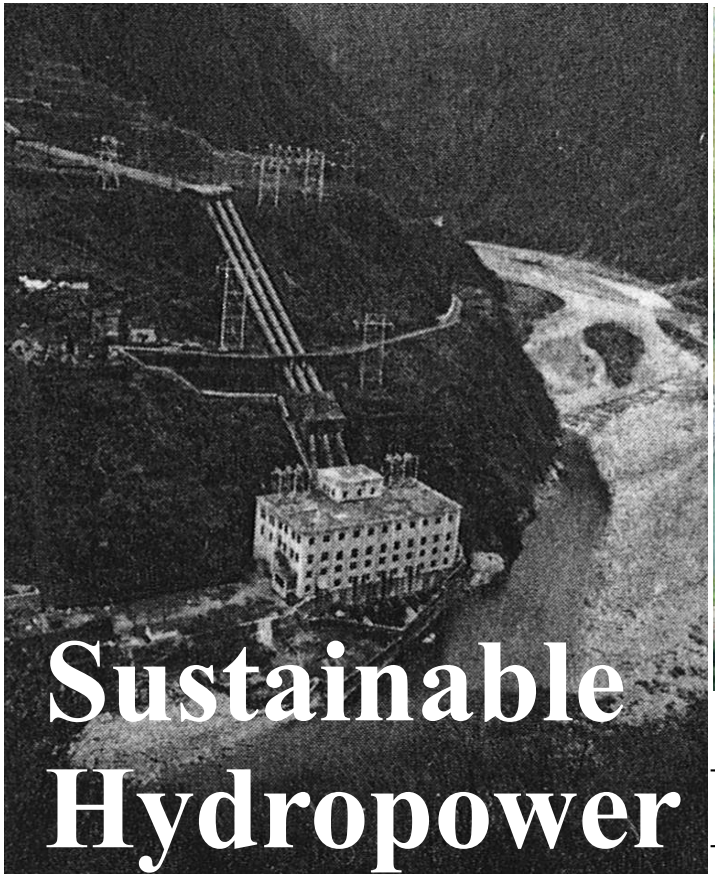
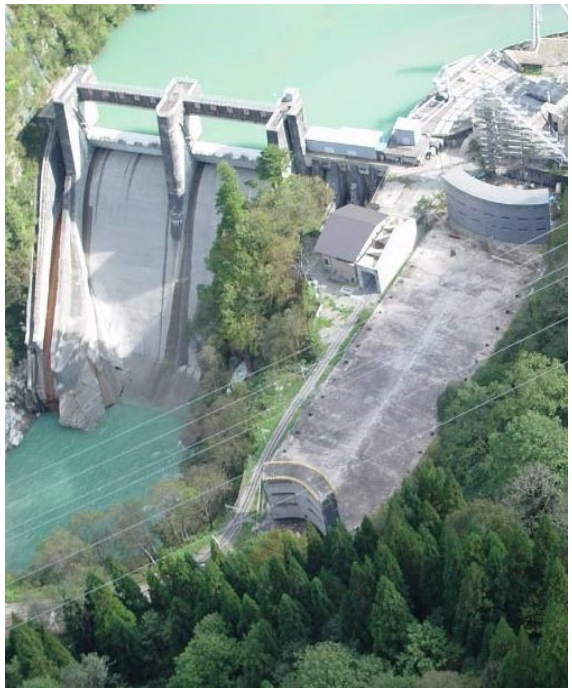
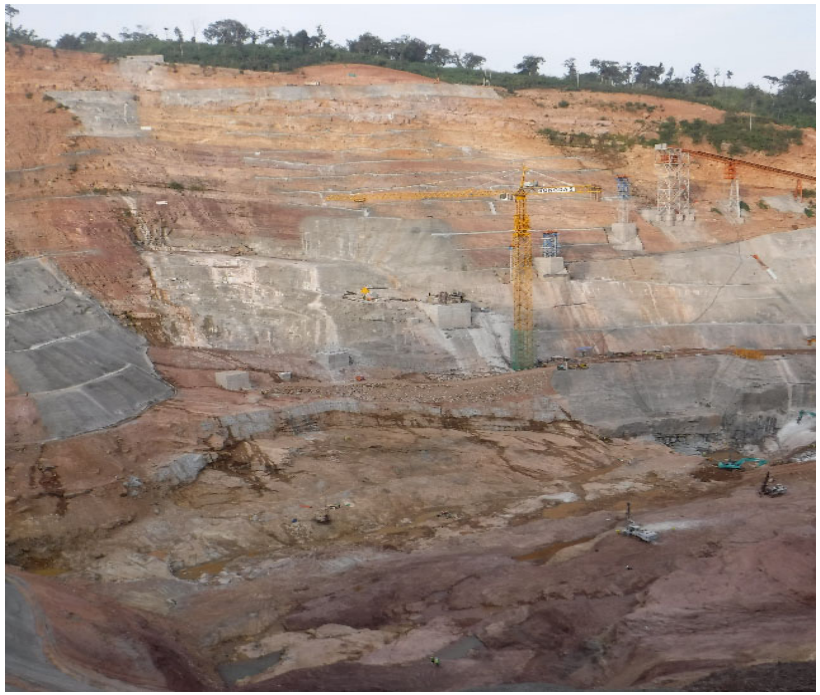






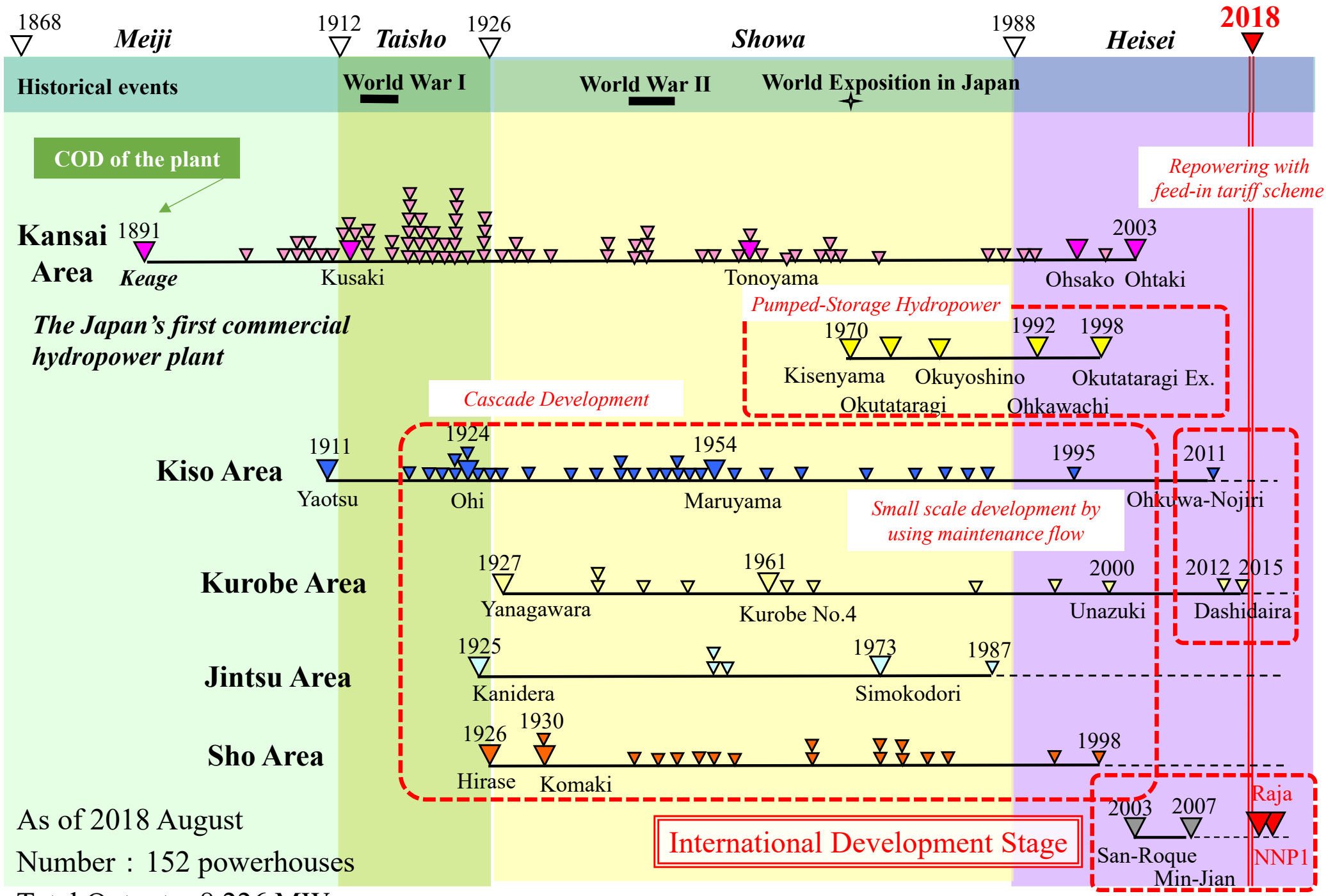
Sustainable Hydropower Development

2019 December

Kansai Electric Power Co., Inc.

History of KANSAI's Hydropower Development

Track Record on Hydropower Projects



As of 2018 August

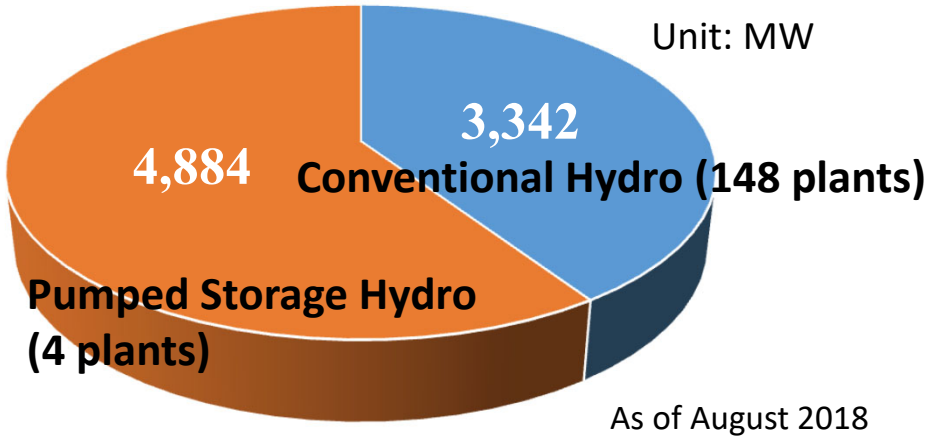
Number : 152 powerhouses

Total Output : 8,226 MW

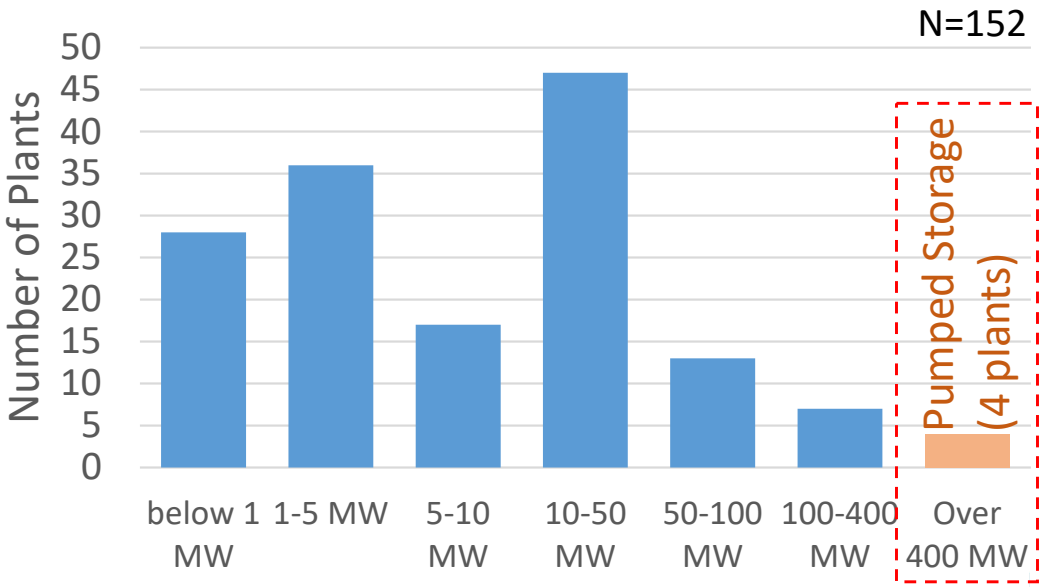
Domestic Key Features

KANSAI's Hydropower

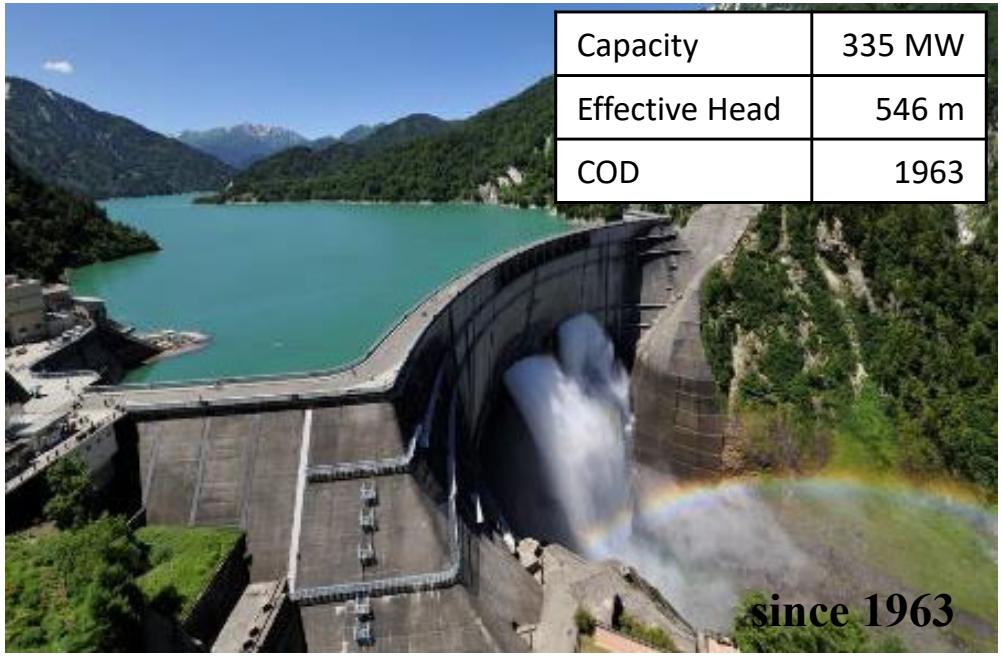
8,226MW/152 plants in total



As of August 2018



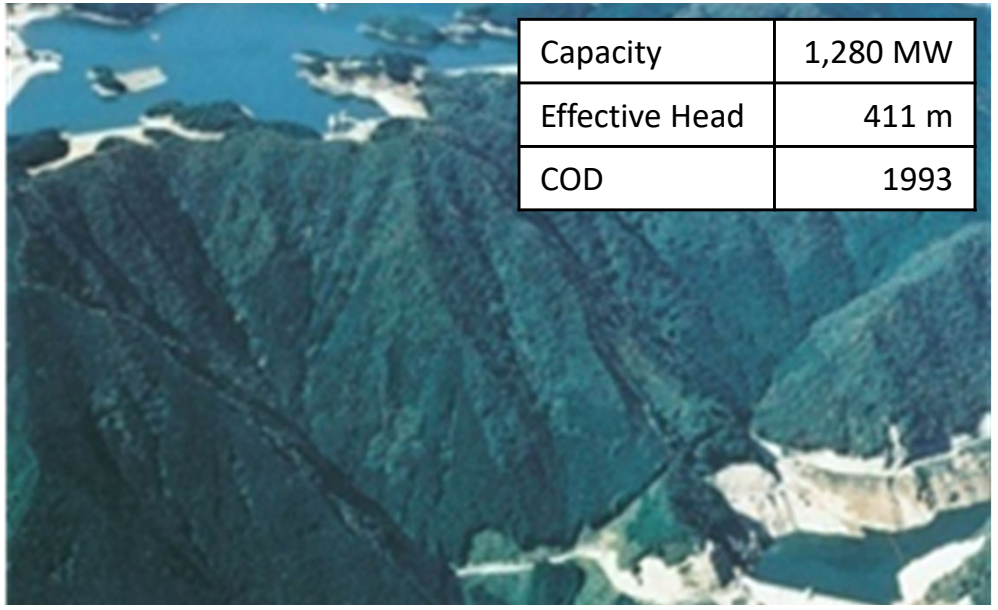
"KUROYON" Hydro Project



Capacity	335 MW
Effective Head	546 m
COD	1963

- ✓ Financed by World Bank
- ✓ **Awarded for IEEE Milestone (April 2010)**

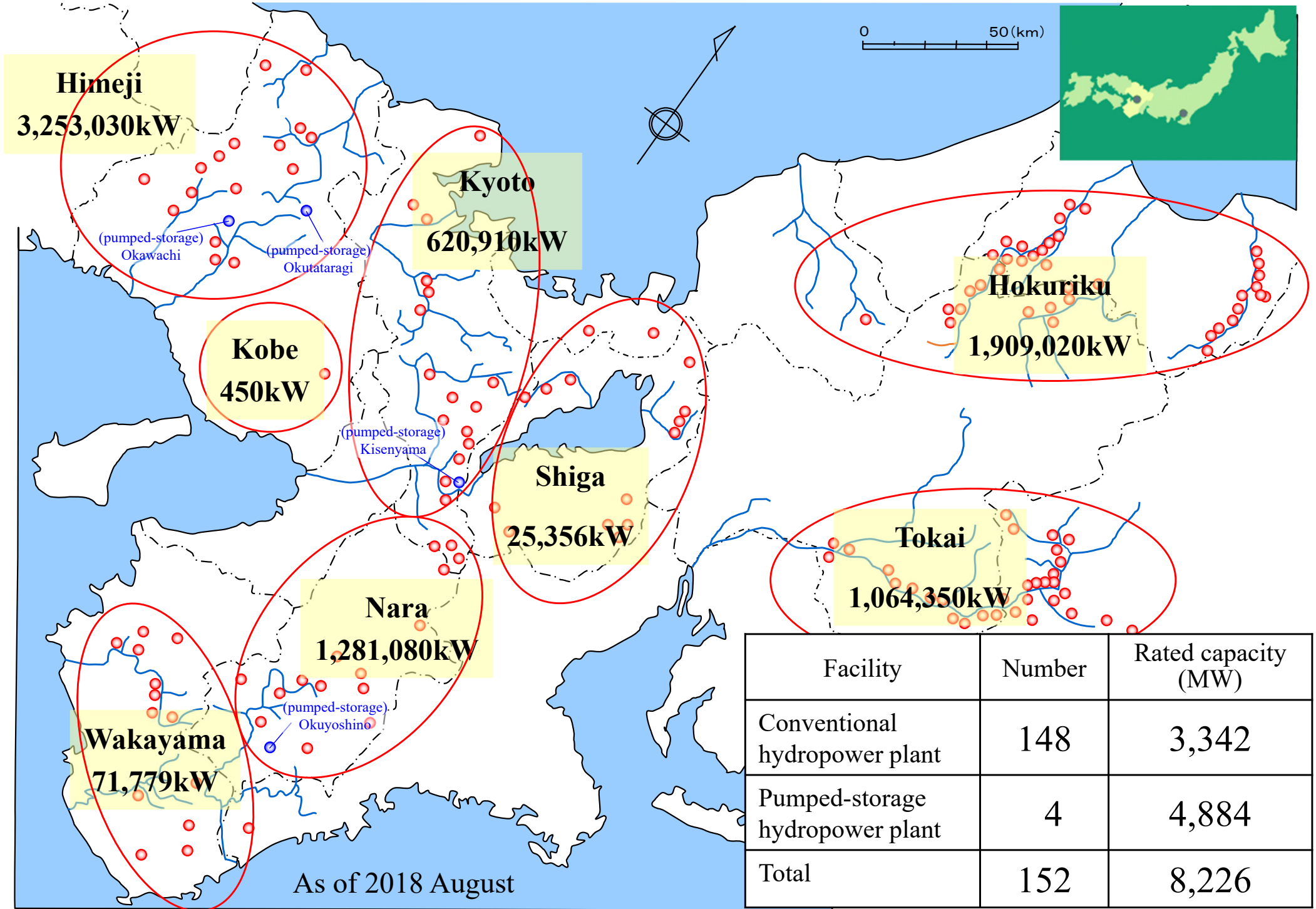
OKAWACHI Pumped Storage Hydro P/S



Capacity	1,280 MW
Effective Head	411 m
COD	1993

- ✓ World-first large-scale **variable speed umped-storage (VSPS)** co-developed by Hitachi and Kansai

Domestic Hydropower Plants



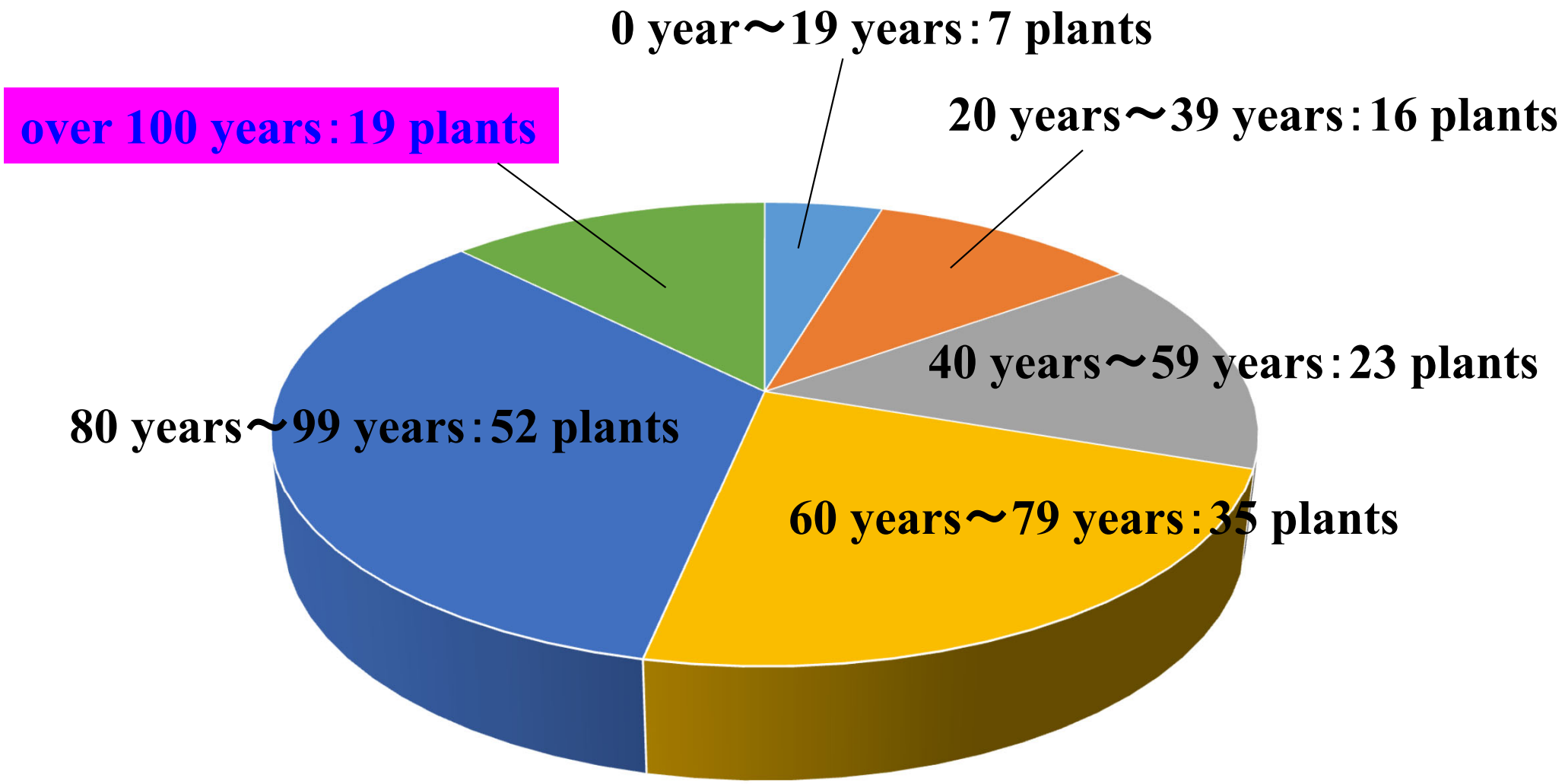
Facility	Number	Rated capacity (MW)
Conventional hydropower plant	148	3,342
Pumped-storage hydropower plant	4	4,884
Total	152	8,226

KANSAI's Hydropower Plants – Distribution of Age

Total: 152 hydropower plants

Ave.: 72 years

As of Aug 2018



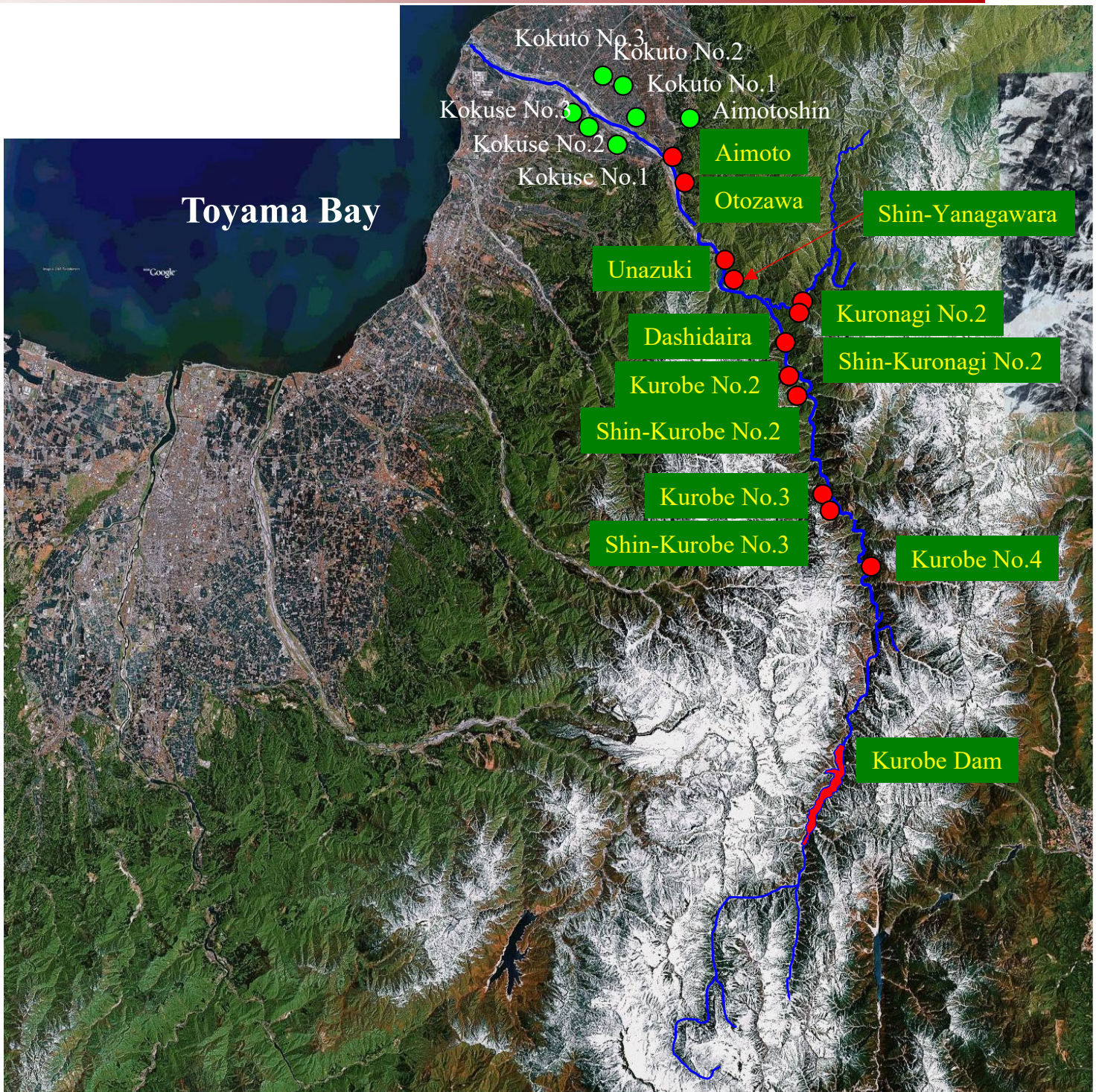
Key Topics

- *Cascade Development of the Kurobe River*
- *VSPS*
- *Sediment Flushing/Bypassing System*
- *Maintenance Flow Hydropower Development*

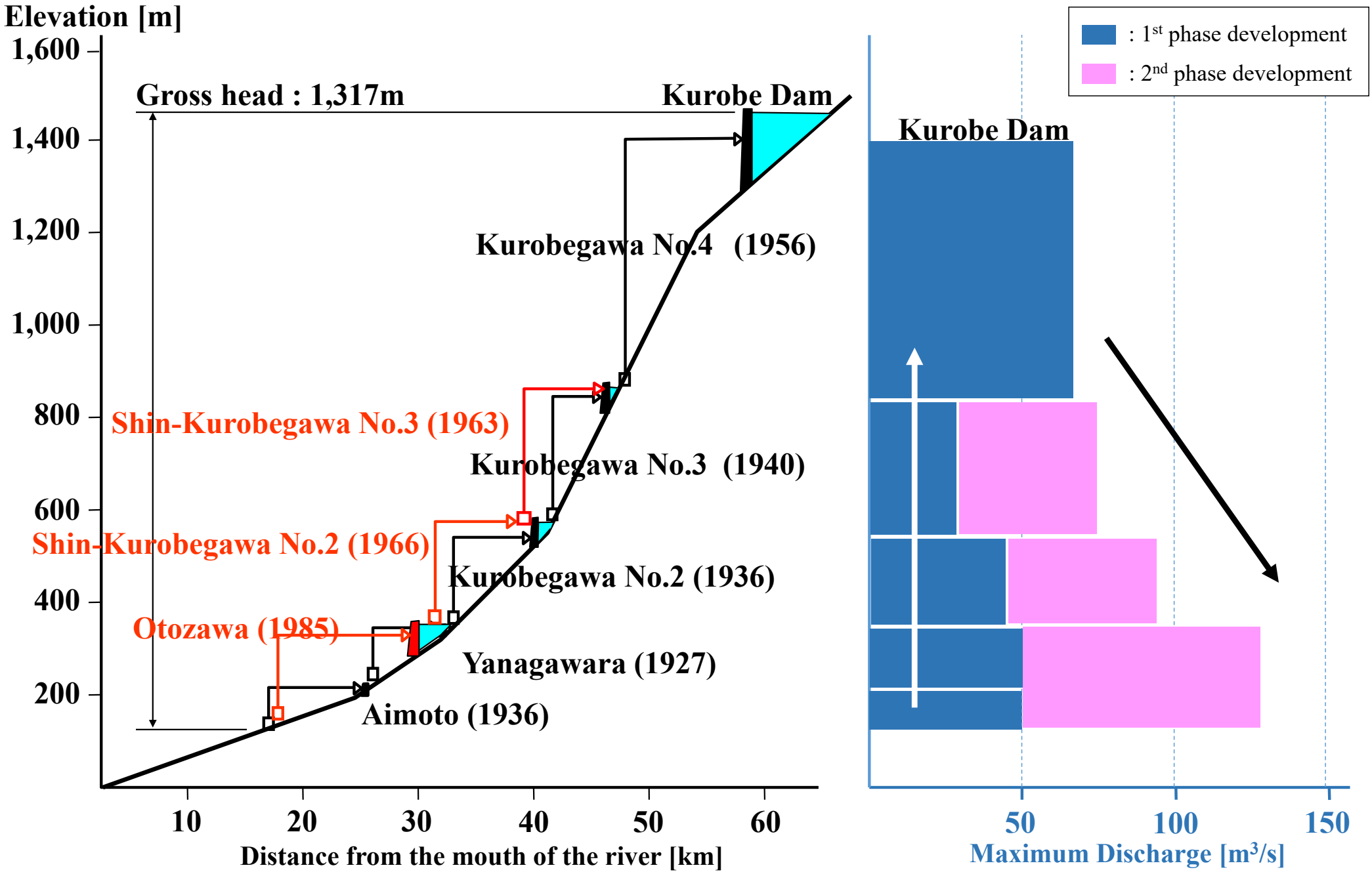
Cascade Development (Kurobe River)

● **KANSAI owned**
12 plants
901,120 kW

● **Others owned**
8 plants
34,510 kW

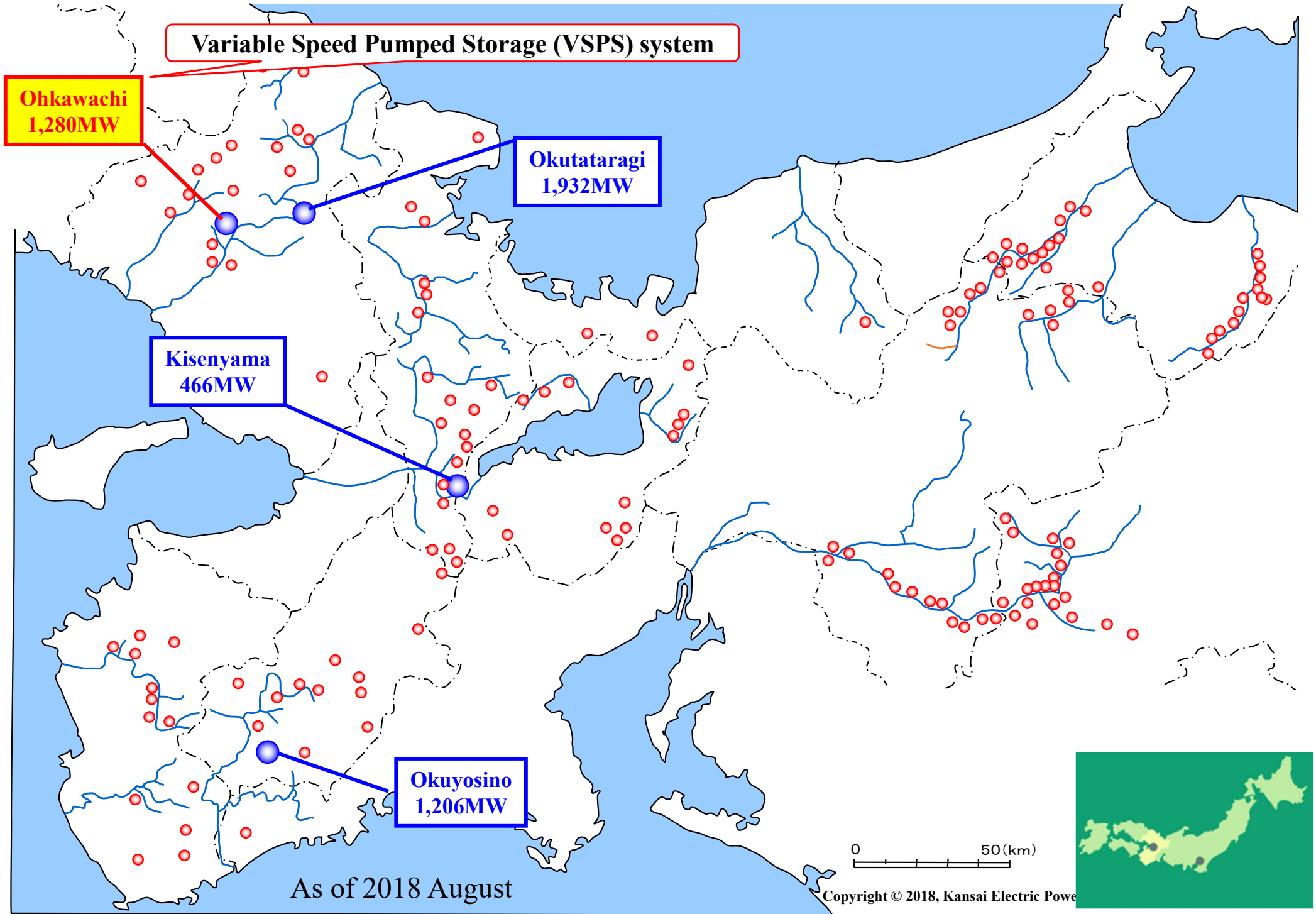


Cascade Development (Kurobe River)

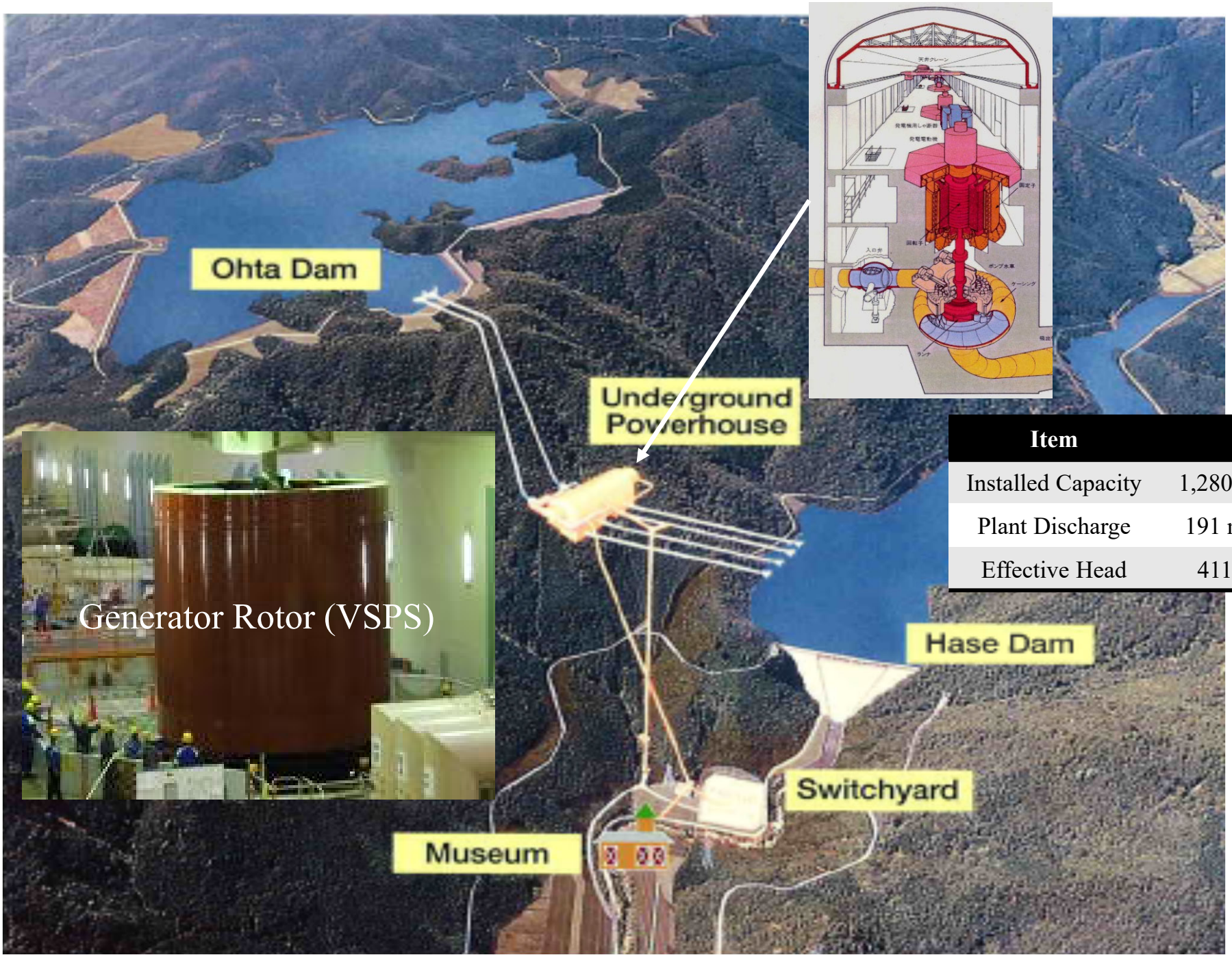


Phased cascade development has been completed utilizing regulated water discharge from Kurobe Dam

Pumped Storage Hydropower Plants



Ohkawachi Pumped Storage Power Plant

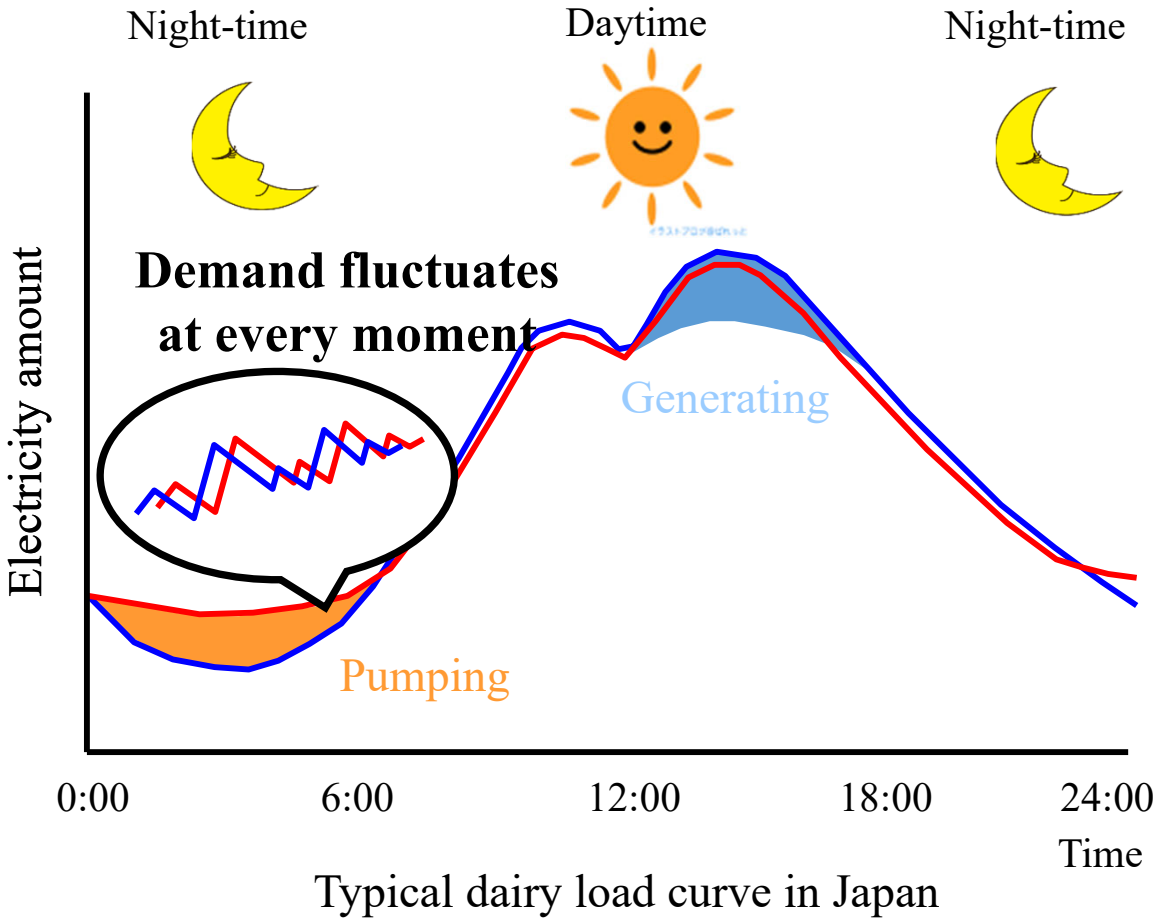


Item	
Installed Capacity	1,280MW
Plant Discharge	191 m^3/s
Effective Head	411 m

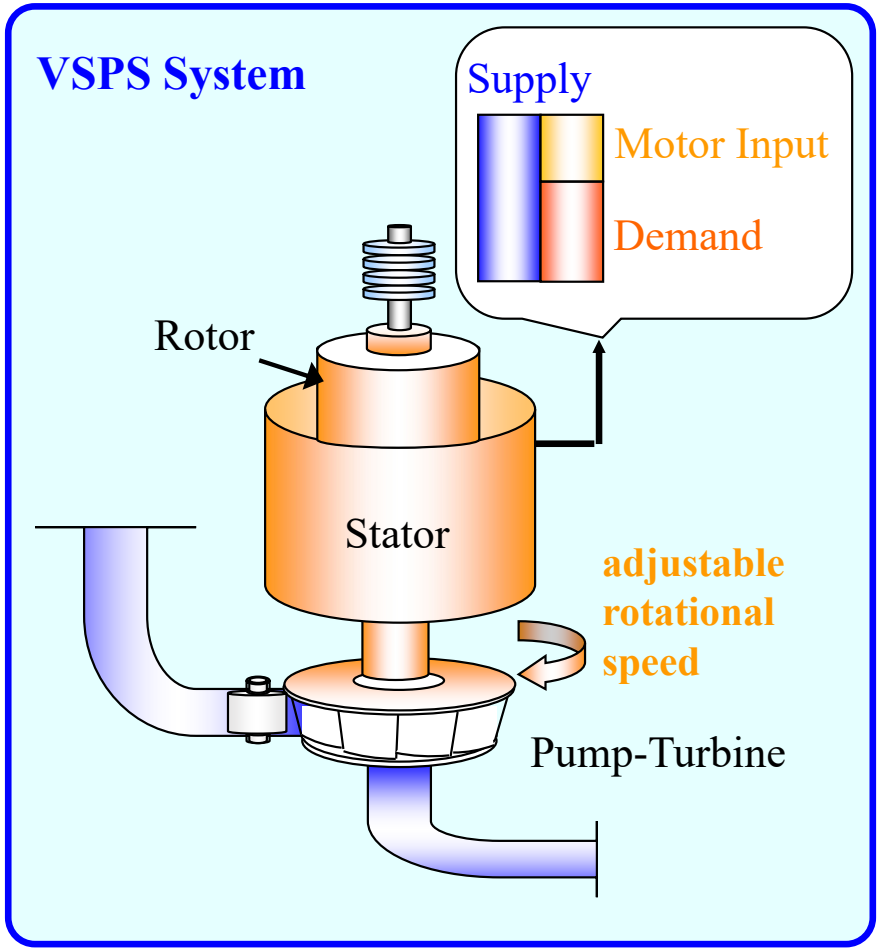
Variable Speed Pumped Storage (VSPS) System

Necessity of VSPS

- Demand fluctuates at every moment.
- Grid frequency fluctuates if we cannot keep the balance between demand and supply.
- Conventional pumped storage system cannot control the input in the pumping mode, that is, it cannot keep the balance between demand and supply in night-time.
- VSPS can control the input in the pumping mode, that is, it can keep the balance flexibly between demand and supply in night-time.



Typical dairy load curve in Japan



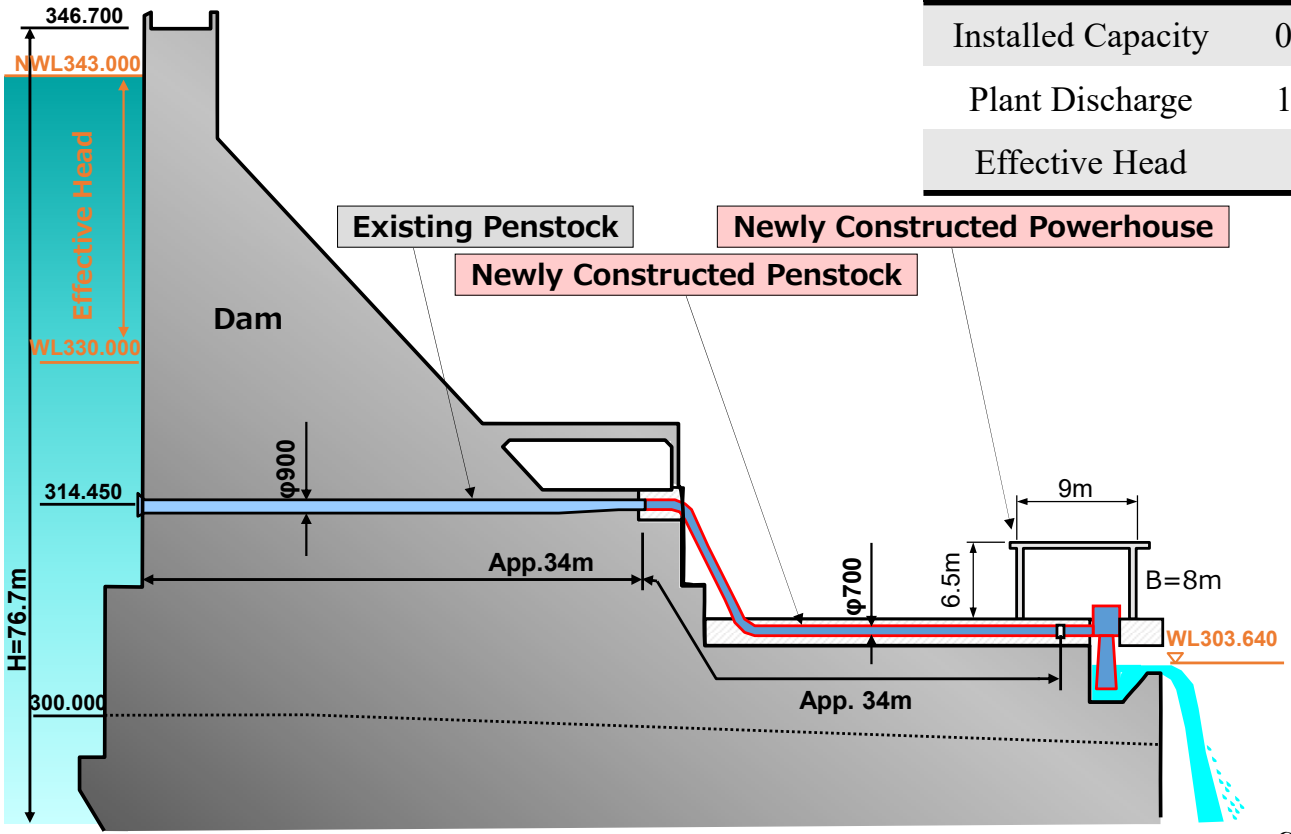
Maintenance Flow Hydropower Development

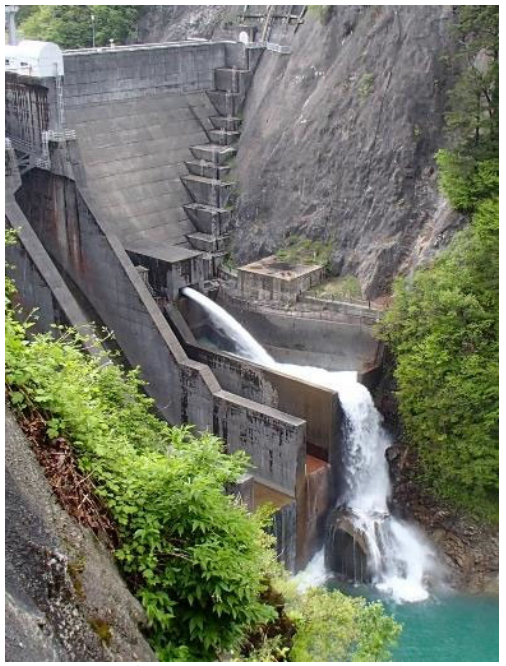
Maintenance flow, which was originally and lawfully introduced to maintain the river function lawfully needs to be maintained for the waterway type hydropower project,
- to maintain the function of river
- to protect the surrounding landscape

New hydropower projects (mini-hydro) has been established using the existing maintenance flow.

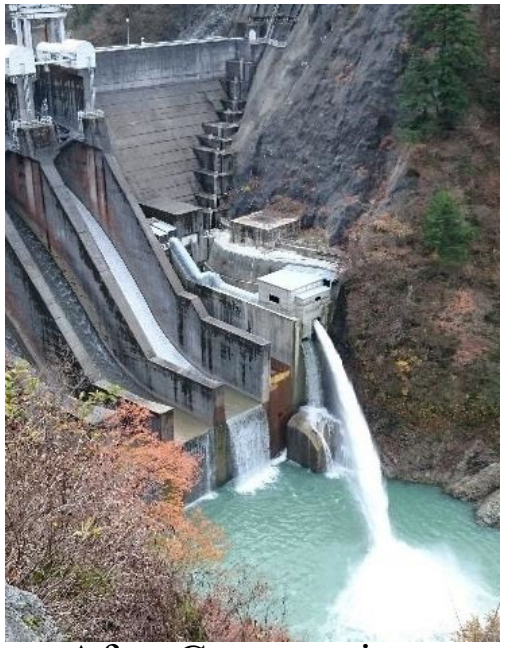
Outline of Dashidaira Mini-Hydro

Item	
Installed Capacity	0.52MW
Plant Discharge	1.76m^3/s
Effective Head	37.3m





Before Construction

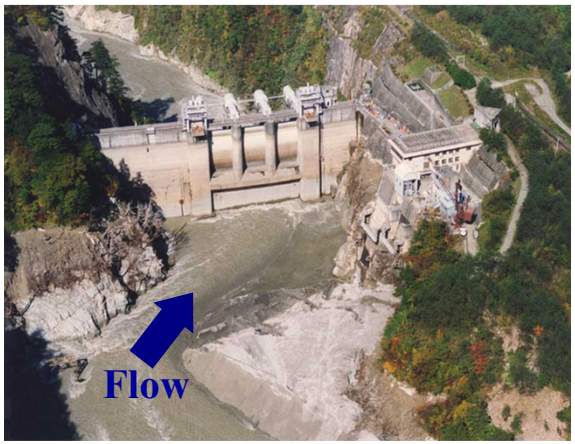


After Construction

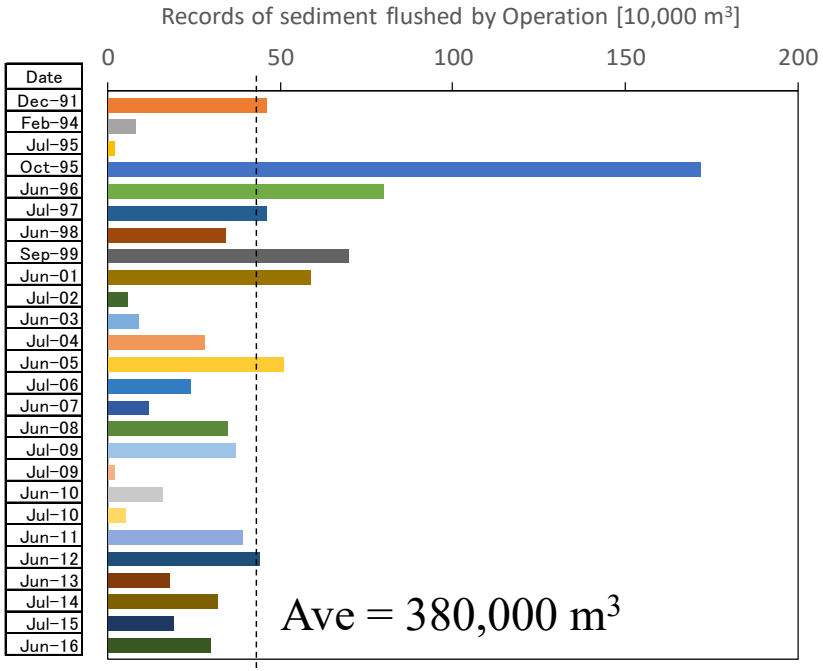
Sediment Flushing Operation (Dashidaira Dam)

- Equipped with full-scaled sediment flushing gates
- Optimization of flushing gate operation by lowering the water level and reaching the free-flow river condition during floods
- Environmental assessment committee in operation, involving academic experts

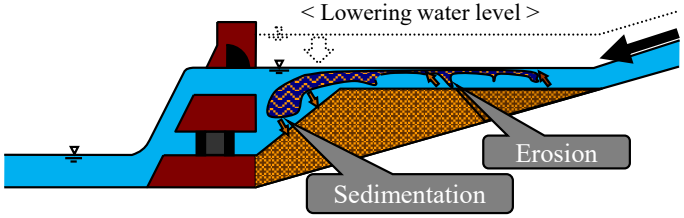
After peak of floods



Decline stage of floods

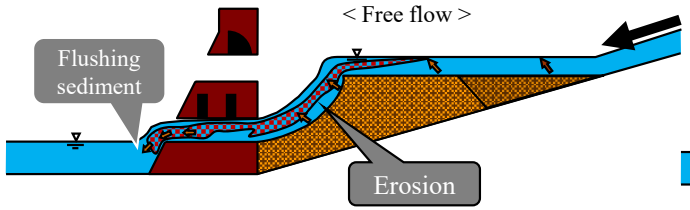


After floods



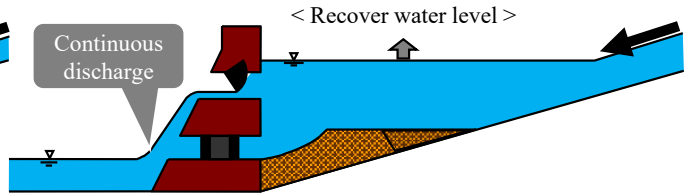
i) Lowering water level

After confirmation of the peak of the inflow, the flushing gates start opening, and then sediment upstream of the reservoir only starts to move.



ii) Free-flow condition

Once free-flow river condition appears during the decline stage of floods, more sediment moves by the large tractive force of the flow and is discharged downstream through the flushing gates.

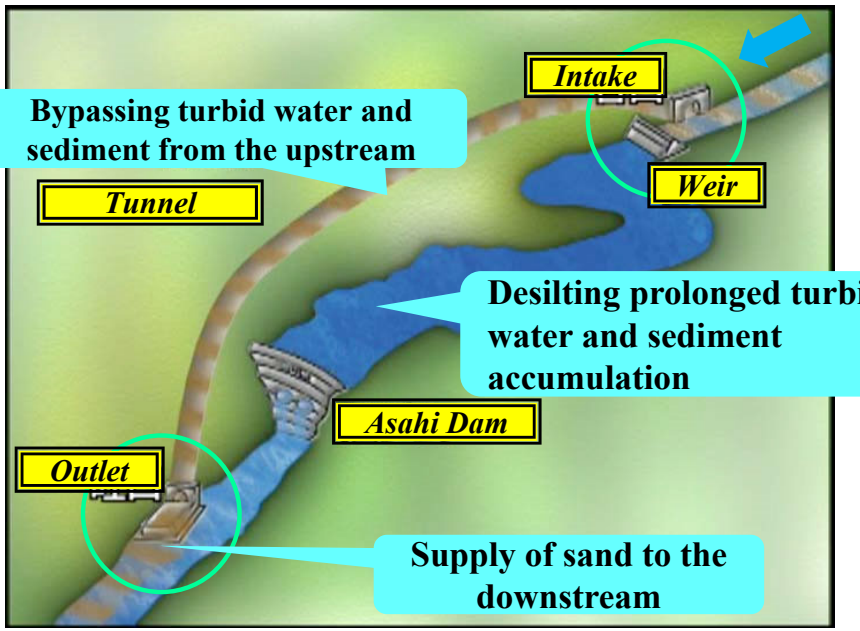


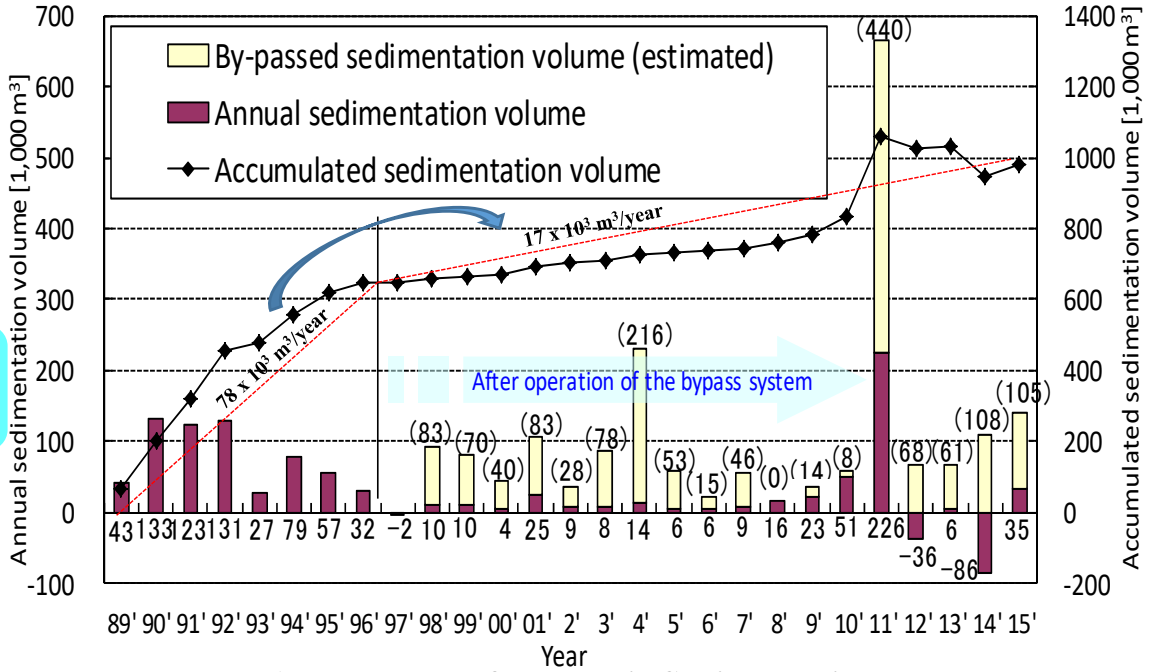
iii) Recovering water level

When the inflow decreases to certain level – before dilution effect of water dramatically drops, the flushing gates start closing.

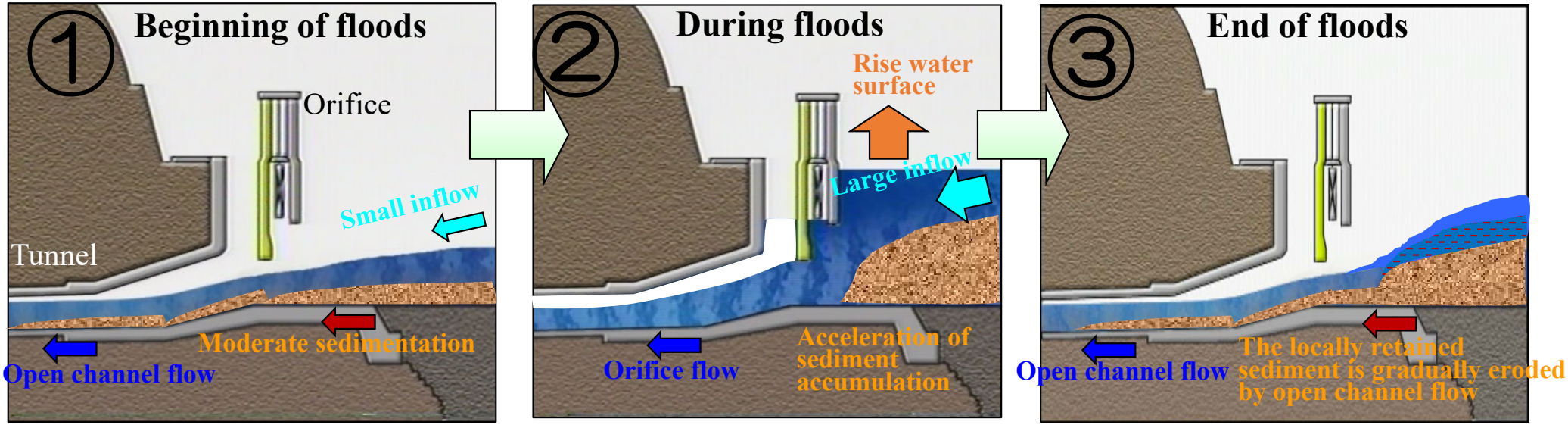
Sediment Bypassing Operation (Asahi Dam)

Turbid water coming from upstream is diverted before the reservoir to downstream through the bypass tunnel.





Annual Rate of Reservoir Sedimentation



Overseas Key Features

KANSAI's Overseas IPP Hydropower Projects

MING-JIAN Hydro (Taiwan)

17MW (25%)
Run-off-River
Participation: 2005

SAN ROQUE Hydro (Philippines)

436MW (50%)
Reservoir Dam
Participation: 1998

Deedoke Hydro (Myanmar)

56MW
Run-off-River

Kulawi Hydro (Indonesia)

Under FS

Nam Ngiep 1 Hydro (Laos)

290MW (45%)
Reservoir Dam
Exp. COD : Feb 2019

Rajamandala Hydro (Indonesia)

47MW (49%)
Run-off-River
Exp. COD : May 2019

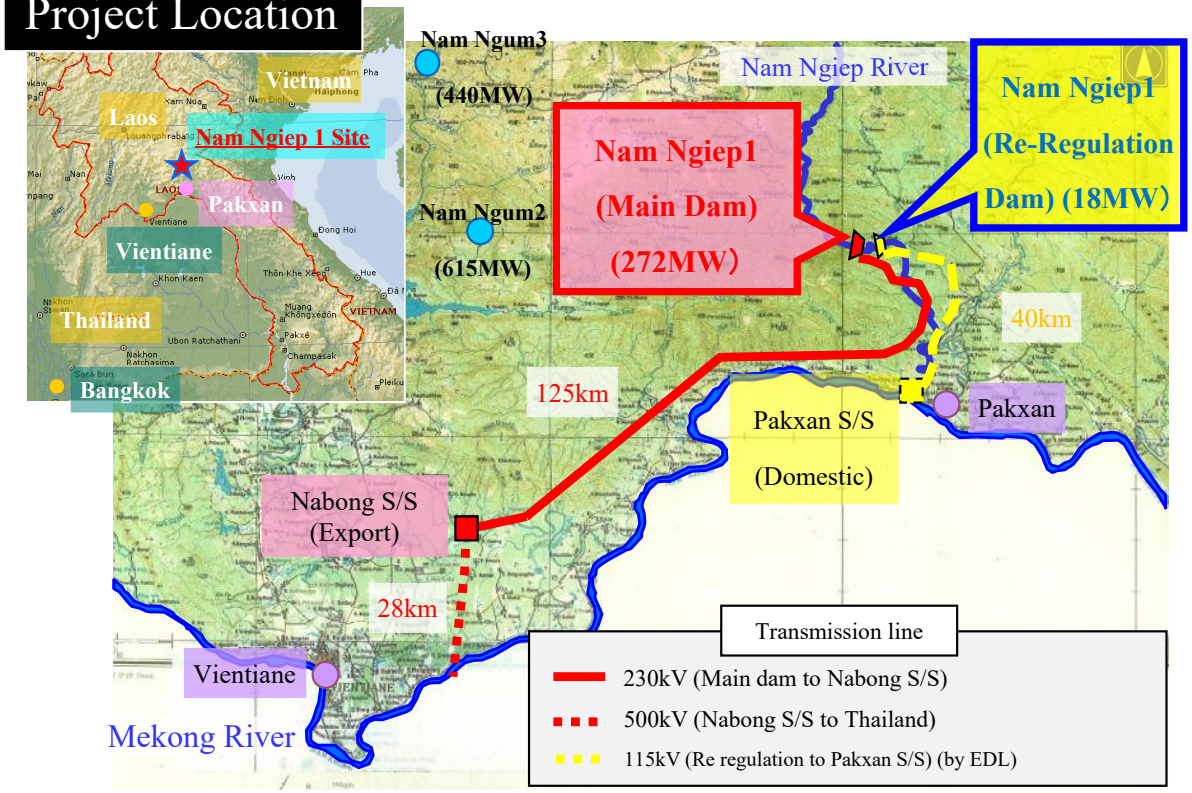
● : Completion

◌ : Under Construction

◌ : Under Planning

Nam Ngiep 1 Hydropower Project (Lao PDR)

Project Location



Salient Feature

Item (Main Dam)	Spec.
Installed Capacity	272MW
Annual Energy Generation	1,447GWh
Dam Height	167m
Reservoir Area	67km^2
Effective Storage Capacity	1.2 Bil. m^3

Development Schedule

Date	Event
Oct. 2014	Financial Close Start Construction
Apr. 2016	Start Dam Construction
Apr. 2018	Completion of Dam Construction & Resettlement
May 2018	Start Reservoir Impounding
Feb. 2019	Commercial Operation

Environmental & Social Consideration for NNP1

Environmental Considerations

Biodiversity Restoration



Catchment Area
3,700 km^2

Biodiversity Offset

Watershed Management

- ✓Forest/River Protection
- ✓Restriction of Land-Use
- ✓Fishery Control

Reservoir	
Length	70km
Area	67km^2
Capacity	2.0 Bil. m^3

Biomass Clearance

Environmental/Safety at Construction Site

- ✓Environmental Monitoring
- ✓Safety & Health Activities
- ✓Zero-tolerance (Code of Conduct)

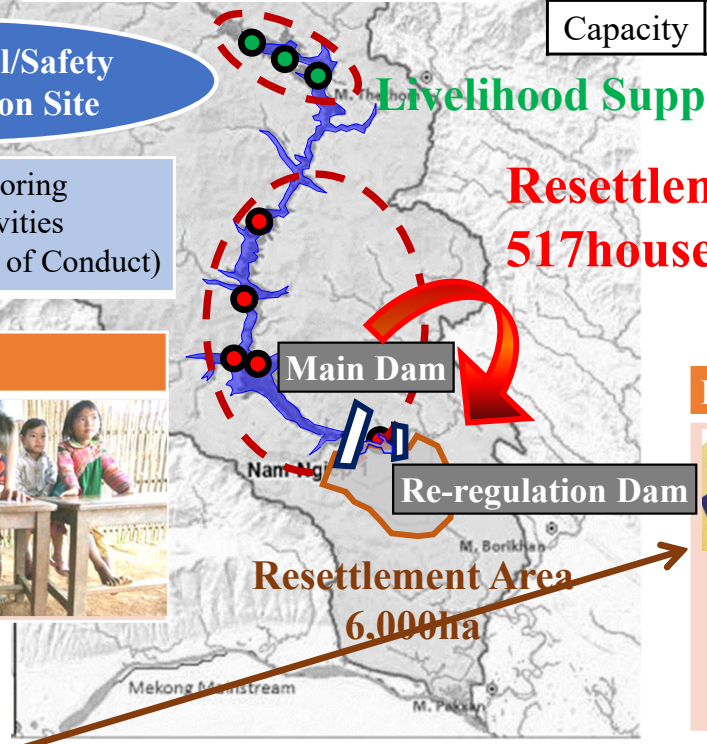
Livelihood Support

Resettlement for 5 villages, 517households, 3,500 people

Education

Compensation for Resettlement

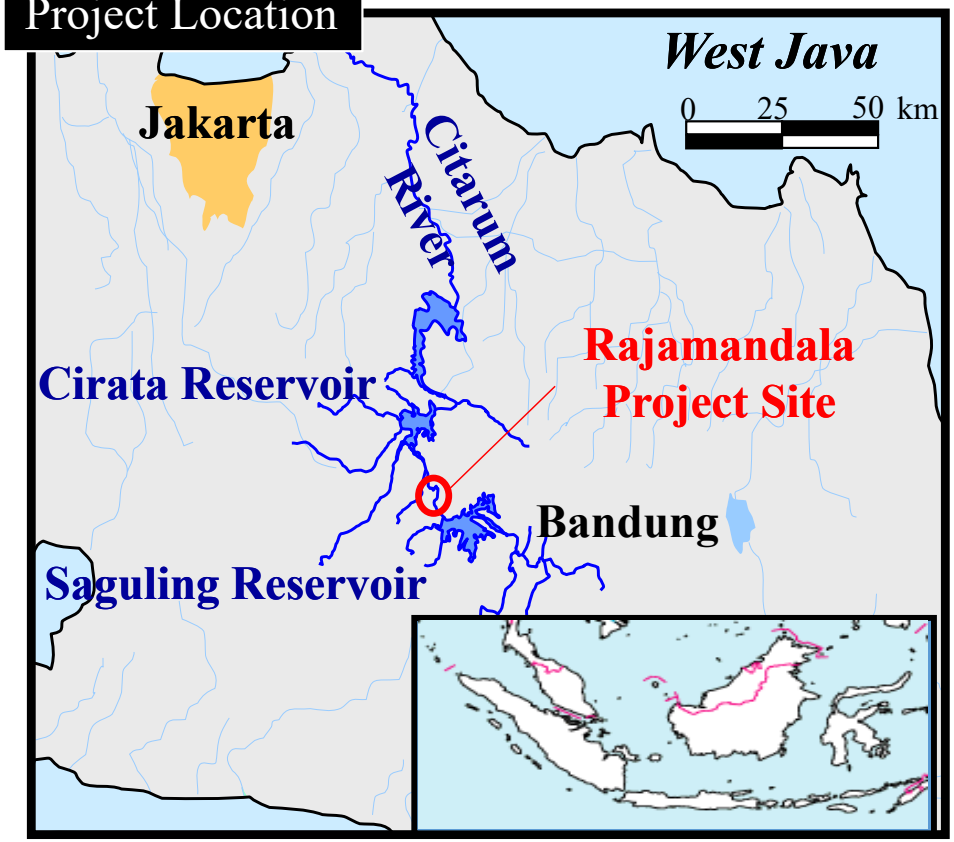
Livelihood Restoration



Social Considerations

Rajamandala Hydropower Project (Indonesia)

Project Location



Run-off-river type hydropower project, utilizing stable discharge from the Saguling HPP immediately upstream.

Salient Feature

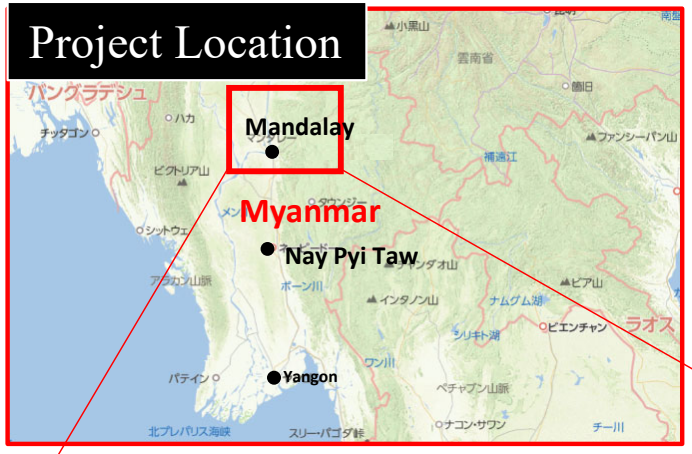
Item	Spec.
Installed Capacity	47MW
Annual Energy Generation	181 GWh
Plant Discharge	168m^3/s
Effective Head	31.7m

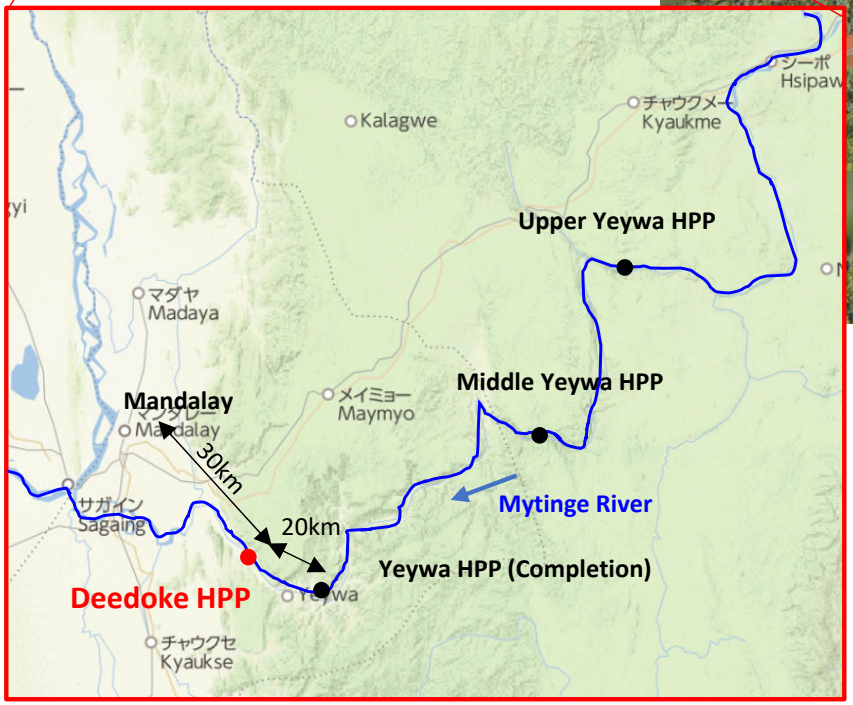
Development Schedule

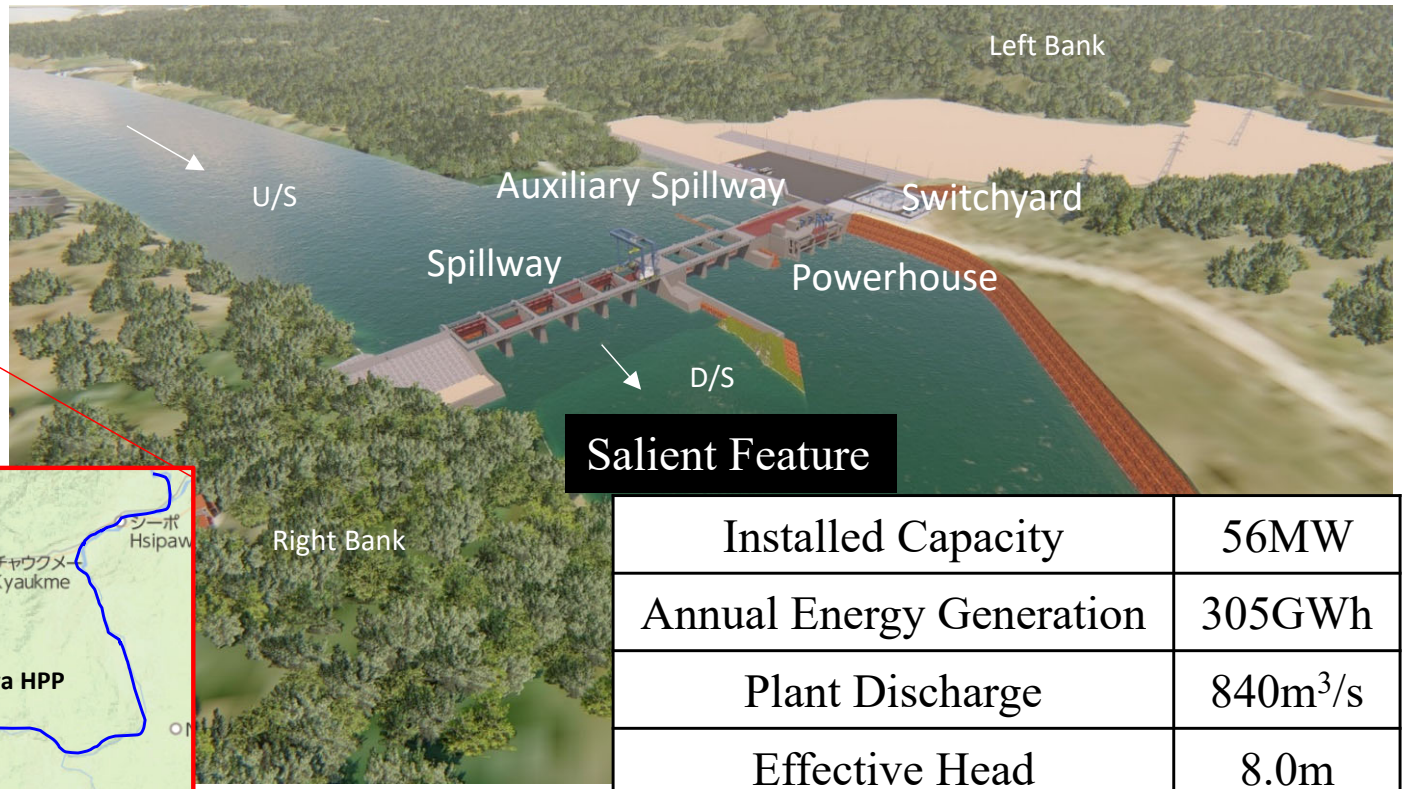
Date	Event
Feb. 2012	SPC Establishment
Aug. 2013	PPA Signed
Mar. 2014	EPC Contract
Jun. 2014	Financial Close
Aug. 2014	Start Construction
May. 2019	Commercial Operation

Deedoke Hydropower Project (Myanmar)

Project Location







Salient Feature

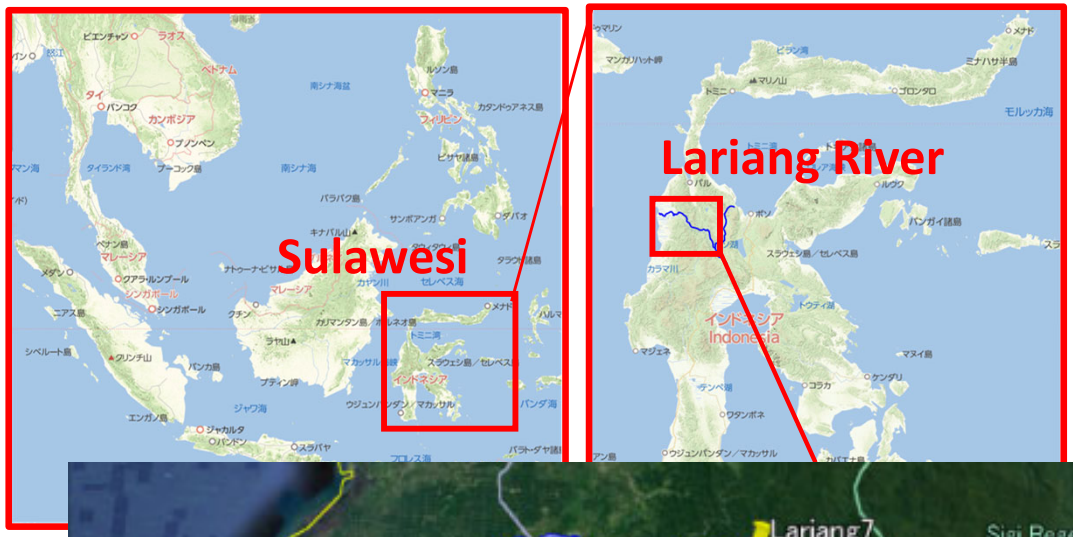
Installed Capacity	56MW
Annual Energy Generation	305GWh
Plant Discharge	840m^3/s
Effective Head	8.0m

NTP Signing
(16 Aug. 2018)

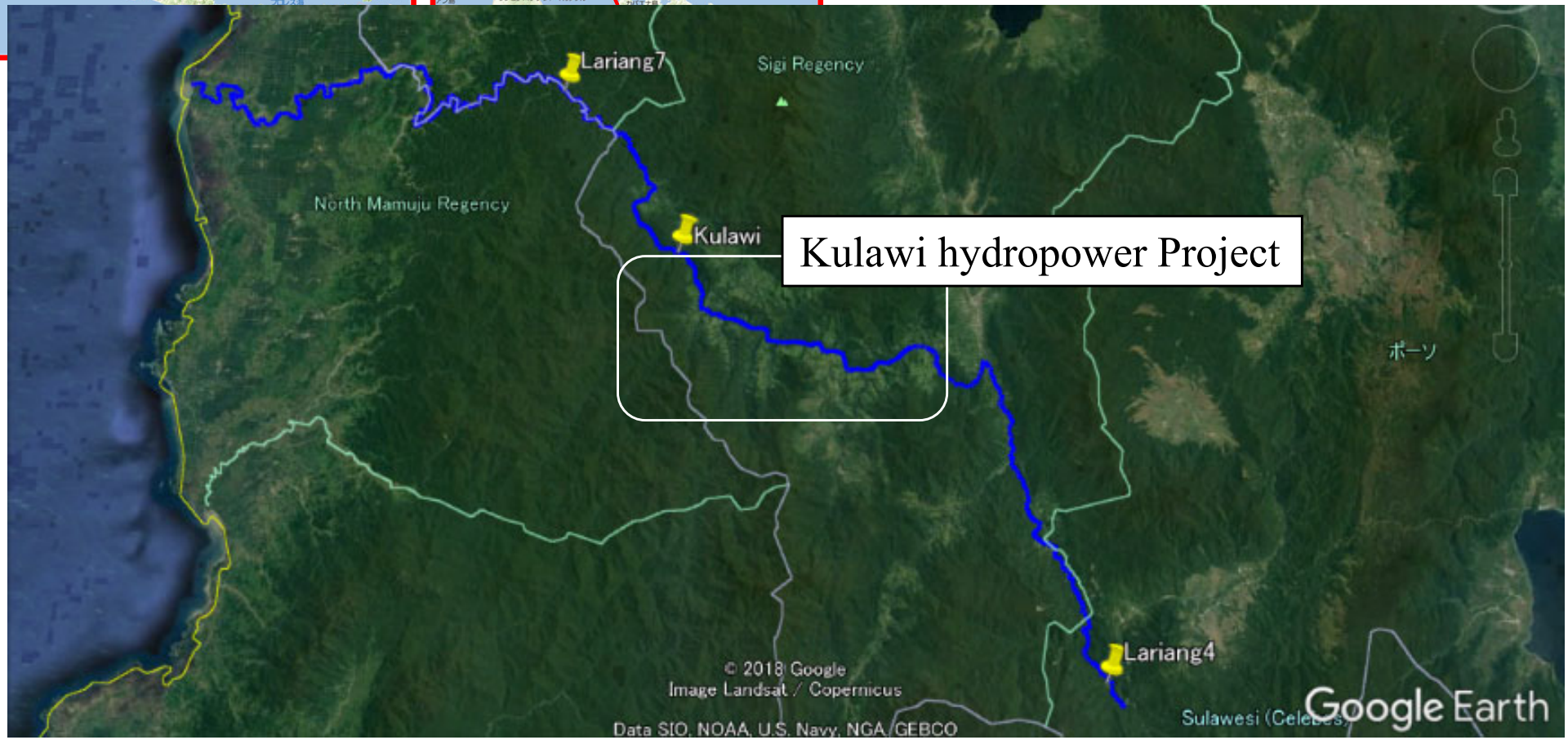
Development Schedule

2019 : Financial Close, Start Construction
2022 : Commercial Operation

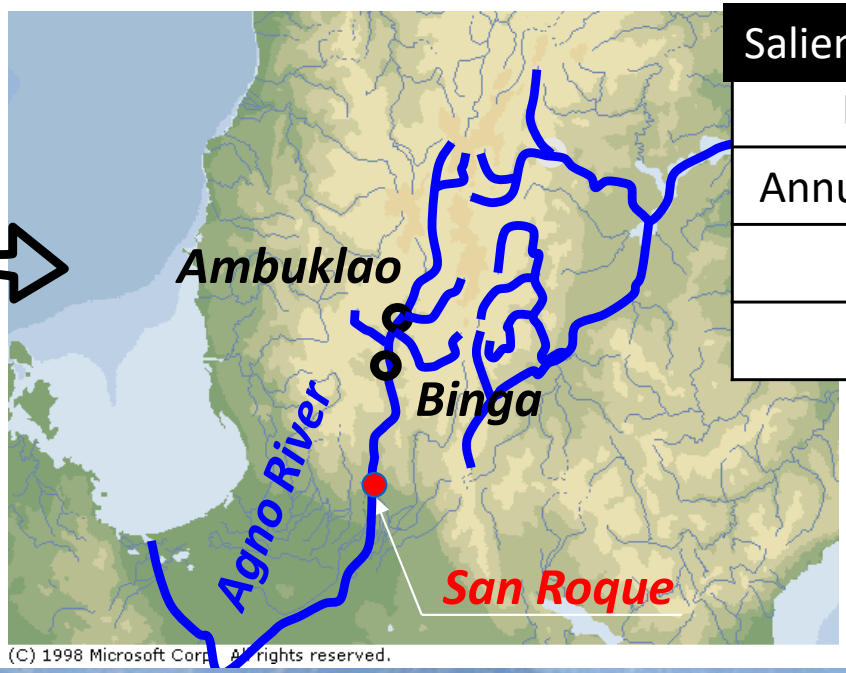
Kulawi Hydropower Project (Indonesia)



- ***We started the feasibility study with a local partner in 2017, which is scheduled to complete in 2019.***



San Roque Hydropower Project (Philippines)



Salient Feature

Installed Capacity	411MW
Annual Energy Generation	1,000GWh
Plant Discharge	260m^3/s
Effective Head	180m

Development Schedule

Date	Event
Nov. 1997	PPA Signed
Mar. 1998	Start Construction
Oct. 1998	KANSAI joined the PJ
May. 2003	Commercial Operation

Challenges for 2018

Sustainability for efficient asset management

Streamlining the facilities management and maintenance by promoting the application of leading edge of AI, IoT and drone technologies

Improvement for low cost-efficient power plants

Improving profitability pursuing the applicability of the critical maintenance method for low cost-efficient power plants, depending on the risk level for malfunctioning in operation and the third parties impacts

Optimization of pumped storage hydropower plants in operation

Optimizing the maintenance cost of existing pumped storage hydropower plants to make the maximum use