



**Workshop on**  
**“Renovation, Modernization, Uprating & Life Extension**  
**of Hydro Power Plant - Diverse Issues & Handling Strategies”**  
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**Why and How: Renovation, Modernization and**  
**Uprating of Hydro Power Plants**

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## WHY – RENOVATION, MODERNISATION AND UPRATING

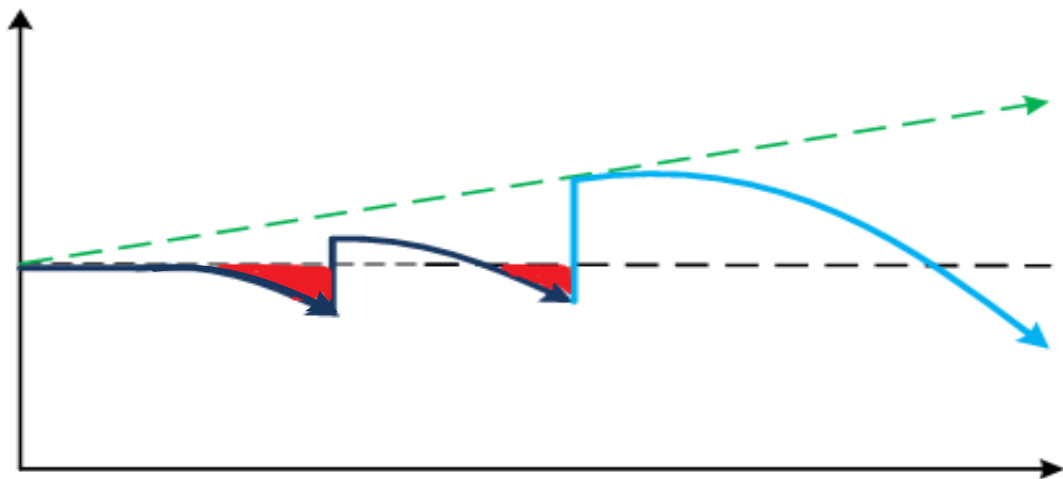
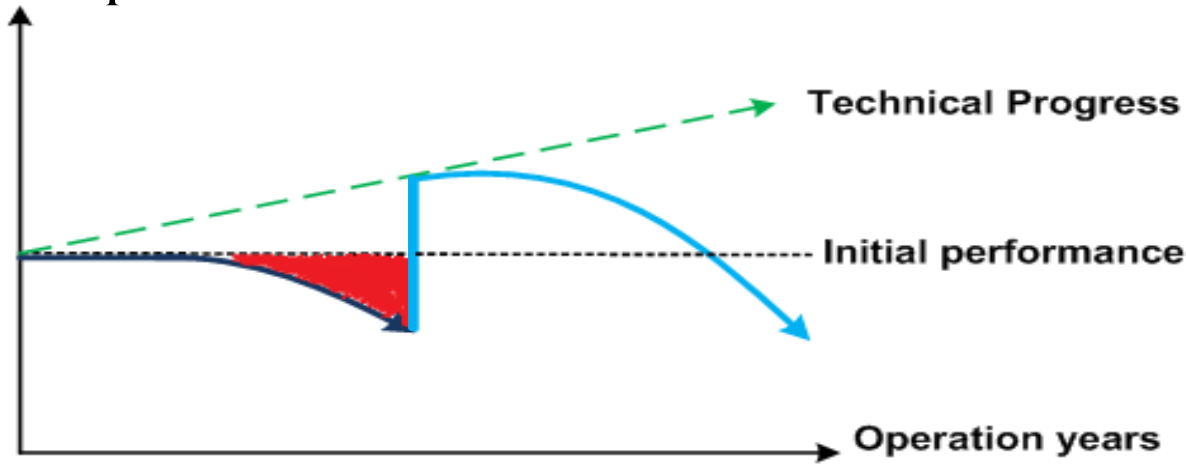
- Hydro-Electric Power Generation has many well recognised advantages.
- For overall economic interests, hydro generation is to be kept up by constant maintenance, renovation and modernisation of hydropower plants.
- Uprating to be attempted wherever possible.
- Hydropower policy 1998 and 2008 supports RMU of power plants.
- Power Finance Corporation Ltd. and Ministry of New and Renewable Energy support for RMU of plants.

- Normal life expectancy of a hydroelectric power plant is 30 to 35 years and conventionally renovation is planned thereafter.
- In a fast changing technological environment, however the plant can also become somewhat outdated in a period of about 15 years itself, after which it needs to be modernised to produce reliable and higher yields especially in present market dynamics.
- Most hydro plants use the most advanced and efficient technology economically available at the time they are built.
- Incorporate new technology into existing plants, for making them more efficient.

- For Himalayan and Sub-Himalayan range run of river projects having high silt cause erosion to the hydraulic structures and turbines and call for technological innovations and modernisation.
- Modernisation is a continuous process.
- Modern instruments for monitoring vibrations, silt in water etc. and silt resistive epoxy painting on turbine blades, static excitation, SCADA, electronic governors, high speed static relays for improving reliability as-well-as quality of generation.

# Why to Wait to Get Renovation for Upgrading Performance

- Higher efficiency, reliability and longevity using CFD design
- Advance manufacturing process, new materials
- Provide upgrade or renovate solutions with fast lead time implementation



# Performance not limited to turbine efficiency but may cover

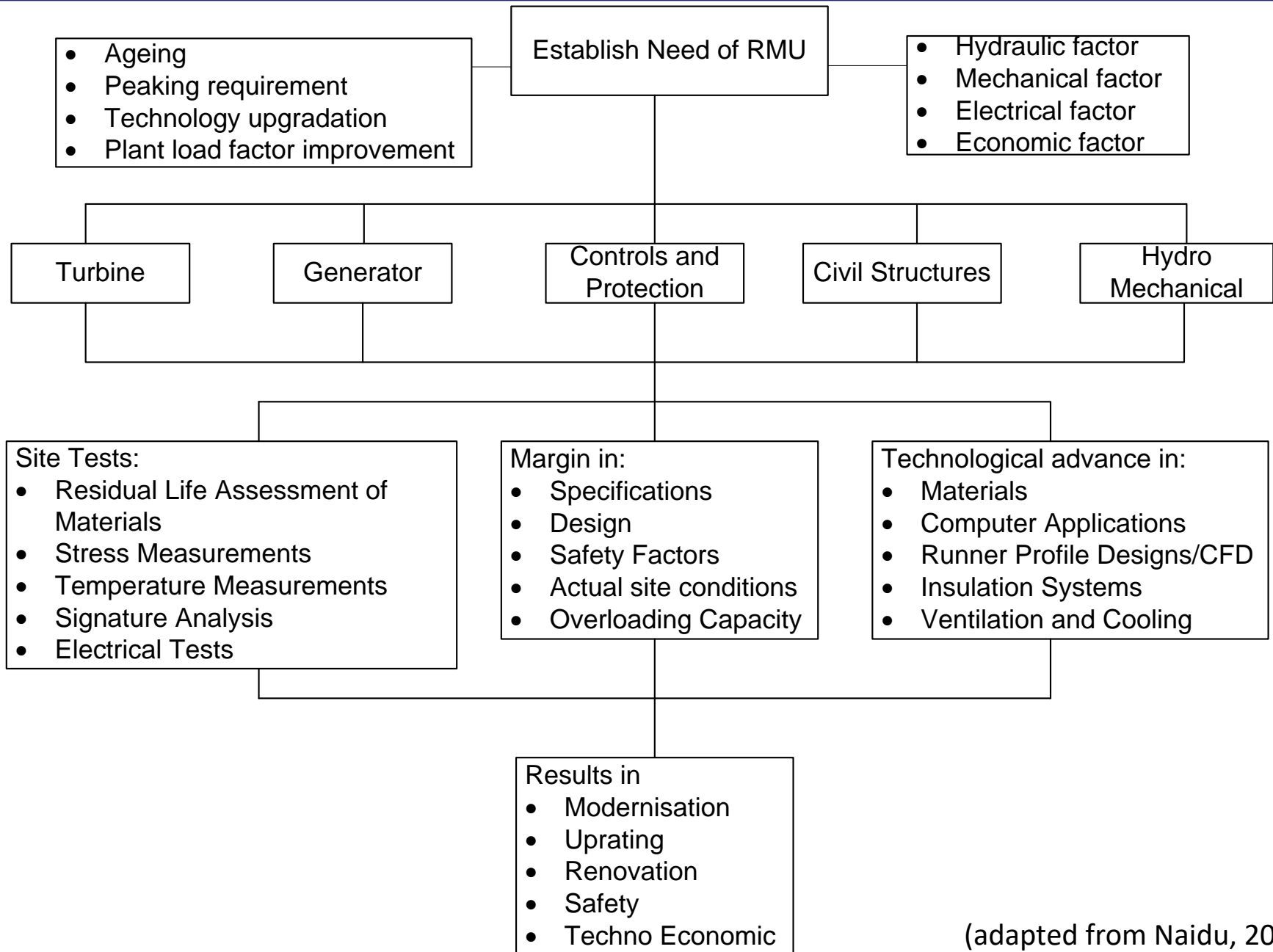
- Loss reduction for generator or for hydraulic passes
- Reliability
- Availability
- Operating performance : time response
- Low maintenance
- TCO reduction (total cost of ownership)
- CoE reduction (Cost of Electricity)
- Environmental aspects
- Health & Safety

# Performance may cover

## Added values

	<b>INCREASE PERFORMANCE</b> Efficiency, output	<b>REDUCE MAINTENANCE</b>	<b>LOWER ENVIRONMENTAL FOOTPRINT</b>
Composite Stay Vane Extensions	- Up to 2% hydraulic loss reduction		
Blades set for Kaplan	- Up to several % in efficiency		
Brushless Excitation		- Stator & rotor winding cleaning reduction - Consumables & spares cost reduction	- No more pollution with carbon dust
Generator Ventilation losses	- Up to 0,3% efficiency improvement		
Digital Governor	- Increased response time to the grid		
Hydrostatic water bearing in 2 bolted parts		- No spare oil to store - No oil monitoring	- No more pollution with oil
Biodegradable Oil			- Biodegradable - Low toxicity
Hydro-Optic™ Water treatment solution	- Better Cooling	- Increased intervals between cleaning cycles	- Chemical free

# HOW - RMU



(adapted from Naidu, 2004)



# Attention Required for All kind of Works

- Presently RMU proposals are electrical and mechanical works centric.
- Perhaps people preparing the proposals primarily are responsible for operation and maintenance the hydropower plant or related E&M people.
- The civil works and hydro mechanical works are often not considered or do not get adequate attention in RMU plans may be due to expected longer life of civil works.
- Erosion and damages on the civil works specially the diversion works, channels, tunnels, desilting tank, spilling works, penstock, valves, gates, trash racks also require a special attention for preparing the renovation of plant.

# Outputs from Renovation and Upgradations

- **Increasing Installed Capacity**

Can be increased by replacing or reshaping turbine runners and increasing the discharge, speed governors, shafts, bearings, distributors and draft tubes, runners

- **Improving performance of machines and water conveyance capacity**

Comprehensive and coordinated work can the performances of hydraulic machinery and conveyance systems be improved.

- **Improving Plant Availability**

- **Improving Energy Efficiency**

Regularly measuring efficiency, controlling wear in turbines, and improving the operating ratio between the angle of the guide vanes and the angle of the blades.

- **Refurbishing Penstock Linings**

Refurbishing the inner linings of penstocks will extend the life of penstock, CFD analysis of penstock for assessment problem location

- **Controlling wear in Turbines**

# Outputs from Renovation and Upgradations

- **Improving operating ratios**
- **Renovation in civil works for reducing the water loss and head losses**
  - Water conductor system may have water and head losses
  - Possibility of modifying the layout to reduce the overall water and head loss be studied with techno economic evaluation.
  - Afforestation, stabilization of hill slopes and soil conservation
- **Renovation on Hydro mechanical works**
  - Gates, hoisting arrangements and valves requires careful RLA studies
  - Automatic trash cleaning machine for reducing the high head losses and power losses even without waiting for a comprehensive RMU proposal of the plant.
- **Installation of online monitoring instruments**
  - Condition monitoring
  - Performance assessment
  - Condition assessment

# UPRATING

As per different studies reported in the literature

- plants commissioned before 1967 may be uprated up to 30%
- plants between 1967 – 1982 up to 15%.

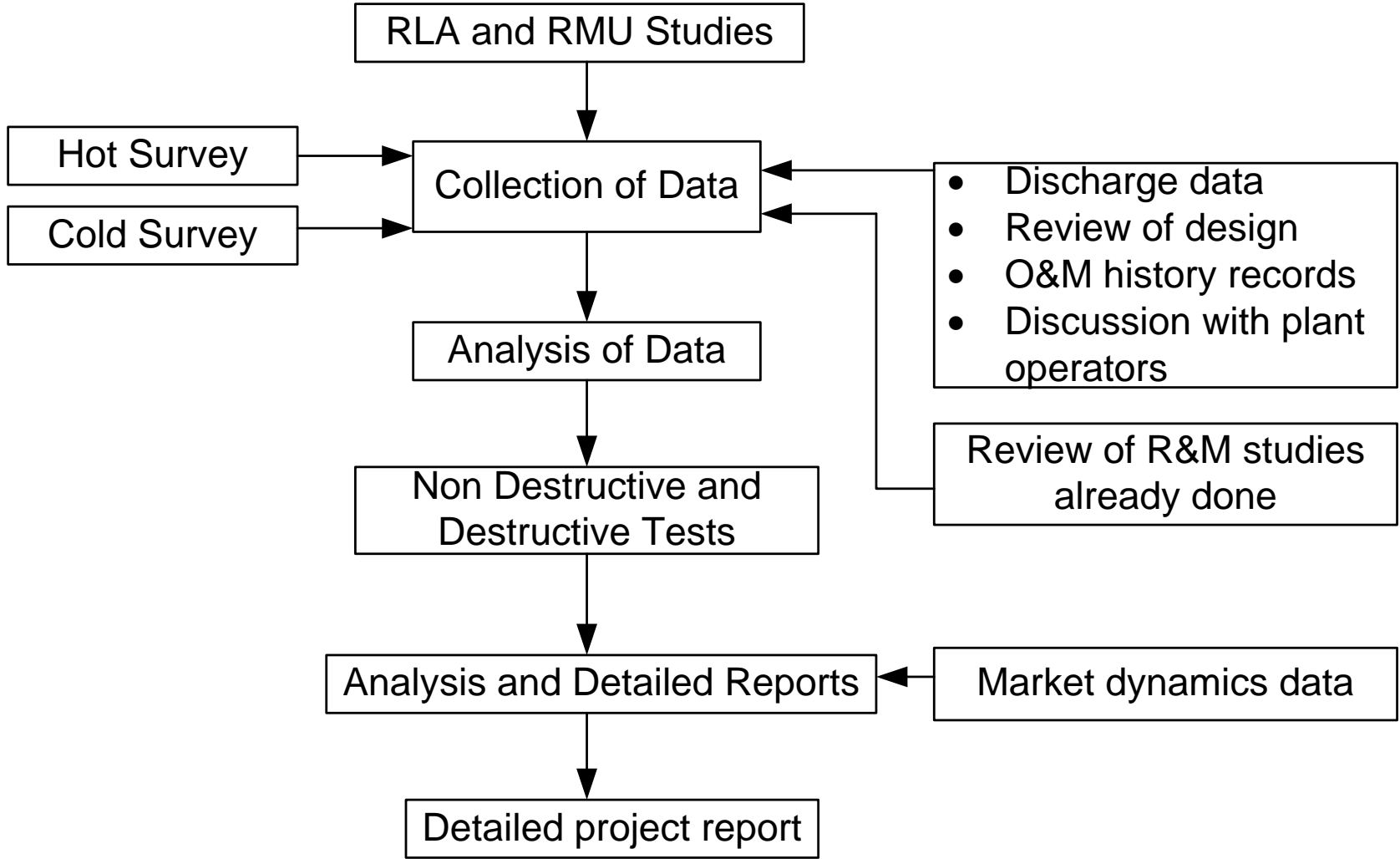
Uprating requires an extensive engineering studies of the units as well as water conductor system

# OPERATION MODELS

- O&M of the plants normally done by the plant owner.
- Models like Rehabilitate, Operate and Maintain (ROM) by private sector be considered and encouraged
- Incidental uprating would be an additional gain for the plants retrofitted with new generation (higher specific speed and higher efficiency) runners of turbines.

e.g. Bhandardara project from 10 to 14.5 MW

# SEQUENCE OF RLA AND RMU STUDIES



**Flow Chart for RLA and RMU studies** (Adapted from Mathur et al, 2005)

# DIAGNOSIS FOR RENOVATION

- For RMU, a complete diagnostic and analytical study is required.
- Before residual life assessment and life extension (RLA&LE) studies to ascertain which components are to be replaced and which are to be reused after renovation for extending the life of the power house.
- Analysis of operational history, flaw detection, material state assessment and computation of expended life
- Study of available water flows and power output
- Observe physical condition of various mechanical, hydraulic and electrical components
- Discharge measurements
- Pressure at the inlet of turbine.
- Study of recurring mechanical and electrical problems in the generating system, electrical control & supply systems.

- Study and preparation of a report of water conductor system along with analysis of silt content in the water system.
- Study life assessment of various components of the generating system on the basis of visual observations and by carrying out various non-destructive tests on these components.
- Tests to check governor response and operation of voltage regulators.
- Measurements of bearing temperatures, windings temperatures, etc., under steady state operation conditions (log book records to be also consulted).
- Check for excessive vibrations on critical components.
- Study of operational behavior of machines and all problems associated with the plant from logbooks and other records.
- Study on operation of power plant auxiliaries and operation of hydro mechanical equipment.
- Preparation of a detailed report based on above.

## Economic Aspect

- Cost/benefit analysis of RMU plans is required for investment decision.
- Plans are also approved by regulatory commission for tariff fixation with the investment by project owner of the plant.
- Being the cost to specific project, it difficult to be understood the necessity and justification of the quantum of investment.
- Regulators do not have enough data for analysis
- The RMU work are to be done in isolation unit wise
- Internationally every conference on hydro will have presentation by project owners and manufacturers on RMU
- Hardly any presentation in the international conference or journal are seen on the experience on Indian hydropower plant.



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**Thank You**

