Feasibility Studies with the Aim of Developing a Bilateral Offset Credit Mechanism FY2011

Studies for Project Exploration and Planning

Studies for Project Exploration and Planning Rehabilitation Project of Hydro Power Plants in Indonesia

New Energy and Industrial Technology Development Organization (NEDO)

Recycle One, Inc.
Toshiba Corporation

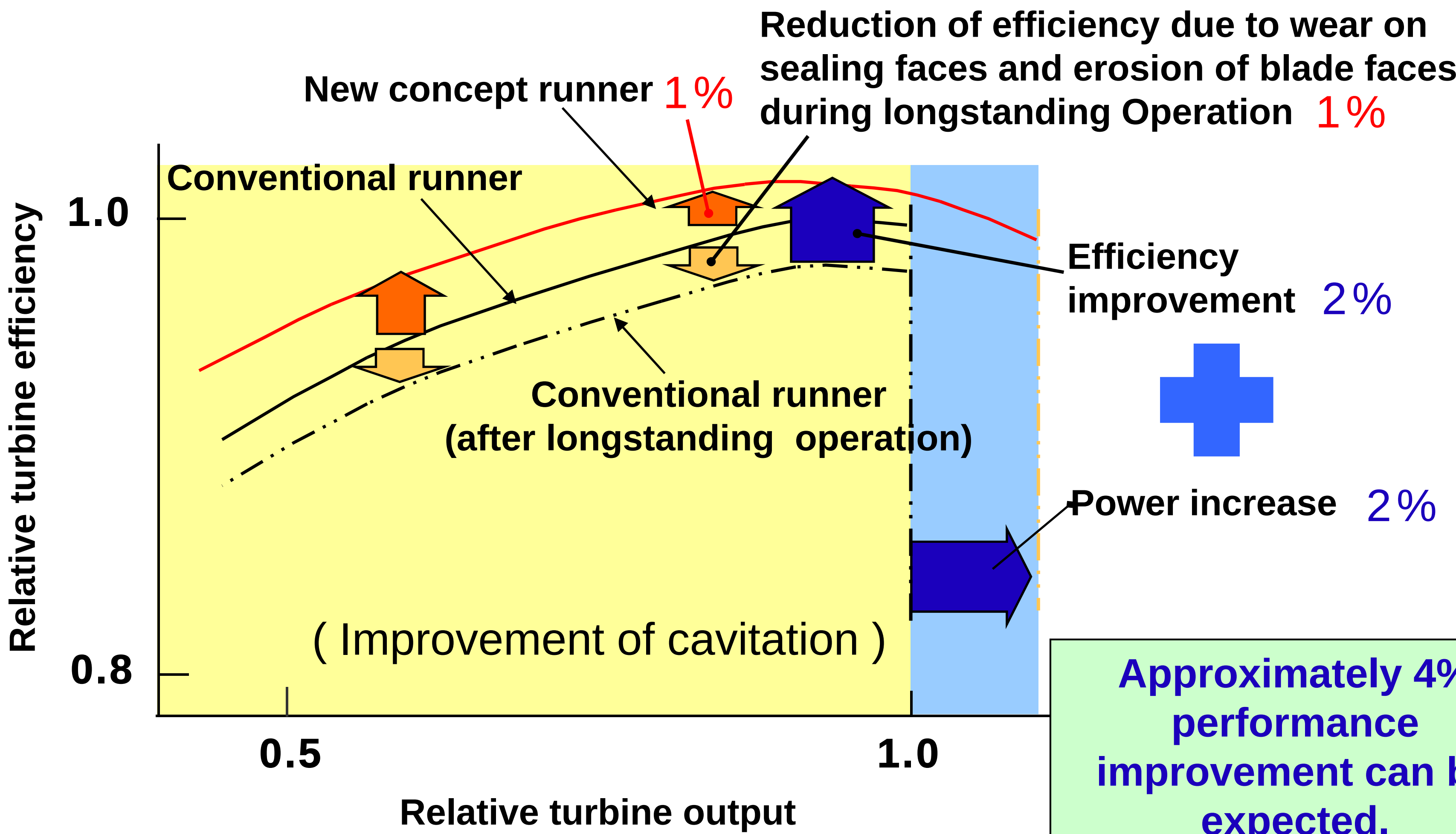
1) Project Overview
Rehabilitation of PLN's Saguling Hydro Power Plant

- Rehabilitation of **PLN's hydro power plants** (HPPs) in Indonesia.
- **Improved power generation and cost savings** by rehabilitation of **turbines and generators** at aging and inefficient hydro power plants.
- Case study at **Saguling** hydro power plant, among 12 hydro power plants installed by **Toshiba** in Indonesia.
- Consideration of a **new MRV methodology** based on power generation efficiency factors.
- **Possibility of expanding** to other hydro electric power plants in Indonesia.

1) Project Overview
Images of HPP Rehabilitation

	Stator core/coil	Runner	Guide vane	Control system, Governor, AVR…
Before				
After				

1) Project Overview
Concept of Efficiency Improvement and Output Increase



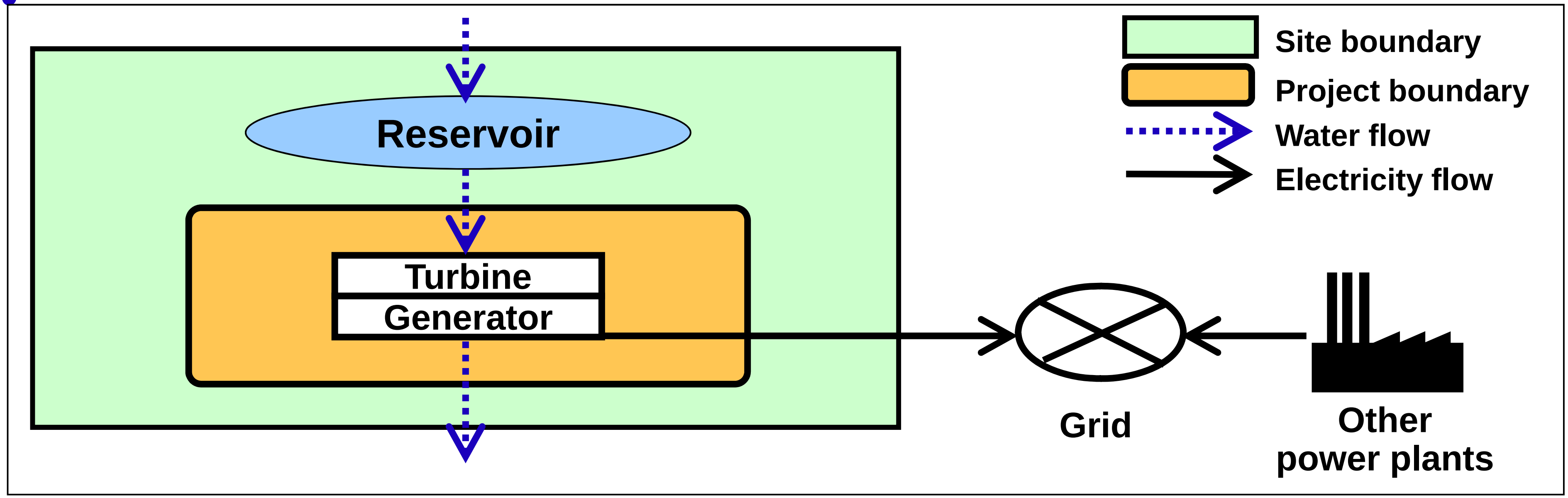
Approximately 4% performance improvement can be expected.

1) Project Overview
Issues with CDM and Overview of Proposed Methodology

Issues with current CDM*	Proposed BOCM Methodology
Cannot reflect efficiency improvements from rehabilitation of HPPs.	Based on power generation efficiency factor** to reflect improvements.
Non-experts unfamiliar with technology and local conditions make decisions.	Positive list taking technological and local conditions into account.
Requires long time to register, mainly due to financial analysis to prove additionality.	
Requires non-expert project participants to calculate grid emission factor.	Default grid emission factor authorized by both governments for each grid.

* ACM-0002, AMS-I.D were referred.
** Electricity generated per volume of water inputted in MWh/m3.

2) Baseline Scenario
Project Boundary



Reference of GHG emissions*	Boundary**	Calculation for GHG emissions**
Mining resources, supplying materials and manufacturing plants		
Transport, construction and waste disposal in the rehabilitation		
Water input for electricity generation	✓	✓
Displacing grid electricity	✓	✓
Transmission loss of electricity	✓	

*Reservoir is not included in the rehabilitation so that CH4 from reservoir does not increase.

**ACM-0002, AMS-I.D were referred.

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2) Baseline Scenario
Baseline Scenario and Additionality of Project Scenario

	Scenario 1 Business as usual	Scenario 2 Voluntary rehabilitation	Scenario 3 Major rehabilitation

Technology

- **No company with expertise in and experience of rehabilitating large HPPs, aimed at efficiency improvement, exists in Indonesia. (BAPPENAS, MEMR, BPPT)**

Prevailing Practice

- **No known examples of rehabilitating MW class HPPs in Indonesia.**
- **Developing new power plants, rather than improving existing ones, are more important in energy policy to improve electrification ratio.**
- **HPP rehabilitation is not a part of existing climate change policy.**

Investment

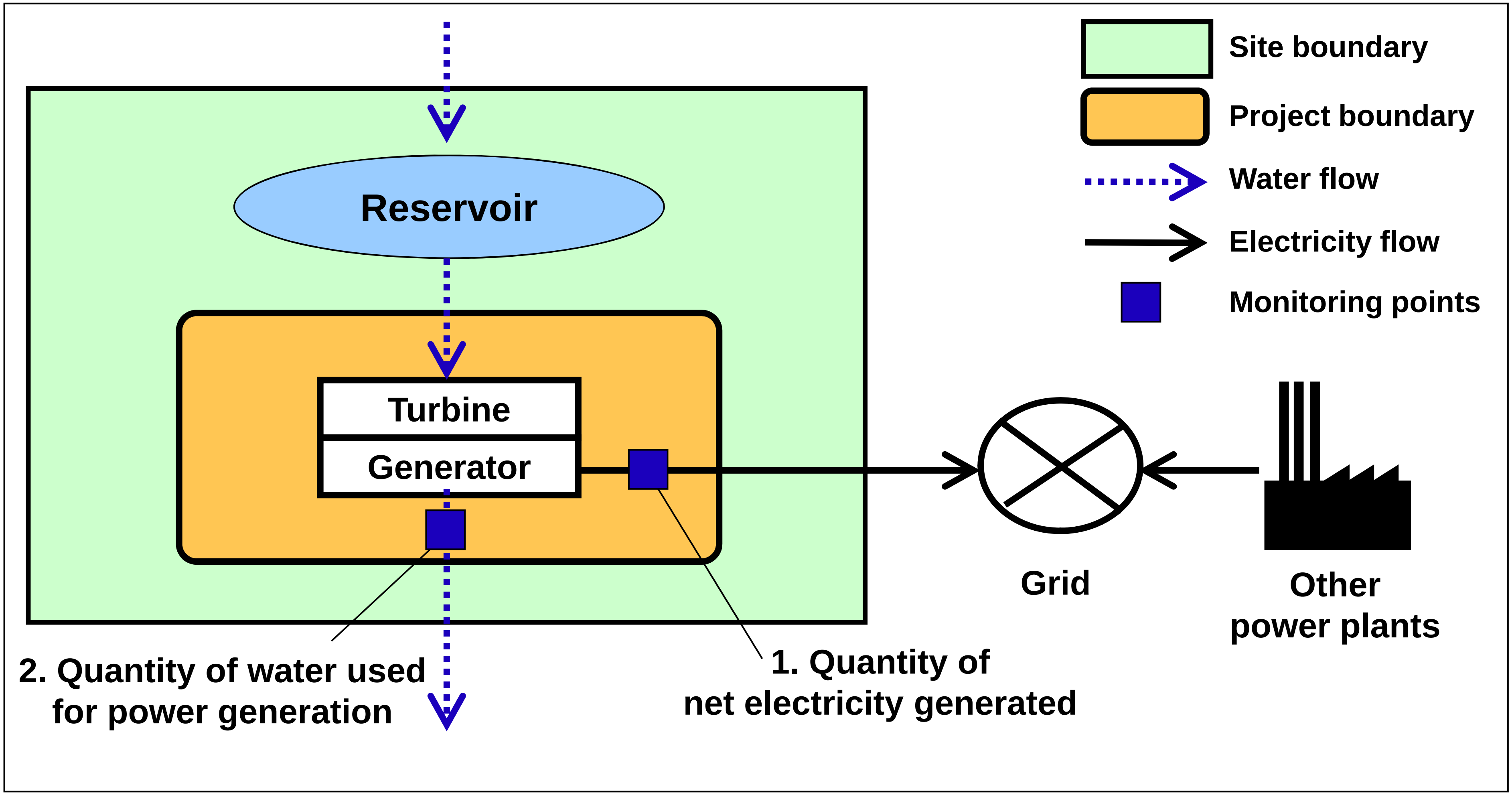
- **Return on investment not very attractive.**
  - **Project IRR < Benchmark rate * = 12.9%**
  - **Project IRR = 11.55%(15yrs)**

Scenario 1 → **Baseline Scenario**

Scenario 3 → **Project Scenario**

* Average Interest Rate of Rupiah Investment Loans by Bank Indonesia in 2007-2011

3) Monitoring Method
Monitoring Points

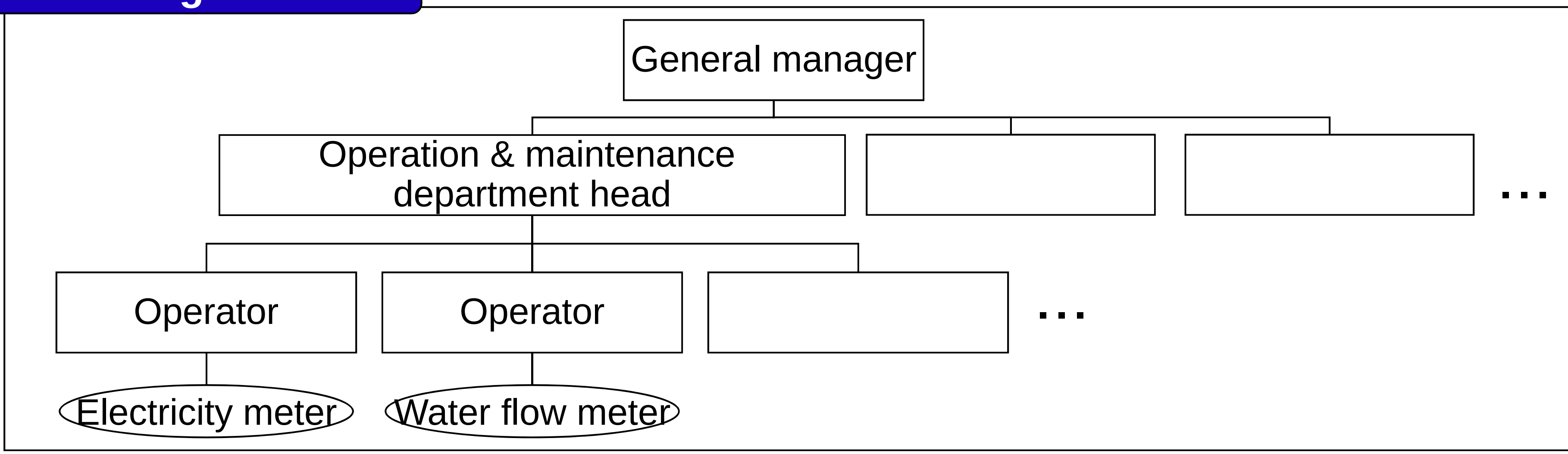


3) Monitoring Method
Monitoring Data, Frequency, Method and Plan

Monitoring data

ID	Description	Unit	Frequency	Measurement/Archive
1	Quantity of net electricity generated fed into in year y	MWh	Monthly	● Measured by power meter ● Archived electronically.
2	Quantity of water for generation in year y	m^3	Monthly	● Measured by water flow meter ● Archived electronically.
3	GHG emission factor of the grid in year y	tCO2/ MWh	Yearly	● Annual default value provided by host country, d verified by a third party.

Monitoring scheme



4) GHG Emission Reduction
Calculation for GHG Emission Reduction

$$ER_y = BE_y - PE_y - LE_y$$

$$LE_y = 0\ (default)$$

$$PE_y = 0\ (default)$$

$$BE_y = EG_{Add,y} \times EF_{co2,y}$$

$$EG_{Add,y} = GF_{Add,y} \times WQ_{PJ,y}$$

$$GF_{Add,y} = GF_{PJ,y} - (GF_{historical} + \sigma_{historical})$$

High generation efficiency as a results of the rehabilitation

$$GF_{PJ,y} = \frac{EG_{PJ,y}}{WQ_{PJ,y}}$$

Low generation efficiency before the rehabilitation

$$GF_{historical} = \sum_{n} \frac{EG_{beforePJ,beforey}}{WQ_{beforePJ,beforey}} \times \frac{1}{n}$$

4) GHG Emission Reduction Definitions of Parameters

Parameter	Description
ER_y	● Emission reduction in year y (tCO2e/y)
BE_y	● Baseline emissions in year y (tCO2e/y)
PE_y	● Project emissions in year y (tCO2e/y) ● Default value is 0. Since this methodgy is available for the rehabilitation for the hydropower station whose power density is less than 4 W/m^2, CH4 from its reservoir is neglected
LE_y	● Leakage emissions in year y (tCO2e/y) ● Default value is 0.
$EG_{PJ,y}$	● Quantity of net electricity generation fed into the grid as a result of the rehabilitation in year y (MWh/y)
$EG_{beforePJ,beforey}$	● Quantity of net electricity generation fed into the grid before the rehabilitation in year y (MWh/y)
$EG_{Add,y}$	● Additional quantity of net electricity generation compared before the rehabilitation in year y (MWh/y)

Parameter	Description
$EF_{co2,y}$	● GHG emission factor of the grid in year y (tCO2e/y)
$WQ_{PJ,y}$	● Quantity of water for generation as a result of the rehabilitation in year y (m3/y)
$WQ_{beforePJ,beforey}$	● Quantity of water for generation before the rehabilitation in year y (m3/y)
$GF_{PJ,y}$	● Generation efficiency factor as a result of the rehabilitation in year y (MWh/m3)
$GF_{historical}$	● Annual average historical generation efficiency factor before the rehabilitation (MWh/m3) ● Historical data for at least 5 years is needed
$GF_{Add,y}$	● Additional generation efficiency factor compared historical in year y (m3/MWh)
$\sigma_{historical}$	● Standard deviation of the annual average historical generation generation efficiency factor before the rehabilitation (MWh.m3)

4) GHG Emission Reduction
GHG Emission Reduction of Saguling HPP Rehabilitation

$$ER_y\ [tCO2e/y] = \{ GF_{PJ,y} - (GF_{historical} + \sigma_{historical}) \}\ [MWh/m3] \times WQ_{PJ,y}\ [m3/y] \times EF_{co2,y}\ [tCO2e/MWh]$$

Assumptions:

(1) Improvement in Generation efficiency: +4%

$$GF_{PJ,y}\ [MWh/m3] = (1+0.04) \times GF_{historical}\ [MWh/m3]$$

(2) Historical generation efficiency: Average for the past 5 years*

(3) Quantity of water: Average for the past 5 years*

(4) Grid : JAMALI

$$EF_{co2,y}\ [tCO2e/MWh] = 0.891^{**}\ [tCO2e/MWh]$$

ER_y [tCO2e/y] = **68,005 [tCO2e/y]**

* 2007-2011

** National Council on Climate Change(NCCC)

5) MRV Methodology
MRV Methodology for HPP Rehabilitation

	Proposed methodology
Unit of MRV	● **MRV by project of GHG emission reduction activity** ● **Only one HPP in one project.**
Measurement and Reporting	● **A third party validates monitoring plan before the project start.** ● **Project participant acquires data according to the validated monitoring plan, and report to the third party.**
Verification	● **Validation to check additionality, calculation method, monitoring plan, and others before the project start.** ● **Verification to review monitoring according to validated monitoring plan during project period.**

5) MRV Methodology
Validity of Proposed MRV Methodology

Based on CDM	● MRV Process based on current CDM. ● Methodology based on current CDM methodologies. ● CDM Methodology using specific unit factor exists.
Refers to other crediting mechanism	● Methodology refers to existing project-based methodologies under other schemes, such as Domestic Credit and J-VER in Japan. ● Positive list is used in these schemes.
Reality checked	● Methodology based on interviews with Japanese experts in market-based mechanisms, project developers, and DOEs.

6) GHG Emission Reduction Potential
Operating Status of HPPs over 10MW in Indonesia

HPPs	Initial year of operation	Installed capacity
Sutami HPP	1973、1974	36MW×3units
Riam Kanan HPP	1973	10MW×3units
Wlingi HPP	1978、1980	27MW×2units
Maninjau HPP	1980、1983	17MW×4units
Garung HPP	1982	13.2MW×2units
Saguling HPP	1985、1986	175MW×4units
Murica HPP	1988	60.3MW×3units
Sengguruh HPP	1988	14.5MW×2units
Bakaru HPP	1990	63MW×2units

HPPs	Initial year of operation	Installed capacity
Kedungombo	1992	22.5MW×1unit
Tulunggagung HPP	1993	18MW×2units
Singkarak HPP	1998	43.75MW×3units
Cirata HPP	1997,1998	126MW×4units
Batutegi HPP	2000	14.88MW×2units
Sipansihapo-rasu HPP	2001	17.0MW×1units 34.6MW×1units
BiliBili HPP	2005	14.1MW×1unit 6MW×1unit
Musi HPP	2007	67MW×3units

6) GHG Emission Reduction Potential
GHG Reduction Potential through HPP Rehabilitation

Target HPPs	Initial year of operation	Installed capacity	GHG reduction*
Sutami HPP	1973、1974	36MW×3units	**14,036**
Riam Kanan HPP	1973	10MW×3units	**5,570**
Wlingi HPP	1978、1980	27MW×2units	**3,474**
Maninjau HPP	1980、1983	17MW×4units	**3,648**
Garung HPP	1982	13.2MW×2units	**1,699**
Saguling HPP	1985、1986	175MW×4units	**68,005**
Murica HPP	1988	60.3MW×3units	**11,639**

Total
108,071
tCO2e/year

*Each level of reduction effect iss assumed as same as Saguling HPP.