation through upgrades and repairs, and new facilities that will capture the kinetic energy of water flowing in man-made systems, such as water distribution systems.

Kinetic energy or free flow turbines are a promising technology for these new facilities, as they do not rely on the potential energy of water in order to operate (water doesn't need to actually be falling) and can capture kinetic energy from any type of moving water. These turbines, referred to colloquially as "underwater windmills," can also be used to capture energy in waves and tides. Kinetic systems do not need to be part of a huge construction project, as with impound facilities; instead, they can be installed on existing structures, such as bridges. A municipality considering generating electricity from a free-flowing local river should consider installing a micro hydropower plant (<100 kW) with kinetic turbines.