Biomass

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Sources of Biomass

- Wood
- Energy crops
- Organic wastes

Wood Pellet Boilers

- Domestic CH boilers usually pellet
- High efficiency, high convenience, fully automated systems
- Need **dry storage** facility (pellets disintegrate when wet): approx $6m^3$ for 3 tonnes
- Option for auto-feed direct from storage via **auger** or manually fed internal hopper
- If auto-feed, boiler must be adjacent to storage
- Larger houses may be suitable for a chip or log system

10 kW central heating boiler

3 tonne storage silo

Biomass Renewable sources and technologies

- Biomass
  - Short rotation coppice
  - Tradable fuels
    - Wood pellets
    - Wood chip

Biomass practicality matrix					
Resource	Sector				
	Domestic	Public	Commercial	Industrial	Agricultural
Wood Pellets	*				
Wood Chip		*	*	*	*
SRC wood chip[21] (2012)		*	*	*	*

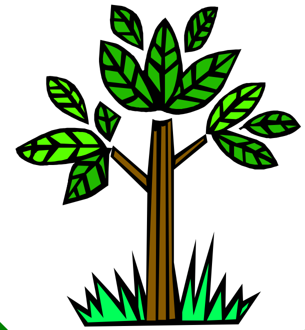
Biomass sources and technologies

- Good growing conditions in AZ
- World’s fourth largest producer of cotton
- Arable land covers 18,000km2
- Permanent crops – 2,200km2
- Permanent meadows – 26,900km2
- Forest area – 9,360km2
- Over 7 million cattle; over 6 million poultry

Wood

- Harvest wood from woodlands and forestry
- Recover forestry and saw-mill wastes
- Recover arboricultural trimmings
- Wood pellets
  - Small-scale installations in domestic sector
- Wood chip
  - Larger scale installations across non-domestic sectors

Wood



•Chips

•Lower fuel cost

•Higher capital cost

•Bulky material

•Non-domestic

•30kW and above

•Boilers and large CHP

•Pellets

•Higher fuel cost

•Lower capital cost

•Clean, easy to handle

•Domestic and non domestic

•Range of appliances

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Chips

Pellets

Biomass – constraints, economics, actions

- Practical potential limited by resource constraint
- Practical actions
  - Stimulate fuel supply chain
  - Encourage procurement of biomass installations in public sector to provide early market
- Economic potential
  - Payback periods less than 6 yrs for pellet, chip and other applications off-gas across sectors without support and when capex offset against cost of replacing like for like.
- Economic actions
  - Main economic barrier is initial capital outlay

Waste

- Wastes – total high estimated practical potential
  - Landfill gas
  - Municipal and commercial waste – Energy from Waste plant
  - Sewage treatment
  - Industrial waste
- Electrical power generation gives greater economic benefit from both landfill gas and energy from waste schemes
- Combined Heat and Power (CHP) over 80% efficient
- Heat/CHP potential from sewage treatment biogas. Heat and electricity potential from recycled timber but level of contamination (paint, lacquers, glue, nails etc) is an issue

Waste

- Driven by needs and costs to deal with waste
  - Avoids landfill
  - Technologies include incineration, gasification, anaerobic digestion and pyrolysis
- Cost of emissions abatement
  - Large scale can release emissions of NOx and other pollutants, like any conventional power plant
  - Electricity generation only or CHP if close to heat demand improves cost effectiveness

Waste Sources

- Landfill gas
  - Mostly electricity generation only
- Energy from Waste plant
  - Potential heat output with CHP
- Sewage sludge
  - Straight incineration or conversion to a biogas by anaerobic digestion prior to combustion in CHP
- Recycled timber
  - Wood chip co-firing in power stations

Agricultural wastes

- Cattle slurry
  - Anaerobic Digesters on agricultural sites or at local dairies
- Poultry litter
  - Use on agricultural sites
  - Co-fire with wood in industrial or district heating plant

Agricultural Wastes

- Slurries may not be economic unless locally used
  - Aspect of cost relates to transport/delivery costs. Where this is not required e.g. where resource used on or near site then resource may be economically viable.

- Poultry litter is viable. It can be incinerated along with wood wastes

Opportunities for biomass in Azerbaijan – issues for investigation

- Investigation of land use for energy crops
- Investigation of waste management strategies
- Investigate and assess specific industrial applications for biomass heat and electricity
- Identify agricultural Anaerobic Digestion sites giving the best economic case
- Investigate usefulness of available tools for spatial or geographic targeting of biomass developments and support

Anaerobic digestion plants

- Lubeck, Germany
- Used for municipal waste treatment

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AD

- Neumunster Farm-Scale AD plant, Germany
- Digests silage and slurry

Biogas from Anaerobic Digestion

- A mixture of mostly methane and CO2
- Can be used to generate heat and electricity onsite in a CHP engine
- Can be filtered and methane concentration increased
  - Allows injection into the natural gas grid
  - Reduces demand for natural gas which can be exported for revenue
- Can be used for transport
  - Reduces demand for oil

Gasification and Pyrolysis

- Gasification and Pyrolysis convert organic wastes into a synthetic gas (syngas) for combustion
- Gussing gasification plant, Austria

Summary of Biomass

- Variety of resources available used for heat or electricity or both
- Type of generation is linked to resource availability
- Biomass and Biogas can be used to provide a baseload electricity generation
- Requirement for study into resource availability in Azerbaijan
  - Types of resources
  - Quantities of resources
  - Suitable conversion technologies – combustion, anaerobic digestion, gasification and pyrolysis
  - Levels of generation possible
  - Location of plants
  - Potential for job creation in developing biomass supply chains

Hydroelectric Power

History of Hydro Energy

- Concept dates back 2000 years in form of waterwheels – mechanical energy
- In 1086AD the Domesday Book recorded 5,624 water driven mills in England
- First used to produce electricity in 1882, Fox River, Wisconsin
- Hydro electricity was initially more reliable and efficient than fossil fuel plants
- Increase in demand made coal & oil generators more popular

Hydro Electricity

- Contributes 60% of electricity in Canada
- Contributes 15% of electricity worldwide
- Norway, with its reserves of oil and gas, obtains 98% of its electricity from hydro
- Small Hydro is considered less than 10MW in Europe

Hydro in NI

- Provided first electricity supply in NI
- Col William Traill, Portrush to Bushmills electric tram 1883 – 1949 (66yrs)
- Roe Valley Country Park, Limavady
- Operational between 1896 – 1963 (67yrs)
- First electricity outside of Belfast

Courtesy of BBC Northern Ireland

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More About Hydro

- Absence of high mountains = run of river schemes
- Recent emphasis on renewables has seen rejuvenation in established millraces
- Range in size from few kilowatts to several megawatts
- Small-scale hydro is a renewable energy technology
  - No large environmental impact from damming rivers
  - More environmentally friendly
  - Typically described as below 10MW (EU classification)

Sion Mills, intake to Herdman's Mill hydro scheme on Mourne River

750kW hydro scheme

Courtesy of Herdman Mills, set of three large turbines

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What Does a Modern Hydro Turbine Look Like?

Francis Turbine

Example of a Large Turbine for a Turkish installation, 120MW

Note: Scale

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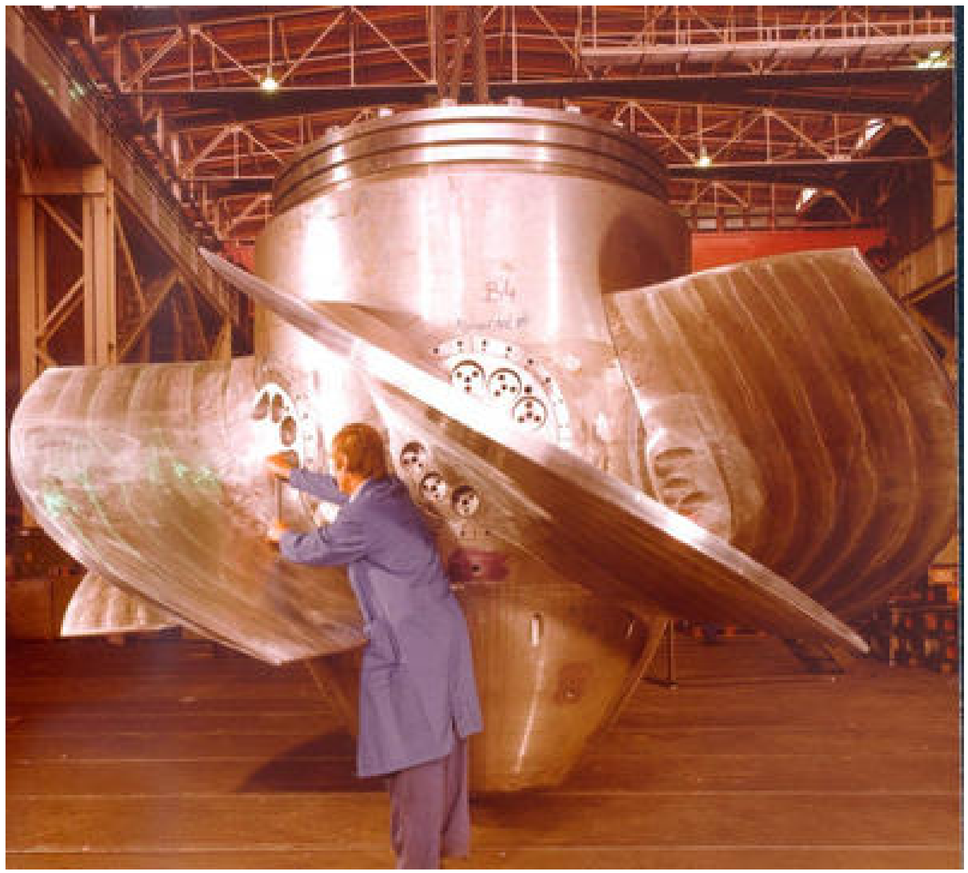
Courtesy of VA Tech website

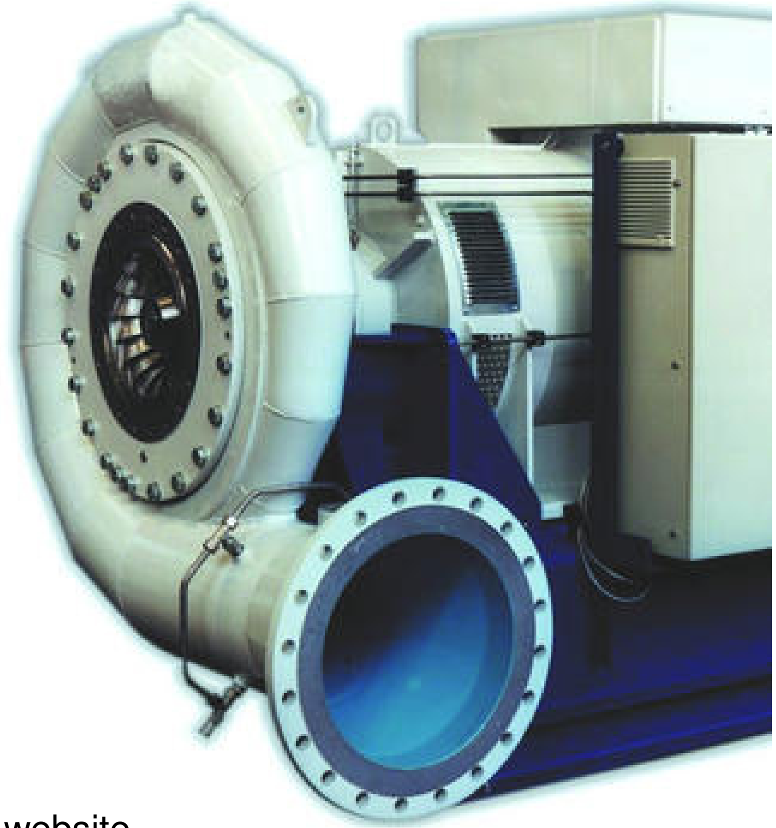
Kaplan (propellor) turbine

Example of a Large Turbine for a Sudanese installation



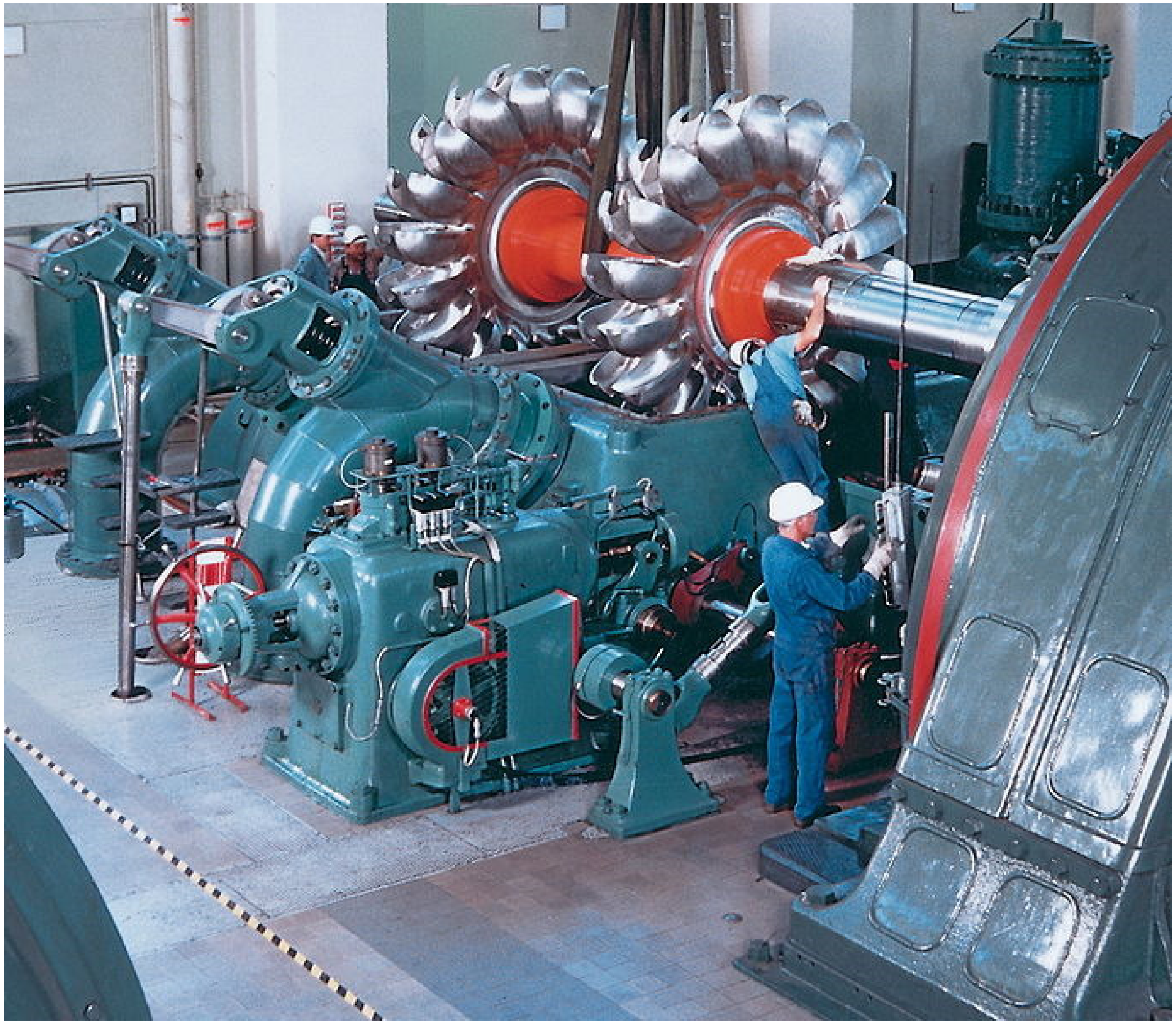
Courtesy of VA Tech website

Smaller Scale 410KW Turbine System



Courtesy of VA Tech website

Pelton Wheel



Output power from hydro schemes

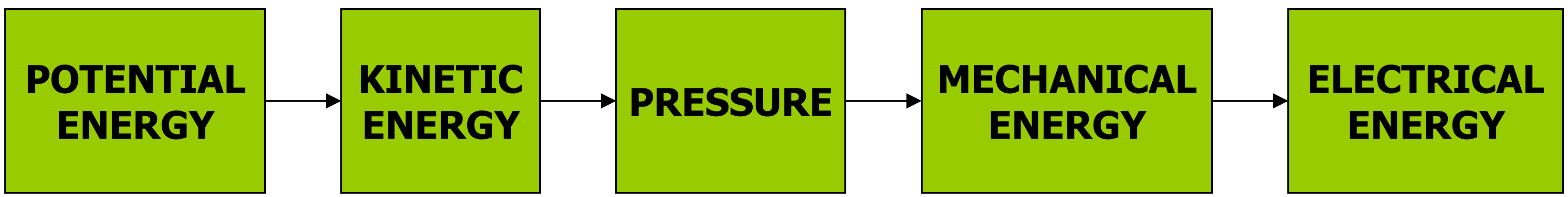
- Dependent on:
  - available flow of water (Q) in m3/s
  - Head – the height through which the water falls (H) in m
- Expressed as:
  - $P = \rho \, g \, H \, Q \, \eta$
  - Where P = rated output (kW)
  - ρ = water density (kg/m3)
  - g = acceleration due to gravity (m/s2)
  - H = head (m)
  - Q = flow (m3/s)
  - η = turbine efficiency
- A site with a high head and low flow can give the same power output as a site with a low head but high flow

Appropriate turbine designs for selected head heights and specific speeds

- Specific speed is used to determine turbine type
- It is related to rpm and head

Single jet Pelton	Multi jet Pelton / Turgo / Cross-flow	Francis	Kaplan / Propellor	Specific Speed	Application
				7	High head
				27	High head
				39	Med. Head
				60	Med. Head
				175	Med. Head
				300	Low Head
				900	Low Head

How Is it Renewable?

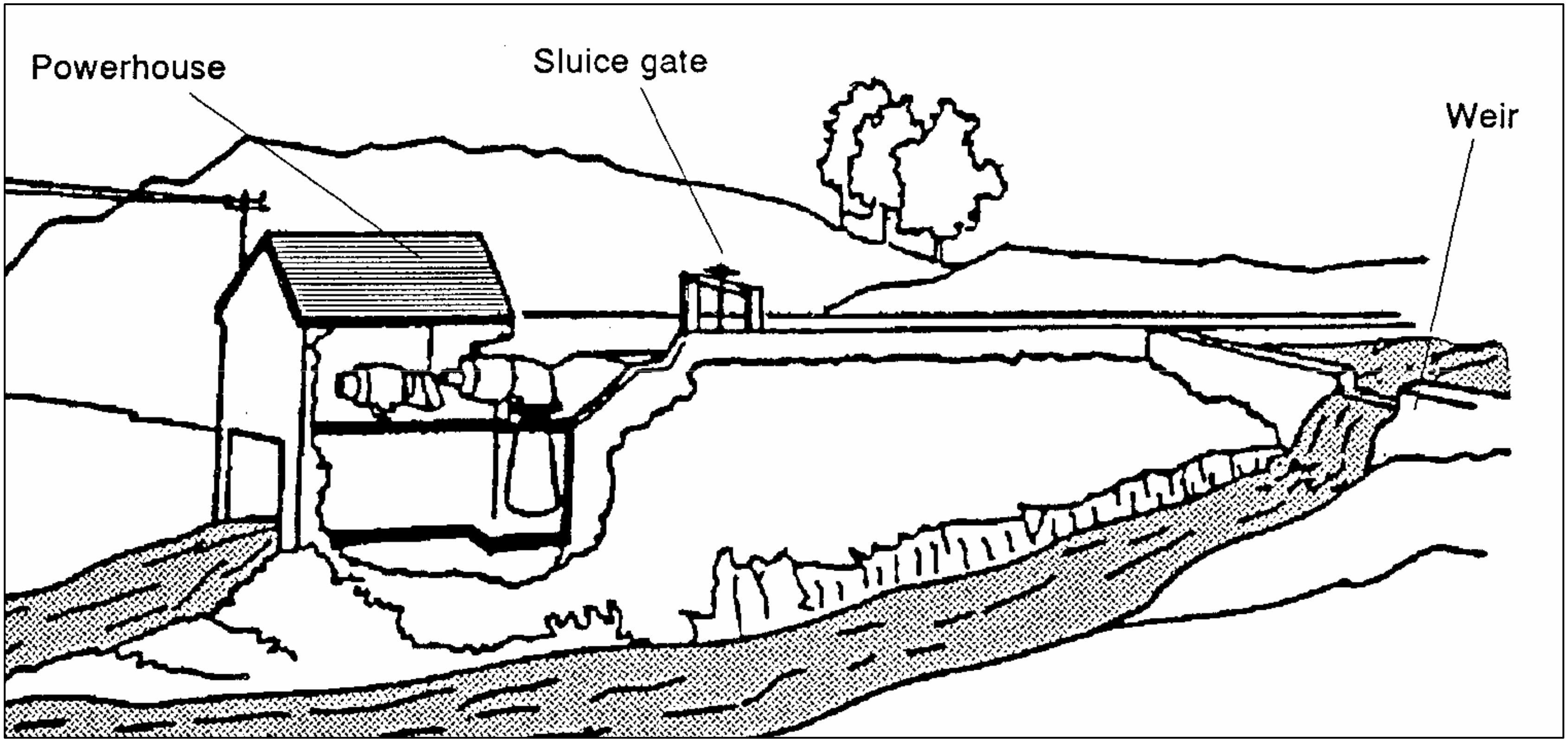


- Water is naturally replenished through hydrological cycle
- Small hydro schemes do not have significant environmental impacts

Typical Scheme Designs

Low Head Scheme Layout

Less than 5m



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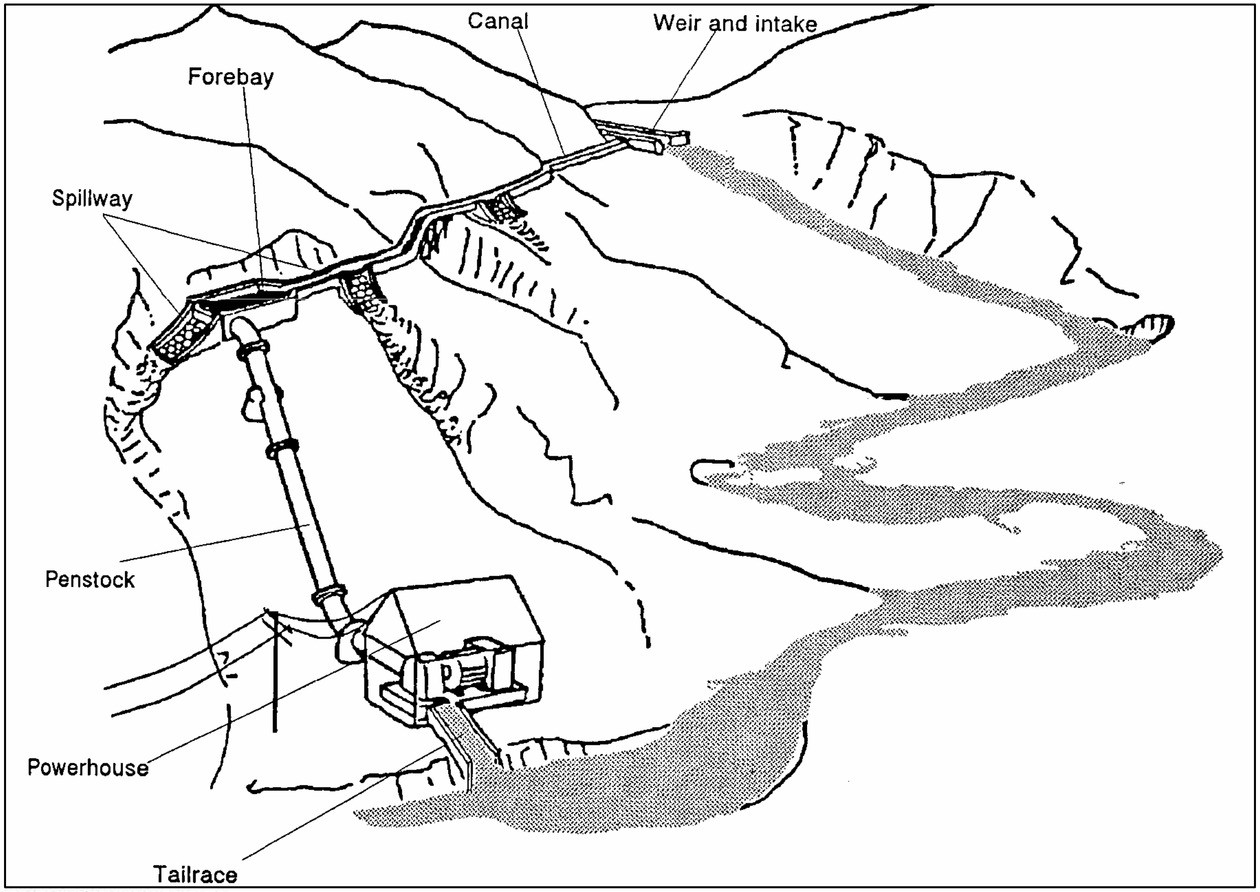
Medium Head Scheme Layout

More than 5m



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How Does the System Work?

Water Intake System

- Covers process of extracting water from normal river flow. Includes weir intake and screens

Delivery System

- Delivers water from intake to “power house” and back to the river

Power Generation System

- Turbine, drive mechanism or transmission and electricity generator – includes power house

Electricity Distribution System

- Distributing electricity from generator to grid or to point of use within stand alone system
- Includes control mechanisms necessary to managing loads and power quality and batteries where necessary

Advantages of Hydro Electricity

- Hydro stations require few staff
- Low maintenance
- Requires no fuel, just the hydro resource
- Cost of generation not subject to change
- Sustainable, turbines could last for over 100 years
- Non-polluting e.g. CO_2, SO_2, NOx – doesn't contribute to Global Warming or acid rain

Hydroelectricity in Azerbaijan

- About 10% of gross theoretical hydro power has been developed in Azerbaijan
- It is the largest modern form of renewable energy generation in Azerbaijan
- About 1000MW of hydro currently installed – includes large scale and small-scale plants
- Economics vary greatly from site to site, depending on construction work required
- Remote generation can support local electricity grids

Three gorges dam in China

- The worlds largest electricity generator of any kind – 22,500MW. Not small-scale!

Small-scale hydro Summary

- Applicable in Azerbaijan
- Expertise already exists
- Study of locations and technically achievable outputs is required
- Project ongoing funded by UNDP
  - Small hydro power plants in Azerbaijan could supply 5TWh – about 25% of electricity demand. This estimate needs to be refined to determine feasibility
- Development cost is very site specific
  - Depends on flow and head resource
  - Civil works required
  - Grid connection costs