# Small & Micro Hydropower

DoradoVista, Inc.

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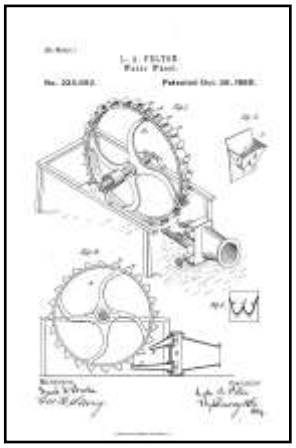
## Water Power and Renewable Energy's Future

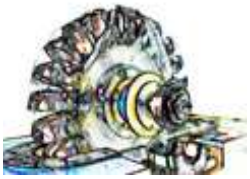
Often, to see the future, we must look back to the past. Let's start with the California Gold Rush of 1849. The cry was "There's gold-Gold-GOLD in those hills!" Looking back, though, we see that the wealth of this Gold Rush was not limited to the value of the gold found in those hills. It brought about inventions that are still valuable today, in 2009.



The 1880 patented invention designed to "Save the World," Lester Pelton's water wheel.

One of those inventions came through the genius of a man named Lester Pelton. While working in Camptonville, CA as a mining engineer, Pelton made a discovery bigger than just gold. As he was testing one of the mines' water wheels that had slipped on its axle, Pelton had an "Ah ha!" moment that reshaped the field of hydro power. The water jet was striking the wheel off center, causing water to splash across the face of the bucket. What caught Pelton's attention wasn't that the wheel was about to fall off. No, he wasn't concerned about his safety because he had noticed something far more important. The misaligned wheel had picked up speed!

Further research led Pelton to develop his highly efficient *PELTON WATER WHEEL*. To this day, the Pelton design remains one of the most efficient water engines ever. With Pelton's design, water to mechanical energy conversion in excess of 90% is quite common.



Pelton – 250 kW
Small Hydro Turbine

We'll talk more about hydro history and efficiency in future issues.

**Inside this issue:**



## Comparison Shopping for Renewable Energy – Small & Micro Hydro

When considering renewable energy sources, hydropower provides several key advantages.

First is hydro's ability to convert energy with greater efficiency. Hydro turbines can convert water to mechanical power with up to 93% efficiency, depending on the type of turbine used. Solar's conversion efficiency is between 10% and 40% with Concentrated PV (photo-voltaics).

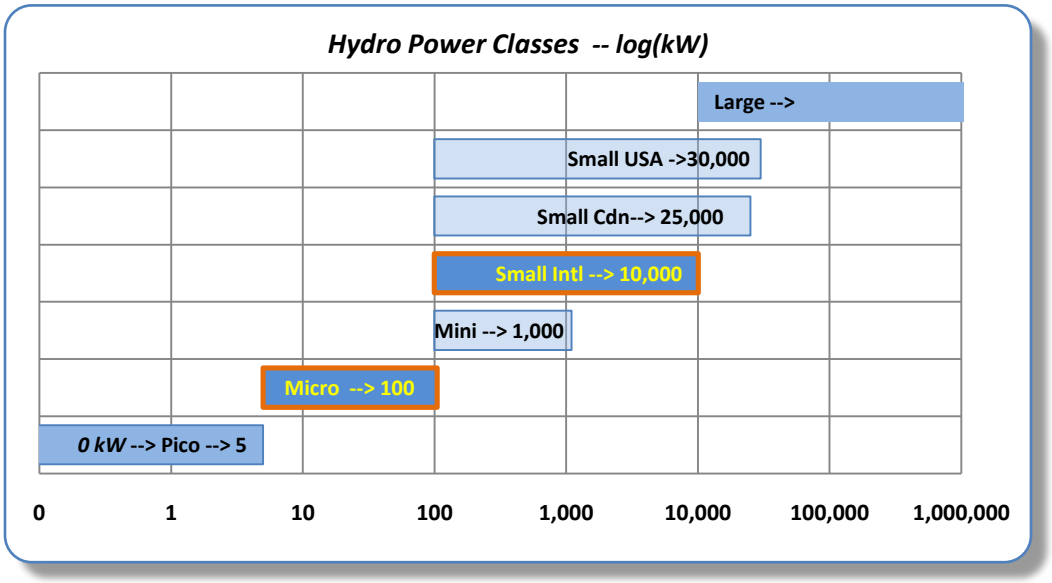
Second, due to daily variations in weather conditions, both wind and solar power plants must contend with highly variable output and less total power generation time (capacity factor) than hydro.

Another advantage of hydro is that it provides more than a century of technological development and stability. Newer energy sources have technological hurdles yet to be overcome.

**Advantages of Small Hydro**

- Very Efficient Technology
- Capacity Stable
- >100 Years Experience!
- Best Practices are Known
- No Emissions
- Small Footprint
- Mature Technology

## Small & Micro Hydropower Definitions




Looking at the somewhat varied definitions for hydropower classes can be confusing. In general, the different classes apply to licensing procedures for a given region. Impact and economic advantages are the focus of the definitions.

The typical classes mentioned in hydropower literature are shown in this chart. The lighter shading shows some regional redefinitions. Other variations to these conventions exist. The plot is logarithmic in kW. As you near the permit application process, you will need to investigate further.

## What do I do with all this Potential Energy?

**Nugget—**

*"Remember to allow for losses in the conversion of energy between water and wire."*

Gravity-driven water power distills down to friction plus two main factors:

- Q: Rate of water flow
- H: Head or vertical water drop

Of these two factors, head is more important when evaluating a site's potential to produce energy with good economic returns. This is because of the cost of pipes, valves and infrastructure. More head means that smaller pipes can produce the same power.

Water friction will always reduce the net energy produced from the ideal potential available. There are also conversion losses (heat) at each stage of energy conversion, from the turbine through the gears or pulleys to the generator itself and any transformers and wires.

When using the ideal power calculation shown below, remember to allow for losses in the conversion of energy between water and wire.

As a general rule, assume:

$$P_{typical} = P_{Ideal} \times 85\% \text{ turb} \times 85\% \text{ elec}$$

Or simply:

$$P_{typical} = P_{Ideal} \times 72\%$$

Where:

$$P_{Ideal} = H \times Q/11.8 \text{ kW}$$

(In English units → H ft x Q ft³/s)

## Why Small & Micro Hydro?

**Nugget—**

*"Some 30,000 Megawatts of renewable energy is still untapped in the streams and rivers of the United States."*

http://hydropower.inl.gov/resourceassessment/pdfs/doeid-10430.pdf

Some 30,000 megawatts of renewable energy are still untapped in the streams and rivers of the United States.

This estimate, by the US Department of Energy, is based on the use of small and micro hydro schemes in either a "run of river" configuration or the reconfiguration of smaller dams and reservoirs with small hydro. If these were ecologically developed by small or micro hydro, they would represent a large, efficient, renewable reserve. The world as a whole has a much larger reserve. Even a small fraction of this would represent a huge increase in energy availability with minimal impact on the environment. Micro- through small-sized hydro units are best suited for deployment at such sites.

Many individuals would like to enjoy energy independence, living free from the grid without the emissions of a generator. For these people, too, micro hydro and small hydro make sense.

## What's in it for me? Owning a Small or Micro Hydro Power System

As a hydropower system owner, you benefit in several ways, depending on your system and its application.

If you are on the self-sustaining micro end of the hydro spectrum, you benefit by reducing both your fuel costs and greenhouse gasses and hydrocarbon consumption.

If you participate in the development and installation of a hydropower system, you get the satisfaction that comes from completely understanding both the system and its components.

If you own a larger small-hydro system, you will likely benefit personally from the energy supply. In addition, you may gain significant passive income by selling excess power on the local grid.

If you are a community or local government entity, you benefit by providing hydro power that enhances economic growth and public health.

In whatever way you look at it, the hydropower owner is a winner. Power is produced for personal use, you have potential economic returns, and the benefits extend to the entire community.

With application of the right implementation methods, hydropower ownership pays back with both economic and ecological returns.

## What Gives Water its Power?

The earth continually receives 174 petawatts ($174 \times 10^{15}$ watts) of solar energy as it rotates. Compare that to 15 terawatts ($15 \times 10^{12}$ watts) of average human power consumption in 2004. Where does all that solar energy go?

Approximately 71% of the earth's surface is covered with water. That water represents the largest solar energy sink on the planet.

It's an amazing fact that all those little water molecules absorb this heat only to change from liquid into vapor. They rise into the air as vapor but return to a liquid state as the air around them cools. As liquid, they fall back to earth.

Of course there is a change in altitude and temperature involved at each stage. When the mass of water moves upward against the force of gravity, work is done and potential energy is stored. As water rushes down from the mountain tops, kinetic energy is released. With a little knowledge and some creative activity, we have learned to participate in this, the greatest heat engine on earth, by using water turbines and wheels to tap this energy.

In later issues of our Newsletter, we will explore various opportunities to harness this renewable energy resource as careful stewards.

Solar Power in Cloud Form

## Introduction to Small & Micro Hydro – Getting Started

The first step in getting started is to perform a preliminary or basic site survey. Several initial measurements need to be determined:

- The typical Q or flow rate for the site[1]
- Head or total drop in elevation for the water.
- Distance between the intake and exhaust or tail water.
- Length of Penstock

Length and diameter of the pipe or penstock is important. Penstock is one of the most expensive components for your system, especially if the pipe is large in diameter and long.

The main expenses of small and micro hydro power fall into these categories:

- Turbine, generator & switch gear
- Grid tie, if applicable
- Penstock & waterways
- Infrastructure: intake & powerhouse
- Permits, research & development

[1] Seasonal flow rate variations are charted using a Flow Duration Curve (FDC.) In the next Newsletter we will give a tutorial on how to create an FDC.

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**DoradoVista – Harnessing Renewable Energy, one drop at a time!**

## About DoradoVista

DoradoVista is a hub for several entrepreneurial efforts. The first effort is a ranch with agriculture at its center (blueberry and boysenberry production.) With agriculture came the need for water and power to irrigate.

Somewhere between these points it became clear that the property had a potentially valuable resource in flowing water. There is sufficient flow and head to make enough electric power for pumps and other ranch energy with excess to sell to the grid for profit. The hydropower projects we have tackled are a good match for our engineering background.

We serve an international market with small and micro hydropower interests, gold prospecting tools and Web marketing strategies. We plan to produce mighty fine berries in the future as well! Service is our focus and mission. We look forward to serving our clients better every step of the way.

Sincerely,
Jess
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## Small & Micro Hydropower Future Topics

This is just the beginning. We plan to continue the discussion regarding small and micro hydro's place among the myriad of renewable energy producing technologies.

Next issue we will introduce Head measurement techniques and the Flow Duration Curve or FDC. The FDC is a statistical charting device for evaluating a creek or river's variations in flow, or Q. The FDC is important to understand when evaluating a "run of river" small hydro prospect. It will help predict more accurately how much power, and during which months, you can expect to produce. Understanding the FDC will help determine the most effective size of hydro turbine and penstock for your project.

We are introducing these topics gradually to provide a foundation. Then, in later issues, we can expand into more detailed technical discussions without losing too many readers.

We offer our apologies to the experts among us for this deliberate, gradual pace. Our hope is to accelerate toward more technical discussions, with some of our seasoned small and micro hydro readers participating, in the near future.

Thanks again!

Jess and the Hydropower Team at DoradoVista, Inc.

Jess & his Gold Pan

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http://www.DoradoVista.com/ReadersCorner.html