Asia Solar Energy Forum (ASEF)

Solar-Ice Project in Dhiffushi Island in Maldives

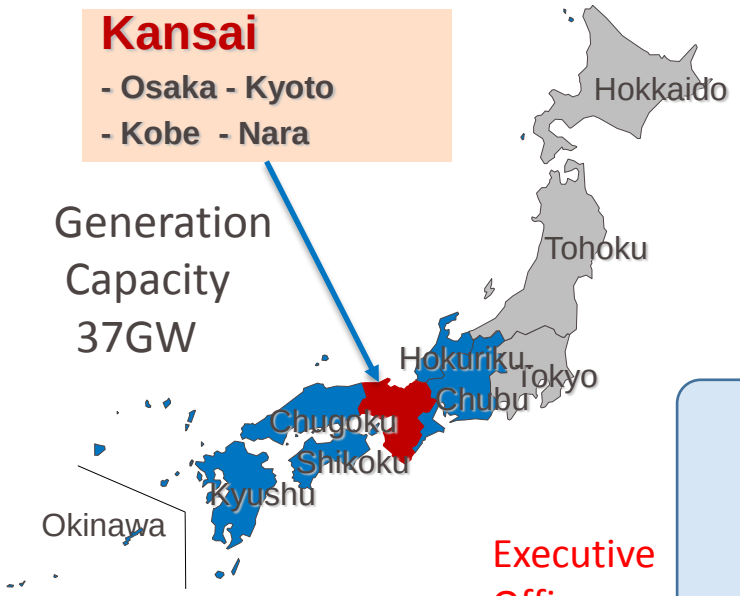
5th June, 2017

Kansai Electric Power Co.

Toshikazu Ohashi

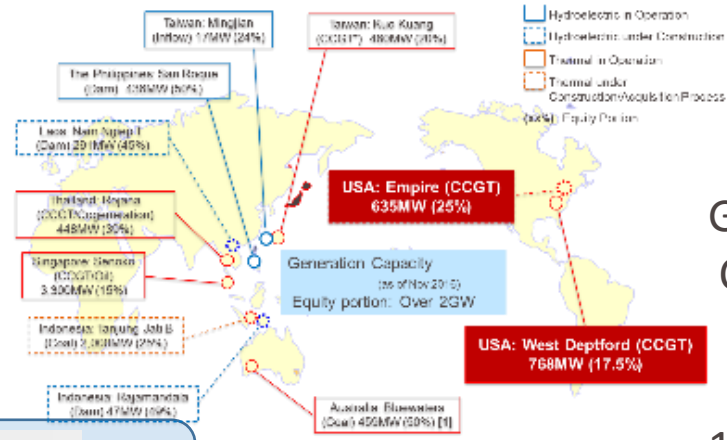
Kansai Electric Power
power with heart

International business of Kansai Electric Power



Managing Executive Officer (& Director)

HIDEHIKO YUKAWA (A)
(Power Distribution Engineer)



Generation Capacity
2GW(now)
↓
10GW~12GW
(year 2025)

Executive Officer

MASAYUKI HAMANO (A)
Planning & Asset Management
（Power System Engineer)

HIROSHI NAKAJIMA (A)
Investment & Development
(Power System Engineer)

- Paris Office
- Bangkok Office
- Jakarta Office

* U.S.Office is planned in 2017

General Manager

YOSHIHIRO TAKECHI	MANAMI ARIMOTO	TORU KUWAHARA	KIYOSHI TAKEBAYASHI	MAKOTO TAKEUCHI	TOSHIHIRO TAKANO
Planning & Administration (Transmission Engineer) **<18 staff>**	Communication & Marketing Intelligence (Finance /Marketing) **<5 staff>**	Asset Management (Thermal Power Engineer) **<16 staff>**	(A) Project Development & Strategy (IT Engineer) **<10 staff>**	(W) Project Development (IT & Power System Engineer) **<7 staff>**	(A) Project Construction (Hydro & Power System Engineer) **<15 staff>**

<Experience of international institutions>

A : Asian Development Bank

W: World Bank

Technical support & human resources

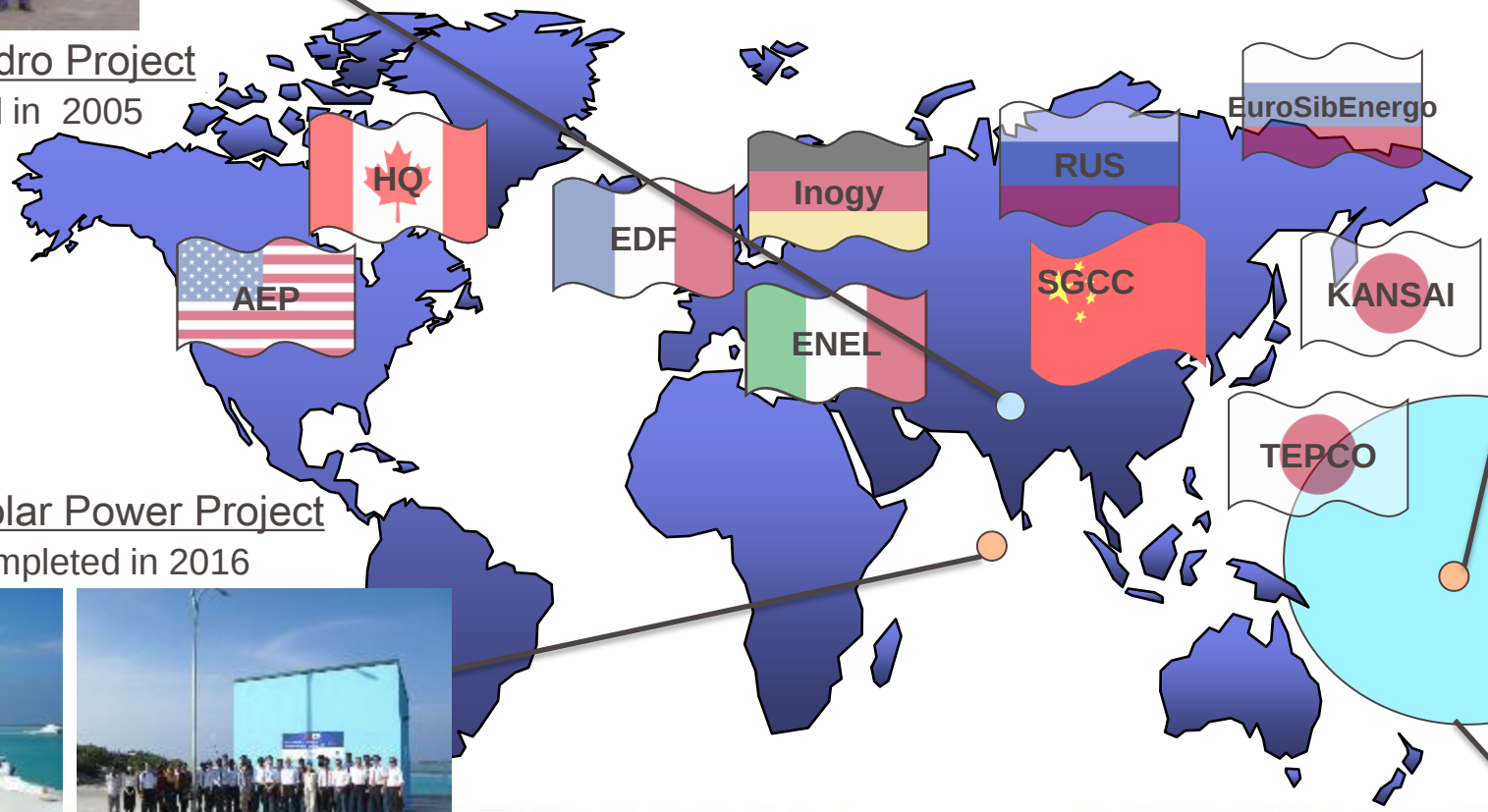
Hydro & Civil Department | **Thermal Power Department** | **Transmission / Distribution Department**

Global Sustainable Electricity Partnership

Bhutan Micro Hydro Project

70kW. Completed in 2005

Global Sustainable Electricity Partnership



Tuvalu Solar Power Project

40kW. Completed in 2008

PPA/GSEP Workshop

since 2005. Executed 14 times

Maldives Solar Power Project

40kW.Completed in 2016

The key for " Business Sustainability"

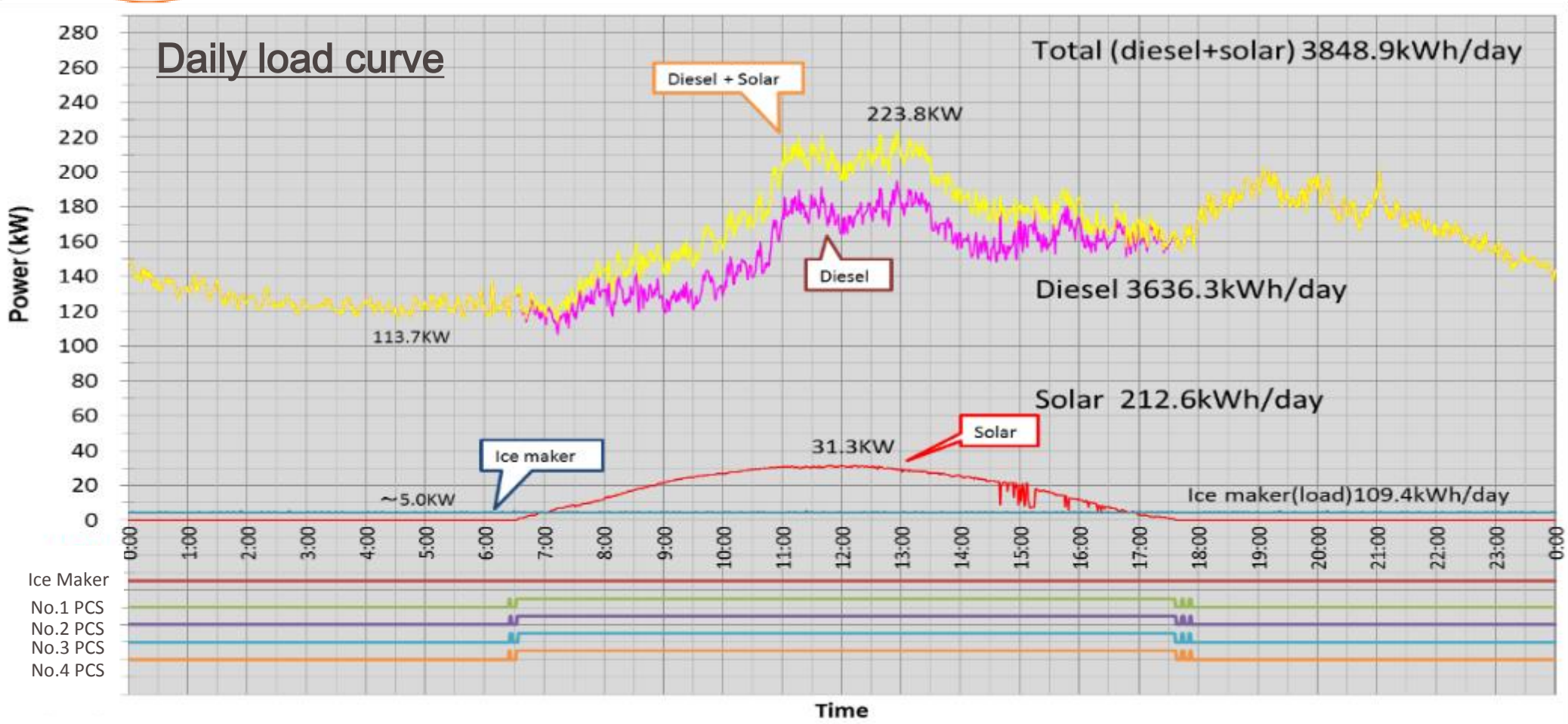
	Tuvalu	Dhiffushi	key
Demand/Capacity of island	Peak demand 700kW(in 2006) Diesel generator 600kW×3	Peak demand 130kW(in 2012) Diesel generator 140kW×1	Should consider high percentage of RE
GSEP project	*40kW solar power*	*40kW solar power*	
Capacity Building (Human resources)	1 Workshop. It seems insufficient to prepare O&M staffs	2 Workshops (supported by ADB) Two-year monitoring (till Feb. 2019)	Should consider sustainable O&M by themselves
Financial resources	Electricity tariff 0.23USD/kWh	0.45USD/kWh	
	Rely on WB, ADB, etc.	.same as Tuvalu	

Use an ice-making machine instead of a conventional battery system

- Easier O&M than battery system
- Ice supports fishery ; the main economic activity in Dhiffushi.

Video(5 min)

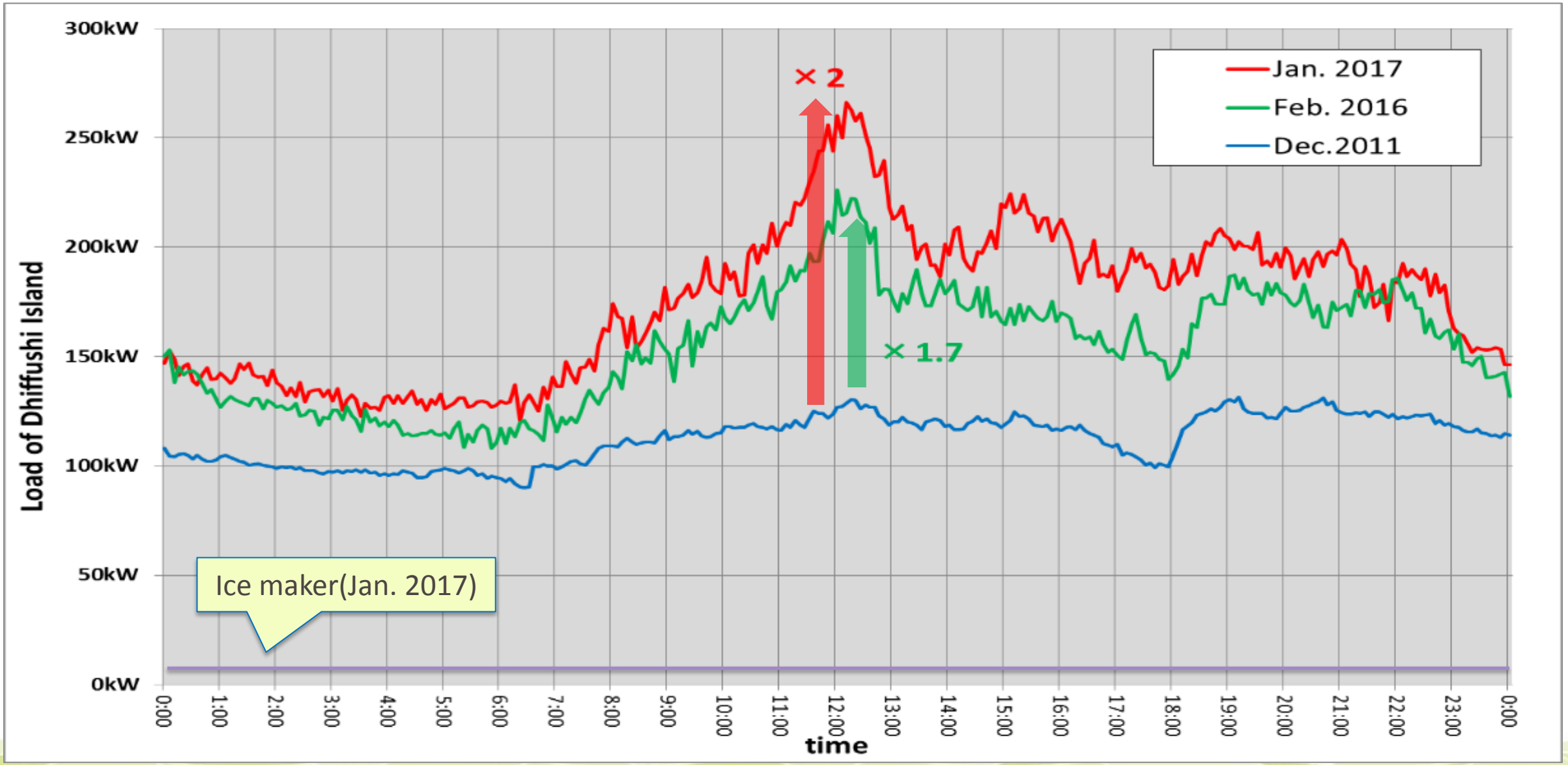
Results of Power Generation (2016)



- Annual PV power generation : 64,823 kWh (180kWh/day, 5% of total consumption)
- Capacity factor of PV : 18.7%
- Annual CO_2 reduction by PV : 52.0 t - CO_2/year
- 1 ton of ice is produced every day

Increase of Electric demand

Comparison of daily load curve



Benefit from Solar Ice

1 ton of ice
can be sold
US $59

Save fuel for
fishermen to
buy ice

$

65MWh/year of
Electricity can be
sold for US $ 30,000
(US $0.49/kWh)

1 ton of ice
costs about US $55
(112kWh of electricity)

19 tons of diesel is
displaced by solar
(US$ 18,000/year)

Idea for sustainable Solar Ice system

Connected by grid

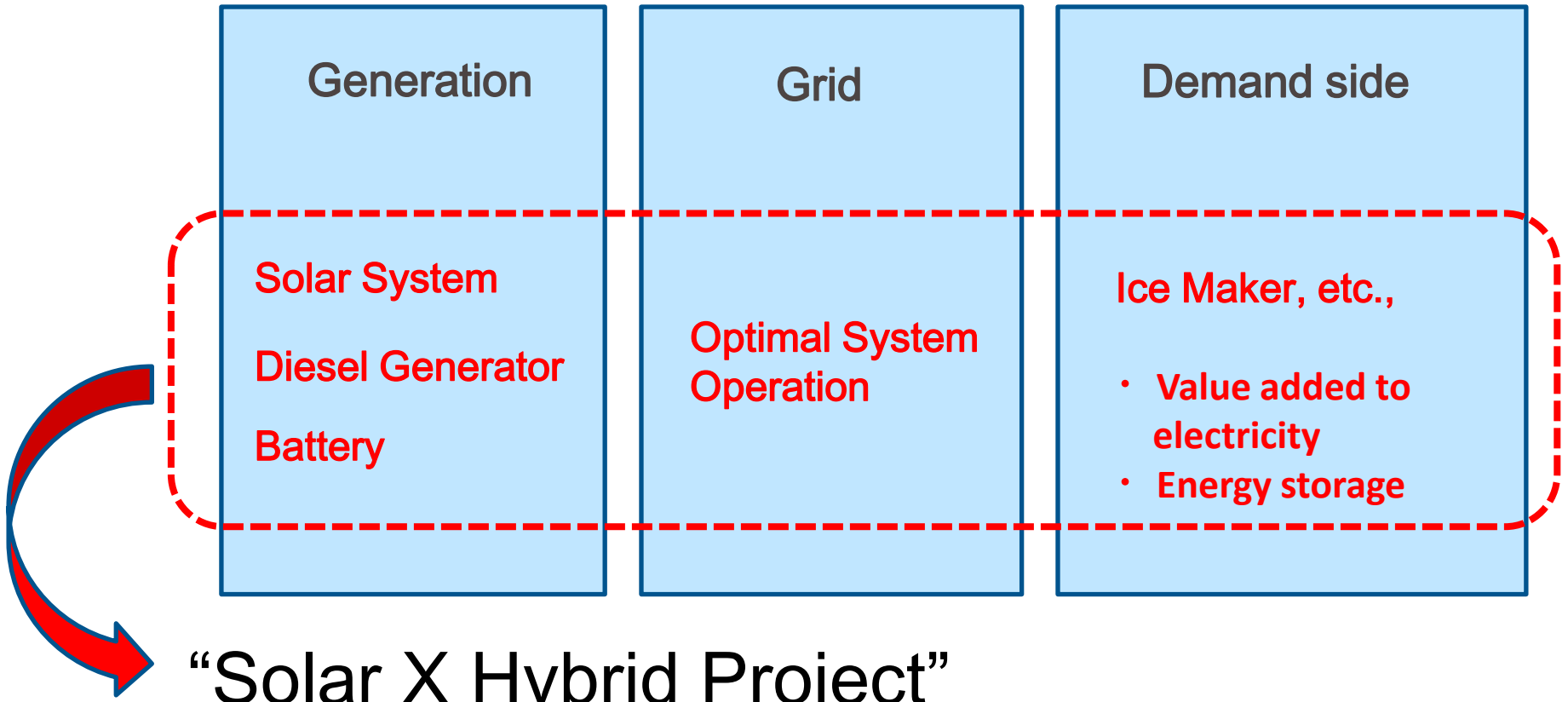
Sustainable Solar System

Customer can pay for electricity by ice.
Utility can prepare for maintenance.

Sustainable Ice Maker

The PV system provides sufficient electricity for the ice production at a reasonable price

Advanced Concept of Solar Ice Project

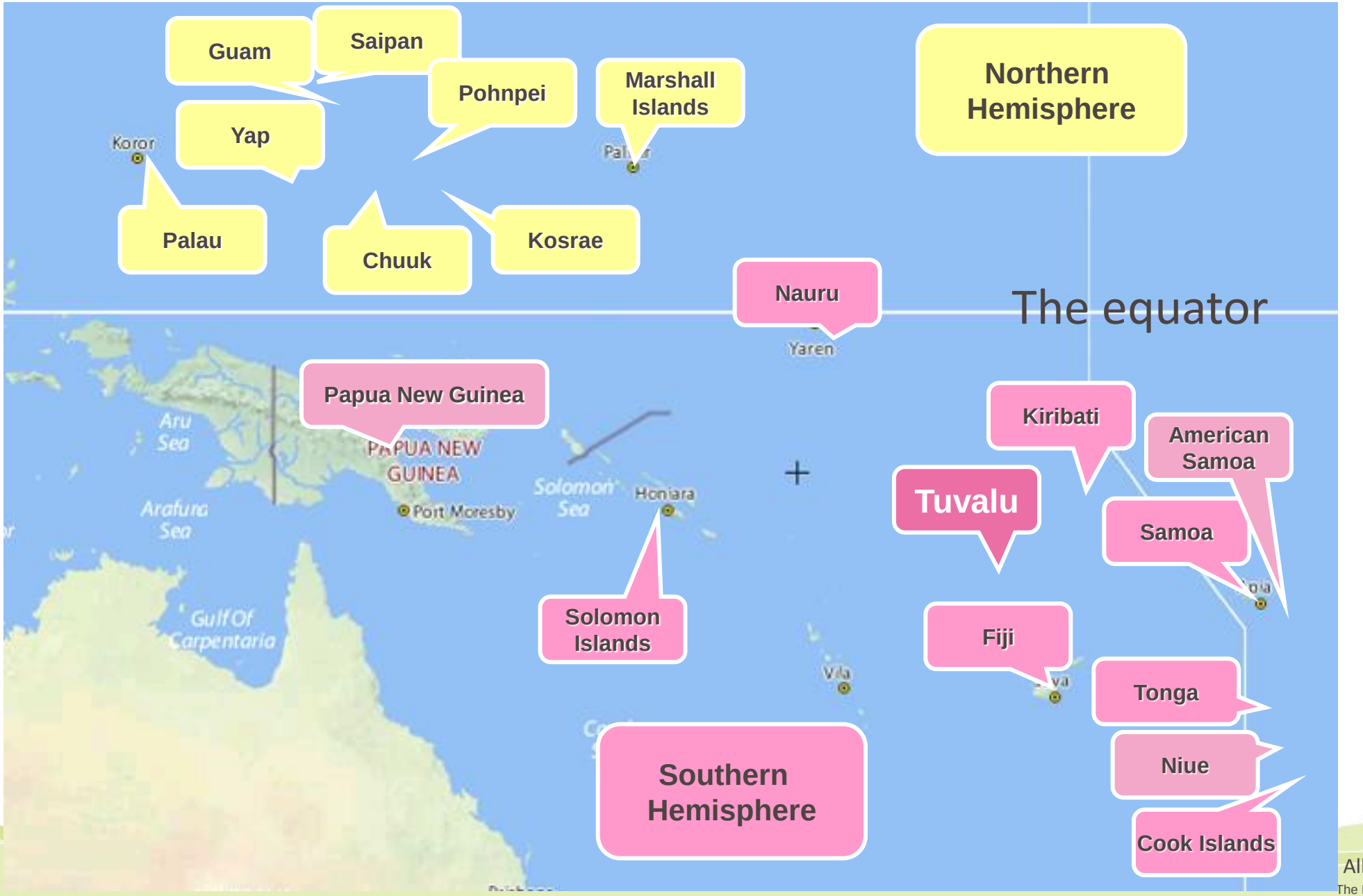


“Solar X Hybrid Project”

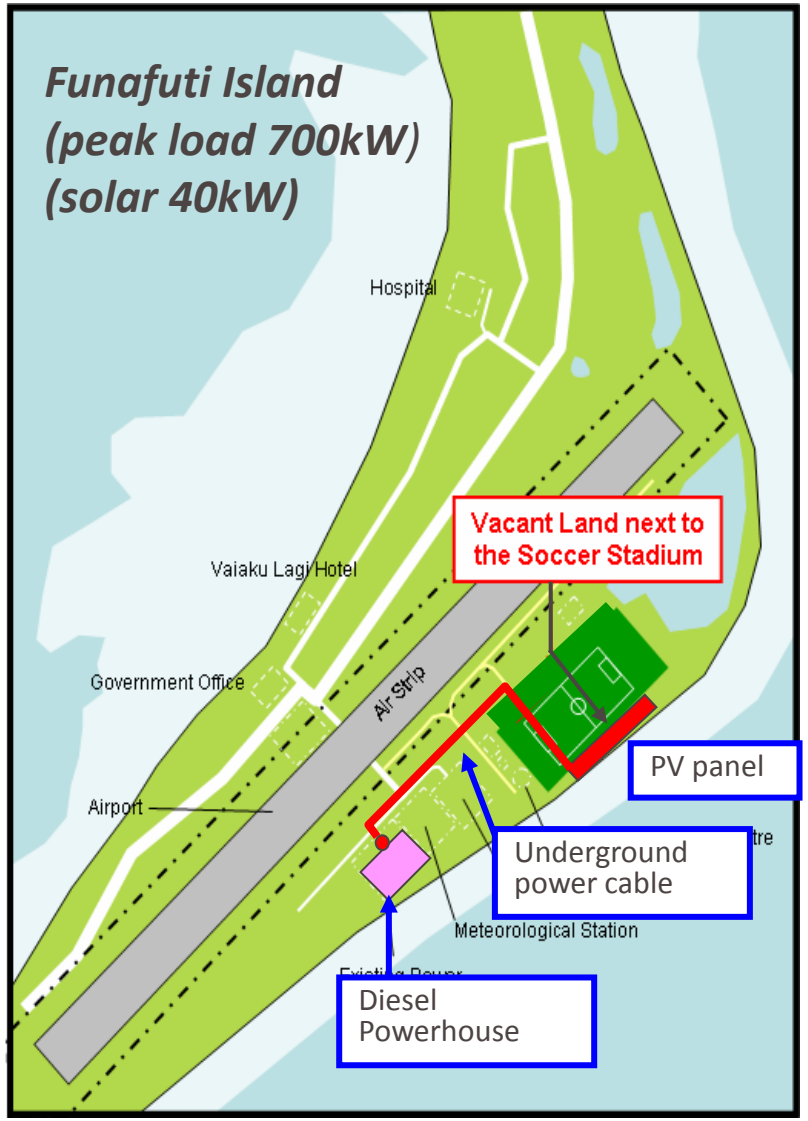
- Integration of power supply (solar) ,grid and demand (ice etc.)
- Achieve economical feasibility of the rural electrification type project by providing not only electricity value added commodity such as ice itself.

Thank you.

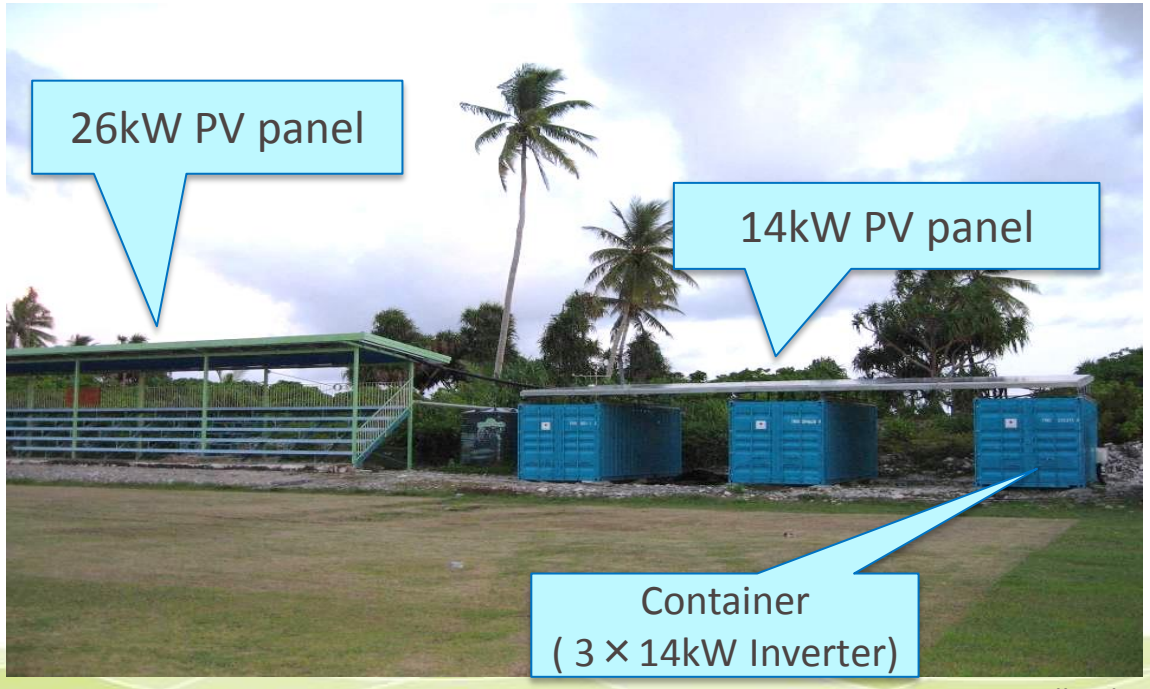
Pacific Power Association



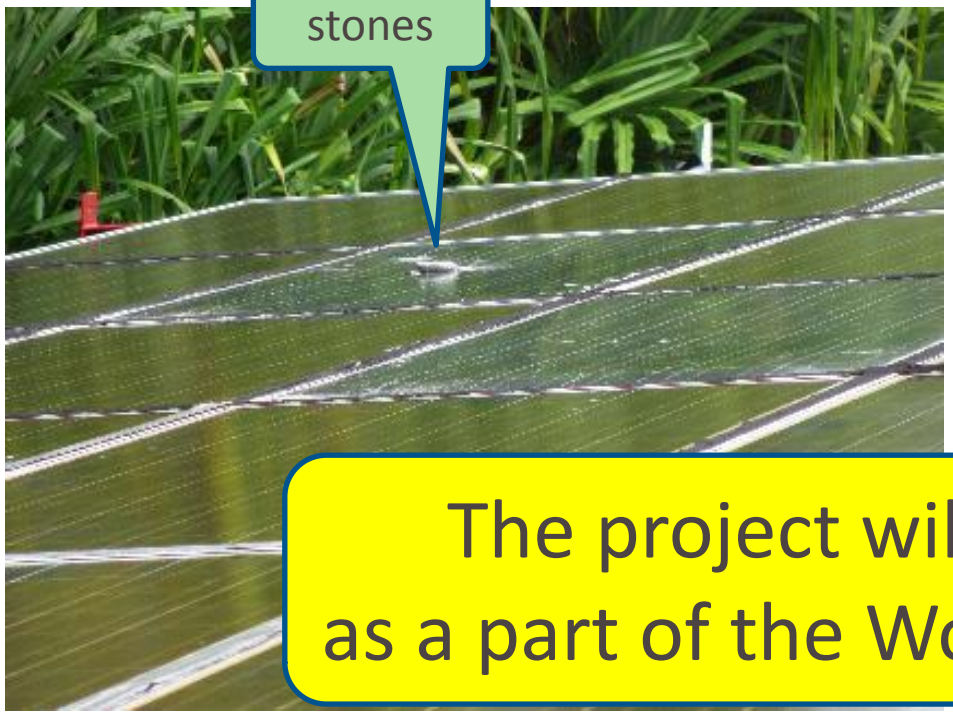
Tuvalu project



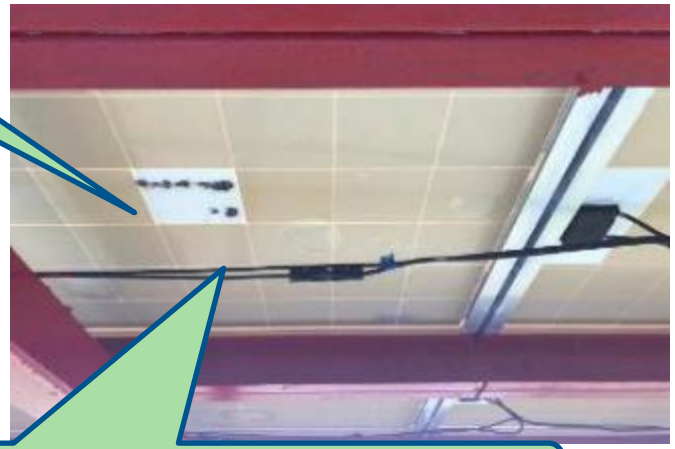
Inauguration Ceremony (Feb. 2008)
(first solar power station in Tuvalu)



The status of Tuvalu project (April. 2017)



The project will be refurbished in 2018
as a part of the World Bank projects (US$ 9M)



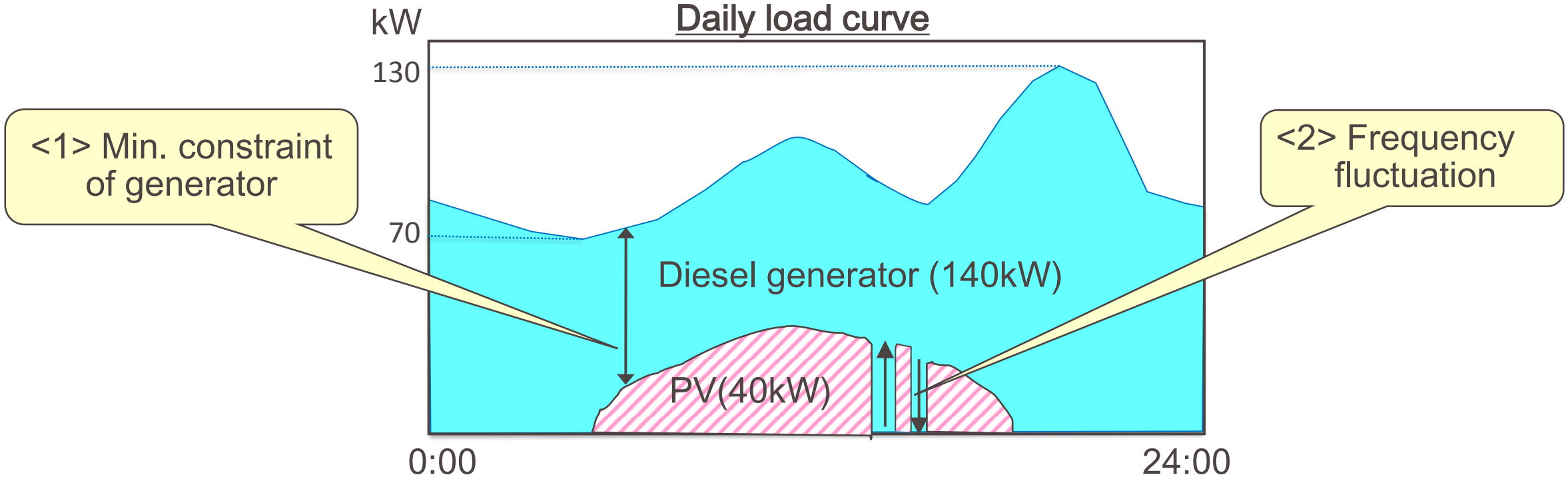
Technical improvement

Component		Tuvalu	Dhiffushi	Note
PV	PV module	Shade of trees and thrown stones caused hot spots	Avoid trees Select main/busy place	improved
	Connection cable	No-fixed installation caused disconnection of cables	All cables are fixed by covering materials	Improved
	Flame/Huts	Seriously rusted Stands of the stadium are periodically painted to prevent rust.	Use SuperDyma® Suggest periodical painting	need to follow-up
Inverter	Inverter	Indoor type Broken by heat(estimated)	Indoor type Installed inside powerhouse STELCO staffs stay there 24/7	improved
	Air conditioner	Compressor seriously rusted		
Underground power cable/fiber cable		Broken by digging Small animals	Route of cable is indicated by marks	improved
Display of power output		broken (not working)	Set indoor	improved

Dhiffushi Island

- Dhiffushi is one of the inhabited Island located in KAAFU Atoll of North Male' Atoll next to Meerufenfushi Island.
- The population at Dhiffushi end of 2015 reports 1247 with 51% of them are Male population.
- Peak demand is 130kW (in 2012)
- 40% of the population engage in fishing.
- Traveling from Male' to Dhiffushi take 40-45 minutes by speed boat.

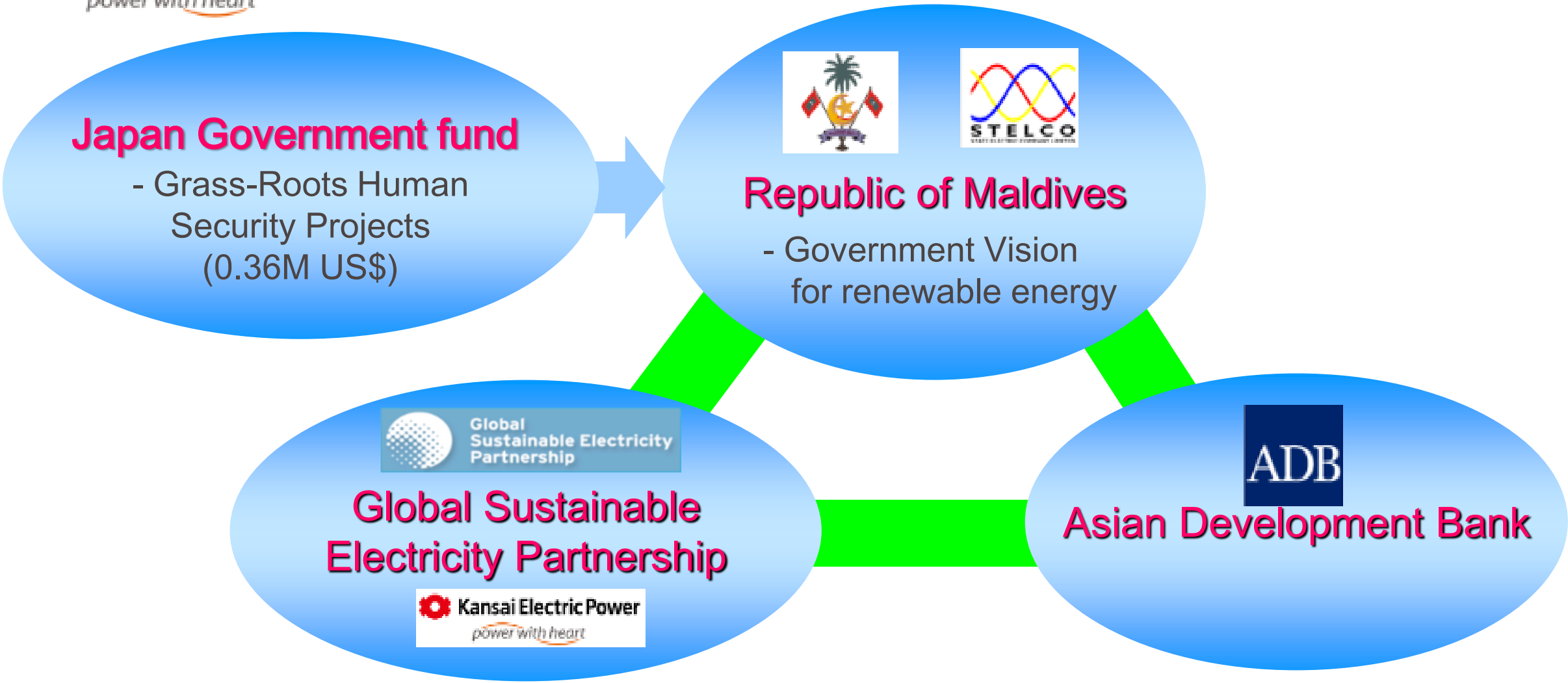
Basic Concept of Solar Ice Project



Basic Concept of system

- ✓ Avoid using battery as much as possible
- ✓ Use Ice making machine as the controllable load
- ✓ Unit control of PV panel (0kW,10kW,20kW,30kW,40kW)
- ✓ Ice also contributes recovering initial investment not only from electricity but also from ice

Project Scheme



- Main funding for implementation(0.37M US$)
-Technical and overall coordination

- Funding for HCB
- Funding for replicable project

Outline of Dhiffushi Solar Ice Project

POWERHOUSE

New powerhouse built by STELCO for its existing diesel generators and the new PV system equipment.

HYBRID SYSTEM

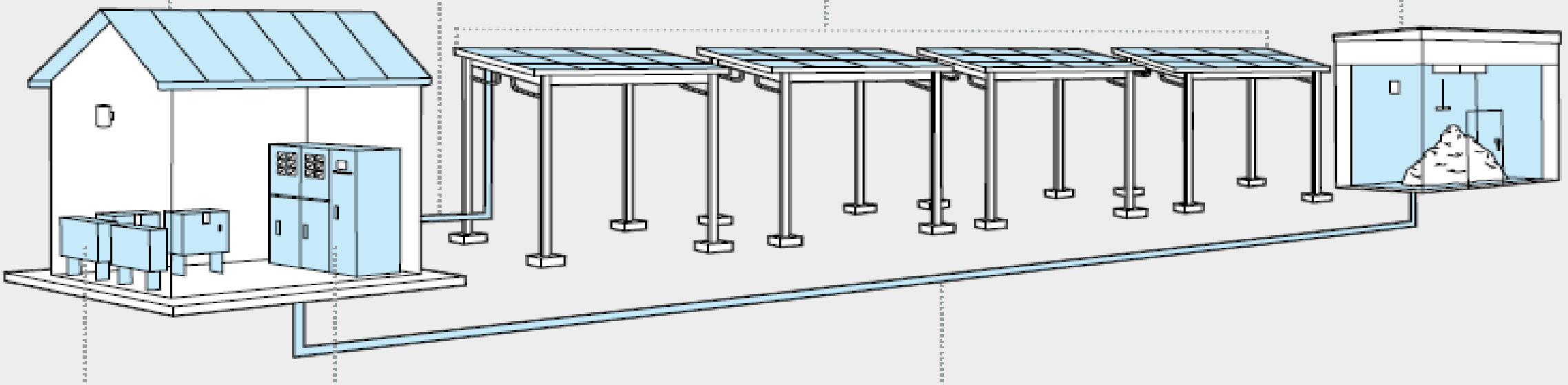
40 kW PV system is connected to Dhiffushi's power grid and works in conjunction with the existing diesel generators.

MULTI-FUNCTIONAL FRAME STRUCTURE

3 metre-high frame structure holds four separate 10 kW PV panel arrays inclined at 5 degrees, limiting the extent of damage in case of a tsunami and providing good shade for residents.

ICE HOUSE

Industrial ice machine installed in new ice house on the pier effectively functions as the supply-demand controller for the grid-connected PV system.



POWER CONDITIONERS

Four power conditioners and a system controller are installed inside the powerhouse.

FLEXIBLE CONTROL SYSTEM

The control system is operated in both automatic and manual mode. This flexibility helps maximize PV power generation and improve its stability, making maintenance and troubleshooting easier.

CABLING

The PV system and ice-making machine are connected to the powerhouse through underground cables.

System Layout of Maldive project