

Hydroturbines

Its all downhill from here...

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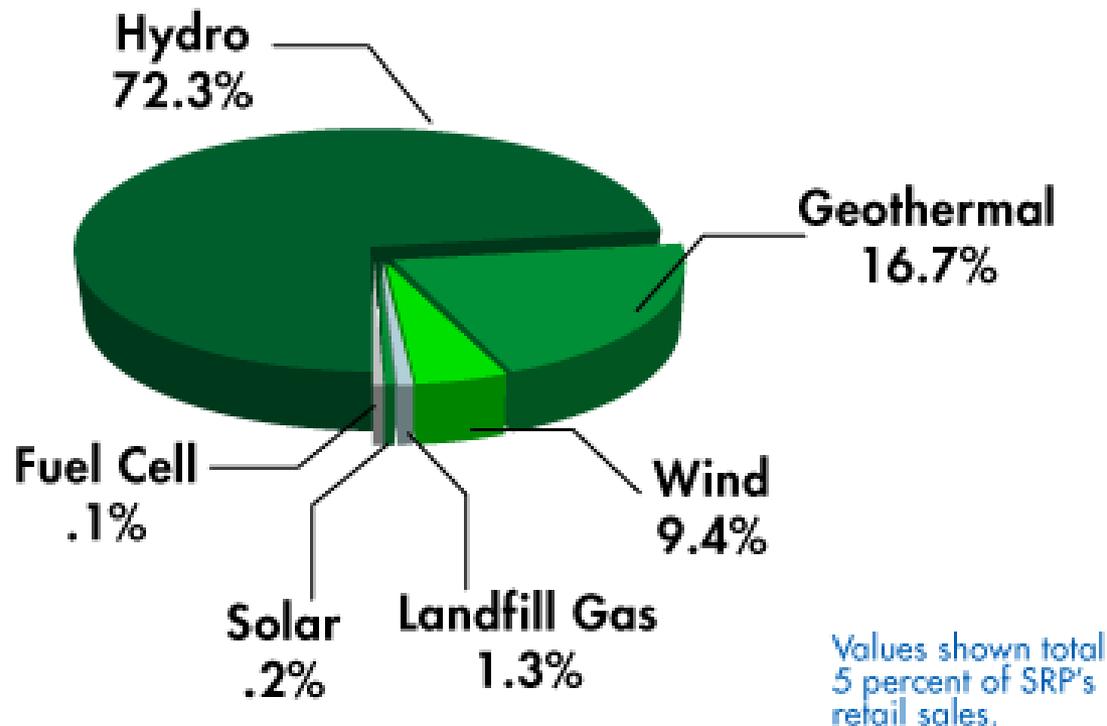
Historical use of water as energy



- 31 BC to 14 AD Water wheels used in Roman engineering (vertical)
- 31 AD Ancient China used water wheels (horizontal)
- 1500s Water wheels used for mining
- 1909 USBR built its first hydroelectric plant to help build Roosevelt Dam
- 1920 only 2% of energy was used to make electricity
- 1937 formation of SRP Agricultural Improvement & Power District

SRP Hydro Generation

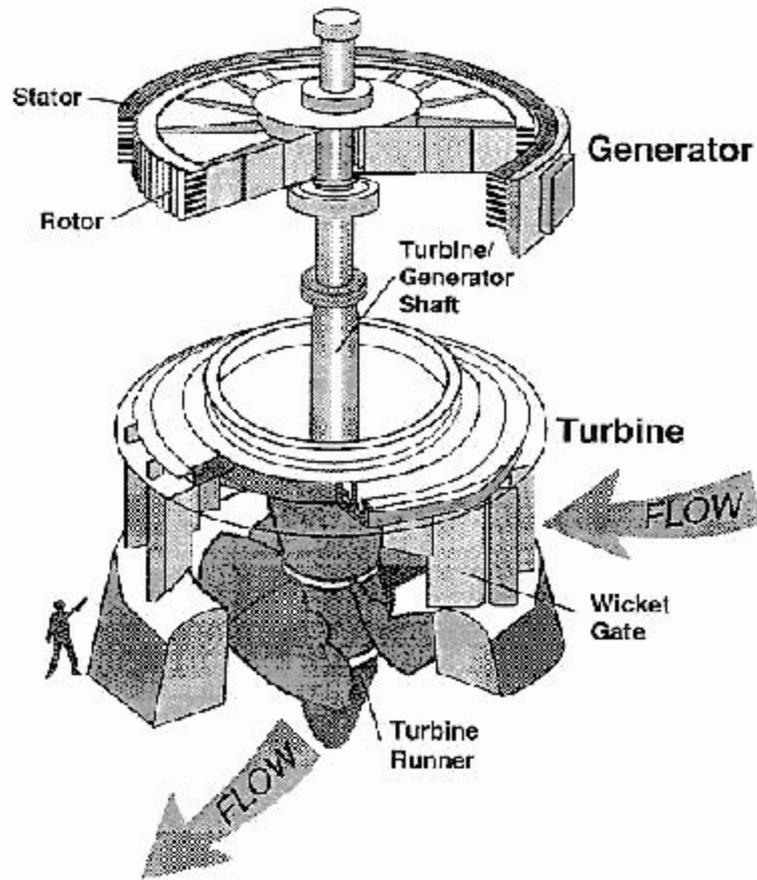
Renewable energy during fiscal year 2007



Watts in a name?

A new frontier for old technology

- Water wheel usually used for mechanical work
- Hydropower
- Hydrogeneration
- Hydroturbine
- Microturbine
- Hydroelectric Power



Courtesy of Doug Filer,
Army Corp of Engineers

Open channel vs closed pipe Vertical

- Elevation change (available head)
- Volume
- Velocity
- Load on generator



Elevation change or feet of Head

- 510' Head Glen Canyon Dam (Lake Powell)
27,000,000 AF
- 249' Head Theodore Roosevelt Dam
2,910,200 AF
- 72' Head Parker Dam (Lake Havasu)
648,000 AK
- 29' Head/1400 kw South Canal (SRP Canal)
- 14' Head/ 750 kw Arizona Falls (SRP Canal)
- **Note: Some offshore installations work off tide water**

SRP Arizona Falls



- 14 ft elevation change/16" pipe
- 750 kilowatts
- 150 homes powered

City of Phoenix Water System

- Service area varies 940' to 2020'
- Pressure Zones generally 100' elevation intervals
- Water mains 2" to 108"
- Storage tanks and reservoirs provide 2' to 43' of operating head

COP Hydro-generation Studies

- 1987 Energy audit at four WT plants and considered hydro-generation on gravity mains
- 1991 In-line Hydro-generation Feasibility Study multiple pressure zones at 24 St WTP
- 2003 COP participated with SRP to re-construct Arizona Falls
- 2004 Hydro-generation potential for a new PRV station and a modified PRV at 24 St. WTP
- 2009 Lake Pleasant WTP Optimization- Investigate power production potential at PRV sites on the 54" transmission main

Use of Energy Dissipaters

- Pressure Reducing Valves
- Pressure Regulating Valves
- Pressure Control Valves
- Hydro-pneumatic Tanks

Hydro Generation Potential

- Potential PRV sites near I-17
 1. 5ED-R1 (54" main) and 100' head
 2. 4A-R (54" main) and 100' head
 3. 3D-R11 (20" main) and 100' head
- \approx 30 MGD (20,000 gpm) at each site
- 335 KW produced at each site



LPWTP Intake

W State Route 74

6B-B2

W Carefree Hwy

Black Canyon Fwy

5ED-R1

26701 N 19th Dr, Phoenix, AZ 85085

4A-R2

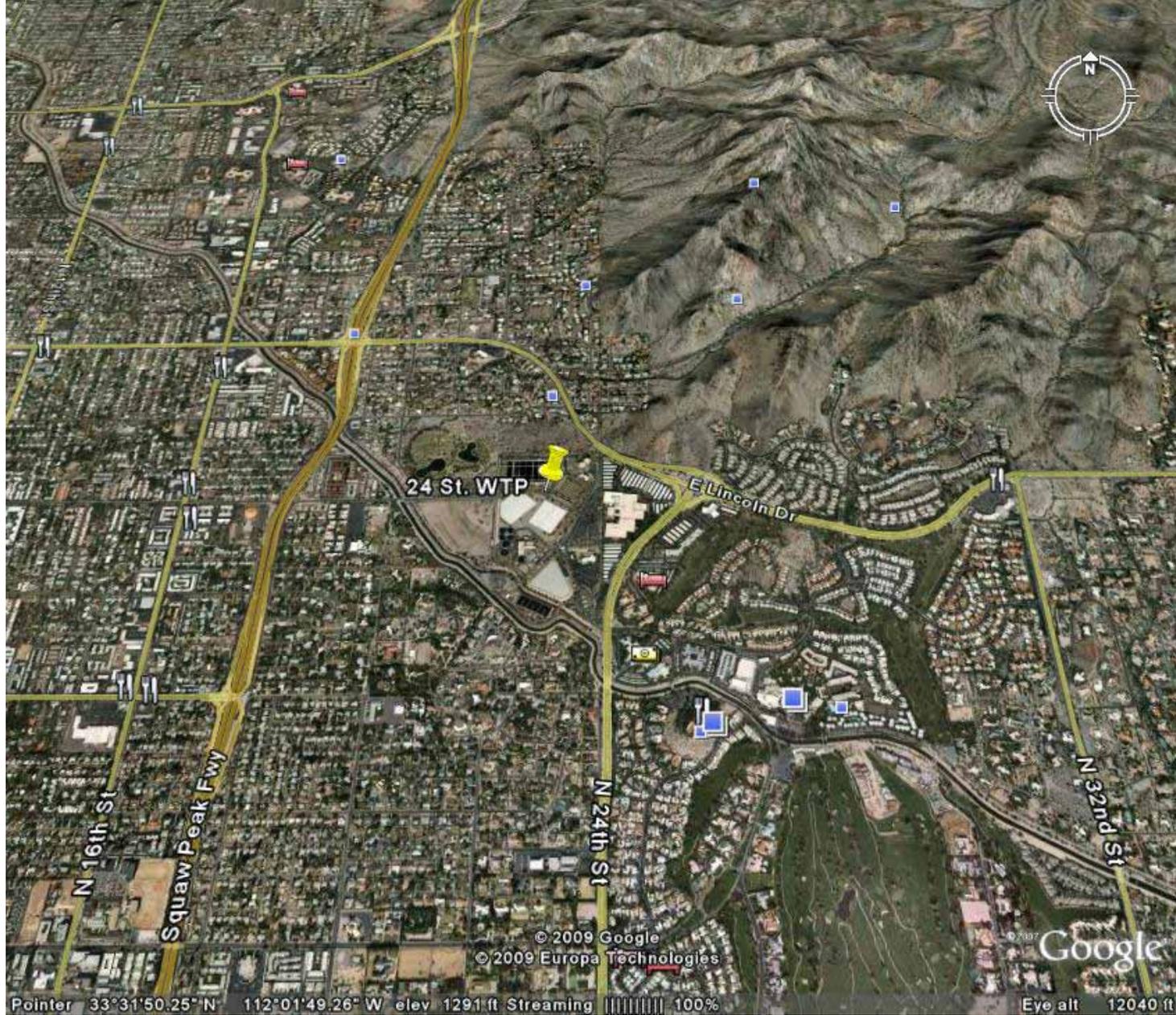
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Google

Pointer 33°47'05.62" N 112°09'29.63" W elev 1615 ft Streaming ||||| 100%

Eye alt 14.67 mi



Potential site near 24 St WTP

Pros for the sites

- Continuous operation at I-17 (possible at 24ST WTP)
- Consistent flow and head
- High head/ high flow
- Proximity to power utility connection to grid
- Green energy incentives
- Payback for installation
- Generate revenue
- PRV manufactures (Cla-val) options

CONS

- Hydroturbines are not traditionally used in water distribution systems
- All parts and lubricants that contact potable water are required to meet NSF 60/61 standard
- A special permit is required to generate electricity and send it to the grid
- Most installations will involve third party agreements to maintain equipment and negotiate send to grid
- No available facilities and infrastructure

Revenue Potential

- I-17 PRVs
 - 54" main, 100' head, 340 to 420 kW potential
- 24 St WTP
 - 48" main, four pressure zones with 108' to 371' head
 - 400 to 1,000 kW power generation potential
- Sellback rate \$.05 to \$.095 per kWh
- Payback in 8 to 16 years

Considerations

- The most important variables that will determine the type of turbine and generator are:
 1. Head height
 2. Pipe diameter
 3. Flow rate
 4. Velocity

- Las Vegas Valley Water Authority
 - 48" with 930 kW power generation
 - 42" with 671 kW power generation
 - 36" with 522 kW power generation
- Greensboro, NC
 - 87' head, 10 MGD, 81% efficiency, 87 kW
- San Diego