Bad News, Good News

Equipment for a Hydroelectric Power Plant

NHA Finance Forum

June 3, 2013

New York, New York

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Hydropower Overview

Hydroelectic Power

Hydroelectric power captures the power of moving water and transforms it into electricity.

How much energy is captured depends on head and flow.

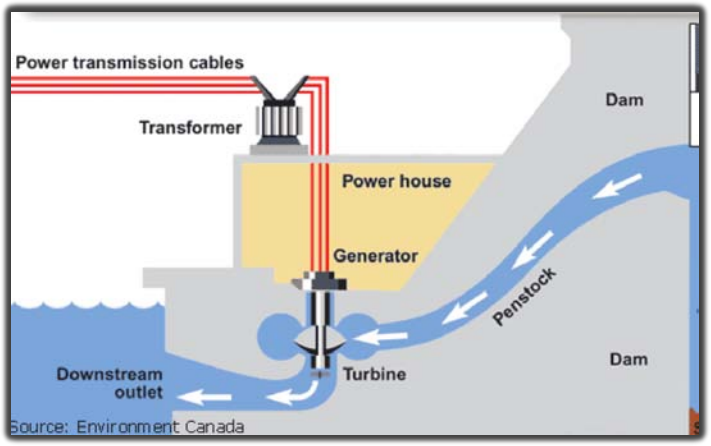
Hydroelectric Power Project

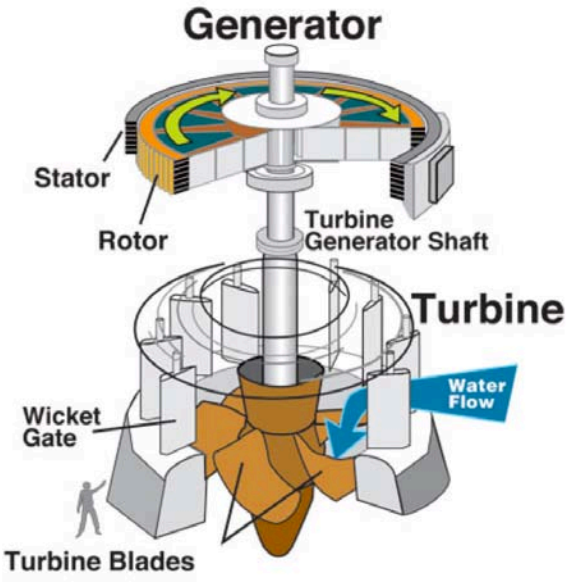
1. Design

1. Licensing and Permitting

1. Civil Construction
   - Waterways
   - Weir / Dam
   - Powerhouse

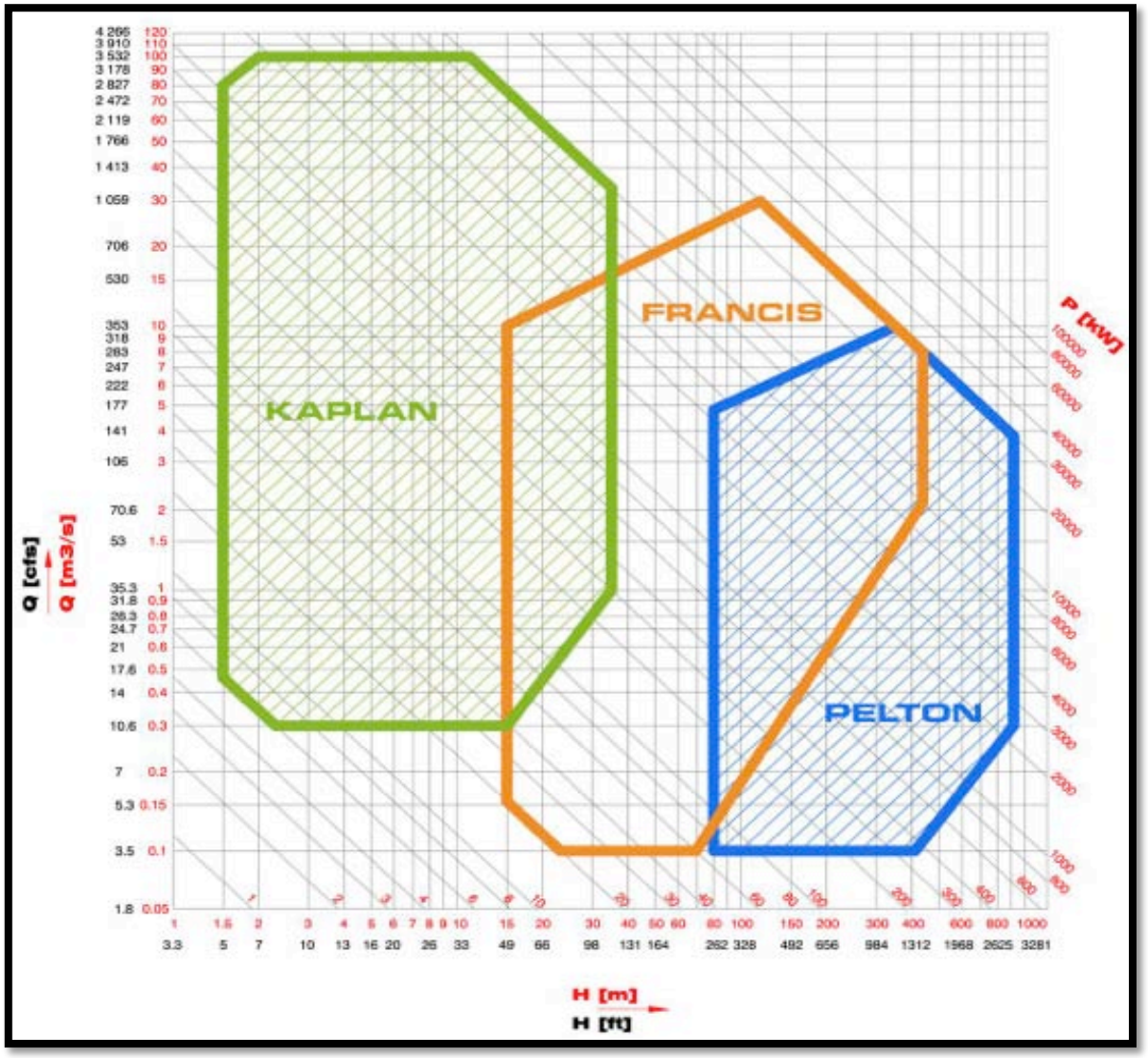
2. Equipment Supply
   - Turbine
   - Generator
   - Hydraulic Power Unit
   - Controls
   - EBOP
   - Transformer





The Hydro Turbine

Turbine Application Range



The Heart of a Hydro Power Plant

Conventional Turbine Types

Kaplan

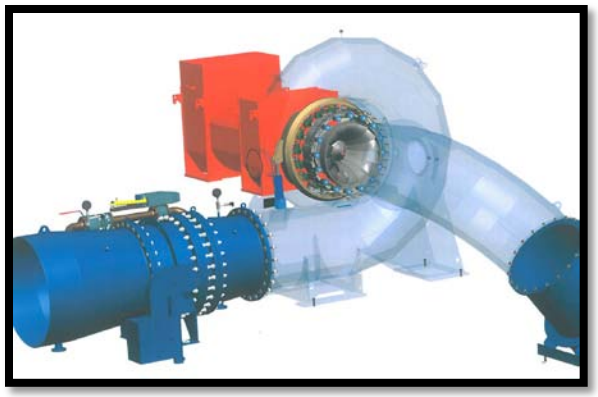
Francis

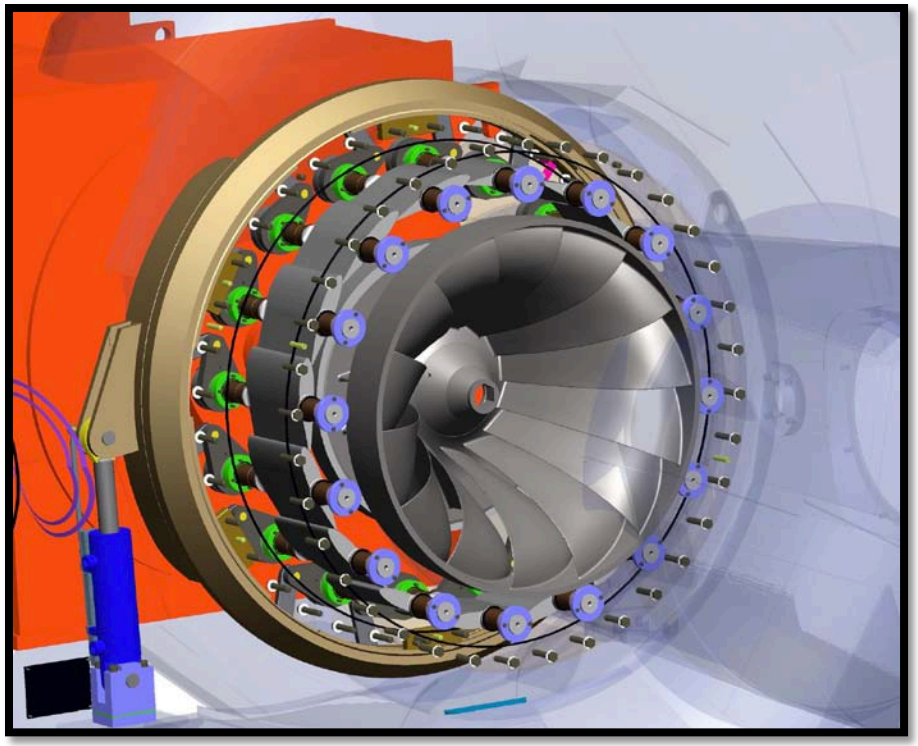
Pelton

Francis Turbine

The Francis Turbine was invented in 1848 by James B. Francis while working as head engineer of the Locks and Canals Company in the textile city of Lowell, MA. The Francis turbine, with 90% efficiency, helped power the industrial revolution and there are still more Francis Turbines installed in the world today than any other type of hydro turbine.

Francis Turbine Hydraulic Design





Francis Turbine Runner Design

Francis Turbine Runner

Francis Turbines Assembled

Two Francis Turbines Assembled / Ready to Ship to Site

Fujiyoshida, Japan

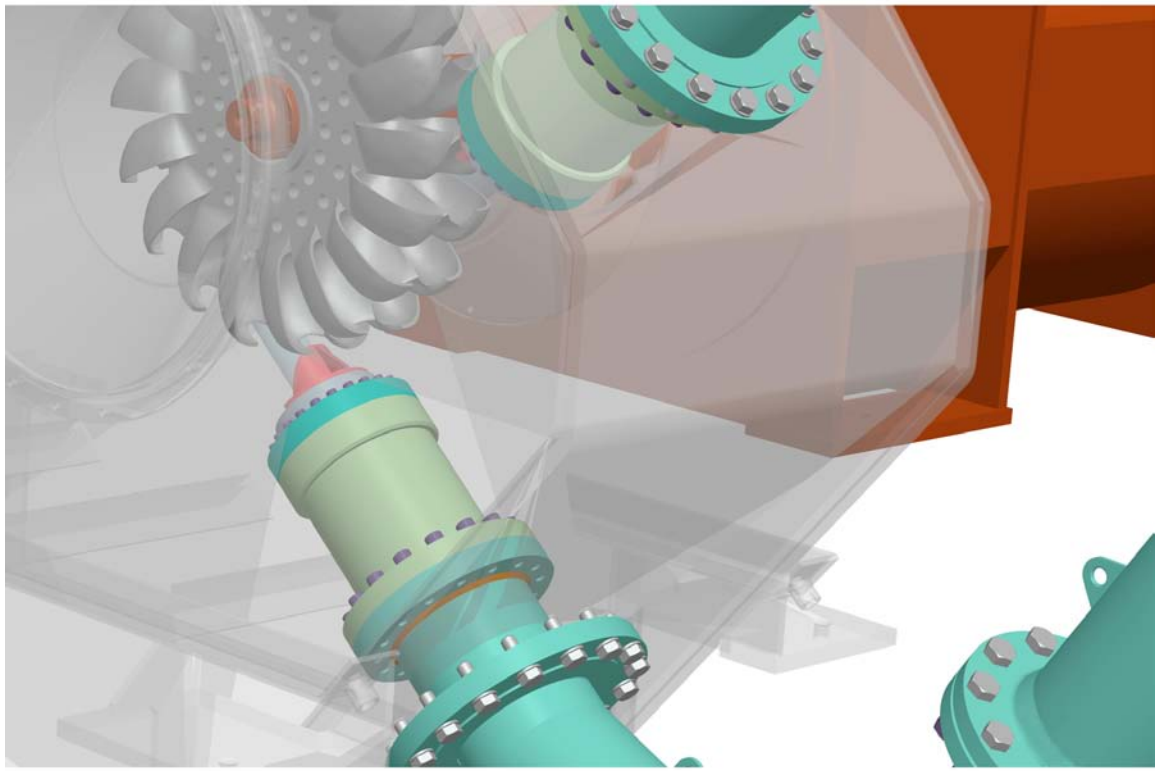
Francis Turbine Being lifted in to Site / Mt. Fuji in Background

Piedra River Cascade, Panama

Concepcion HPP, 2 x5 MW Francis Turbines / 1 or 3 Sites

Pelton Turbines

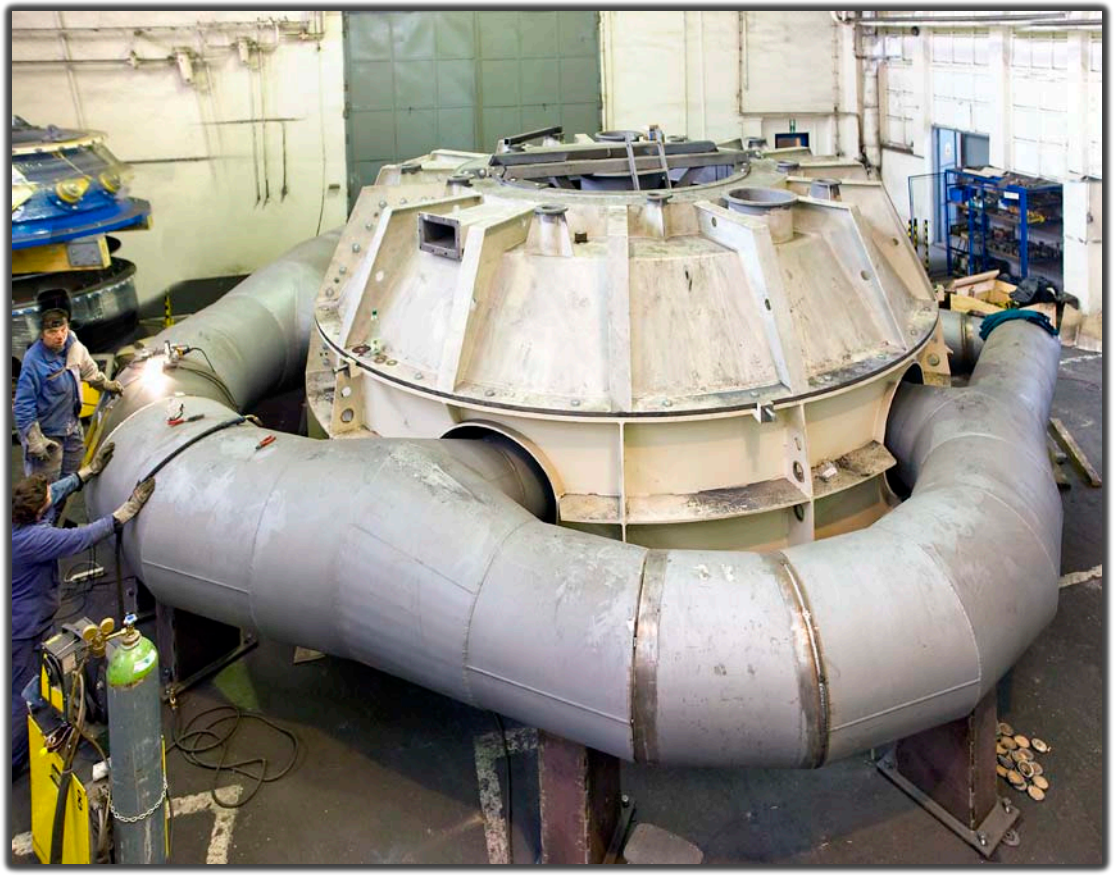
The Pelton Turbine was invented in the late 1800's during the California gold rush by Lester Pelton and are used when there is high head such as in mountainous areas. The Pelton is an impulse turbine and can utilize either a vertical or horizontal configuration and one to six jets. The use of multiple jets can provide two to four times the normal output for a given runner diameter.



Pelton Runner on 5-Axis Milling Machine

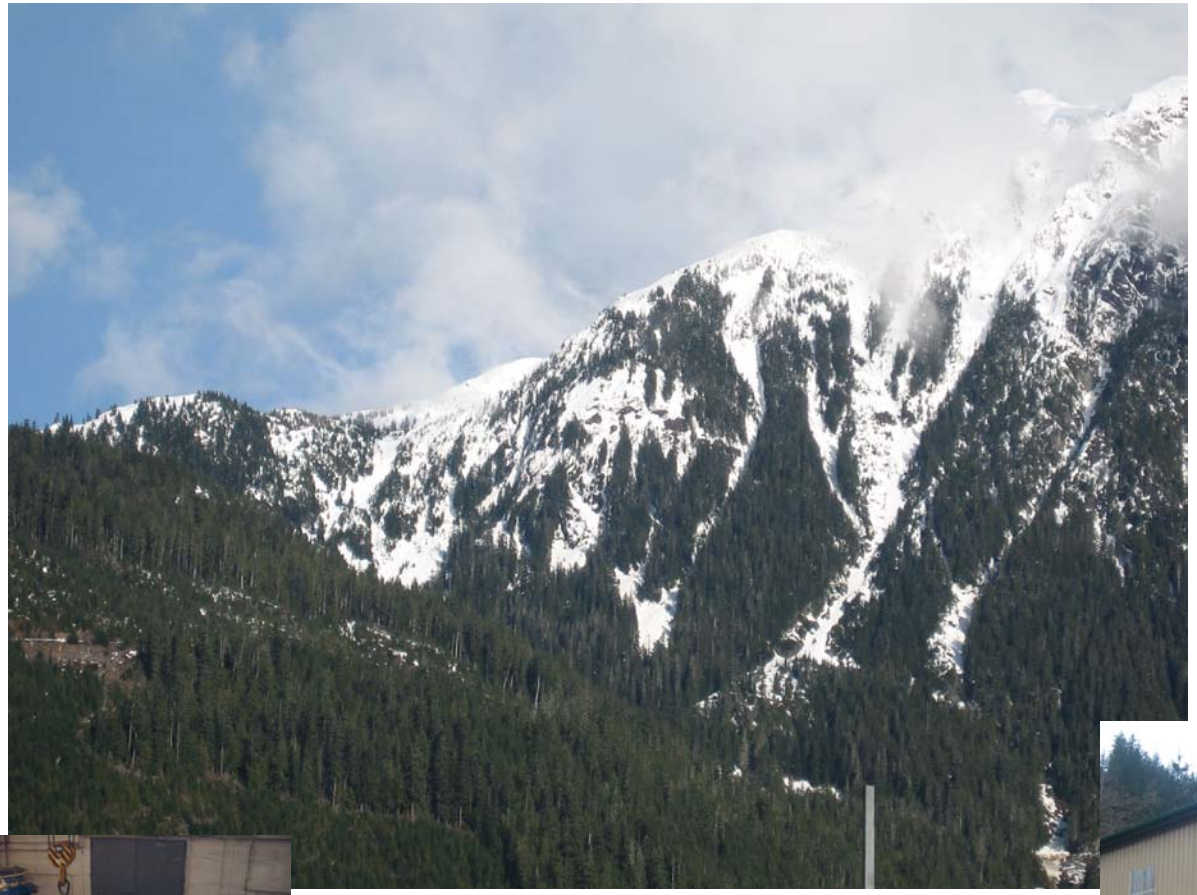
Pelton Turbine Runner

Pelton Turbine – First Assembly / Testing



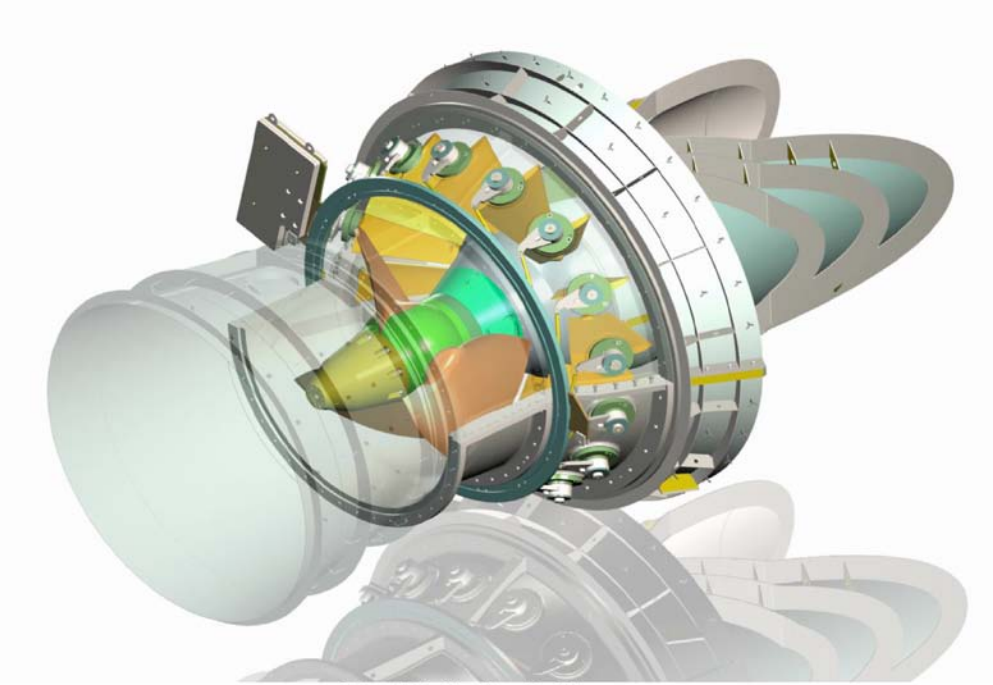
Powerhouse of 13 MW Yeghesis Site, Armenia

Upper Clowhom, 11.3 MW British Columbia



Kaplan Turbines

The Kaplan turbine was invented in the Czech Republic in 1912 by Viktor Kaplan. Over the past 100 years the design has improved significantly and a number of Kaplan turbine variations have evolved. Kaplan turbines include the S, Bulb, Pit and Z with both vertical and horizontal configurations.



Mavel PIT Kaplan Turbine

Kaplan Turbine Runner

Kaplan Turbines Fully Assembled

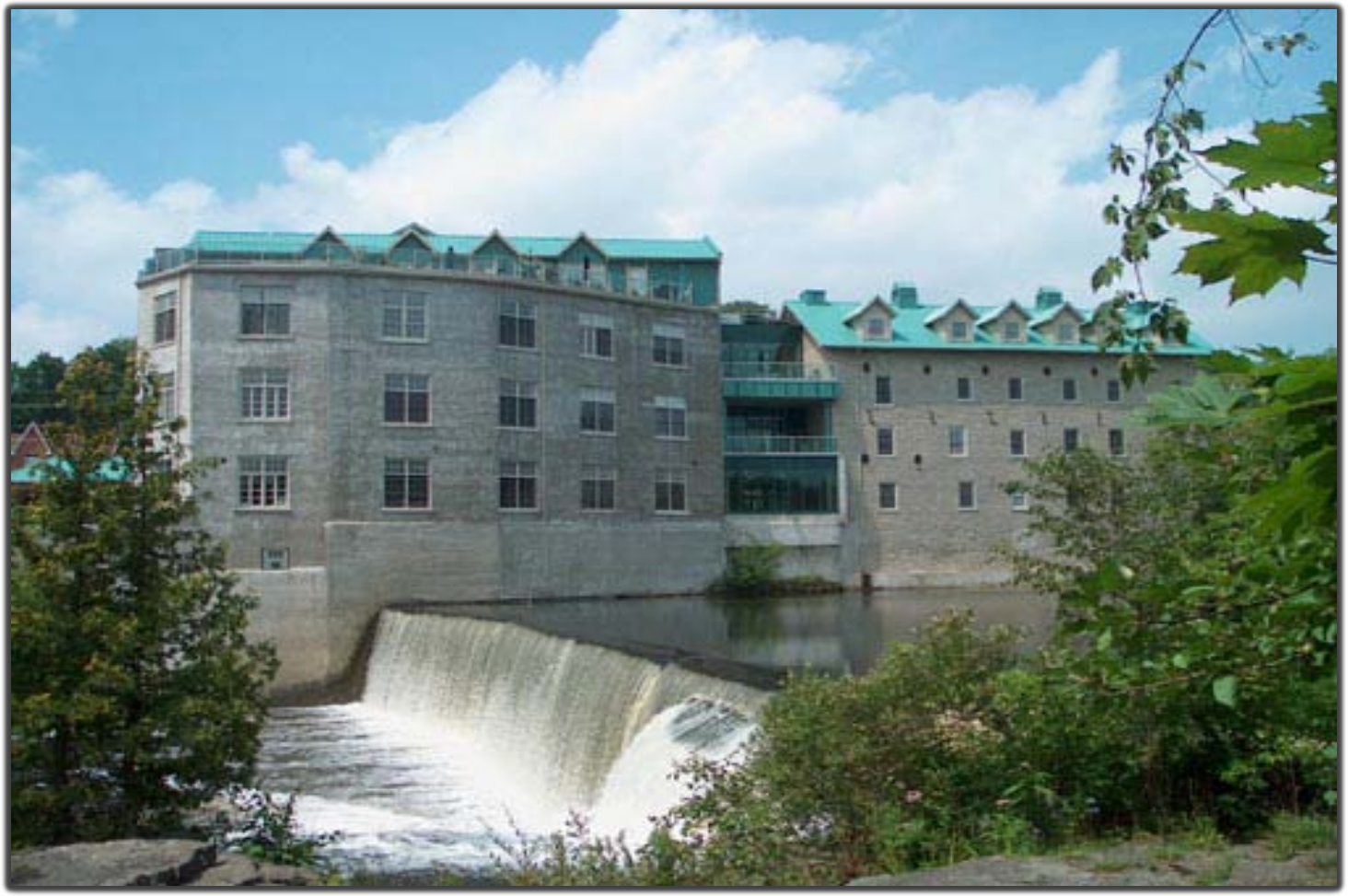
Kaplan Turbine in Powerhouse

Completed Kaplan Hydro Plants

Grodno HPP, 18 MW, Belarus

Lovocise Plant, 4 PIT Turbines, CZ

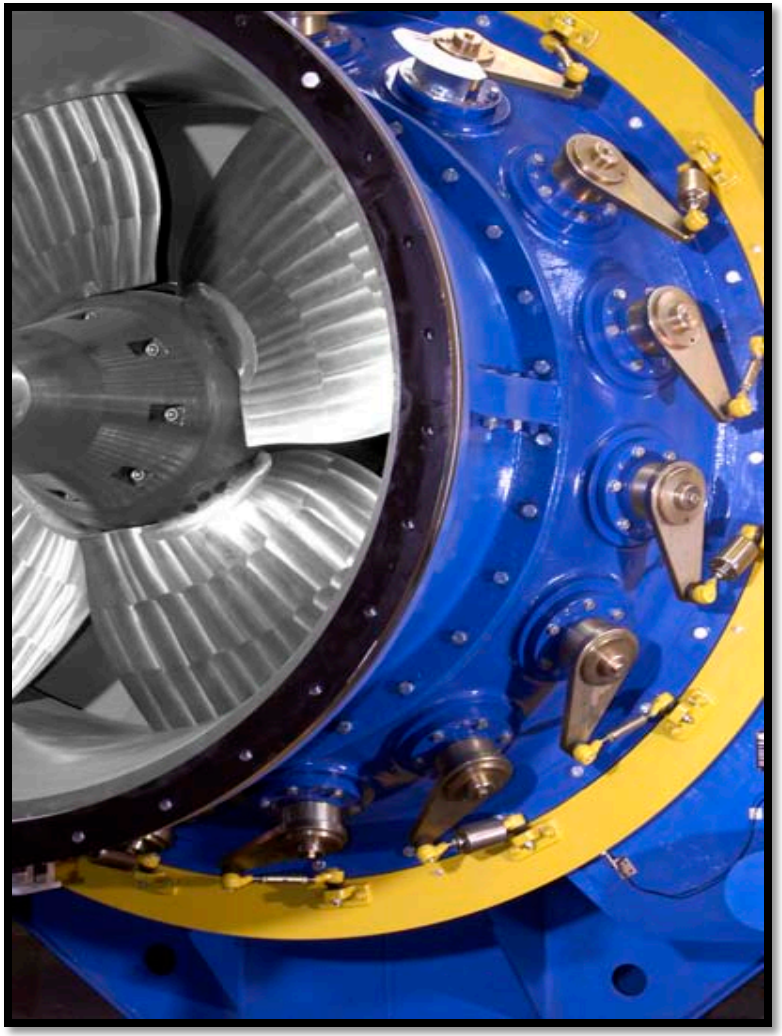
Fergus Mills HPP, Canada



One Kaplan Turbine

Production of a Double Regulated Kaplan

Customized Design



Water Handling Equipment

Penstock/Intake => Regulation =>Turbine => Draft Tube

Components

What it Takes

Example: 3 Meter Diameter Pit Kaplan

Engineering – Production – Installation

Delivery Time Signature to Power:_____ Months

Steel/Metal: _____ Tons

Pieces: _____

Average Man Days: _____

What it Takes

Example: 3 Meter Diameter Pit Kaplan

Engineering – Production – Installation

Delivery Time Signature to Power: 12 to 24 Months

Steel/Metal:	112	Tons
Pieces/Parts:	3,810	Pieces
Average Man Days:	2000 to 3000	

casting, cutting, bending, grinding, milling, welding, balancing, painting, hand polishing, etc

Other Components and Technology

Other Components

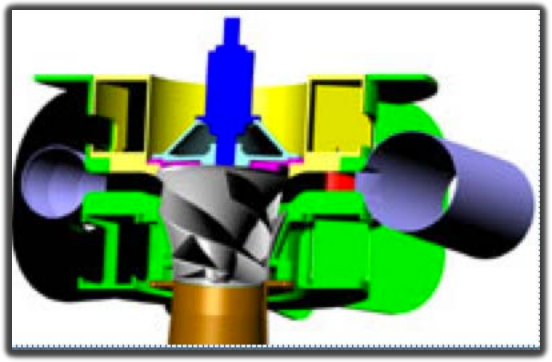
Control and Electrical Systems

Generator

Gearboxes

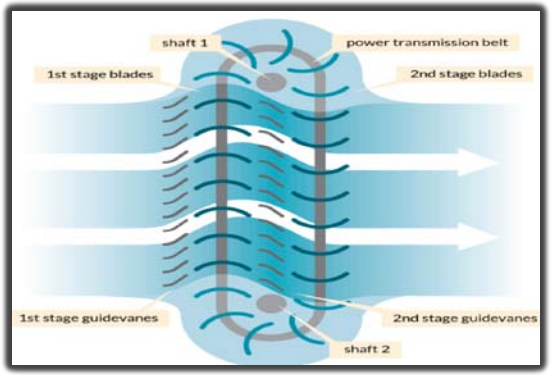
Non-Conventional Turbines (1 of 2)

Alden Laboratories
- Fish Friendly Turbine



Hydro Green Energy
- Modular Low Head Installation

Natel Energy
- Hydro Motor



Non-Conventional Turbines (2 of 2)

Western Renewable Energy (UK)
- Archimedes Screw Turbine

Mavel Micro Siphon Turbine
- Modular Low Head Installation

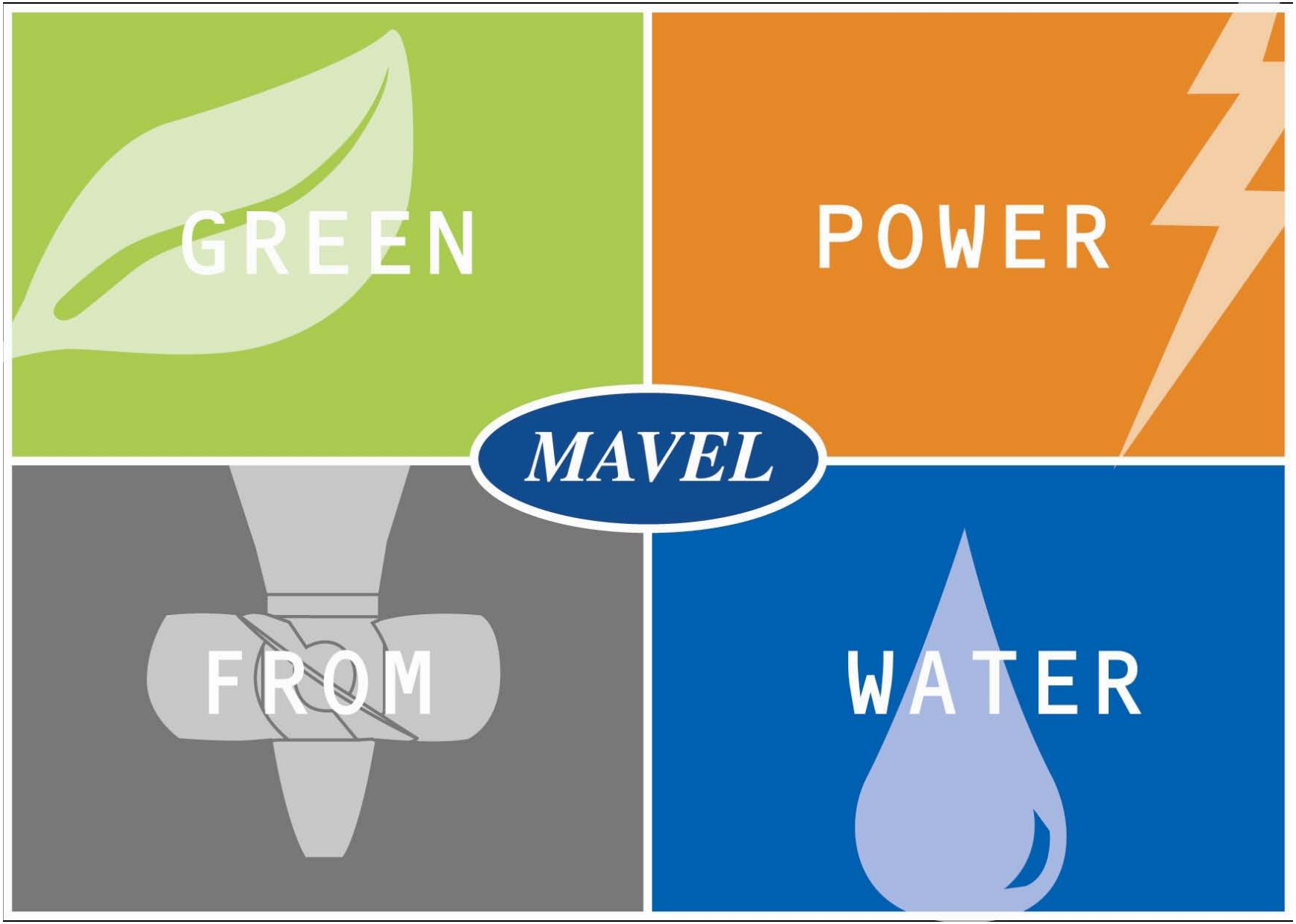
Bad News, Good News

Bad News for Mavel – Turbine Supplier

Customer Base:	Global
Type:	Diverse: IPP, Utility, Government, Private Investor, Development Company, Mom & Pop, etc.
Local Mandates:	Technical, legal, regulatory
Typical Contract Scope:	Water-to-Wire
Project Type (Custom vs. Standard):	100% Custom
Manufacturing Runs:	One to Six / Job Shop
Product Life:	50 to 100 years
Equipment Life:	50 to 100 years
Service Contract:	One in 300
Added Service Revenue:	1% to 2% of Revenue

Good News For Customers/Financing Entities

Equipment Suppliers:	Most have 100+ Years Experience
Equipment Life:	50 to 100 years
Equipment Reliability:	Proven / Predictable
Typical Equipment Contract:	Full Scope with Turbine Supplier
Operating Costs:	Minimal
Revenue Predictability:	Strong
New Capital Investment:	Minimal / Predictable


GREEN
POWER
MAVEL
FROM
WATER