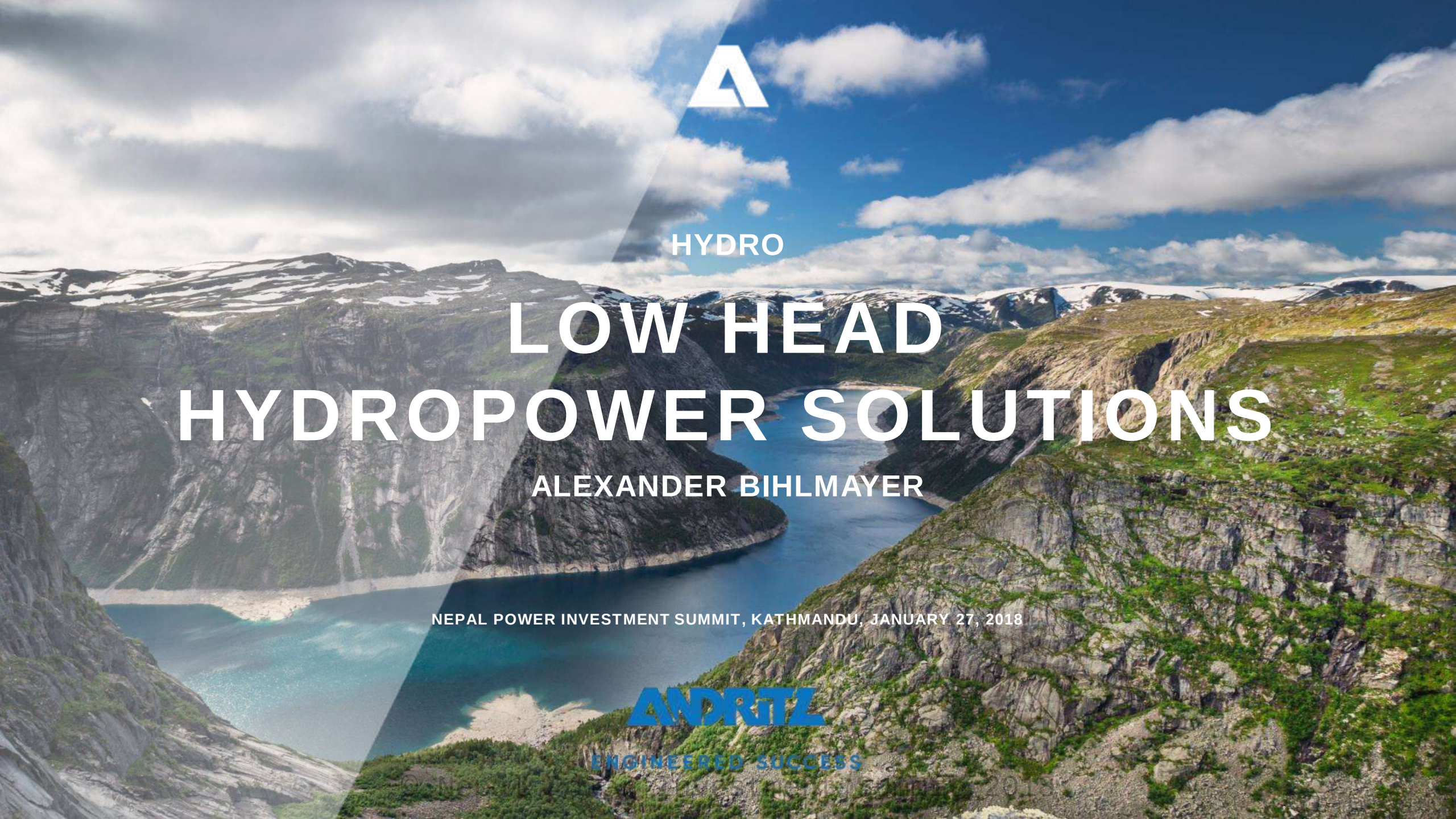


HYDRO

LOW HEAD HYDROPOWER SOLUTIONS

ALEXANDER BIHLMAYER

NEPAL POWER INVESTMENT SUMMIT, KATHMANDU, JANUARY 27, 2018

ANDRITZ

ENGINEERED SUCCESS

ALEXANDER BIHLMAYER

- 06.09.1967
- Technical University in Graz, Austria:
- Master (DI) Mech. Engineering & Business Administration
- Johannes Kepler University Linz, Austria
- M.Sc. in Innovation Management
- Married, 2 children
- Since 1995 VOEST ALPINE MCE resp. VA - TECH
- Since 2006 part of Andritz Group
- Since 2007 Vice President of Business Development
- Since 2016 also Managing Director of ANDRITZ HYDRO Myanmar

alexander.bihlmayer@andritz.com

CHAPTER OVERVIEW

KEY CONSIDERATIONS

Needs of HPP Developers	ANDRITZ Low Head HPP Solutions
1. Maximum Energy Yield	• Higher hydraulic efficiency due to better streamlined horizontal water flow -> higher annual energy output
2. Operational Flexibility	• Possibility of operation at larger head variations
3. Low Construction Cost	• Shallower setting –> less excavation -> less civil engineering and construction costs (up to 30% cost savings for powerhouse) • Use of existing non-hydro dams -> HYDROMATRIX • Shorter erection schedules
4. a. Low Environmental Impact **b. Fish Friendliness** **c. Ecological safety**	• Small powerhouse footprint -> easier integration into landscape • Fish friendly runner design • Oil-less runner hub
5. Easy & Low Cost Maintenance	• Abrasion and cavitation easily manageable • Easy accessibility to Turbine parts

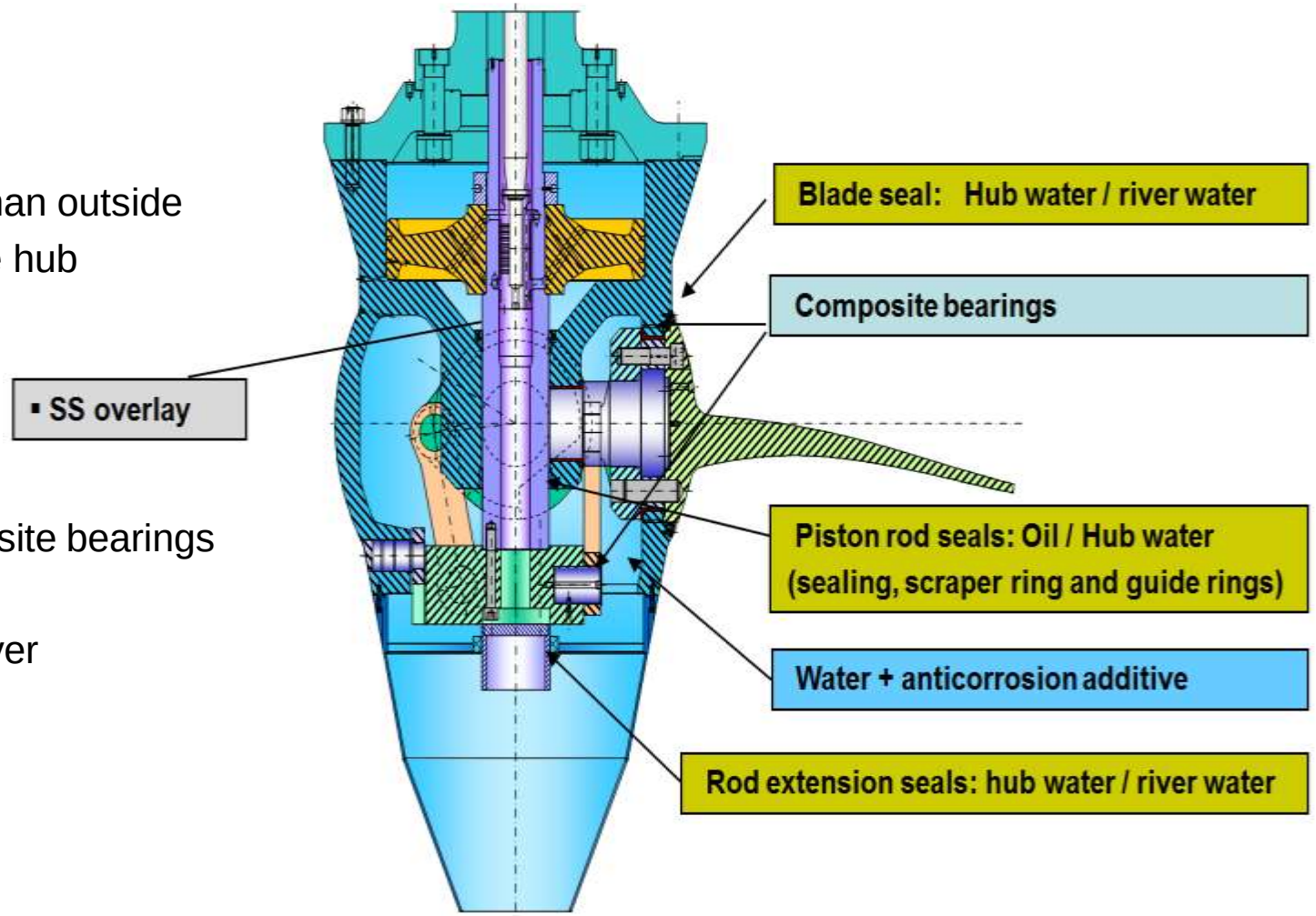
OIL FREE HUB - KEEPING THE WATER CLEAN

Conventional Hub Design

- “Oil-filled hub” → inside hub pressure higher than outside
- In case of seal failure the oil will leak out of the hub

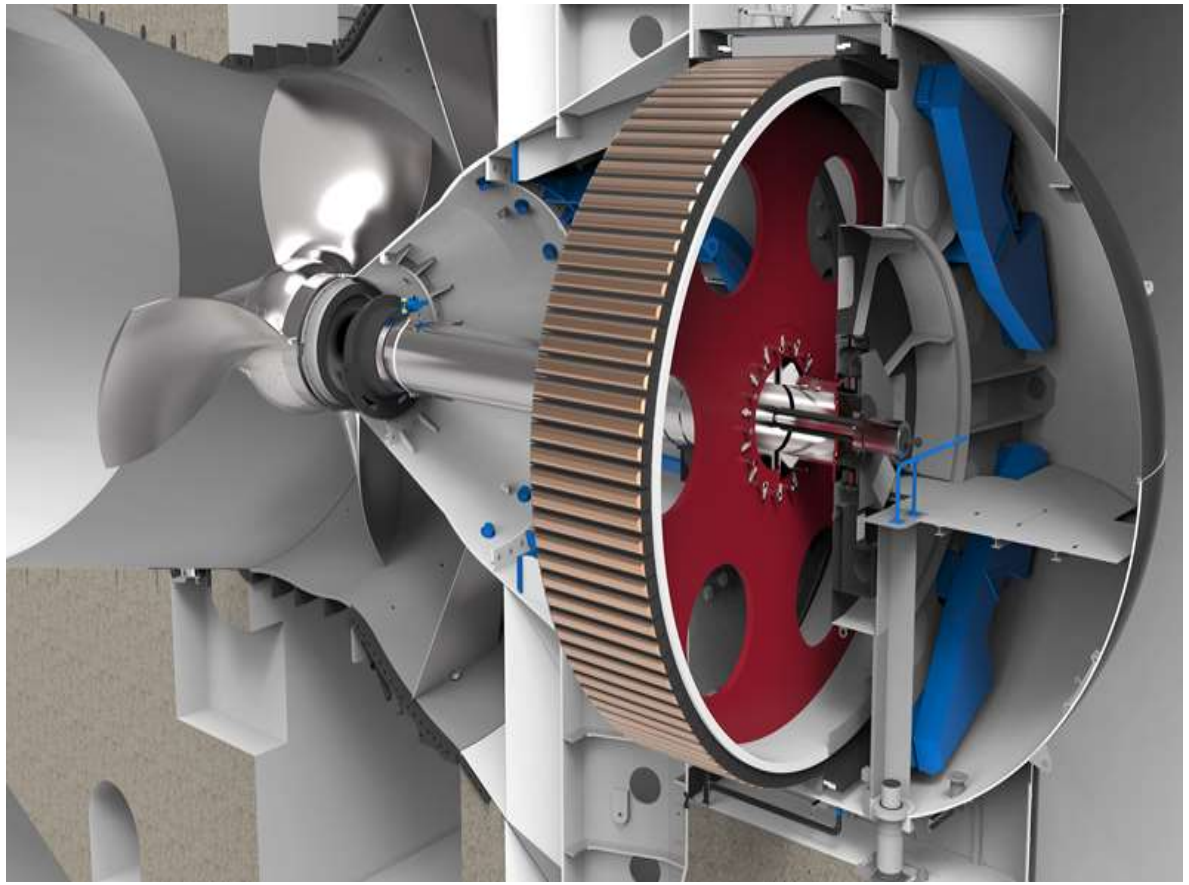
“Oil Free Hub” Design

- Special blade and piston rod seals and composite bearings
- Special coating and hub filling
- Safely prevents any oil from leaking into the river



LOW HEAD HYDROPOWER BULB TURBINES
WORLD LEADING TECHNOLOGY

- 749 installed units in operation
- Over 80 years of experience
- Approx. 12,800 MW installed
- Over 70% market share for large BULB units
- Largest direct driven BULB turbine
  7,700 mm runner diameter (Racine / USA)
- Highest unit output 76.55 MW (Jirau / Brazil)



CHOOSING THE RIGHT TECHNOLOGY

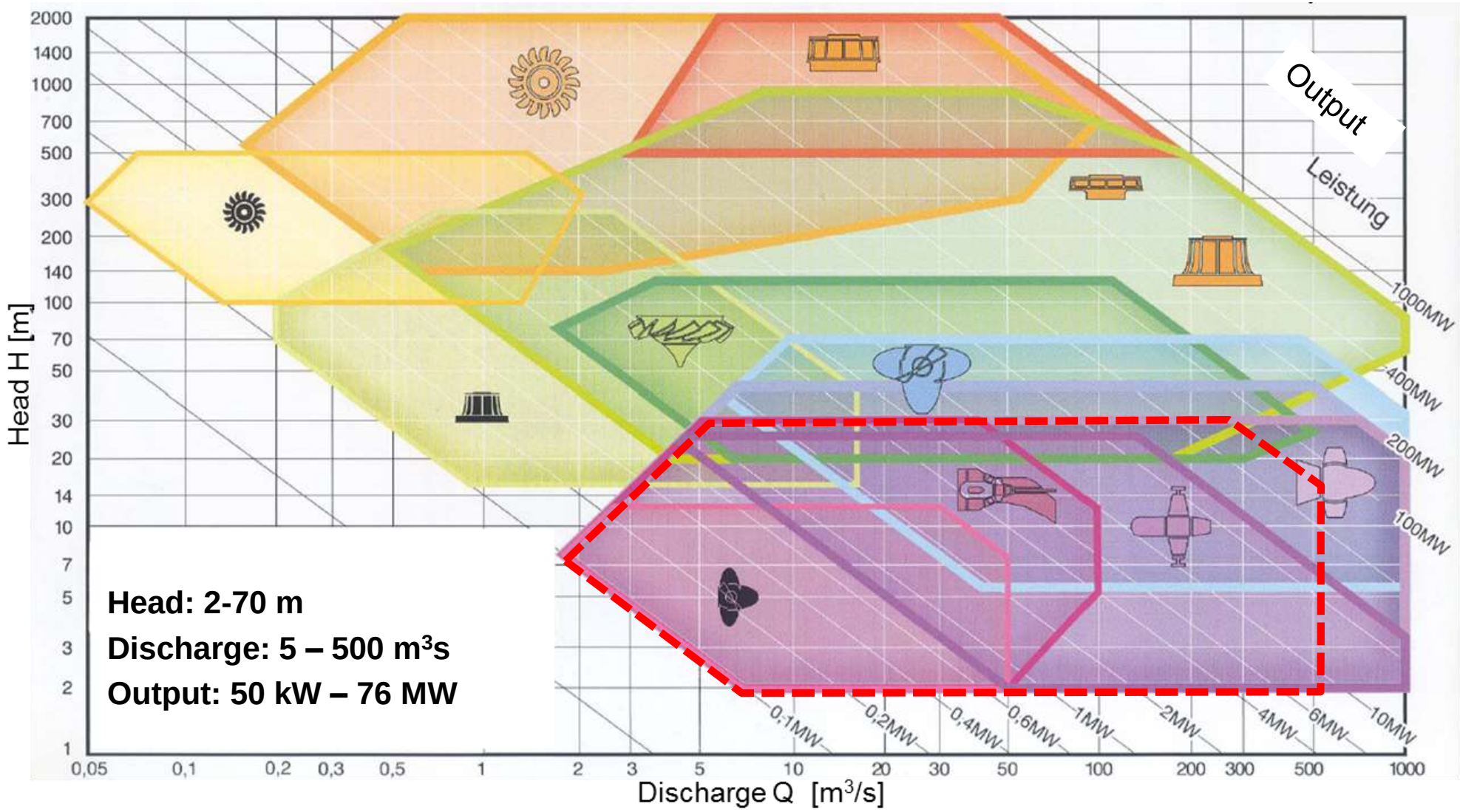
- ✓ Complex decision process
- ✓ Multitude of available technologies
- ✓ Overlapping operation ranges of different technologies
- ✓ Many decision criteria

Proper Assessment Process is Crucial

Bulb turbines (mid size to large size diameters)	LOW HEAD APPLICATION
Small Axial Turbine (Compact Bulb)	
Bevel Gear and Belt Driven Bulb Turbine	
HYDROMATRIX® and StrafloMatrix™	

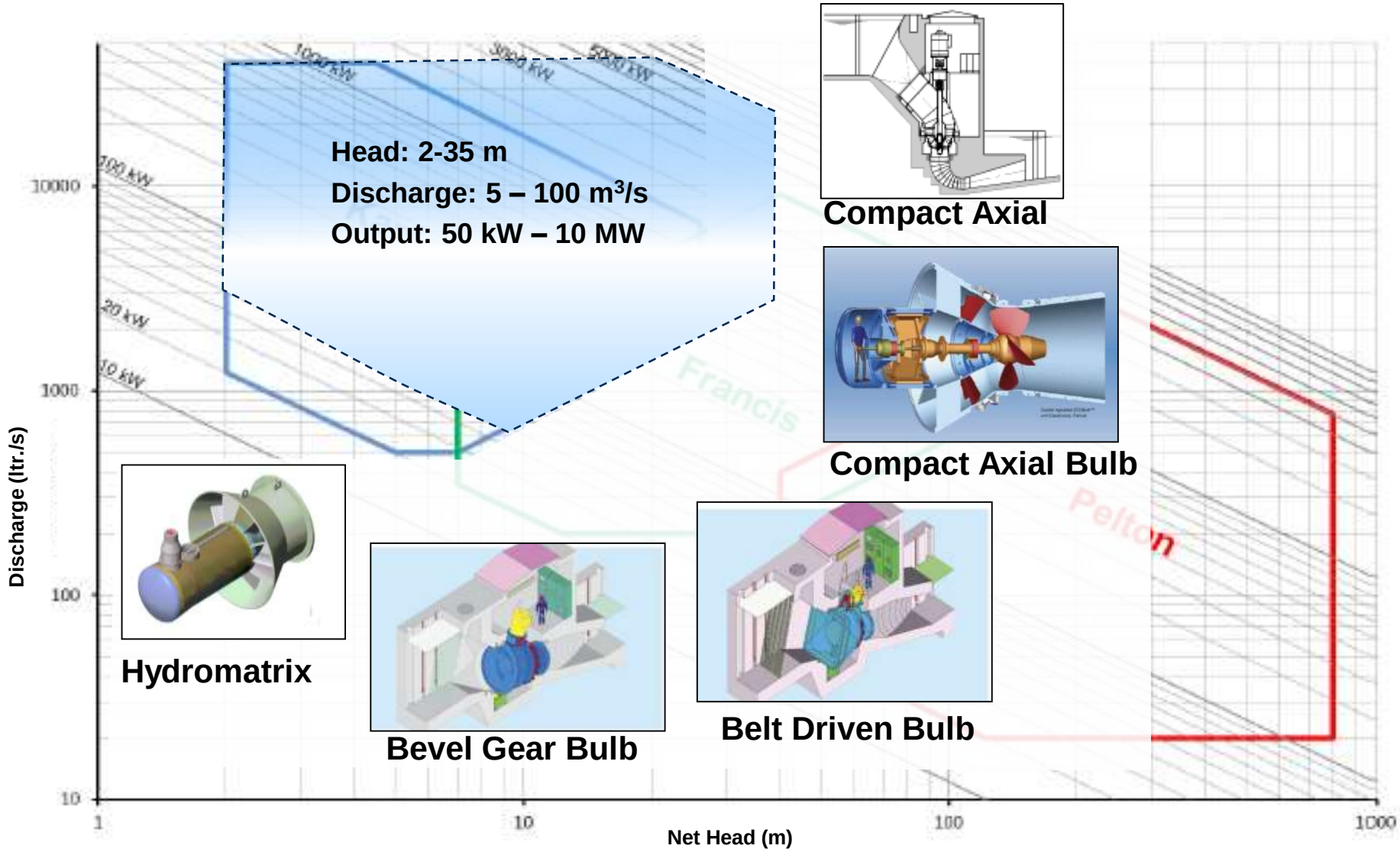
CHAPTER OVERVIEW

OPERATING RANGE

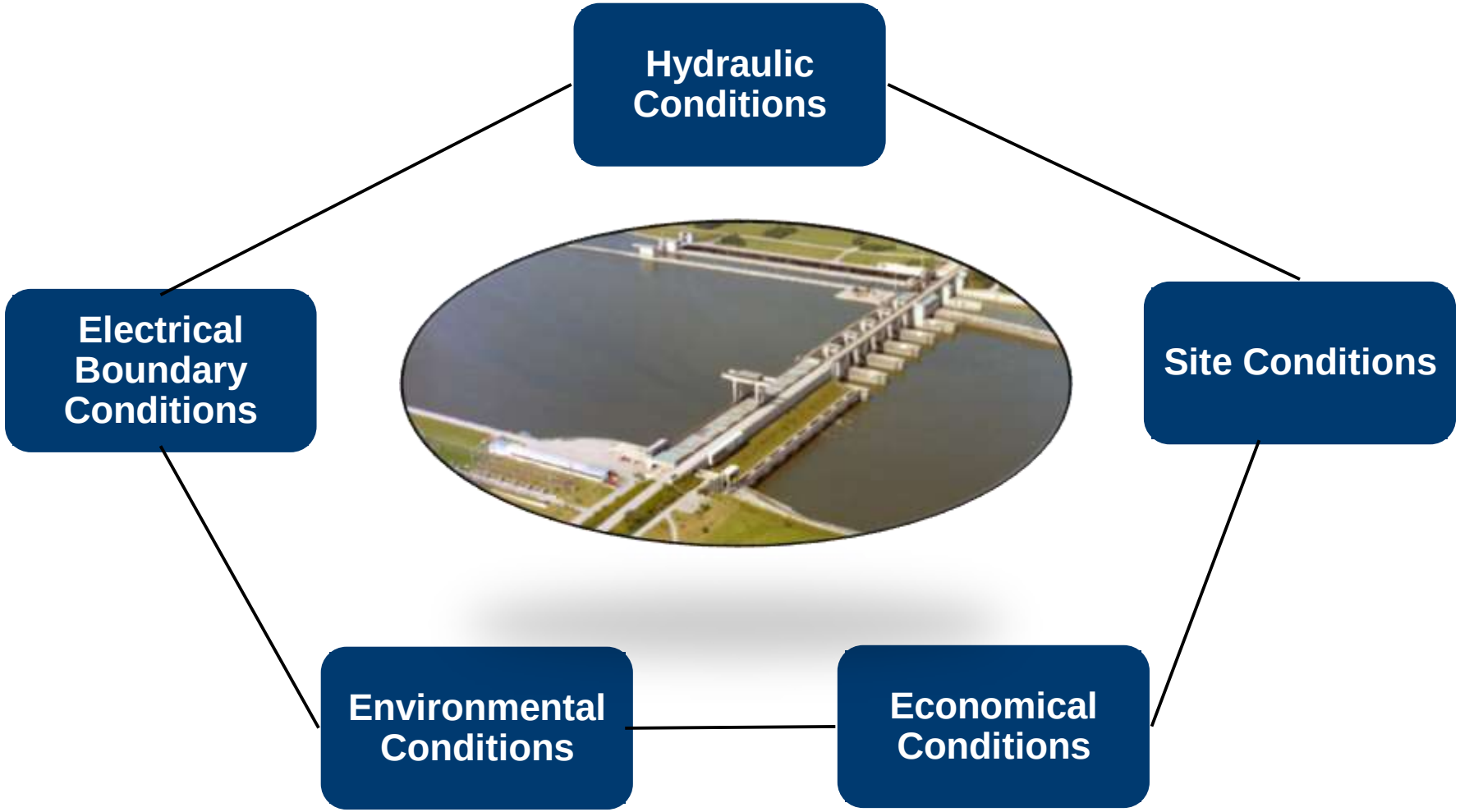


LOW HEAD “SMALL” HYDROPOWER

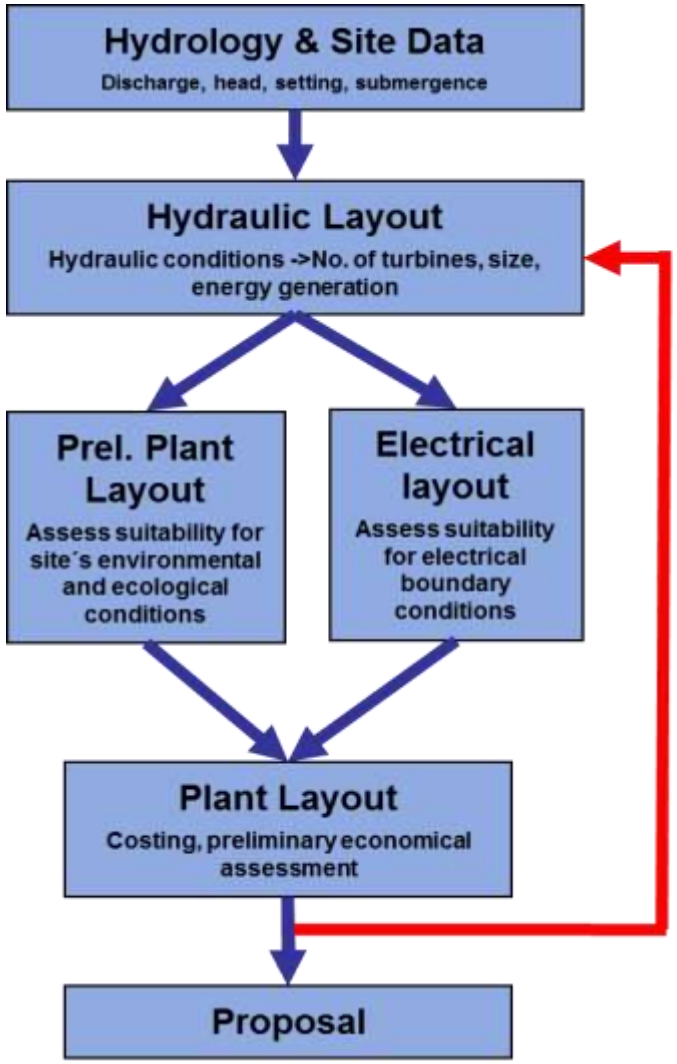
Turbine Types



BOUNDARY CONDITIONS



SITE ASSESSMENT PROCESS



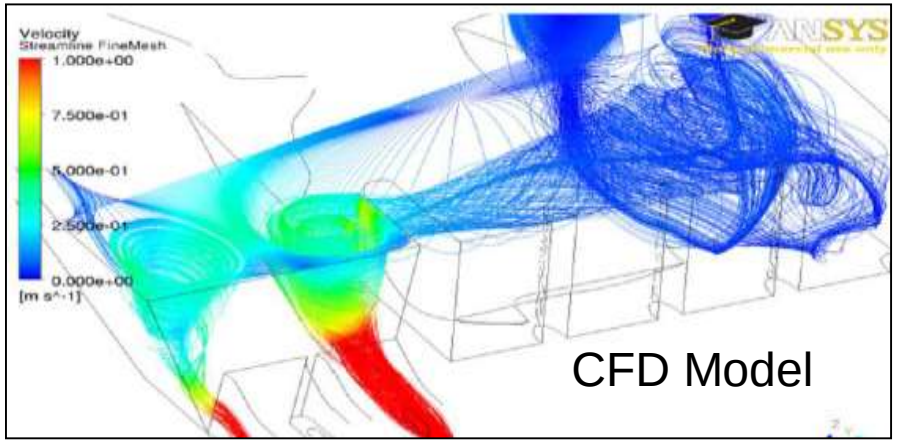
- Structured and iterative assessment process using site assessment tool
  - Step 1: Technical feasibility check
  - Step 2: Economic viability check
- Considers all listed boundary conditions
- Eliminates non-viable solutions
- Suggests feasible technical solutions
- Optimized plant performance and, construction schedule
- Considers innovative design options

CHAPTER OVERVIEW

CHI KHE / VIETNAM - PLANT OPTIMIZATION

CLIENT : POSCO E&C

- 2 Bulb Turbine units, H =11.28 m, 21.09 MW each
- Contract Year: 2013
- ANDRITZ HYDRO supported POSCO in the design of intake area to optimize inflow conditions
  - CFD Analysis
  - Civil Design recommendation
- Support was crucial for optimizing energy revenues



CFD Model

YEOJU / KOREA - OPTIMIZING CONSTRUCTION SCHEDULE

New Plant at Greenfield Site

- 3 Bevel Gear Bulb Turbines
- Gross Head: 5.77 m
- Plant Output: 5.35 MW

Selection Criteria:

- Fast project implementation
- Rapid mechanical site assembly
- Economical solution with LV generator

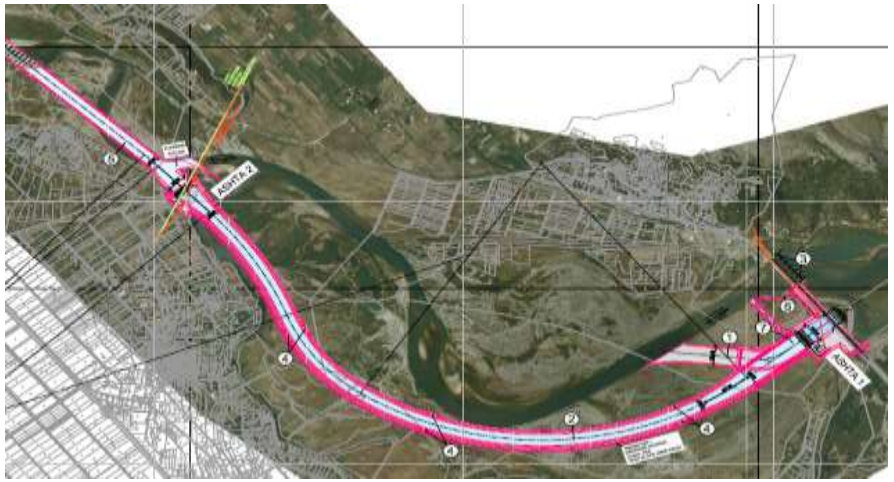
ASHTA I AND II / ALBANIA - INNOVATIVE PLANT DESIGN

Greenfield Application at existing weir

Originally: large dam with Bulb Turbines
Alternative: 2 HPP Stages with 90 HYDROMATRIX Units

- Gross Head : 5 - 7.5 m
- Unit Output : 534 – 1003 kW
- Total Output : 54 MW
- Annual Energy : 250 GWh

	2-3 Bulb	90 HM
E&M cost	$$	$$$
Civil Cost	$$$	**$**
Construction risk	$$$	**$$**
O&M	$$	$



CHAPTER OVERVIEW

SELECTION CRITERIA CONVENTIONAL BULB VERSUS HYDROMATRIX

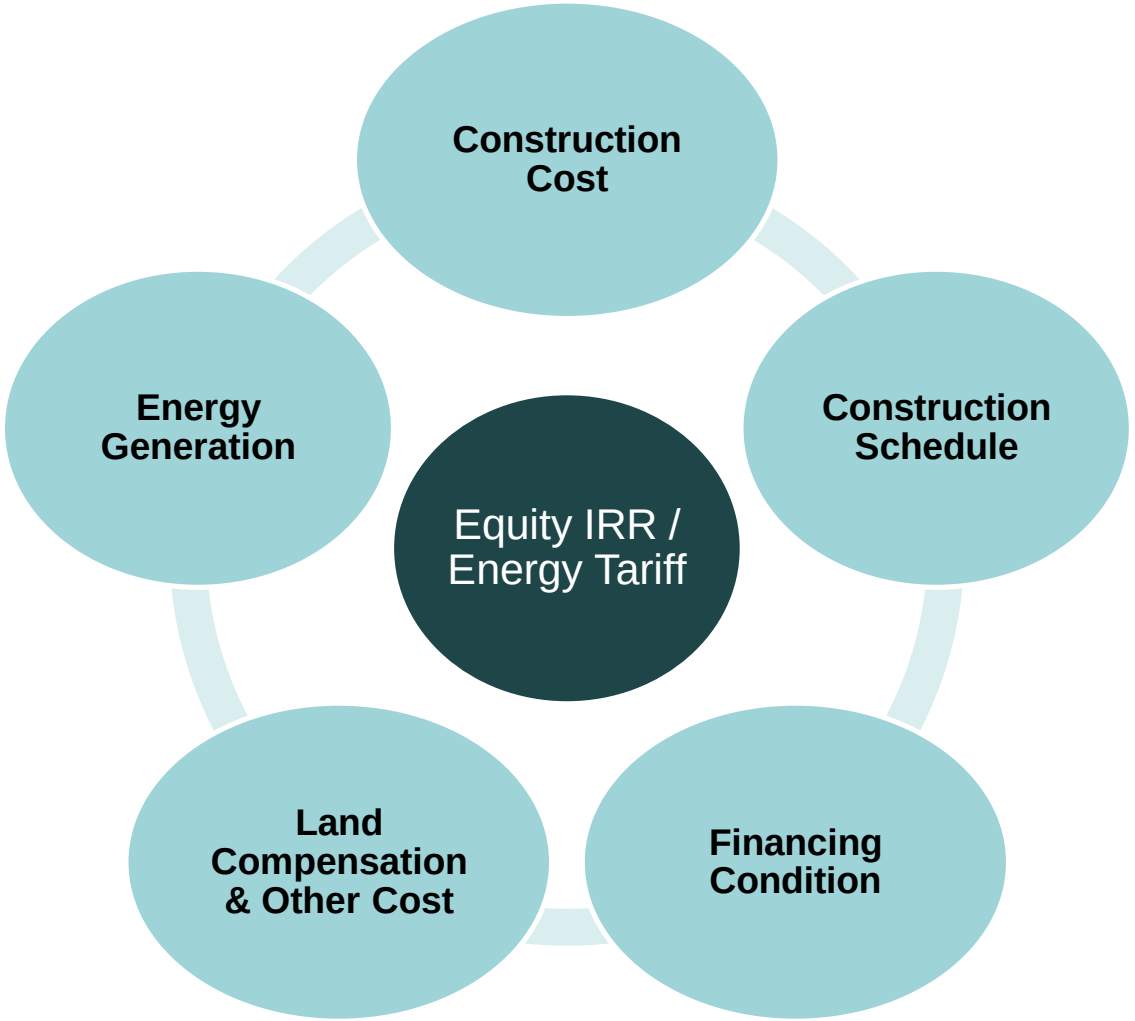
LARGE and COMPACT HYDRO Applications

- New plant (greenfield site) with good geological conditions
- Wide operating range
- No restrictions to grid requirements
- No space restrictions allowing river barrage with spillway and adjacent powerhouse

HYDROMATRIX Application

- Best for existing structures or multi-purpose dams requiring small footprint
- Mid- to high river discharges with small head fluctuations
- Greenfield sites with problematic geological conditions
- Special flood / discharge requirements

PROJECT DEVELOPMENT AND WHAT ANDRITZ CAN OFFER



Support we can offer:	
Hydraulic Layout Optimization	✓
Plant Design & Construction Methodology	✓
Construction cost input & project cost validation	✓
Planning and Structuring	✓
Project Financing	✓
Raise of Equity	✓
Financial Modeling	✓

CHAPTER OVERVIEW

CONCLUSIONS

- Low Head Hydropower Technologies offer High Energy Yields, Low Construction Cost and Risk and Environmental Safety
- ANDRITZ has extensive Know-How based on 8 decades of experience and 750 installed units
- ANDRITZ can help you throughout the development process:
  - Assessing your site conditions and development needs
  - Choosing the best technology for your particular site conditions
  - Assisting in technical layout, project cost and scheduling and financial engineering

Let us help making your projects a success !

Thank You
धन्यवाद