Indonesia
Clean Energy Development Project (ICED)

Lessons Learned
Development, Construction and Operations
MHP in Indonesia

June 2014
Common Problems/Lessons Learned

Hydrology and Energy

Project Layout

Water Conveyance

Construction Problems

Contracting and Risk Allocation

Operations Experiences
Hydrology and Energy – PROBLEMS

Daily versus Monthly or Periodic Averages

Analysis too simple

Estimates of losses
  Grid stability?
  Water conveyance?

Efficiency Estimates
The Importance of Daily Flow Analysis

Willow Creek Hydrograph, November, 1960
Hydrology and Energy  SOLUTIONS

Use method for energy not dam construction or irrigation
Analysis too simple- Use details
   Need to test hydrology
   Run actual daily data with specific losses and efficiency
Estimates of losses
   Grid stability?
   Water conveyance?
Efficiency Estimates
Project Layout

Potential power abandoned due to layout of:
- Powerhouse
- Intake
- Flushing gates
- Desanders
- Velocity and Hydraulic Losses
- Head Pond Hydraulics
- Tailrace Construction
Project Layout – Powerhouse Elevation

PROBLEM – Design sacrifices head and energy

Most projects are Francis Turbines Applications

Frequently, an open powerhouse in a horizontal orientation is designed
   Well above tailwater
   Well above flood level
   Barrier is placed in tailrace to provide backwater pressure

More efficient layout is “Vertical Powerhouse”
   Equipment is placed in a pit, well below powerhouse openings
   River tailwater sets the back water level
   Gates used to isolate
Example of Vertical Orientation Powerhouse
Project Layout – PROBLEM  Intake Design
Project Layout - Problems with Intake

PROBLEM – DEBRIS PROBLEMS AND HEAD LOSS
Make entire river make a right turn
Enter Gates
Make another right turn
Adjacent to flushing- All debris pulled towards Power Intake
Project Layout – Proposed Intake Improvements

SOLUTIONS:
Open up intake to river with lower velocity
Keep intake above river bottom as possible
Keep higher than flushing gates
Use tainter gate for flushing
Avoid “bending flow as possible
Project Layout - Flushing Gates

PROBLEM – INADEQUATE FLUSHING AND DAMAGE

Standard is Leaf or Sluice gate
Usually too small and not strong
Gates Jam or get damaged
Debris is not passed
Project Layout - Flushing Gates

SOLUTIONS?
- Use tainter gate if possible
- Double gating for sluice or leaf gates
- Provide for stop logs
- Use multiple gates and large gates
Tainter Gate
Project Layout – Silt Chambers or Desanders

**PROBLEM** – High Cost – Questionable Value

Not all projects need them
They are expensive

Primary use – keep sand and abrasive material from the turbine

What is at risk? Runner and seal wear in the turbine
SOLUTIONS:
ASK - Do you need one at all?
  Is sand present?
  Will proposed structure remove it?
  Is it less expensive to have turbine spares?

Use the diversion pond as primary desander
Use a head pond as secondary desander
Layout: Flow Velocity and Losses

PROBLEMS:
Some velocities in canal and penstock are too high
Excessive losses – Unstable flow
Surge problems
Losses often not correctly calculated
Surge relief for penstocks inadequate
Layout: Flow Velocity and Losses

SOLUTIONS

Pay strict attention to designs
Double check hydraulic losses and surge
Canal Velocity should be 0.7 m/sec and no more than 1 m/sec
Double check any calculations for penstock surge
Check Turbine Manufacturer for pressure rises on trips
Project Layout – Head Pond Hydraulics

PROBLEMS:

Head ponds are not designed adequately:

- Inadequate submergence of penstock opening
- Hydraulically unfriendly

Result:

- Vortices
- “Starved” intakes

= LOST ENERGY
Project Layout – Head Pond Hydraulics

SOLUTIONS:

- Substantial submergence for penstock inlet
- Hydraulic transition at penstock intake
- Large head pond to still flow and maintain operations
- Have head pond reviewed by experienced hydraulic engineer
Project Layout – Tailrace Construction

PROBLEM:
- Like Powerhouse – Tailrace well above river level
- Barrier in tailrace to produce back pressure

Result – Lost potential energy from the site

SOLUTION:
- Tailrace should be set by river level with gates to shut off turbines for maintenance and repair.
WATER CONVEYANCE – Canals, Penstocks, Tunnels

PROBLEM: Significant construction cost over runs and other difficulty in constructing canals

• Excavation Materials unknown
• Massive cuts without sufficient spoil areas
• Unstable slopes
WATER CONVEYANCE – Canals, Penstocks, Tunnels

PROBLEM: Significant construction cost over runs and other difficulty in constructing canals

- Canal Design and Cost Estimates leave out:
  - Geotechnical Exploration
  - Slope Stability
  - Drainage crossing
  - Public safety
  - Foundation stabilization
  - Rock excavation
  - Structural lining
  - Proper Spoil
  - Room for Access Road
WATER CONVEYANCE – Canals, Penstocks, Tunnels

PROBLEM: Canal Dynamics make Complex Operations

- Flow changes cannot be made quickly
- Instrumentation is often missing
- Elevation changes in head pond/canal/intake only way to change flow
- Inefficient operations when not at full output
Project Elements – Diversion and Intake
WATER CONVEYANCE – Canals, Penstocks, Tunnels

SOLUTIONS:

- Buried Penstocks - reduce cut and slope problems
- Tunnels where feasible
- Combination of canal/Tunnel
- Use all costs in selecting conveyance design
- Consider operating efficiency
- Penstocks and tunnels can operate under pressure and simplify operations
WATER CONVEYANCE – Canals, Penstocks, Tunnels

ADVANTAGES OF PRESSURIZED SYSTEM

- Only handle/clean water once
- Eliminate head pond
- Simplify operations
- Quick response by system to river change
WATER CONVEYANCE – Canals, Penstocks, Tunnels

DISADVANTAGES OF PRESSURIZED SYSTEM

- Cost might be higher
- Surge relief still needed for Francis Turbines
- Underground works (tunnel) also have construction risk
Construction Issues

PROBLEM: Construction Contracts do not Allocate Risk

Contractors do not provide fixed cost contracts

• Project not well defined before “EPC”
• Owners do not provide detailed information to fix prices;
• Owners do not want to pay contractors risk premium;
• Cost expectations of projects are not realistic
Construction Issues

PROBLEM: Construction Contracts do not Allocate Risk

RESULT:
- Cost Over-Run
- Schedule delay
- Changes in middle of construction
- Disappointing Quality
- Little control by Owner over Contractor
Construction Issues

SOLUTIONS – Contracts that Allocate Risk

• Contractors are in the best position to manage it
• Sufficient information from the developer is necessary – more details than now provided
• Risk Premium included in pricing
• Negotiations for risk understanding and sharing
Construction Issues—Environmental Damage

PROBLEM: Poor Protection of Environment

RESULT:
- Poor practices result in landscape scars
- Accidents and landslides

SOLUTIONS
- Diligence on part of Owner’s team
- Contract for and enforce Environmental Protection
- Penalty Clauses
Construction Issues

SOLUTIONS:

• Better Project Preparation
• Analysis of Water Conveyance Options
• Discussion of Risk Allocation with Contractors
• Develop proper bid documents that allocate risks
• Negotiate Risk Sharing
• Keep Design Engineer involved
• Site Presence by Owner and Design Engineer
• Formal Quality Control Program
Allocating Risk in Civil Contracting

In order for an Owner to allocate risk to a Good Contractor:

- Define EPC clearly
- Provide a performance specification and definition
- Clarify project constraints
- Substantial topography, cleared areas and good geotechnical data.

EXACTLY WHAT ARE YOU BUYING?
EQUIPMENT CONTRACTING

PROBLEM: Poor E&M Equipment or Controls = Excessive Outage

- “Project can’t afford expensive equipment”
- “Instrumentation not necessary”
- Components and auxiliaries questionable quality
- High outage rates and marginal efficiencies are not economic
- Replacement of equipment prematurely is very expensive
EQUIPMENT CONTRACTING

SOLUTIONS:

• Develop relationships with better manufacturers
• Equipment quality not by country of origin but by manufacturer
• If there is any question, go see installation
• Provide clear specifications of what is needed including quality
• Ask for instrumentation to operate plant
• Know bill of materials before signing the contract
EQUIPMENT CONTRACTING

SOLUTIONS:

- Buy internationally available components
- Buy components by manufacturers with reputations
- Put instrumentation in the project
- Automate as possible – it is inexpensive
- Electronic components continue to get cheaper
OPERATIONS ISSUES

- Cooling water systems
- Poor equipment components
- Limited operation information
- Grid Connection and Quality
- High outage rates
- Spare Parts
Operations – Cooling Water System

PROBLEM: Cooling water system shuts down causing outage
• Usually once-through cooling water is designed
• Water is warm and has many micro organisms
• Filters clog regularly

SOLUTION:
Implement a recirculating system from the beginning
Operations: Poor equipment components

PROBLEM: Poor components cause shutdown, high maintenance, damage to other components, questionable efficiency

SOLUTIONS:
- Most post-commissioning problems are painful to solve
- Replace poor parts with higher quality
- Avoid these problems by paying for good value
Operations: Limited data for Operations

PROBLEM: Actually knowing site operation efficiency is impossible

SOLUTIONS:

• Level sensors at key components, diversion, desander, head pond
• Instrumentation for pressures and temperatures
• SCADA system
• Automation
Operations: Grid Connection Quality and Issues

PROBLEM: High transmission losses and outage rates
- Voltage and frequency changes
- Long 20 KV interconnection
- Generating unit cycling off and on

SOLUTIONS:
- Interconnection Guidelines
- Help PLN have a stable line
- Provide good controls for reaction of generator
Operations: Spare Parts

PROBLEM: Plant outage without proper spares

SOLUTIONS:

• Do risk analysis of components to consider what to buy
• Insist on internationally available components
• Replace spares as used
• Have suppliers on hand for emergency needs
SMALL HYDROPOWER SECTOR
FIVE UNIQUE OPPORTUNITIES IN INDONESIA

1. Huge resource of good sites
2. Power is needed and offsetting expensive power
3. Capital is available
4. Permitting reasonably easy
5. Getting a PPA is relatively simple
Successful Risk Management = Long Term Asset