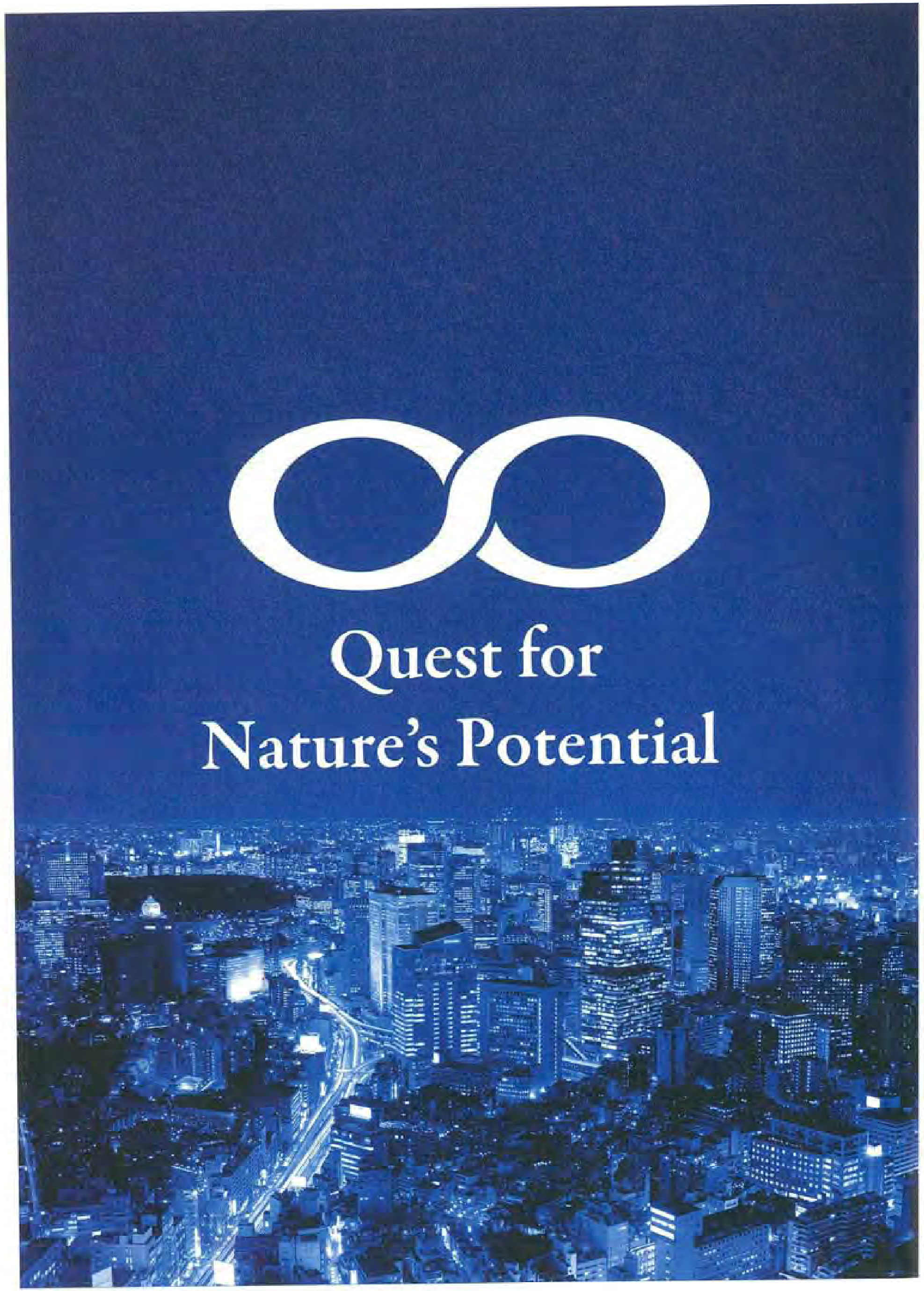
4. Invitation program to Japan

Corporate Profile / 会社案内

HM HYDRO

日立三菱水力株式会社

Hitachi Mitsubishi Hydro Corporation



自然の潜在能力を探求する。

低炭素社会の実現に向けて、自然の水が秘めた力をより有効に活用する。
日立三菱水力株式会社は、株式会社日立製作所、三菱電機株式会社、三菱重工業株式会社の3社が一世紀にわたって築き上げてきた技術基盤と経営資源を活かし、再生可能エネルギーである水力発電のさらなる可能性を探求しています。

1×1×1＝∞

3社から受け継いだテクノロジー、ノウハウ、そしてマンパワーのシナジーを最大限に高めることで可変速揚水発電をはじめとする水力発電機器・システムの技術革新をリードし、日本はもとよりグローバルマーケットにおいても飛躍を目指していきます。

Quest for Nature's Potential

Towards realization of a low-carbon society, making more effective use of the hidden power of natural water, Hitachi Mitsubishi Hydro Corporation has been exploring the potential of hydroelectric power generation as a source of renewable energy even further by utilizing the technology bases and management resources that the three companies, Hitachi, Ltd., Mitsubishi Electric Corporation and Mitsubishi Heavy Industries, Ltd., have established over the past century.

1 × 1 × 1 = ∞

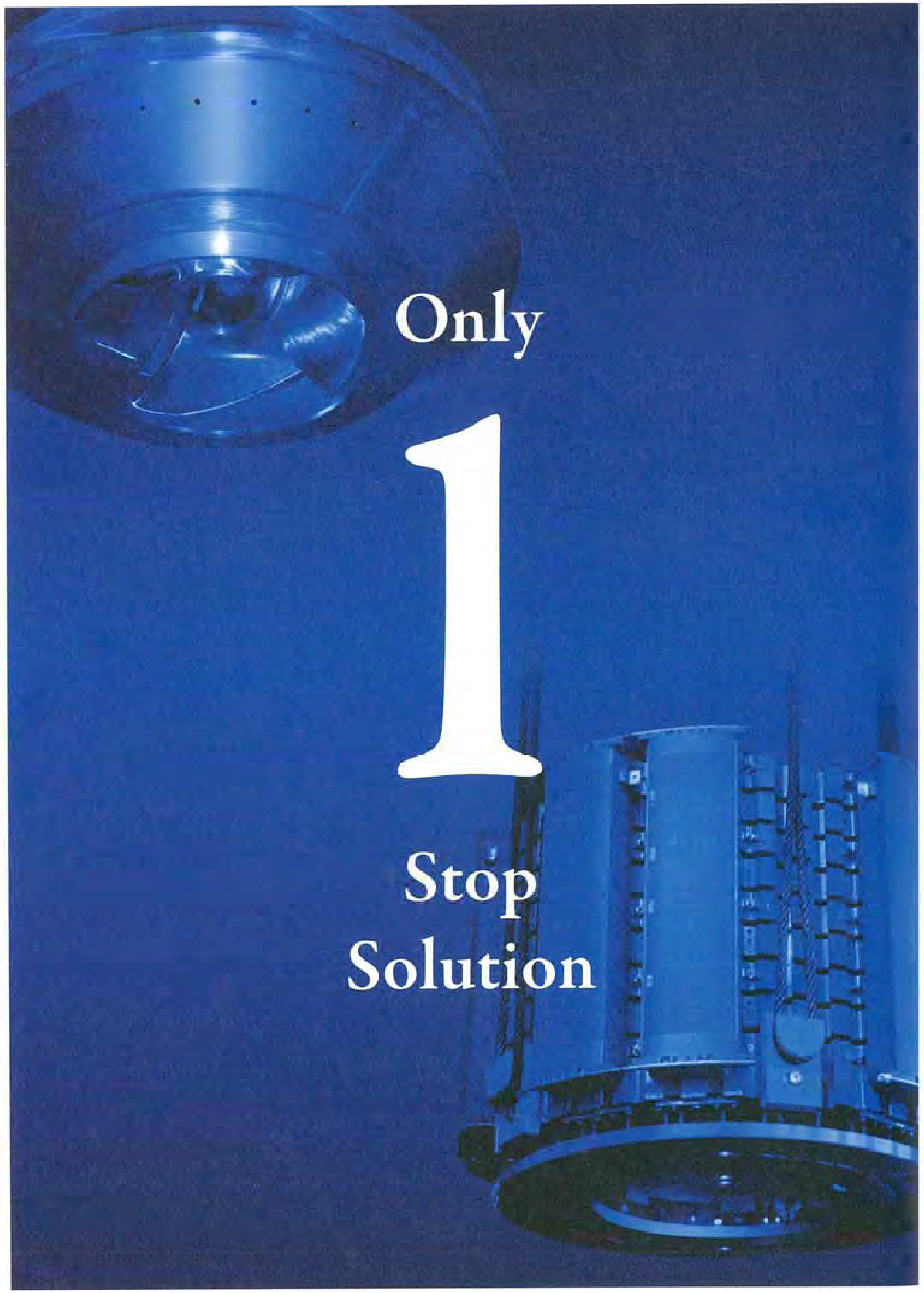
The company aims to take the lead in technical innovation in the fields of hydroelectric power generation equipment and systems, such as adjustable-speed pumped-storage power generation, and make great strides in the global market by maximizing the synergy of the technology, know-how and manpower inherited from the three companies.

Vision

HITACHI
Inspire the Next
日立製作所
Hitachi,Ltd.

MITSUBISHI ELECTRIC
Changes for the Better
三菱電機
Mitsubishi Electric Corporation

三菱重工
三菱重工業
Mitsubishi Heavy Industries,Ltd.



オンリーワンの水力発電ソリューションを ワンストップでお届けします。

電源多様化が進む中、系統安定化に貢献する可変速揚水発電システムをはじめ、先進の技術と長年にわたって蓄積したノウハウを活かし、お客さまの様々なご要望に対して開発・設計から納入、据付・調整、保守まで最適なソリューションをお届けいたします。

The only one-stop solution for hydroelectric power

In the context of ever increasing diversity in the supply of electric power, we will utilise our leading-edge technology and know-how accumulated over many years in the fields that contribute to grid stabilisation to respond to our customers' requests and deliver the best solutions from development and design to delivery, installation, commissioning and maintenance.

1 水車・ポンプ水車

フランシス型をはじめ、あらゆるタイプの高性能水車・ポンプ水車を取り扱っています。揚水発電の分野においては800m級の超高落差ポンプ水車を開発するなど最先端技術の開発に努めています。

Turbines and Pump Turbines

We deal in all types of high-performance turbines and pump turbines, such as the Francis type, and we have been active in the development of leading-edge technology in the field of pumped-storage power generation, with the development of the 800-m class ultra-high-head pump turbine, for example.

1

2 発電機・発電電動機

記録的な発電規模を誇る大容量機や高速機をはじめとする多くの納入実績をもとに、より高効率で信頼性の高い発電機・発電電動機・可変速発電電動機の開発・設計を行っています。

Generators and Generator-Motors

Based on our supply record of delivering generators and generator-motors, such as large-capacity machines that boast a record-breaking scale of generation and high-speed machines, we are now developing and designing even more highly efficient and reliable generators, generator-motors and adjustable-speed generator-motors.

2

3 制御・保護システム

ユニットシーケンサ、保護リレー、調速機、AVR、さらに可変速制御からプラント計算機まで、水力発電プラントのあらゆる制御・保護システムの開発・設計を行っています。豊富な納入実績をもとに経済性に優れた高信頼の制御・保護システムをご提案します。

Control and Protection Systems

We are implementing the development and design of a wide range of control and protection systems for hydroelectric power plants, including unit sequencers, protection relays, governors and excitation controllers, as well as adjustable speed controllers and plant computers. We are able to provide economical and reliable control and protection systems based on our solid supply record.

3

4 研究開発

流体シミュレーション技術や流体計測技術を駆使して水車の最適形状を追求するとともに、より信頼性の高いプラント運転を実現するための各種検証実験を実施。発電所ごとの課題をお客さまと共有し、様々な解析と実験を通じて解決に取り組んでいます。

Research and Development

In addition to pursuing the optimum turbine hydraulic profiles by utilising fluid simulation and fluid measurement techniques, we are also conducting many kinds of verification experiments to achieve an even higher level of reliability in operating plants.Through sharing the issues specific to each power plant with customers, we are aiming to find solutions through various analyses and experiments.

4

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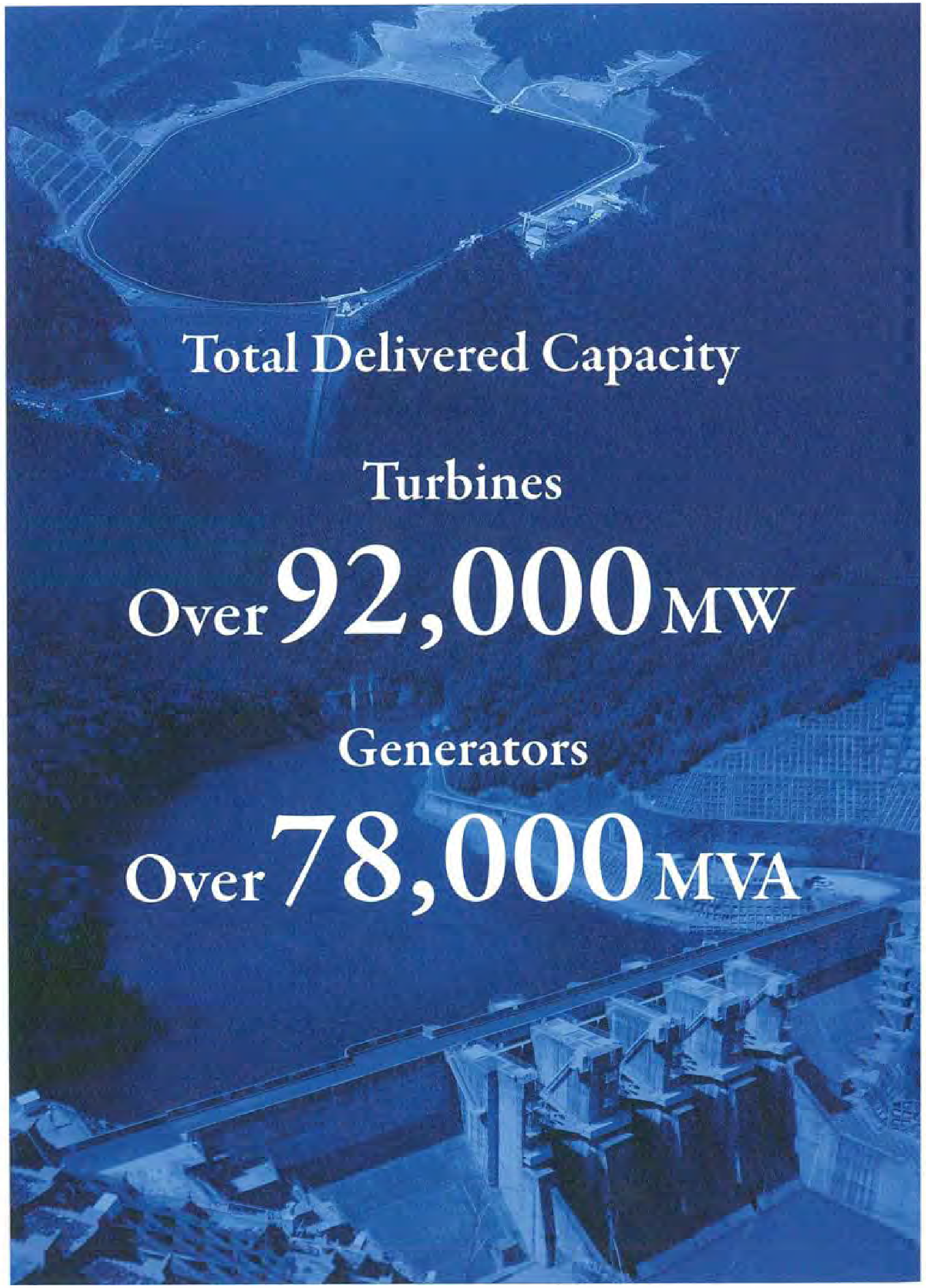
Business Fields



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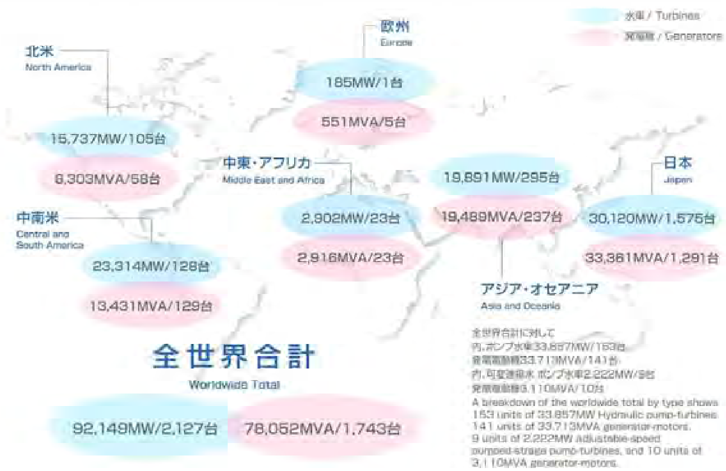
信頼と実績をもとに、さらなる飛躍へ。

Building on trust and results for an even brighter future

■ 地域別納入実績 / Deliveries by Region



全世界合計に対して
内.ポンプ水車33,857MW/153台
発電電動機33,713MVA/141台
内.可変速揚水 ポンプ水車2,222MW/9台
発電電動機3,110MVA/10台

A breakdown of the worldwide total by type shows 153 units of 33,857MW Hydraulic pump-turbines, 141 units of 33,713MVA generator-motors, 9 units of 2,222MW adjustable-speed pumped-storage pump-turbines, and 10 units of 3,110MVA generator-motors.

■ 納入例 / Examples of Deliveries

1 北海道電力/新冠発電所
103MW 斜流ポンプ水車
103MW Diagonal Flow Pump-Turbine
for Niikappu Power Plant, Japan

2 東北電力/大池第二発電所
11.13MW フランシス水車
11.13MW Francis Turbine
for Oike No.2 Power Plant, Japan

3 中部電力/和合発電所
3.24MW ペルトン水車
3.24MW Impulse Turbine
for Wago Power Plant, Japan

4 電源開発/田子倉発電所
112MVA 発電機
112MVA Generator
for Tagokura Power Plant, Japan

5 東京電力/神流川発電所
525MVA 発電電動機
525MVA Generator-Motor
for Kannagawa Power Plant, Japan

6 九州電力/小丸川発電所
345MVA/319MVA 発電電動機(可変速機)
345MVA/319MVA Adjustable-Speed Generator-Motor
for Omarugawa Power Plant, Japan

7 関西電力/大河内発電所
395MVA 発電電動機(可変速機)
395MVA Adjustable-Speed Generator-Motor
for Okawachi Power Plant, Japan

8 インド/プルリア発電所
φ3400 球形弁
φ3400 Spherical Valve
for Purulia Power Plant, India

9 プラント運転監視システム
Supervisory Control and Data Acquisition System

Achievements

日立三菱水力株式会社
〒108-0014 東京都港区芝5丁目29-14 田町日工ビル TEL(03)3769-8000(代表)
http://www.hm-hydro.com/

Hitachi Mitsubishi Hydro Corporation
Tamachi Nikko Bldg. 29-14, Shiba 5-chome, Minato-ku, Tokyo 108-0014 +81-3-3769-8000
http://www.hm-hydro.com/en/

2015.12

日立三菱水力株式会社
Hitachi Mitsubishi Hydro Corporation

Corporate Overview

会社概要 / Corporate Profile

◎会社名	日立三菱水力株式会社
◎本社所在地	〒108-0014 東京都港区芝5丁目29-14 田町日エビル TEL(03)3769-8000(代表)
◎設立	2011年10月1日
◎取締役社長	楠田　靖夫（くすだ やすお）
◎資本金	20億円　出資比率：株式会社 日立製作所 50% 三菱電機株式会社 30% 三菱重工業株式会社 20%
◎従業員数	約380名(2016年4月1日現在)
◎事業内容	水力発電システムの販売・エンジニアリング・据付・工事・保守、主要機器の開発・設計

◎Corporate Name	Hitachi Mitsubishi Hydro Corporation
◎Headquarters	Tamachi Nikko Bldg, 29-14, Shiba 5-chome Minato-ku, Tokyo 108-0014　+81-3-3769-8000
◎Establishment	1 October, 2011
◎President	Yasuo Kusuda
◎Capital	2 billion yen Equity distribution: Hitachi, Ltd. 50% Mitsubishi Electric Corporation 30% Mitsubishi Heavy Industries, Ltd. 20%
◎Number of Employees	Around 380 (as of 1 April, 2016)
◎Scope of Business	Marketing, engineering, installation, construction and maintenance of hydropower generation systems; development and design of core components of hydropower generation systems

組織図 / Corporate Organisation

- 取締役会 / Board of Directors
  - 監査役会 / Board of Statutory Auditors
- 取締役社長 / President
  - 輸出管理室 / Export Control Dept.
  - 業務部 / Strategic Planning & Administration Dept.
    - 各地域統括室 / Administration Office
      日立/Hitachi・大みか/Omika
      神戸/Kobe・高砂/Takasago
  - 財務部 / Finance Dept.
  - 技術・品質保証部 / Quality Assurance & Information Technology Dept.
  - 生産・調達部 / Production Control & Procurement Dept.
  - 営業部 / Marketing and Sales Dept.
  - グローバル営業部 / Global Business Development & Operation Dept.
  - 水力技術部 / Hydro Power Engineering Dept.
  - プラント建設部 / Power Plant Engineering & Construction Dept.
  - 水力研究開発部 / Hydraulic R & D Laboratory
  - 制御システム部 / Control and Protection System Dept.
  - 水車部 / Turbine Engineering Dept.
  - 発電機部 / Generator Engineering Dept.

事業拠点 / Network

❶本社
〒108-0014 東京都港区芝5丁目29-14
田町日エビル
Headquarters
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Hitachi
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❸大みか
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Omika
2-1, Omika-cho 5-chome, Hitachi, Ibaraki 319-1293

❹神戸
〒652-8555 兵庫県神戸市兵庫区和田崎町1丁目1-2
Kobe
1-2, Wadasaki-cho 1-chome, Hyogo-ku, Kobe, Hyogo 652-8555

❺高砂
〒676-0008 兵庫県高砂市荒井町新浜2丁目8-30 第3高砂菱興ビル
Takasago
No.3 Takasago Ryoko Bldg, 8-30, Araicho-Shinhama 2-chome, Takasago, Hyogo 676-0008

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MHPS Gas Turbine

H-25

MITSUBISHI HITACHI POWER SYSTEMS, LTD.

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Mitsubishi Hitachi Power Systems Americas, Inc. ········· https://www.mpshq.com/
Mitsubishi Hitachi Power Systems Europe, Ltd. ········· http://www.emea.mhps.com/

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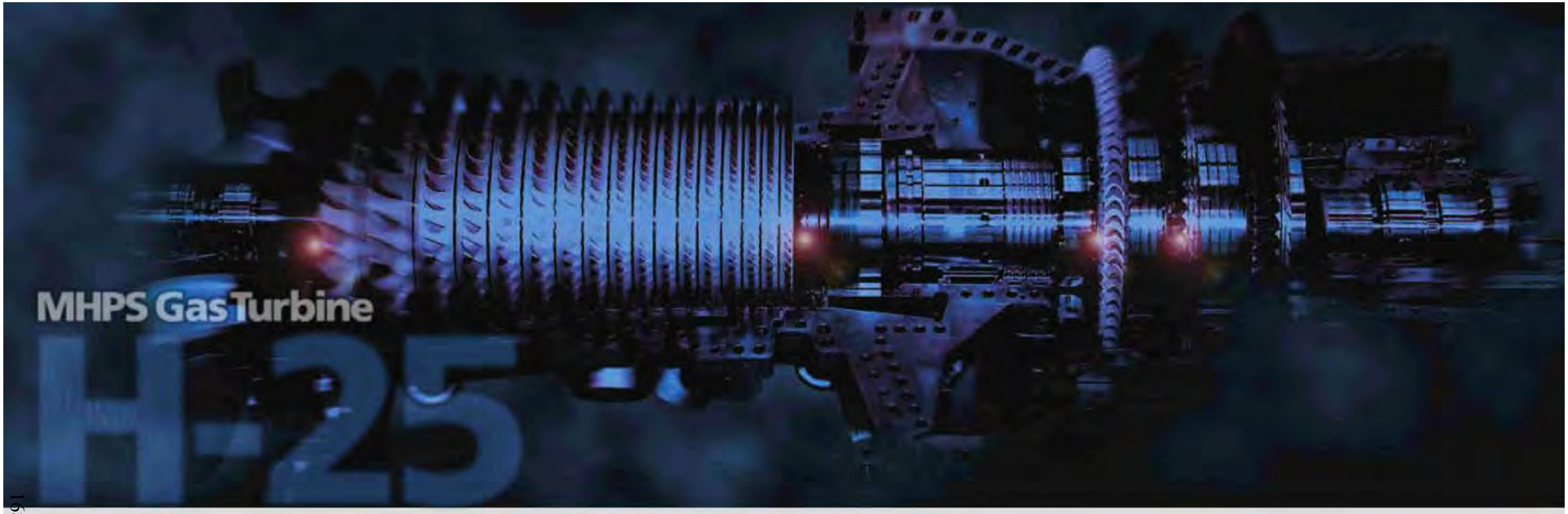
Printed in Japan

MHPS Gas Turbine
H-25

MITSUBISHI HITACHI POWER SYSTEMS

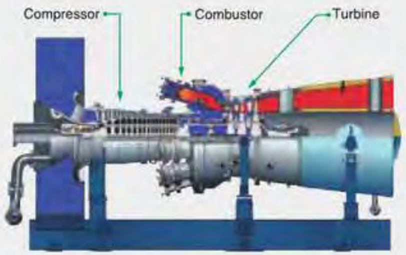


Introduction

MHPS H-25's fuel savings will repay your investment within a few years while allowing you a range of fuels from distillate to natural gas. And with cogeneration or combined cycle power plants, even higher efficiency will be achieved.
Plus an excellent automation system will add ease and precision to your operations after a fast installation.
Excellent engineering, superior quality control, and reliable service has earned gas turbines a reputation for excellence and efficiency.
With an output of 40MW class and, coupled with the latest in gas turbine technology, the H-25 becomes a superior value.

Features

- Reliable heavy duty design
- High efficiency
- Replacement of old gas turbine
- On-site maintenance
- Quick delivery
- Suitable system for cogeneration and combined cycle power plant
- Environmentally friendly combustion system with flexible fuel applications



Specification

Item		Specification
Gas Turbine	Type	Heavy duty design, single shaft
		Horizontal split casing, stacking rotor
	Rotating Speed	7,280 min^{-1}
Compressor	Type	17 stages axial type
Turbine	Type	3 stages impulse type
	Cooling	Air cooled 1st & 2nd stage nozzles and buckets
Combustor	Type	Reverse flow type
		Conventional type or low NOx type
		10 cans

Performance – Simple Cycle

The H-25 heavy duty single shaft gas turbine provide a high efficiency and reliable power plant.

Item	H-25 50Hz/60Hz
Output, MW	41.0
Efficiency, %(LHV)	36.2
Heat Rate, kJ/kWh	9,949
Heat Rate, Btu/kWh	9,432
Exhaust Flow, kg/s	114
Exhaust Temperature, deg.C	569
NO_x Emission, ppm@15%O_2	≤15-25

- All ratings are defined at ISO standard reference conditions:101.3 kPa, 15 deg.C and 60%RH
- All ratings are at the generator terminals and based on the natural gas fuel

H-25 Gas Turbine Project (Venezuela)

Modular Package Design

Package Design

Package design offers the following benefits:

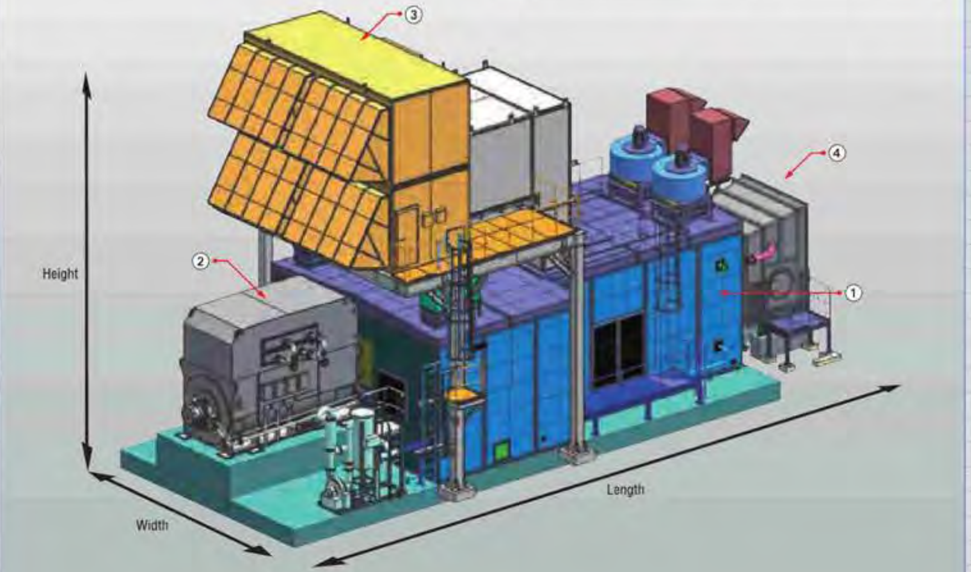
- Minimized site installation work and period
- Flexible site layout
- Economical and delivery-time benefit to customer

Dimensions

Package	H-25
Width	9.9 m
Length	18.1 m
Height	13.7 m

Mass

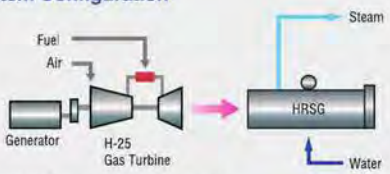
No.	Package	H-25
①	Gas turbine + base	47 t
①	Lube oil tank, reduction gear and auxiliaries	82 t
②	Generator	85 t
③	Air intake system	51 t
④	Exhaust system	7 t



Cogeneration Power Plant

Cogeneration power plant with the H-25 provides large capacity of steam production as well as high thermal efficiency of the heat and power generation.
Applicable to various cogeneration systems, MHPS provides system engineering to meet various heat and power requirements to optimize the design.

System Configuration



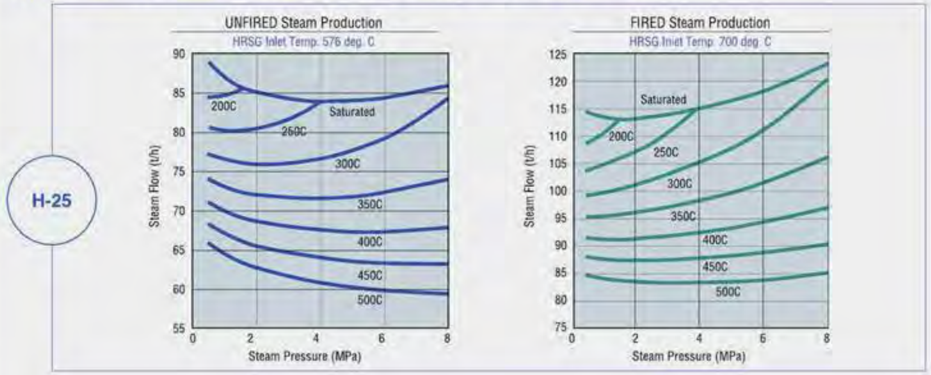
HRSG : Heat Recovery Steam Generator

Performance

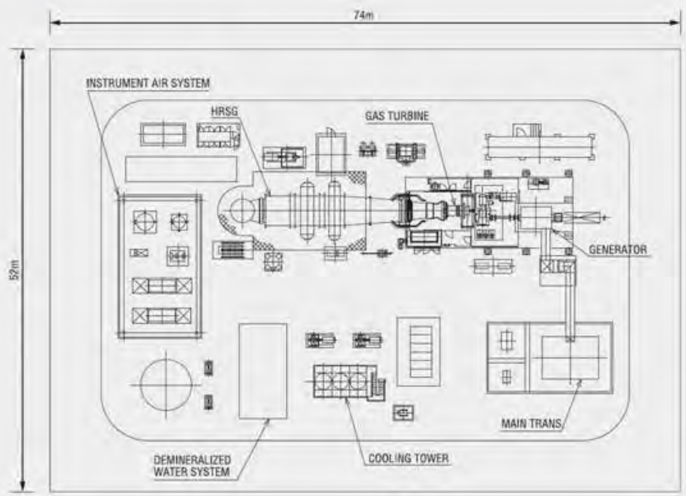
Item	H-25 50Hz/60Hz
Power Output, MW	39.6
Heat Output, t/h (6 MPa/300 deg.C)	79
Overall Efficiency, %(LHV)	More than 80

- All ratings are defined at ISO standard reference conditions: 101.3 kPa, 15 deg.C and 60%RH
- All ratings are at the generator terminals and based on the natural gas fuel

Typical Steam Production Quantity for H-25 Cogeneration System



Typical Plant Layout



Combined Cycle Power Plant

The higher operating temperature of gas and steam cycles makes a H-25 combined cycle power plant achieve higher efficiency generation. By creating a packaged type combined cycle power plant, MHPS makes installation, operation, and maintenance an easy part of your power generation.

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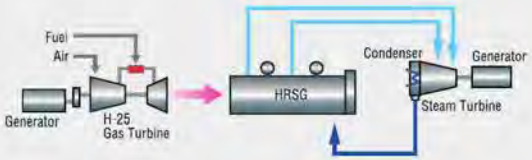
Combined Cycle Power Plant(1-1-1)

Performance

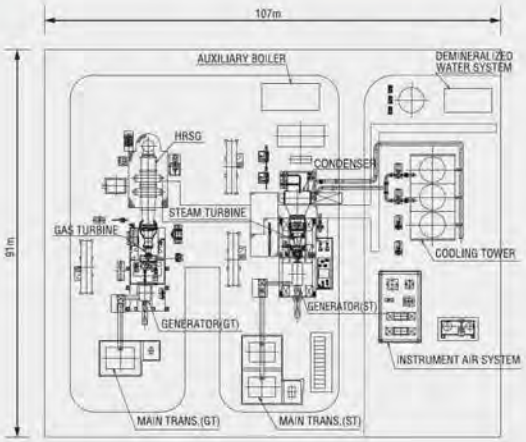
Item	H-25
	50Hz/60Hz
Total Plant Output, MW	60.1
Gas Turbine Output, MW	39.6
Steam Turbine Output, MW	20.5
Gross Efficiency, %(LHV)	54.0

- All ratings are defined at ISO standard reference conditions: 101.3 kPa, 15 deg.C and 60%RH
- All ratings are at the generator terminals and based on the natural gas fuel

System Configuration



Typical Plant Layout



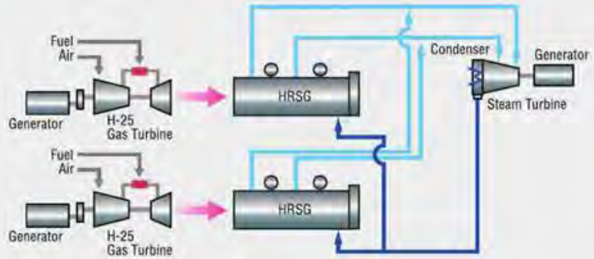
Combined Cycle Power Plant(2-2-1)

Performance

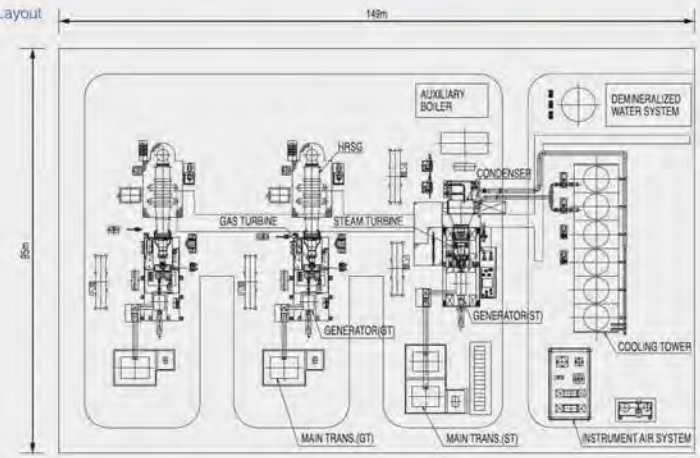
Item	H-25
	50Hz/60Hz
Total Plant Output, MW	121.4
Gas Turbine Output, MW	39.6×2
Steam Turbine Output, MW	42.2
Gross Efficiency, %(LHV)	54.5

- All ratings are defined at ISO standard reference conditions: 101.3 kPa, 15 deg.C and 60%RH
- All ratings are at the generator terminals and based on the natural gas fuel

System Configuration



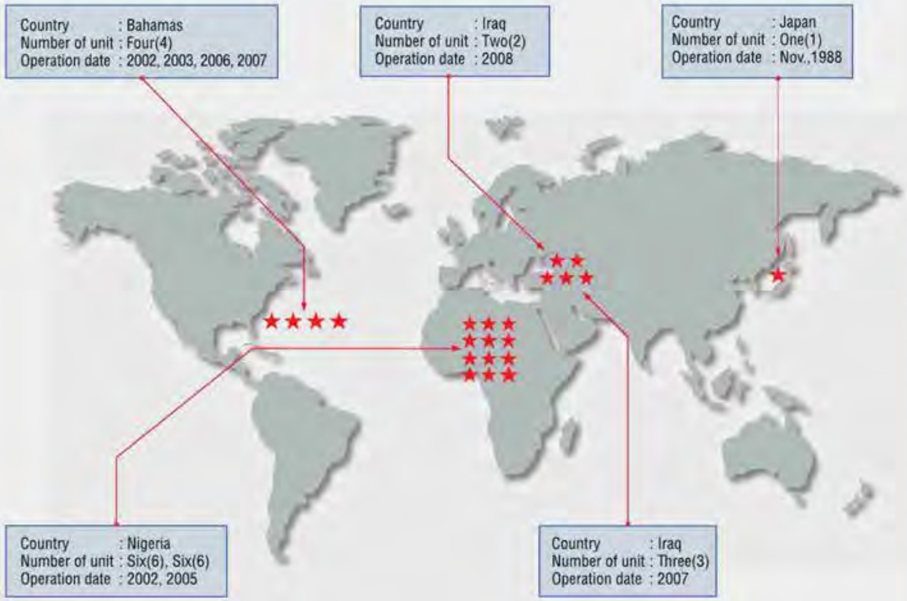
Typical Plant Layout



Various Applications

Replacement Experiences of Old Machine

The H-25 can be used, not only to create new, highly efficient power plants, but also to replace the Old Machine, gaining an immediate 20 percent reduction in fuel consumption. Transported separately, the combination with the re-utilized existing equipment is done at the installation site. And when replacing an existing Old Machine with the H-25, the replacement can be performed in a short period, because existing foundations, building works, and ancillary equipment are compatible.

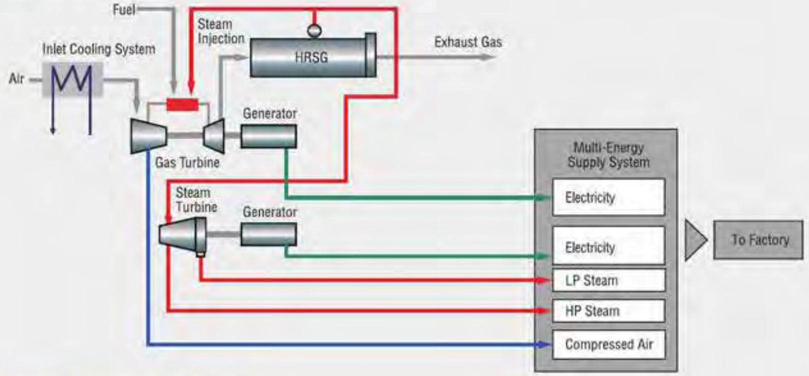


H-25 Gas Turbine Project (Bahamas)

Multi-Energy Supply

The H-25 can be used to supply electricity by generators, high/low pressure steam extracted from steam turbine and compressed air extracted from gas turbine compressor for factory.

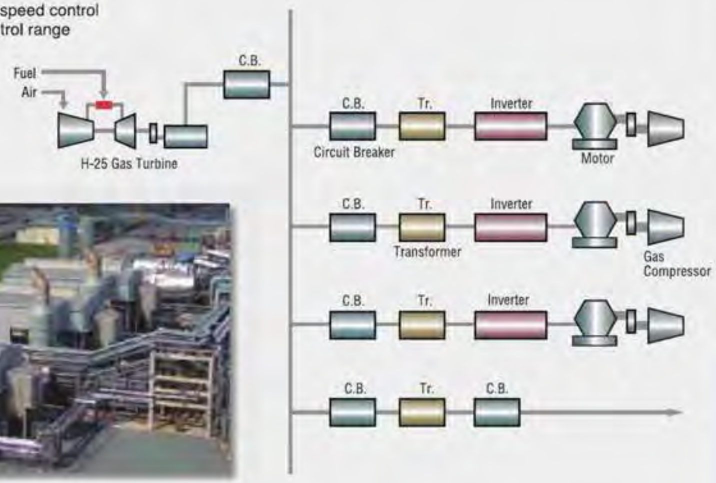
Example of Multi-Energy Supply System



Motor Driven Compressor Drive

The H-25 can be used with motor driven compressor for gas plant.

- Higher response and wide speed control with 50 to 100 percent control range
- Flexible selection of gas compressor sizing
- Less maintenance



H-25 Gas Turbine Project (Indonesia)

MHPS Gas Turbine

H-100

MITSUBISHI HITACHI POWER SYSTEMS, LTD.

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Printed in Japan

MHPS Gas Turbine
H-100

MITSUBISHI HITACHI
POWER SYSTEMS

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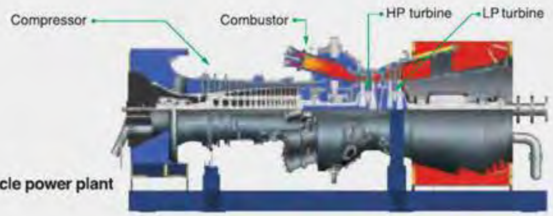
Introduction

H-100 is a 100-120MW class, heavy duty, high efficiency gas turbine.
The H-100 utilizes state-of-the-art technology, based on MHPS's proven track records which show superior quality and reliability.
The H-100 was specifically designed for middle sized power generation and large sized cogeneration power plant.
To be Suitable for numerous applications, including a 150MW class combined cycle power plant (1-1-1 configuration), a 300MW class combined cycle power plant (2-2-1 configuration) or a cogeneration power plant of 200 t/h level steam generation (6MPa/300deg.C), the H-100 incorporates efficiency, reliability and flexibility, together with low life cycle costs. Whatever the application, MHPS's renowned reputation for superior performance, together with outstanding reliability, and our ability to adapt to our customers needs, means customers are always assured of the optimum solution.

Features

- Reliable heavy duty design
- High efficiency
- No–reduction gear
- Replacement of old gas turbine
- On-site maintenance
- Applicable for mechanical drive
- Suitable system for cogeneration and combined cycle power plant
- Environmentally friendly combustion system



Specification

Item		Specification
Gas Turbine	Type	Heavy duty, 2 shafts
		Horizontal split casing
	Rotating Speed	HP turbine & compressor: 4,580 min^{-1}
		LP turbine: 3,600 min^{-1} (60Hz) / 3,000 min^{-1} (50Hz)
Compressor	Type	17 stages, axial type
Turbine	Type	HP turbine : 2 stages
		LP turbine: 2 stages
	Cooling	Air cooled 1^{st}, 2^{nd} & 3^{rd} stage nozzles
		Air cooled 1^{st} & 2^{nd} stage buckets
Combustor	Type	Reverse flow type
		Low NOx type
		10 cans

Performance – Simple Cycle

The H-100 provides a high efficiency power plant for the middle sized power generation sector.

Item	H-100	
	50Hz	60Hz
Output, MW	118.0	105.7
Efficiency, %(LHV)	38.3	38.2
Heat Rate, kJ/kWh	9,409	9,421
Heat Rate, Btu/kWh	8,919	8,930
Exhaust Flow, kg/s	315	293
Exhaust Temperature, deg.C	552	534
NO_x Emission, ppm@15%O_2	≤9-25	

- All ratings are defined at ISO standard reference conditions: 101.3 kPa, 15 deg.C and 60%RH
- All ratings are at the generator terminals and based on the natural gas fuel

H-100 Gas Turbine on Trailer

Modular Package Design

Package Design

Package design offers the following benefits:

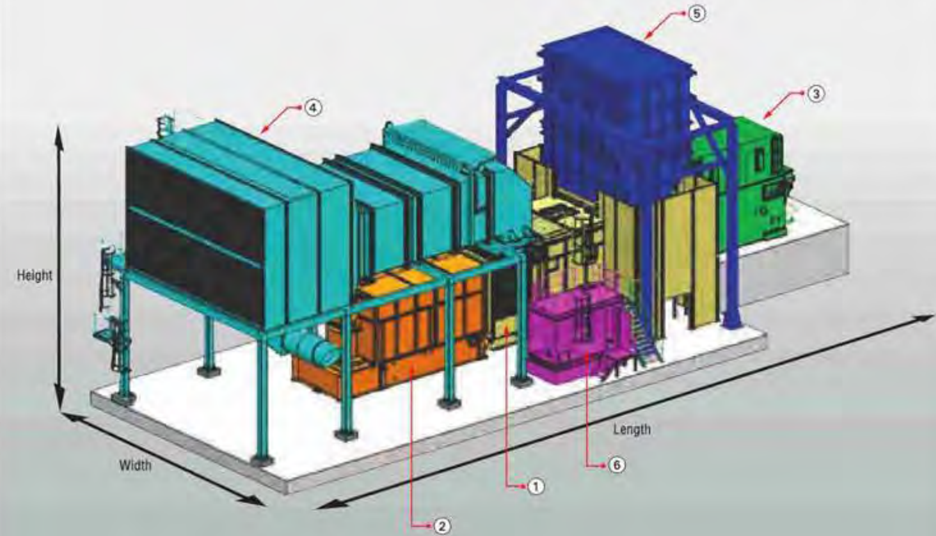
- Minimized site installation work and period
- Flexible site layout
- Economical and delivery-time benefit to customer

Dimensions

Package	H-100
Width	12.2 m
Length	37.0 m
Height	15.5 m

Mass

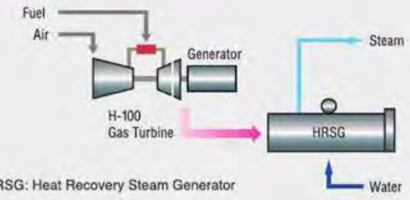
No.	Package	H-100	
		50Hz	60Hz
①	Gas turbine + base	216 t	175 t
②	Lube oil tank, starting means and auxiliaries	95t	
③	Generator	180 t	
④	Air intake system	125 t	
⑤	Exhaust system	33 t	
⑥	Gas valve compartment	5 t	



Cogeneration Power Plant

Cogeneration power plant with the H-100 provides large capacity of steam production as well as high thermal efficiency of the heat and power generation.
Applicable to various cogeneration systems, MHPS provides system engineering to meet various heat and power requirements to optimize the design.

System Configuration



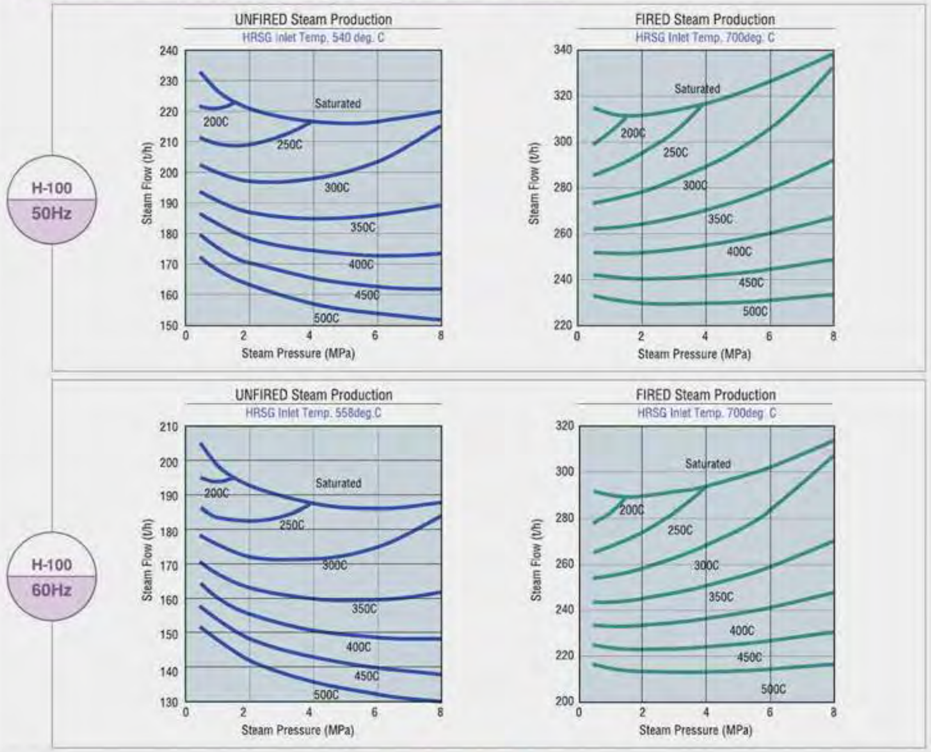
HRSG: Heat Recovery Steam Generator

Performance

Item	H-100	
	50Hz	60Hz
Power Output, MW	114.6	102.5
Heat Output, t/h (6 MPa/300 deg.C)	203	175
Overall Efficiency, %(LHV)	More than 80	

- All ratings are defined at ISO standard reference conditions: 101.3 kPa, 15 deg. C and 60%RH
- All ratings are at the generator terminals and based on the natural gas fuel

Typical Steam Production Quantity for Cogeneration System



Combined Cycle Power Plant

The power plant of 1-1-1 configuration (one MHPS H-100, one HRSG and one steam turbine) provides approximately 150-170MW power output.

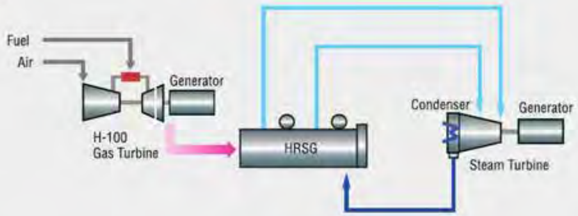
Combined Cycle Power Plant(1-1-1)

Performance

Item	H-100	
	50Hz	60Hz
Total Plant Output, MW	169.6	150.0
Gas Turbine Output, MW	114.6	102.5
Steam Turbine Output, MW	55.0	47.5
Gross Efficiency, %(LHV)	55.8	55.1

- All ratings are defined at ISO standard reference conditions: 101.3 kPa, 15 deg.C and 60%RH
- All ratings are at the generator terminals and based on the natural gas fuel
- Non-Reheat, Dual Pressure

System Configuration



Example of Arrangement

The power plant of 2-2-1 configuration(two MHPS H-100, two HRSGs and one steam turbine) provides approximately 300-340MW power output. This configuration gives operational flexibility to meet various power demands.

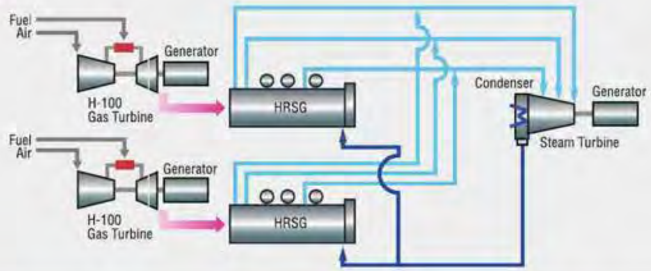
Combined Cycle Power Plant(2-2-1)

Performance

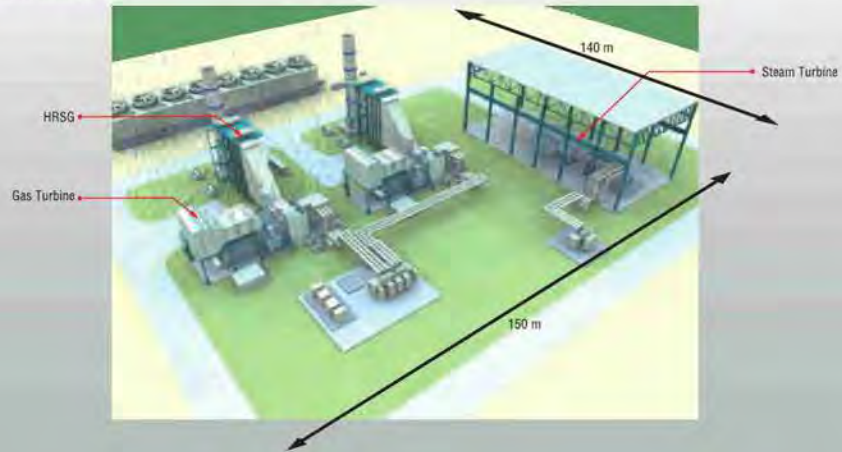
Item	H-100	
	50Hz	60Hz
Total Plant Output, MW	344.5	305.7
Gas Turbine Output, MW	114.6x2	102.5x2
Steam Turbine Output, MW	115.3	100.7
Gross Efficiency, %(LHV)	56.7	56.1

- All ratings are defined at ISO standard reference conditions: 101.3 kPa, 15 deg.C and 60%RH
- All ratings are at the generator terminals and based on the natural gas fuel
- Non-Reheat, Triple Pressure

System Configuration



Example of Arrangement



Replace

As global environmental problem has come under closer scrutiny in recent years, the replacement of old gas turbine with the H-100 provides a benefit to reduce NO_x and CO_2 level and fuel consumption by improving the efficiency of existing power plant, not only in simple cycle but also in combined cycle, using existing facilities as much as possible.

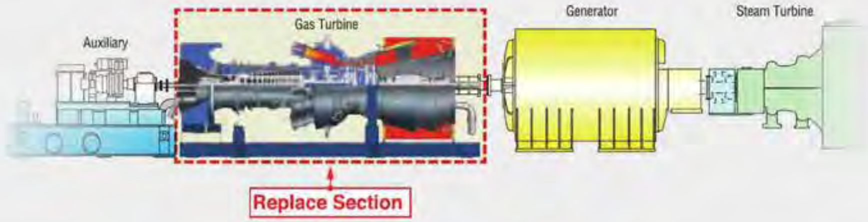
Example of Replacement of Existing Old Combined Cycle

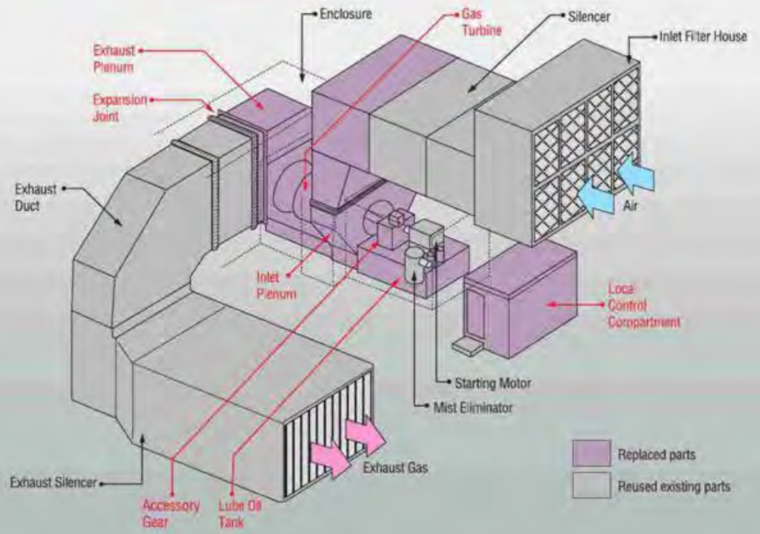
Reused Major Components

- Generator
- HRSG
- Steam Turbine
- Electrical System

Performance improvement evaluation

Item	Existing old 1 on 1 GTCC	H-100 1on1 GTCC	
		50Hz	60Hz
Output	Base	-3%	+13%
Efficiency	Base	+11%	+7 %



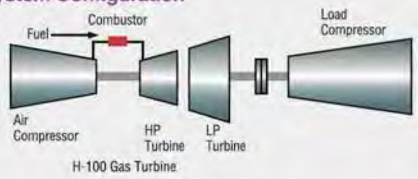


Mechanical Drive

The H-100 is also applicable for Mechanical Drive applications, especially compressor drive for large size of LNG Plant.

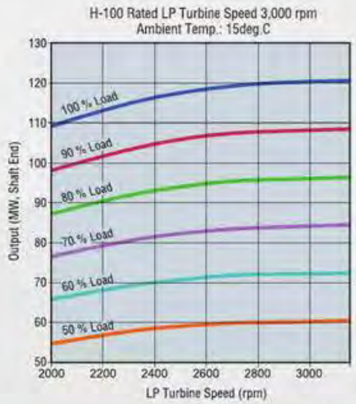
- Variable speed operation (70-105% speed) is available.
- Full pressure starting is available.
- No requirement for Helper motor, Variable Frequency Drive panel and associated electric equipment.

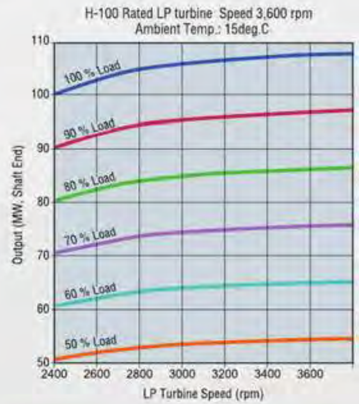
System Configuration



Mechanical Drive Performance

Item	H-100	
Output [hp]	160,780	144,350
Rotating Speed[rpm]	3,000(2,100-3,150)	3,600(2,520-3,780)
Efficiency [%-LHV]	38.9	38.9
Heat Rate[kJ/kWh]	9,266	9,256
Heat Rate [Btu/hp-hr]	6,549	6,542





NGK INSULATORS, LTD.

ENERGY STORAGE

NAS Sodium Sulfur Battery

Sodium-Sulfur (NAS®) Battery

November 2016

NAS, the NAS logo are trademarks of NGK INSULATORS,LTD., registered in the U.S.

Contents

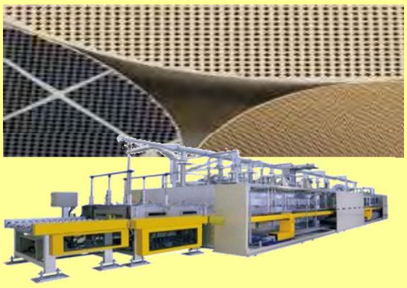
NGK INSULATORS, LTD.

Established Year	1919 in Nagoya, Japan (As the first domestic manufacturer of ceramic insulators.)
Paid-in Capital	$0.6 bil. USD (69.8bil. Yen)
Number of Employees	3,700 (Non-consolidated) 16,657 (Consolidated)
Consolidated Subsidiaries	59 companies
Annual Net Sales	$3,857 mil. USD (as of March 2016, Consolidated)
Operating Income	$ 716 mil. USD (as of March 2016, Consolidated)

NGK's diversified products are based on ceramic material & manufacturing technologies.

Power Business (US$ 0.6 Bil)

Ceramic Business (US$ 1.9 Bil)



Electronics Business (US$ 0.6 Bil)

Overseas Subsidiaries of NGK

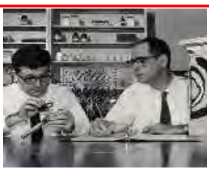
As of May, 2015

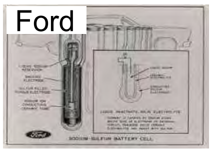
History of NAS® Battery Development

■NGK started R&D with TEPCO in 1984 and commercialized it in 2002.

1967 1970 1980 1990 2000 2010

Ford found the principle





R&D in USA, Europe and Japan

1971－1976 For EV Usage Ministry Project

1980－1990 Development for Utility Usage Moon Light Project（NEDO）

1991－1995 R&D for Utilization

TEPCO – NGK

1984 Start Joint R&D

Element R&D

Technical injection from BBC（now, ABB）

1989 Cell Design

Larger Capacity of Battery Cell/Module

1991 Module/System

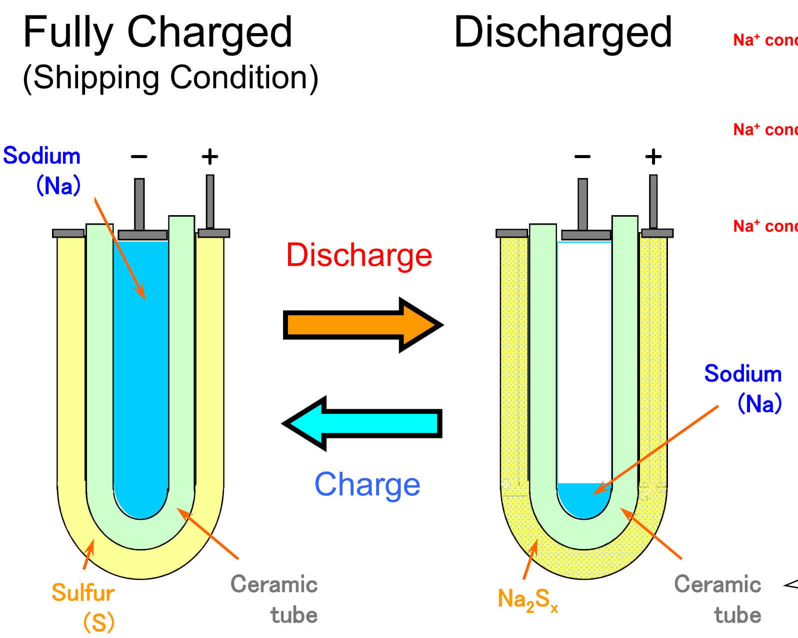
1997 Experiment/Evaluation

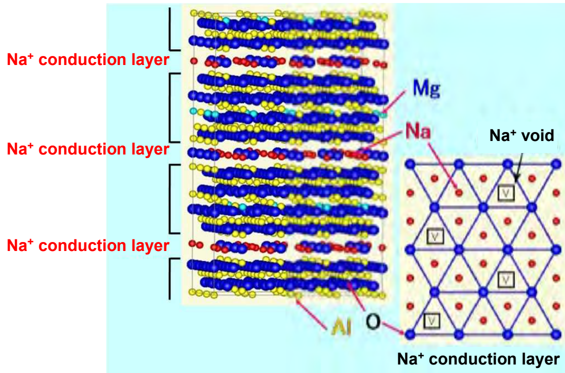
Experiment in Substation
→ Industrial Consumers

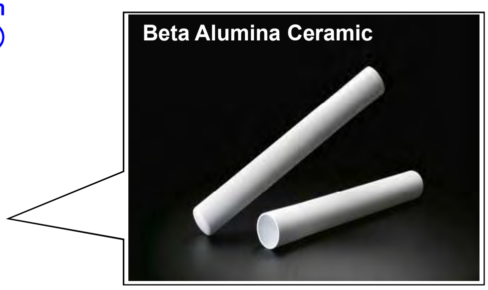
2002
Commercialization
World One Product

Structure of NAS® Battery Cell

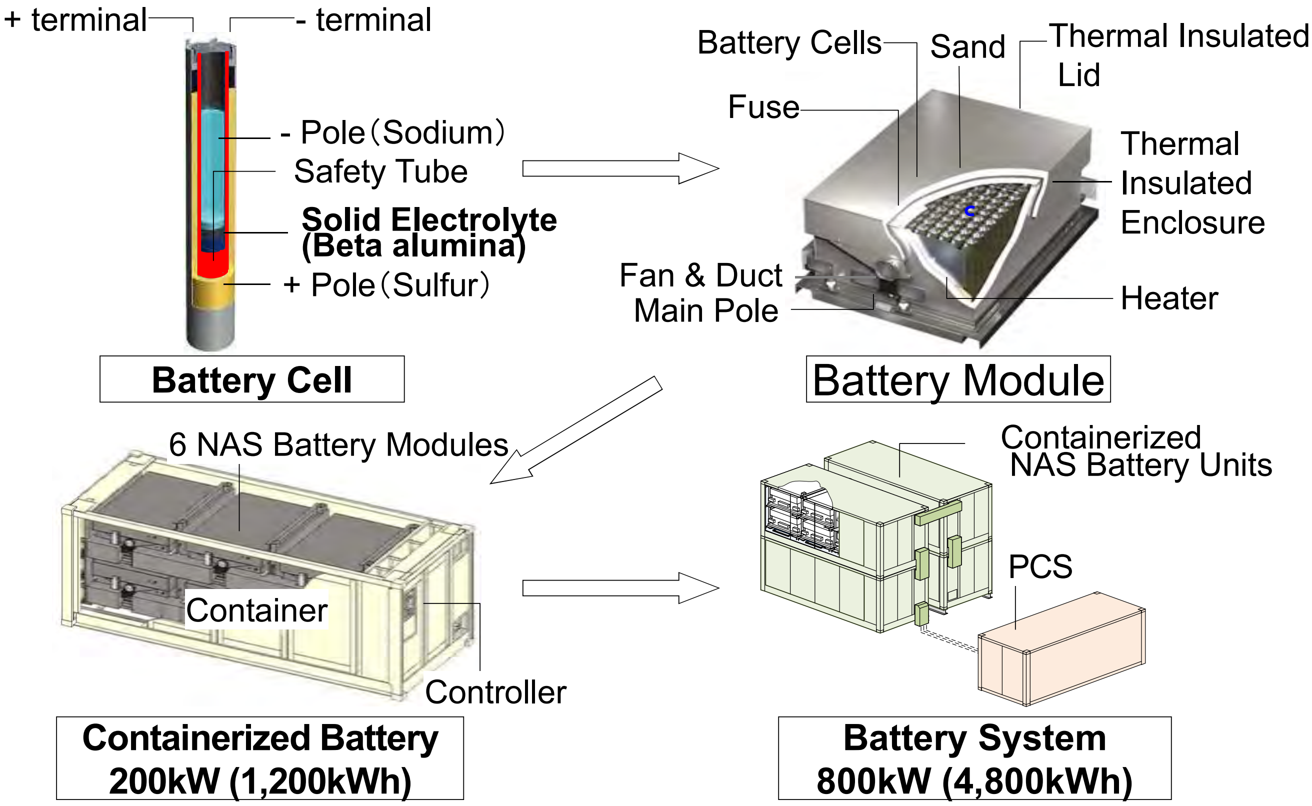
■Special thin Ceramic Electrolyte realized ultimate energy density.







Structure of NAS® Battery System



Containerized 200kW NAS Unit

Installation Image of 4 Container Unit

20 feet Sea Container
(Weight: 21,000kg)

Battery Controllers

6 NAS Modules inside

Features of NAS® Battery Energy Storage

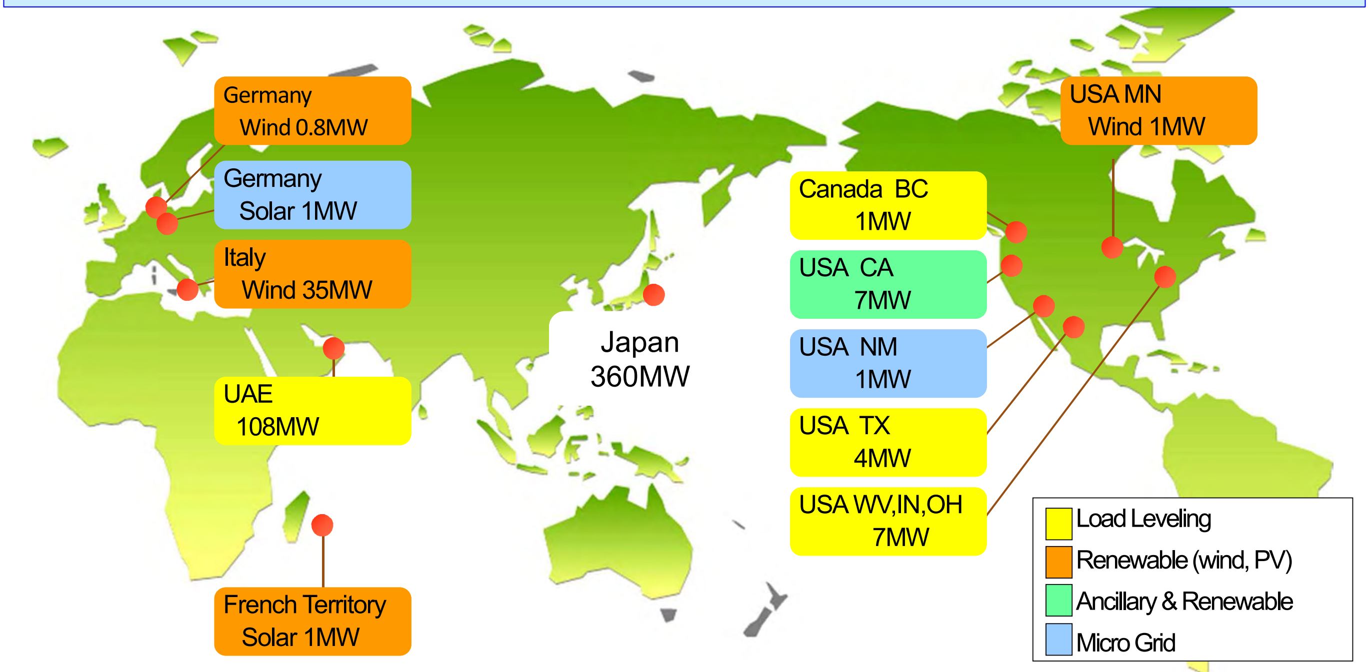
- Proven energy storage technology for high power, large energy capacity.
- Fully commercially available technology (large manufacturing capacity)
- Uses only common materials (Sodium and Sulfur). No rare materials used

Feature

- **Long Duration**
  - Can discharge energy up to 6 hours at rated power
- **Compact Layout**
  - 3 times energy density compared to lead acid battery
- **Reliability**
  - Uses ceramic for electrolyte. No self discharge, superior long term durability
- **Fast Response**
  - Prompt response – full power charge to discharge in 2 milliseconds
- **Safety**
  - Multiple safety features and quality control incorporated to ensure safety
- **Easy Maintenance**
  - Minimal planned maintenance required. Remote operation possible

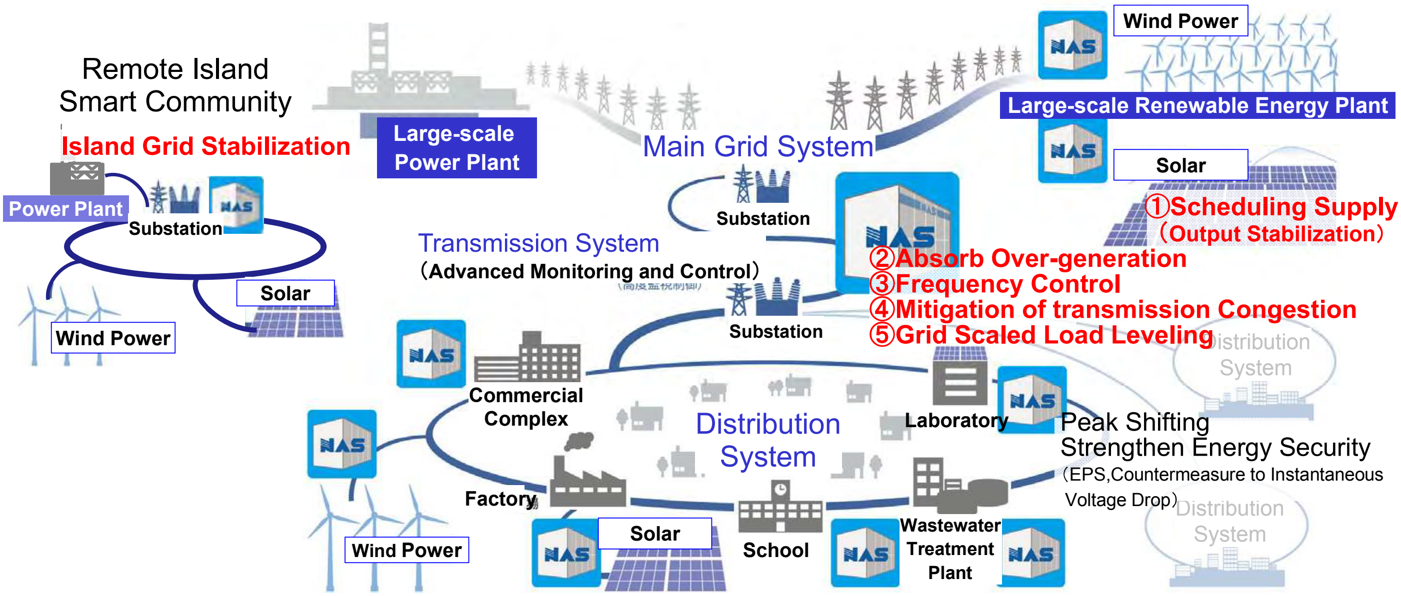
NAS® Battery Installations around the World

- Outstanding supply record in Large Scale Battery Energy Storage
  Total Installation Record of 530MW (3700MWh) (as of Oct. 2015, incl. under construction)
- Annual Production Capacity 150MW (1GWh)



Various applications of NAS® Battery System

- Introduction of massive volume of renewable energy into existing energy system causes quality and reliability problem of electricity.
- NAS® Battery can play important roles at each point of the grid to maintain and increase energy security (no location and time constraint).



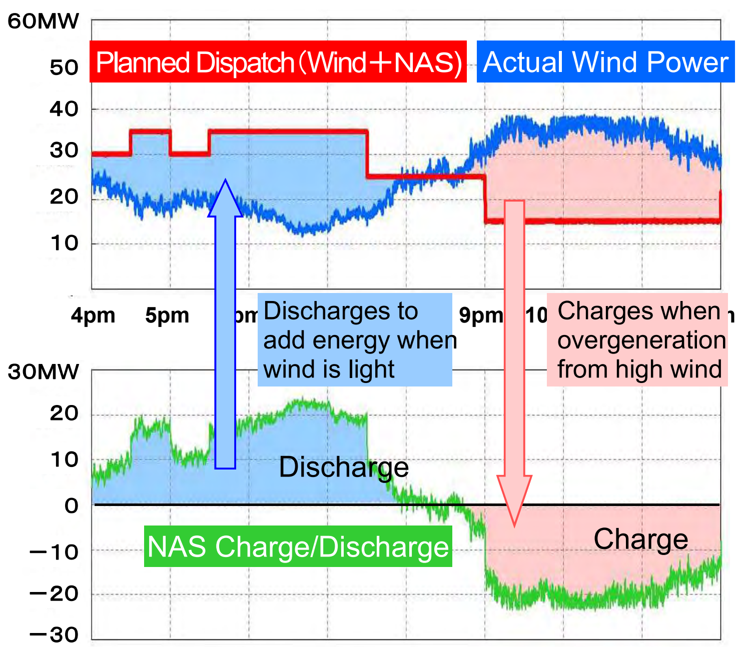
① Scheduled Supply of Wind Power (Rokkasho in Japan)

- 34MW NAS® Battery in operation since August 1st, 2008 to make effective use of wind power during night time

Futamata Wind Generating Station
Wind 51MW (1.5MW wind turbine × 34)

34MW (224MWh)
NAS Energy Storage System

2MW per battery unit
× 17 battery units



Summary of NAS® Battery

- ■NAS® Battery can be utilized in many applications to maintain and increase grid security.
- ■Outstanding and abundant supply record in the world for 14 years after extensive R&D back to 30 years ago.
- ■Short time deployment by containerized system with annual production capacity of 150MW/1GWh.
- ■Most reliable and effective battery to store large amounts of electric by using well-established ceramic technology.

Effective Use of Weather Information for Renewable Energy

November 10, 2016
Japan Weather Association
Kenji Utsunomiya
utsunomiya@jwa.or.jp

Outline

1． Our Organization
2． Weather and Renewable Energy Forecasts for Electricity Supply and Demand Operation
3． Weather and RE Forecasts Technology
4． Summary

1. Our Organization

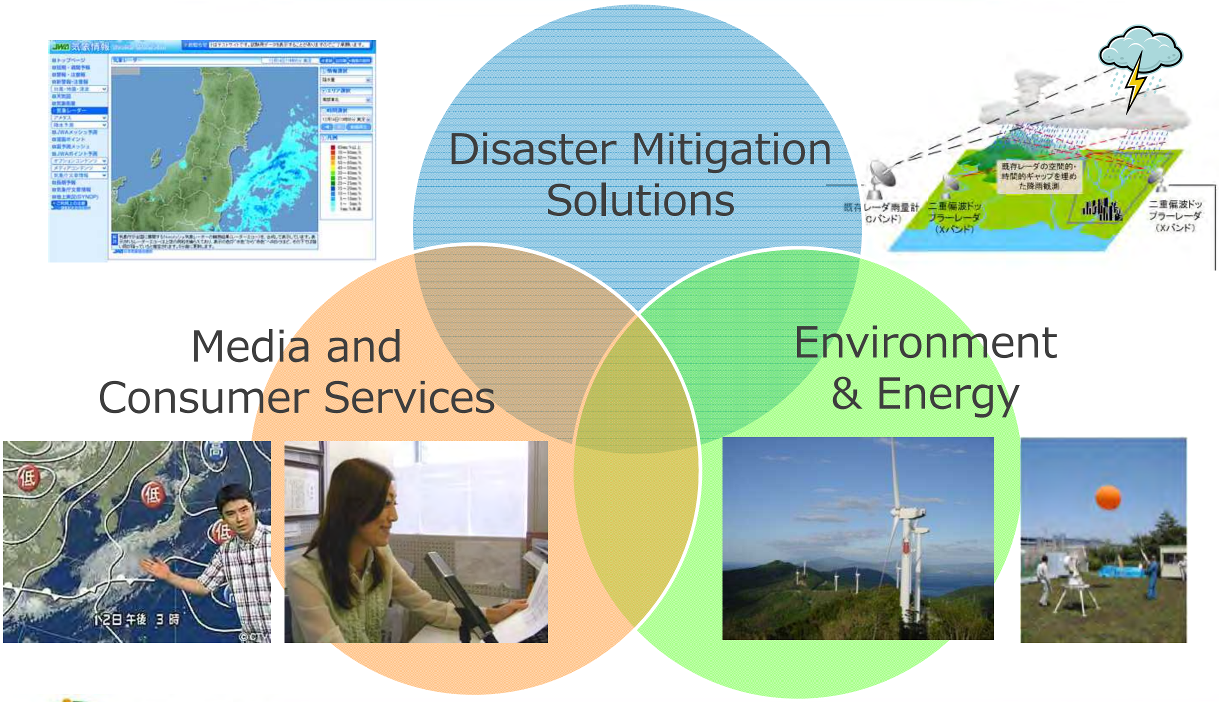
日本気象協会 2

Japan Weather Association (JWA)

- Established: May 10, 1950
- Headquarters: Tokyo, Japan
- Employees: 693 (as of July 1, 2016)
- Major Branches: Tokyo, Sapporo, Sendai, Nagoya, Osaka, Fukuoka
- Main services: Media and Consumer Services
Disaster Mitigation Solutions
Environment and Energy

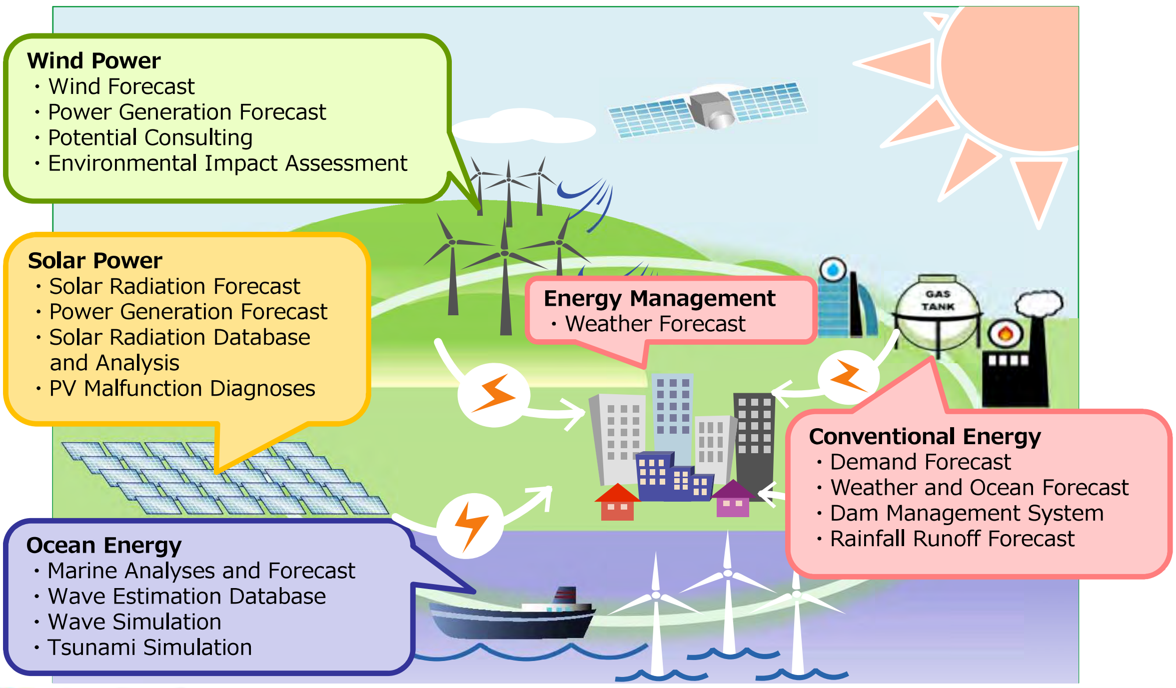
日本気象協会 3

Our Services



日本気象協会 4

Our Services for Energy Sector



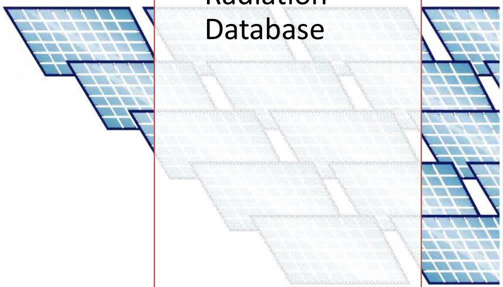
日本気象協会 5

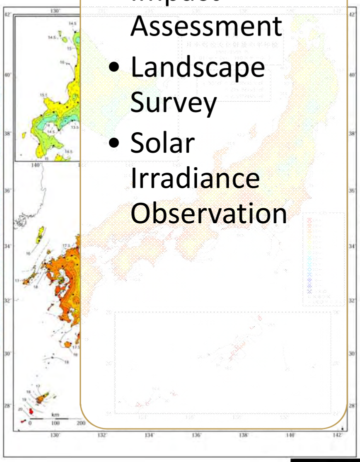
Meteorological Supports for Solar Energy

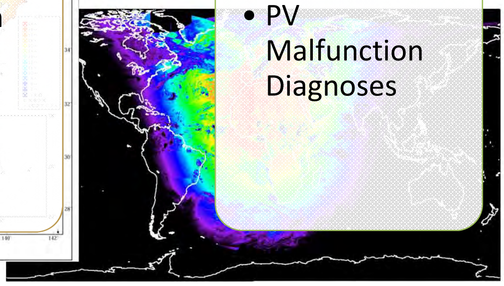
Planning
- Potential Analyses
- Solar Radiation Database

System Installment
- Environmental Impact Assessment
- Landscape Survey
- Solar Irradiance Observation

After Installment
- Power Generation Forecast
- Irradiance Estimation w/ Satellite and Observation
- PV Malfunction Diagnoses







日本気象協会

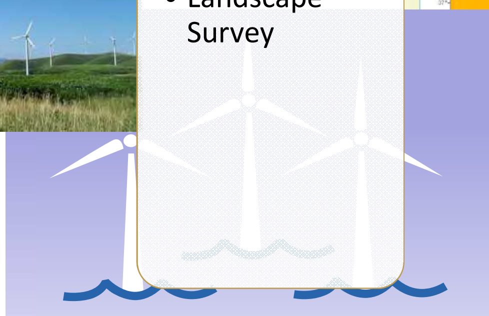
6

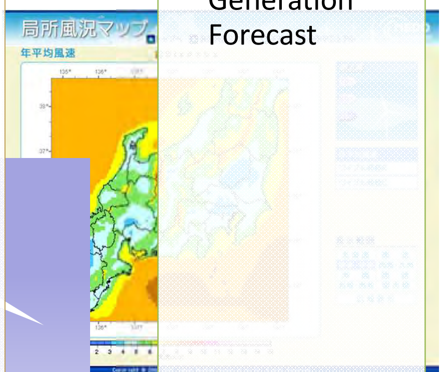
Meteorological Supports for Wind Energy

Planning
- Potential Analyses
- Windmill Arrangement Support
- Wind Potential Database

System Installment
- Environmental Impact Assessment (Consulting, Observation)
- Landscape Survey

After Installment
- Power Generation Forecast





日本気象協会

7

Other Supports for Energy Sector

Oceanic Analyses	Hydraulic Power	Operation
• Wave Analyses • Tidal Analyses • Tsunami Analyses • Tsunami Prediction Support • Ship Support	• Rainfall Analyses and Forecast • Rainfall Runoff Forecast	• Weather Forecast • Demand Forecast • Data Delivery System

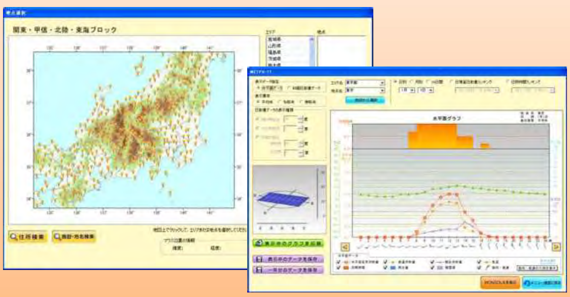
Potential Analyses Support for Solar Energy

Data Analyses → **Estimation** → **Database**

- Data Analyses
  - Solar Radiation
  - Sunshine Duration
- Estimation
  - Optimization
  - Tilting patterns
- Database
  - Map
  - Web tools

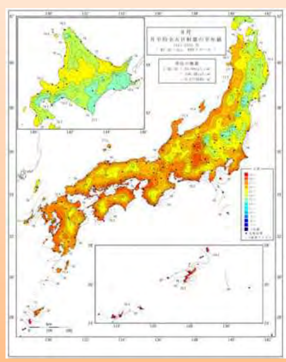
Solar Radiation Database

For monthly generation estimates



Solar Radiation Map

For location selection



Potential Analyses Support for Wind Power

Numerical Simulation

Meteorological elements

Wind Estimation

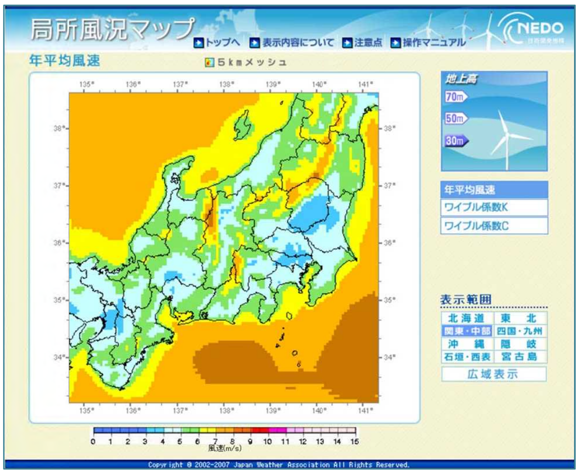
Yearly average | Frequency Distribution

Database

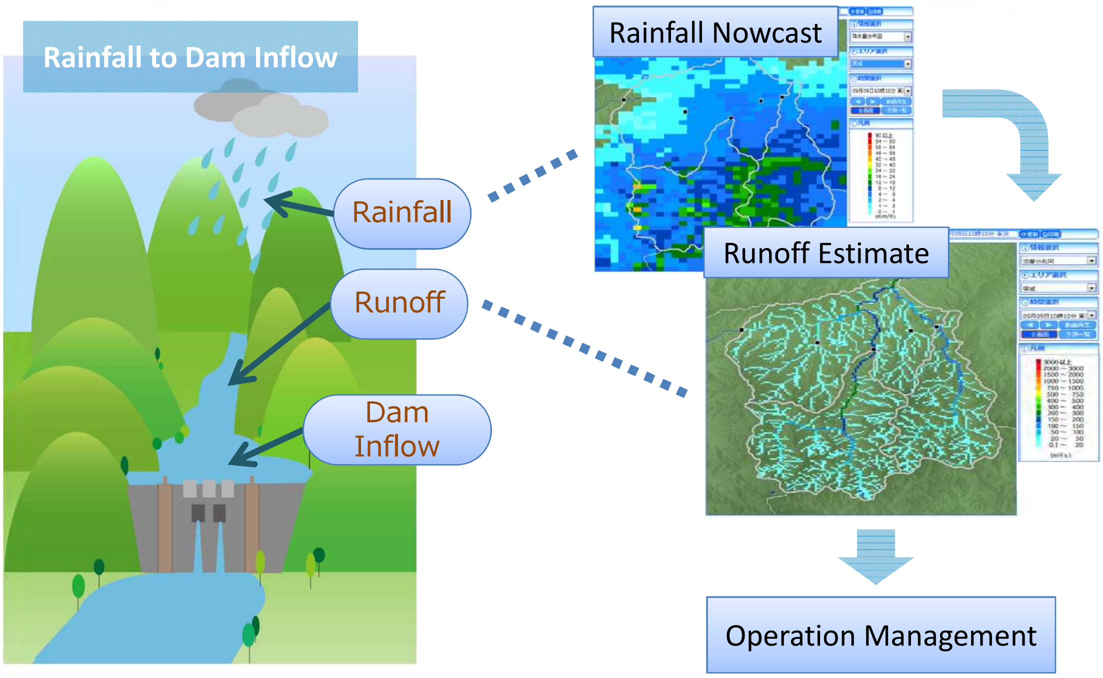
Map | Web tools

Wind Power Map

For generation estimation



Rainfall Runoff Forecast for Dam Operation

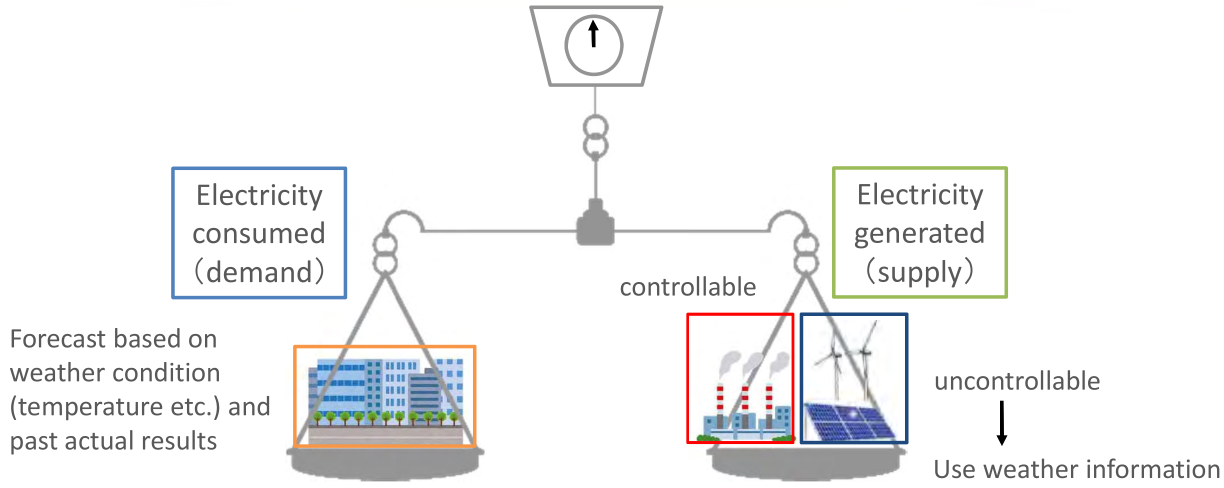


2． Weather and Renewable Energy Forecasts for Electricity Supply and Demand Operation

Characteristics of Each Electricity Generating System

Thermal power	○ high output power, stable output, easy output control, low construction cost × carbon dioxide emission, air pollution, fuel price dependency
Nuclear power	○ high output power, stable output, low-cost fuel, low carbon emission × radioactive waste, accidental disaster
Hydraulic power	○ zero carbon emission, natural energy, usable for output adjustment × huge environmental impact, rainfall/inflow dependency
Geothermal power	○ low carbon emission, stable output × high construction cost, long way to commencement
Solar power	○ zero carbon emission, variety of site selection, × weather-dependent output/efficiency,
Wind power	○ zero carbon emission, night-time generation × weather condition dependency, bird-strike/noise problem

Need of weather and RE Forecasts



- The balance between consumed and generated electricity is disrupted
  ⇒ the supplied electricity voltage and frequency fluctuate
- Solar and wind power are greatly influenced by weather conditions
  ⇒ Uncontrollable, but weather information can help their estimation

Information required for Electricity Planning in Japan

Electricity supply and demand Planning

Weekly plan
- Create a weekly expected plan

Next day's plan
- Create a plan for the next day on the day before

Plan on the day
- Fix a supply and demand plan for that day

Operation on the day
- Manage supply and demand

Type of forecasts

One-week Forecasts
- Release once a day
- Forecast up to 7 to 10 days ahead

Forecasts for the day and the next day
- Release 4 times a day
- Forecast up to 72 hours (the next day and the day after) ahead

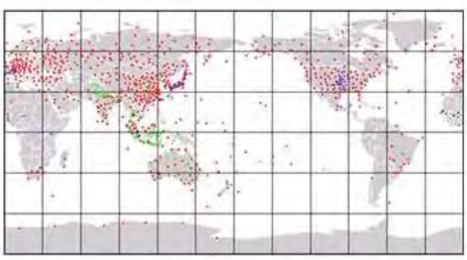
Several hours forecasts
- Release 24 times a day (every hour)
- Forecast up to 3 to 6 hours ahead

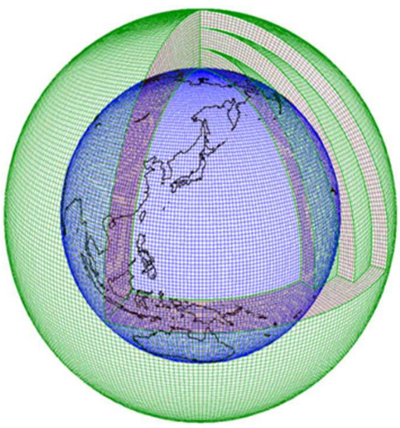
3． Weather and RE forecasts technology

Weather Forecasts and Analysis

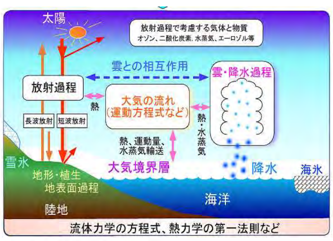
Observation
Upper, surface, satellite, radar …

Objective analysis for initial values
Suitable values (temperature, wind, etc.) for model grid





Numerical Prediction (by high-speed computers)



Numerical Prediction Outputs

Observation for Weather Forecast

Surface Observation

Wind, solar radiation, etc.

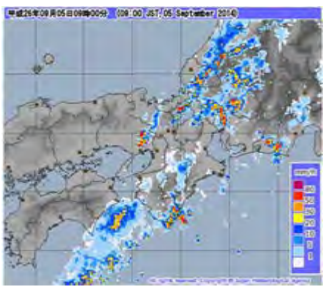
Data processing and communicating

Observation field (temperature, precipitation, etc.)

Source :JMA

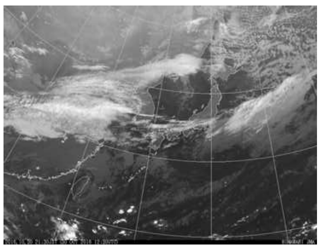
Observation for Weather Forecast

radar



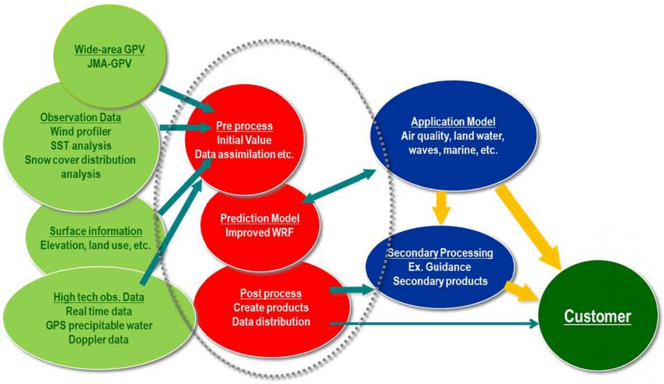
upper

satellite



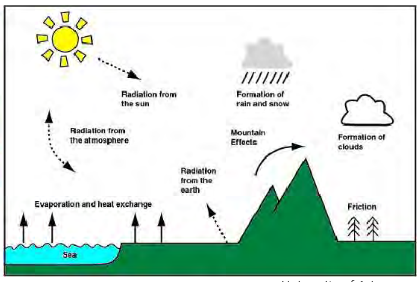
Source: JMA

Numerical Meteorological Model

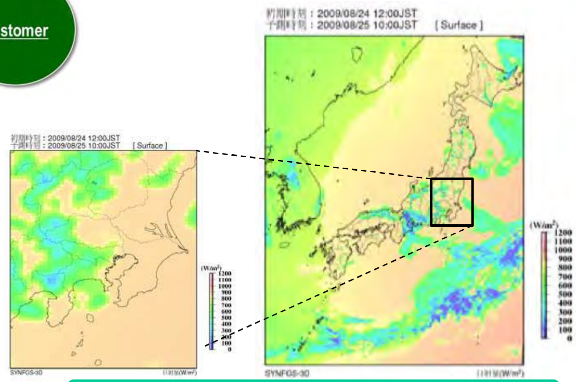


■Original weather forecast model (SYNFOS-3D)

- Combination of multiple weather models for variable spatiotemporal scales.
- Prediction of 6 to 72 hours, 2 weeks by 2.5-km, 5-km and 10-km grid.



University of Arizona



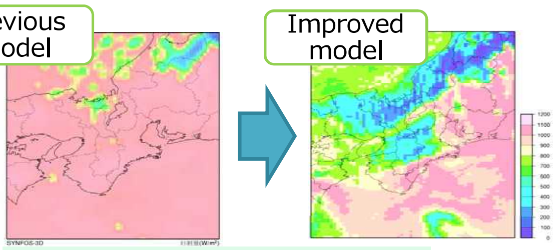
Example: prediction of solar radiation

Numerical Meteorological Model for Solar Radiation Forecast

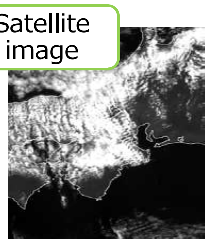
- The numerical meteorological model was improved to accurately forecast the solar radiation.

previous model

Improved model



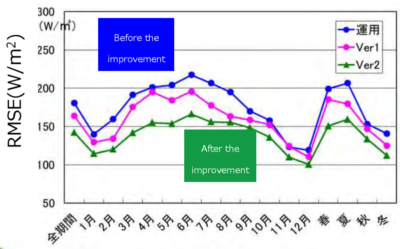
Satellite image



$$RMSE = \sqrt{\frac{\sum(F-O)^2}{N}}$$

F : forecasted value
O : observed value
N : number of data

Before the improvement, clouds could not be predicted, but after the improvement, clouds along the Sea of Japan could be predicted.

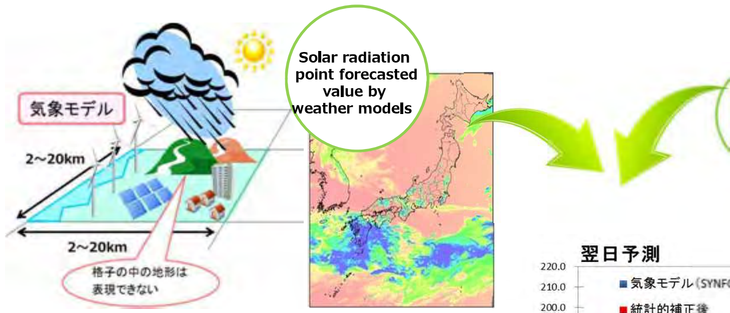


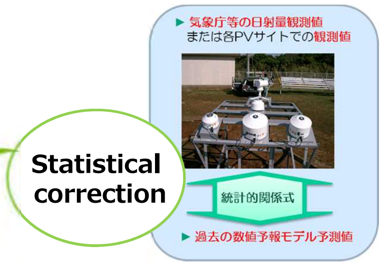
RMSE of the improved model is 20% better than that of the previous one

- Make number of model vertical layer detailed
- Change physical process scheme
- Change radiation process calculation time
- Introduce partial condensation scheme

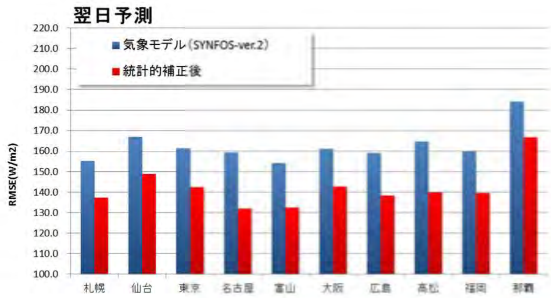
Post-processing of model outputs

For the operation, systematic errors of numerical model are statistically corrected.





Statistical correction:
With statistical relational expressions between past numerical forecast results of atmospheric conditions and observed values of solar radiation, forecasted values are estimated by applying the statistical relationship.

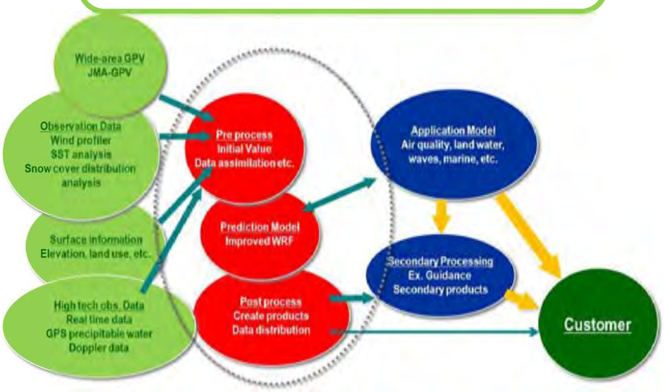


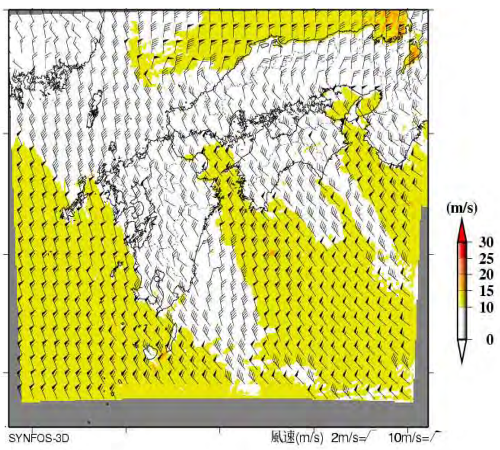
The RMSE is improved by about 15%.

Numerical Model for Short-time Forecast

■SYNFOS-Nowcast

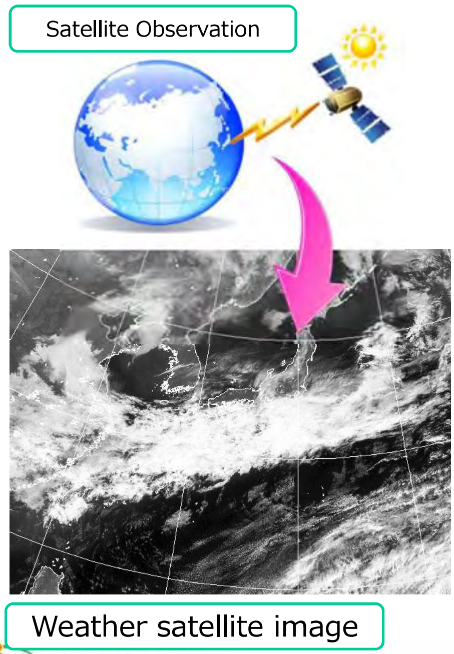
- SYNFOS-Nowcast is a numerical model to respond to abrupt changes in weather conditions
- It forecast once every hour up to the following 6 hours using observation data.
  (2.5-km grid data).

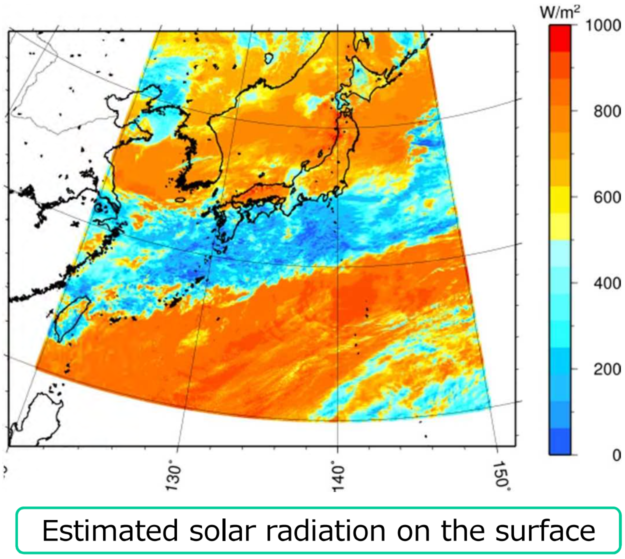




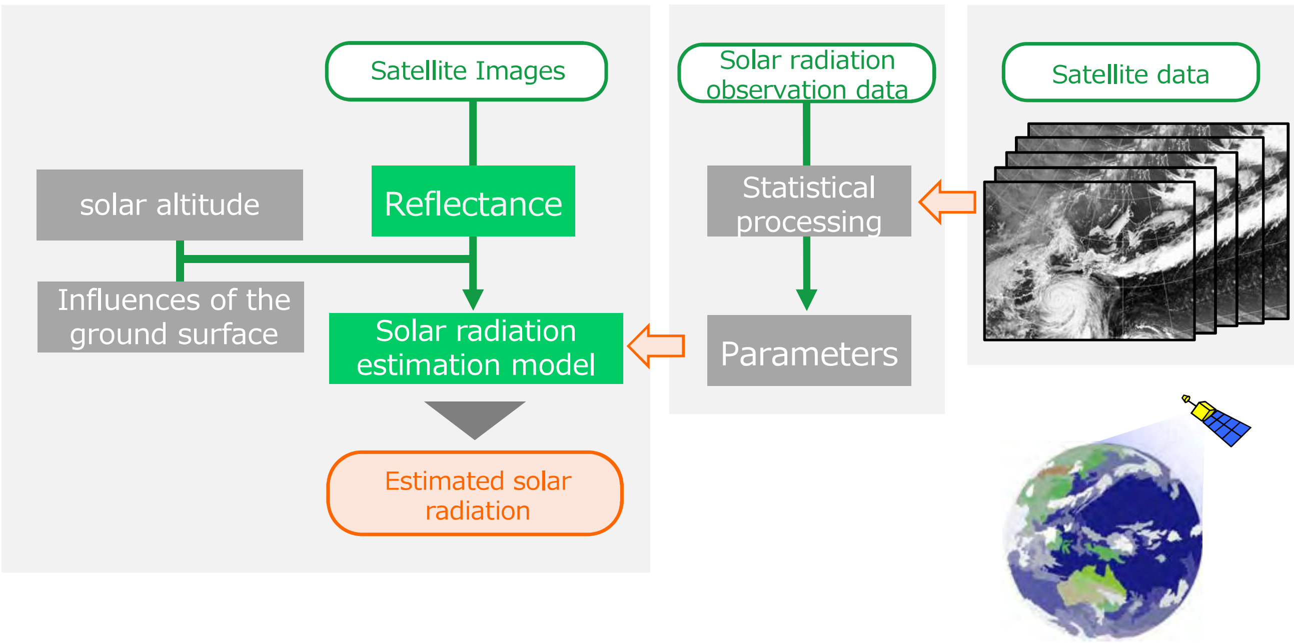
Wind direction and wind speed predicted values

Solar Radiation Estimation Technology with Weather Satellite





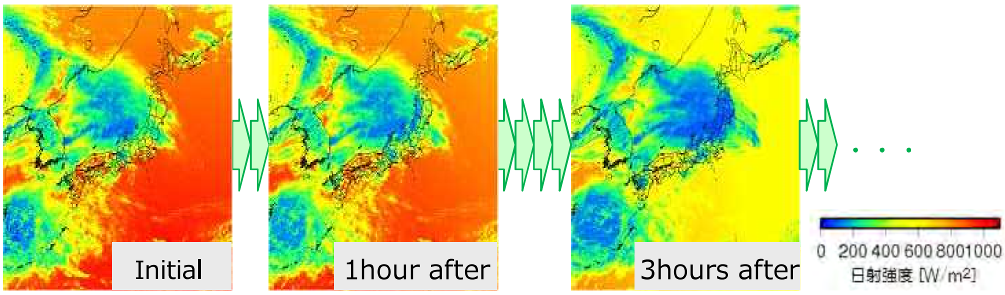
Solar Radiation Estimation from Weather Satellite Images



Solar Radiation Forecast from Weather Satellite Images

■ Prediction by moving distributions of clouds

- “Movement prediction method” which is used for precipitation forecast is applied to predict solar radiation.
- First calculate movement vectors by identifying changes in cloud position using weather satellite images in the past few hours.
- Then, assuming that the movement vectors do not change for the next 6 hours, solar radiation for every 30 minutes are predicted based on the assumption.



4． Summary

Summay

- Meteorological data or analytical results are widely used in many fields.
- Meteorological forecasts are necessary for a reliable supply of electricity.
- Forecast data are used for electricity supply and demand Planning
- I introduced the technologies of weather and renewable energy forecast, particularly about solar radiation forecasts for PV systems.

Thank you very much for your kind attention !

Extra High Strength Aluminum-Clad Steel (14EAS)

14EAS is Aluminum-Clad Steel with 14 %IACS conductivity having a tensile strength which is roughly 30 % higher than conventional ACS and standard galvanized steel.
14EAS significantly improves the corrosion resistance of our Low Loss conductor.

	Tensile strength (MPa)	Conductivity (%IACS)	Density (g/cm^3)	Modulus of elasticity (GPa)
14EAS	1770	14	7.14	170.1
Standard ACS (20SA)	1340	20	6.59	162
Galvanized steel	1290	–	7.78	205.9

Design Examples

Some design examples of possible Low Loss conductors are shown in table below. Other custom-made designs are available for specific projects, upon request from our customers.

Equivalent conventional ACSR			Hawk		Grosbeak		Drake		Curlew	
Type of design			Type 1	Type 2	Type 1	Type 2	Type 1	Type 2	Type 1	Type 2
Size		mm^2	270/30	320	360/40	420	460/48	530	580/53	680
Stranding	Aluminum	No./mm	15/3.65 +8/TW[*1]	12/TW[*1] +8/TW[*1]	15/4.2 +8/TW[*1]	12/TW[*1] +8/TW[*1]	16/4.45 +8/TW[*1]	12/TW[*1] +8/TW[*1]	13/5.95 +8/TW[*1]	16/TW[*1] +12/TW[*1] +8/TW[*1]
	14EAS		7/2.35	7/2.2	7/2.7	7/2.5	7/2.95	7/2.8	7/3.1	7/2.8
Rated tensile strength		kN	87.8	86.8	115.8	113.5	142.5	142.1	165.4	165.9
Diameter	Conductor	mm	21.78	21.78	25.15	25.15	28.13	28.13	31.6	31.6
	14EAS		7.05	6.6	8.1	7.5	8.85	8.4	9.3	8.4
Cross sectional area	Aluminum	mm^2	273.6	315.0	364.9	420.5	461.7	525.2	579.4	677.9
	14EAS		30.36	26.61	40.08	34.36	47.85	43.11	52.84	43.11
	Total		304.0	341.6	405.0	454.9	509.6	568.3	632.2	721.0
Weight		kg/km	972	1065	1294	1413	1617	1765	1977	2189
D.C.Resistance at 20°C		Ω/km	0.1028 (0.1044)[*2]	0.0905 (0.0918)[*2]	0.0772 [0.0783)[*2]	0.0676 (0.0687)[*2]	0.0609 (0.0621)[*2]	0.0543 (0.0553)[*2]	0.0488 (0.0496)[*2]	0.0422 (0.0430)[*2]
Current carrying capacity[*3]	at 90°C	A	631	673	723	806	874	924	1004	1059
	at 150°C		(938)[*2]	(1000)[*2]	(1074)[*2]	(1206)[*2]	(1311)[*2]	(1388)[*2]	(1517)[*2]	(1595)[*2]
Modulus of elasticity		GPa	72.6	70.2	72.5	70.0	72.0	70.0	70.9	68.3
Coefficient of linear expansion		10^{-6}/°C	20.4	20.9	20.4	21.0	20.6	21.0	20.8	21.4

Notes
*1: TW stands for Trapezoidal shaped Wires.
*2: Values in brackets are DC resistance and Current Carrying Capacity of Low Loss conductor with TAL (Thermal resistant aluminum alloy).
Low Loss conductor will have high current carrying capacity (approx. twice of ACSR having same diameter), by means of adopting TAL.
*3: Current Capacity calculation conditions: Ambient Temperature: 40 0C ; Wind: 0.5 m/s ; Wind direction: 45 degrees
Solar radiation: 0.1 W/cm2 ; Absorptivity & Emissivity of conductor surface: 0.5

Supply record

Our Low Loss conductor was developed more than 30 years ago and so far we have supplied more than 14,700km (as of February 2016) in many projects around the world, in very different climatic conditions.

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住友電工

Low Electrical Power Loss Type Conductor

LL-(T)ACSR/AS

Low Loss type Aluminum (Thermal-Resistant Aluminum Alloy) Conductor, Aluminum-Clad Steel Reinforced

SUMITOMO ELECTRIC GROUP

Low Electrical Power Loss Type Conductor

LL-(T)ACSR/AS

Low Loss type Aluminum (Thermal-Resistant Aluminum Alloy) Conductor, Aluminum-Clad Steel Reinforced

Nowadays climate change and global warming pose serious threats to our planet and to the quality of life of next generations. It is imperative to limit the emission in the atmosphere of greenhouse gases (e.g. CO_2, CH_4, N_2O) by reducing fossil fuels power generation. Our Low Electrical Power Loss Type conductor (hereinafter called "Low Loss conductor") can reduce transmission losses by roughly 25%. Transmission lines adopting our Low Loss conductor can operate more efficiently, reducing the need of electricity from fossil power stations. These latter can then reduce their energy generation and the related cost, as well as CO_2 emission.

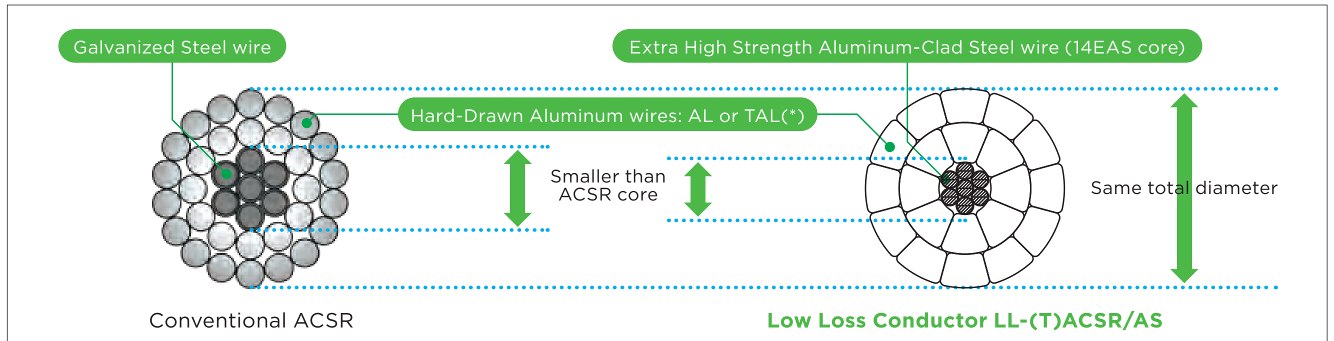
Clear Advantages

- Reduction of line transmission losses **in the range of 10 - 25 %**
- Almost the **same tower loading** as conventional ACSR **(same diameter, same tensile strength)**
- Better **corrosion resistance** than conventional ACSR due to Aluminum-Clad Steel (AS) core
- **Same installation and maintenance procedure** as conventional ACSR
- The higher current capacity, thanks to TAL(*), allows an easy implementation of **N-1 system protection**

Technical Construction

The basic design concept of our Low Loss conductor is **"keeping the same diameter and the same rated tensile strength as ACSR, while simultaneously having a DC resistance lower than ACSR"**. To have lower DC resistance, our Low Loss conductor apply Trapezoidal shaped wires in its conductive layers, as well as Extra-high Strength Aluminum-Clad Steel wire (14EAS) in the conductor core.

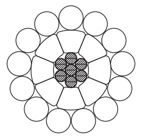
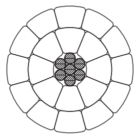
Adoption of Trapezoidal shaped wires instead of Round wires:
increase the AL area while maintaining the total diameter of conductor same as conventional ACSR.
Adoption of 14EAS (tensile strength: 1770 MPa) instead of normal Galvanized Steel wires (1290-1340 MPa)
decrease core area while maintaining its mechanical strength same as conventional ACSR.



(*): TAL stands for Thermal-resistant Aluminum alloy with maximum allowable operational temperature of 150 °C

Design Type

Low Loss conductor can have two design types, depending on the purpose or specific project requirements.

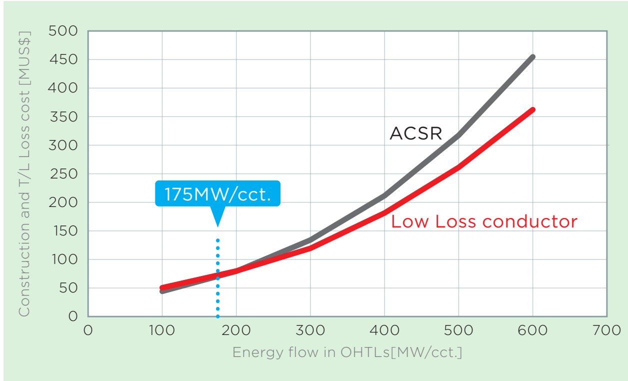
Type 1	Type 2
Use AL(TAL) round and trapezoidal shaped wires:	All aluminum wires are trapezoidal shaped wires:
 **Same diameter** **Same weight** No tower load increase	 **Same diameter** **Have maximum aluminum area** Achieve highest power saving
Reduce power loss by **roughly 10-15%** No sag increase No need to reinforce nor to modify the existing towers Recommended for re-conductoring of existing lines, or for new lines construction	Reduce power loss by **roughly 20-25%** Slight sag increase (because of slight weight increase) Tower reinforcement or modification may be necessary Recommended for construction of new lines

Economic comparison

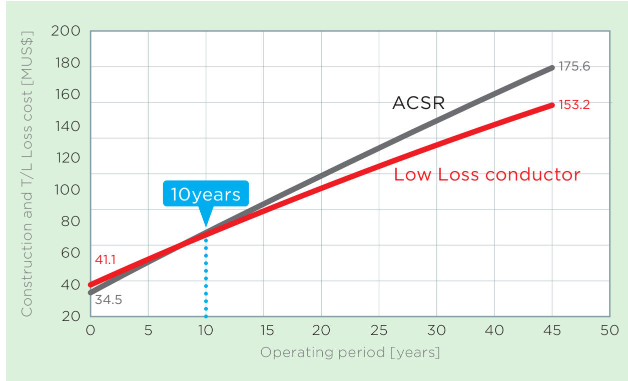
Conditions of the comparison:
- Line Voltage: 275 kV
- Numbers of circuit: 2
- Bundle: twin conductors/phase
- Power factor: 0.9
- Route length: 100 km
- Load factor: 0.5
- Generation cost: 0.07 USD/kWh

Low Loss conductor price is higher than that of ACSR having the same diameter, due to larger aluminum cross section...

...but this initial cost difference is largely compensated by the significantly lower operational cost of the transmission line!



Cost Comparison for 40 years operation



Cost Comparison for 350 MW/cct. operation

In case of energy flow in OHTLs of **only 175 MW/cct.,** the Low Loss conductor recovers the higher initial cost in 40 years, which is the usual lifetime of OHTLs.
Larger energy flow in OHTLs (higher than 175 MW/cct.) give to Low Loss conductor an even bigger economic advantage.

Low Loss conductor can recover the difference of initial cost in only 10 years if energy flow in OHTLs is 350MW/cct. (in the above conditions).
In case the energy flow in OHTLs is bigger than 350MW/cct., our Low Loss conductor provides an even bigger advantage, because the break-even is reached in a period shorter than 10 years.

Load needed (as % of maximum load of the line) to reach Break-Even

kV	in 40 years	in 20 years	in 10 years	Assumed conductor
110 - 132	31%	43%	60%	ACSR Hawk x 1
220 - 275	32%	45%	62%	ACSR Drake x 2
400 - 500	32%	46%	65%	ACSR Drake x 4

Conditions of the calculation:
- Power factor: 0.9
- Load factor: 0.5
- Generation cost: 0.07 USD/kWh
- Low Loss conductor: Type 2
- Maximum load:
  Based on current capacity of ACSR at 75°C

Accessories

Design concepts and materials used in compression joints for Low Loss conductors are the same as those for ACSR, except for Low Loss conductor with TAL (Thermal-Resistant Aluminum Alloy). Compression joints for LL conductors using TAL need larger and longer aluminum body than those for conventional ACSR in order to maintain the same current density and to achieve better heat radiation. All other accessories are basically the same as accessories for conventional ACSR.

Installation & Maintenance

Installation and maintenance procedure of our Low Loss conductor is exactly the same as that of conventional ACSR conductor.

Characteristics and Advantage of ACFR

ACFR stands for

"Aluminum Conductor Fiber Reinforced"

Core : CFCC(Carbon Fiber Composite Cable)

- ■Stranded CFRP cable
- ■Only Tokyo Rope can produce

Conductor : Trapezoidal Shaped Aluminum Conductor

ACFR

CFCC

Characteristic of ACFR

- Large Cross Section Area
- Non Magnetic Core
- Light Weight
- Low Creep
- Low Thermal Expansion
- Anti-Corrosion
- Stranded CFCC Core

Advantage of ACFR

- Reduction of Transmission Loss — 27% Less(※)
- OR
- Increase of Transmission Capacity — X 2 More Capacity(※)
- AND
- Less Sag — 20% Less(※)
- Long Material Life
- Easy Handling — Less Complicated

(※) These figure depends on conditions

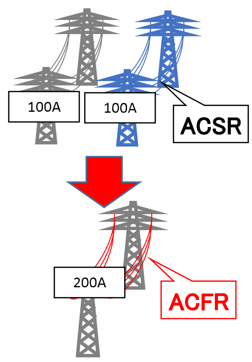
Design Example of ACFR

■Reduction of Transmission Loss

		ACFR 540/55	ACSR 430/55	STACIR 430/55
Core		CFCC	Steel Wire	Invar Alloy Wire
Diameter	[mm]	28.62	28.62	28.62
Electric Current	[A]	700	700	700
Operation Temperature	[℃]	66.55	72.8	72.5
Resistance per Length	[Ω/km]	0.0623	0.0851	0.084
Transmission Loss per Circuit Length	[kW/km]	91.6	125.1	123.5
	Ratio	0.73	1	0.99

27% Less than ACSR

【Capacity Upgrade Image】



■ Increase of Transmission Capacity

		ACFR 540/55	ACSR 430/55	STACIR 430/55
Core		CFCC	Steel Wire	Invar Alloy Wire
Diameter	[mm]	28.62	28.62	28.62
Electric Current	[A]	1643	729	1557
Operation Temperature	[℃]	175	75	210
Resistance per Length	[Ω/km]	0.0847	0.0858	0.1235

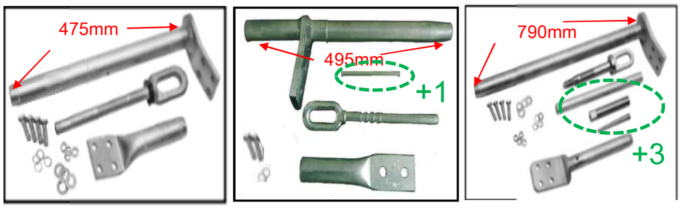
X 2 More than ACSR

Accessories and Comparative Evaluation

TOKYO ROPE MFG. CO., LTD.

■ Accessories of each conductor

	ACSR	ACFR	ACCC



Install Time	10 Min	10 Min	30 Min

■ Comparative Evaluation

Comparative points	ACSR	ACFR	Invar	ACCC
Transmission Capacity	△	◎	◎	◎
Transmission Loss	×	◎	△	◎
Sag	×	◎	○	◎
Installation	◎	◎	◎	×

Design and dimension of Accessories and Installation Procedure for ACFR are almost same as ACSR's

No special instruction and equipment is required for ACFR accessories

ACFR has the highest performance

3

Case Study for ACFR

ALUMINUM CONDUCTOR FIBER REINFORCED

TOKYO ROPE MFG. CO., LTD.

ACFR can recover the difference of initial cost in 11 years

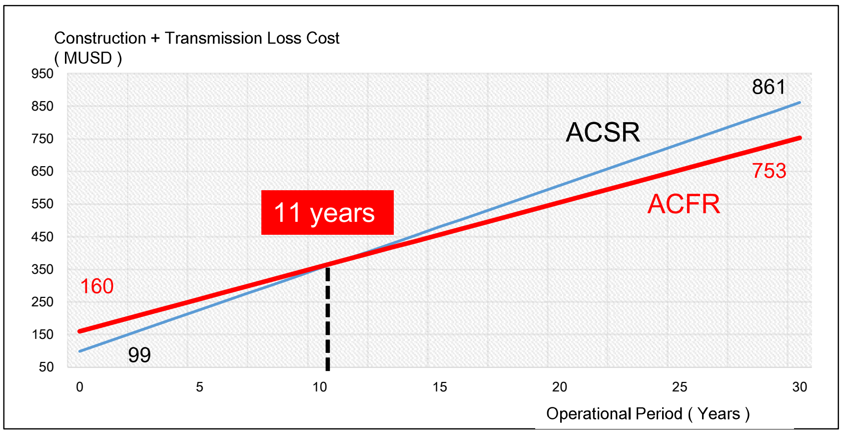
Preconditions

- ■400KV, 1 circuit, 4 bundles
- ■Current 415A
- ■Load Factor 0.5
- ■Route Length 200km
- ■Span Length between towers 400m
- ■Power rate 0.07USD/kWh
- ■Construction Cost 0.32MUSD/km
- ■Interest 1.5% (30years)
- ■ACFR Price (ACSR x 4)

Specification Difference

		ACSR BISON 380/50	ACFR 470/40
Diameter	[mm]	27	27
Weight	[kg/m]	1.444	1.371
Conductor's	[mm^2]	381.7	472.5
Cross-Sectional Area	[%]	100	124

Cost Comparison



4

Supply Record for ACFR

ALUMINUM CONDUCTOR FIBER REINFORCED

TOKYO ROPE MFG. CO., LTD.

Project Name	Kashimadai Line	Sekiya Line	KEPRI Line	Qing Yuan Transmission Line	Hainan island double capacity line	Sambera substation	Kuala Tanjung - Kisaran & Brandan - Binjai
Year	2002	2003	2007	2012	2013	2015	2016
ACFR Size	160/40	160/40	410/65	315/35	320/40	315/40	315/40
Voltage	66kV	66kV	154kV	110kV	220kV	150kV	150kV
Location	Miyagi Japan	Niigata Japan	Gunsan South Korea	Guangdong China	Hainan China	Kalimantan Indonesia	Medan Indonesia
Conductor Length	3km	2km	3km	1km	60km	5km	680km
Owner	Tohoku Electric Power Co., Inc.	Tohoku Electric Power Co., Inc.	KEPCO	China Southern Power Grid	China Southern Power Grid	PLN	PLN

5

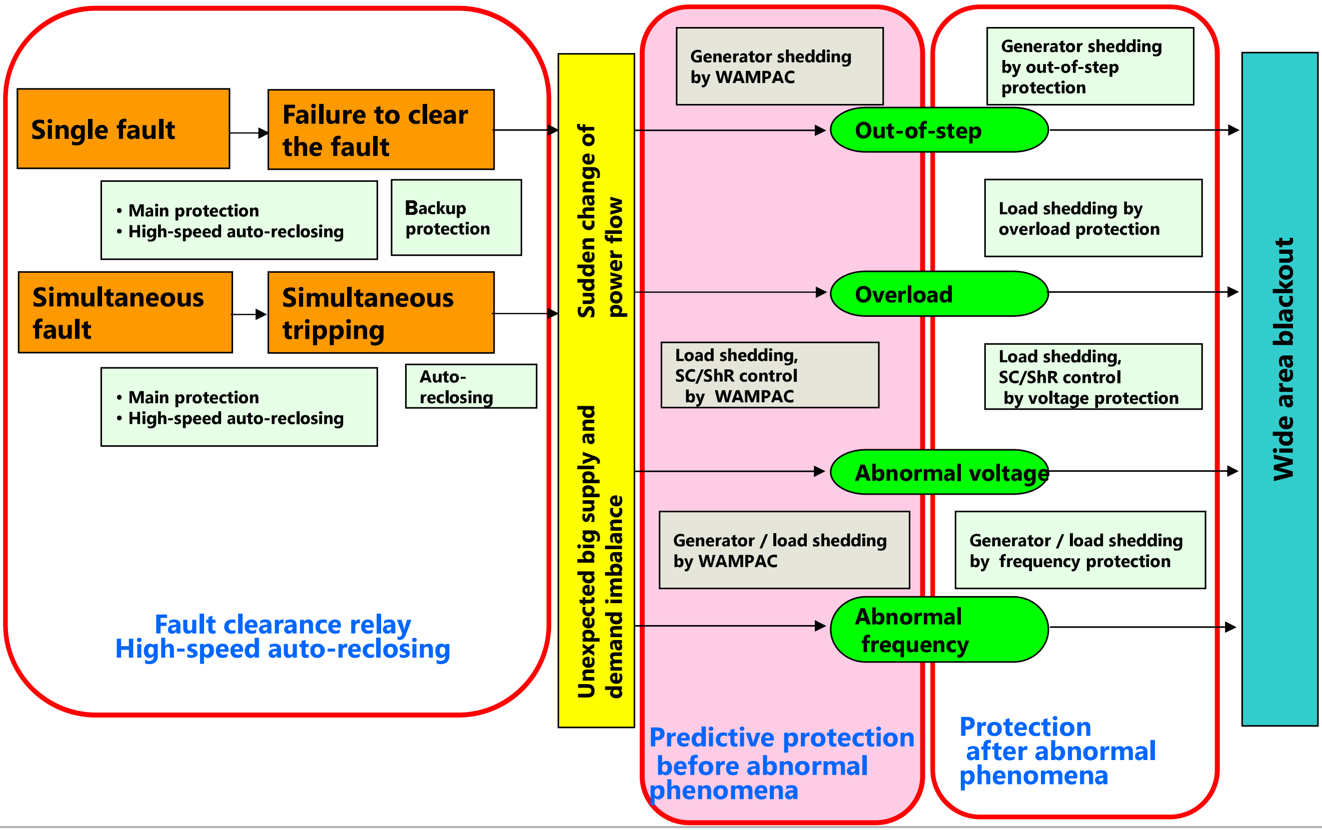
Power System Stability Control System

TOSHIBA CORPORATION
Nov. 10, 2016

Topics

1. **What is “Power System Stability Control System”?**
2. Installation Steps of TSC system
3. Equipment for the grid stabilization
4. Conclusion

Role of Power System Stability Control System



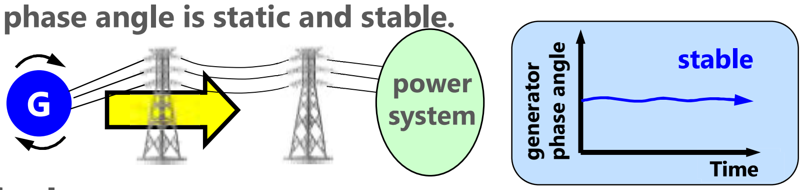
Systems for abnormal phenomenon and Control strategies

Abnormal phenomenon	Power system stability control system	Control strategies
Out of step	Step-out preventive relay system Step Out Relay	Generator shedding
Abnormal voltage	System voltage protection relay system	Load shedding Static Condenser (Capacitor) control Shunt Reactor control
Over load	Over load protection relay system	Generator shedding Output restriction (increase) Load shedding
Abnormal frequency	Abnormal frequency preventive relay system Under Frequency Relay	Generator shedding Output restriction Load shedding

What is out of step?

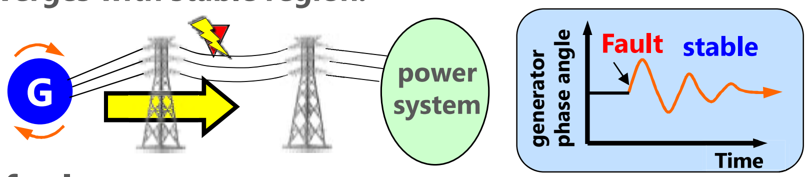
1. Normal operation

The electric power from the generator is well-balanced to power system, and the generator phase angle is static and stable.



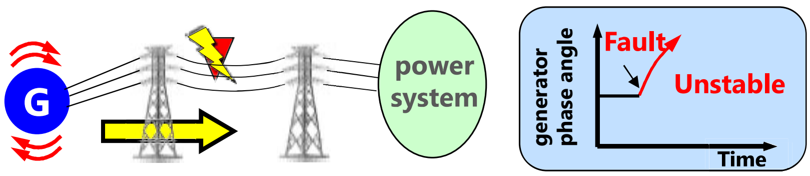
2. Minor fault

Generator phase angle swings temporarily and a generator accelerates and a generator phase angle becomes big, however the variation of generator phase angle converges with stable region.



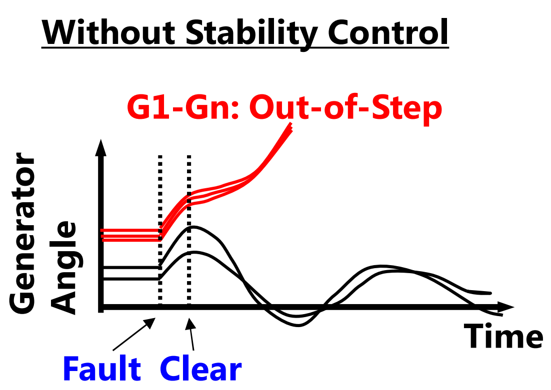
3. Severe fault

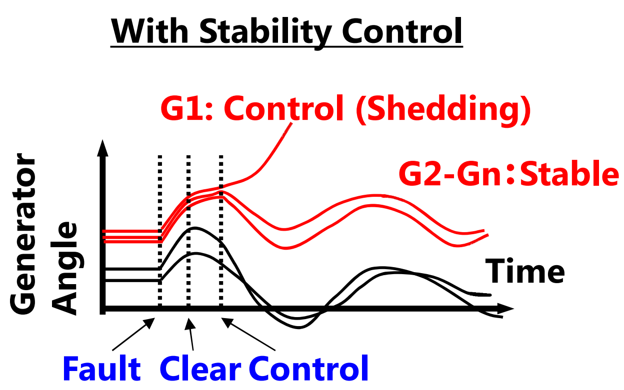
Acceleration of a generator makes the out of step and operation becomes unstable.



Outline of Transient Stability Control

- **Without stability control, G1 to Gn accelerate during the fault, an out-of-step will occur**
- **With stability control, provided that G1 is shedded following fault clearance, stable operation will be maintained for the remaining generators**





3 Types of Power System Stability Control System

Power System Stabilizing Control System

1. Behavior confirmation type

detects occurrence of instability phenomenon directly and controls.

2. Behavior assumption type(Pre-fault calculation)

makes the control scenarios beforehand in case a power system fault occurs, and controls target generator immediately refers to control scenarios when a power system fault occurs actually.

2.1 On-line Stability Analysis Type

calculates stability analysis by using on-line system information

2.2 Off-line Stability Analysis Type

calculates stability analysis by using pre-defined information

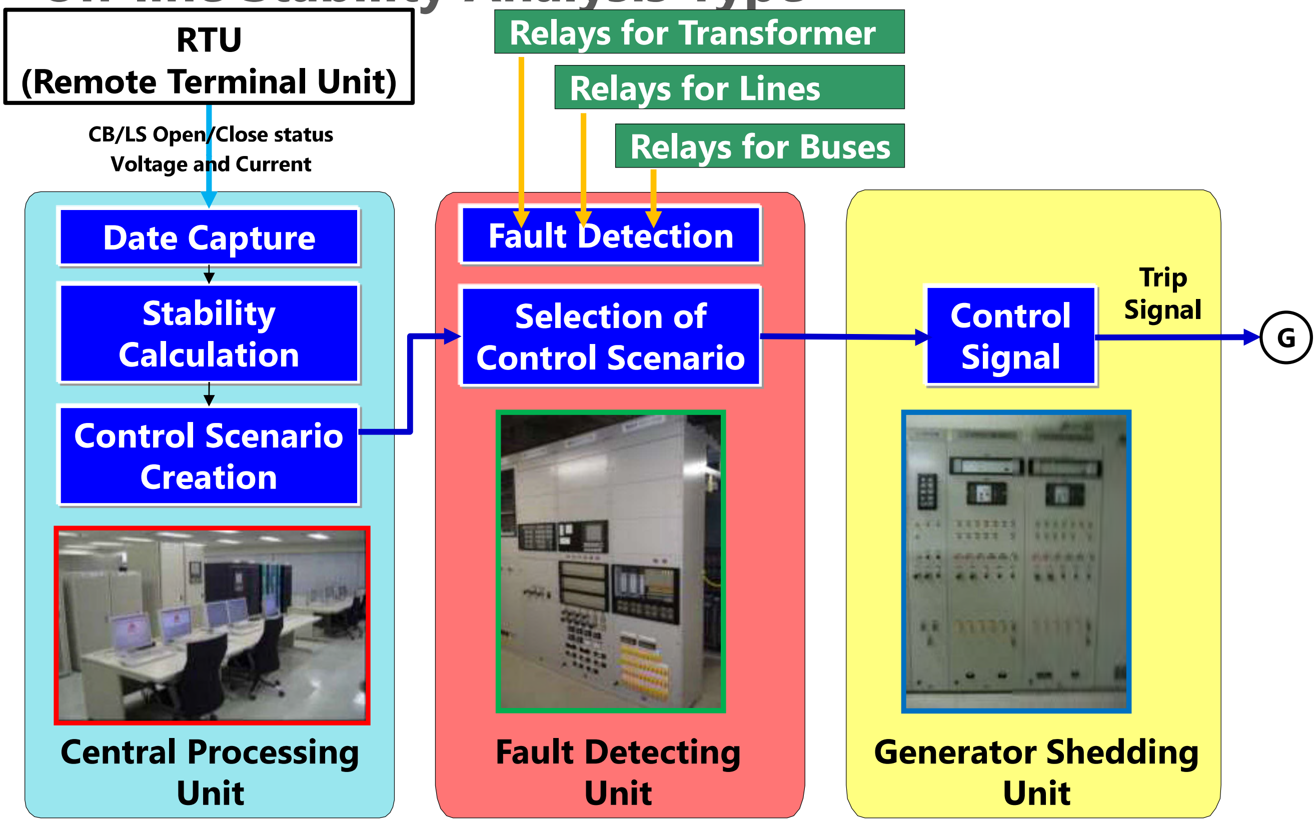
3. Behavior prediction type(Post-fault calculation)

makes the control scenarios after a power system fault occurs by high-speed prediction calculation about a future phenomenon from on-line system information and controls target generator immediately.

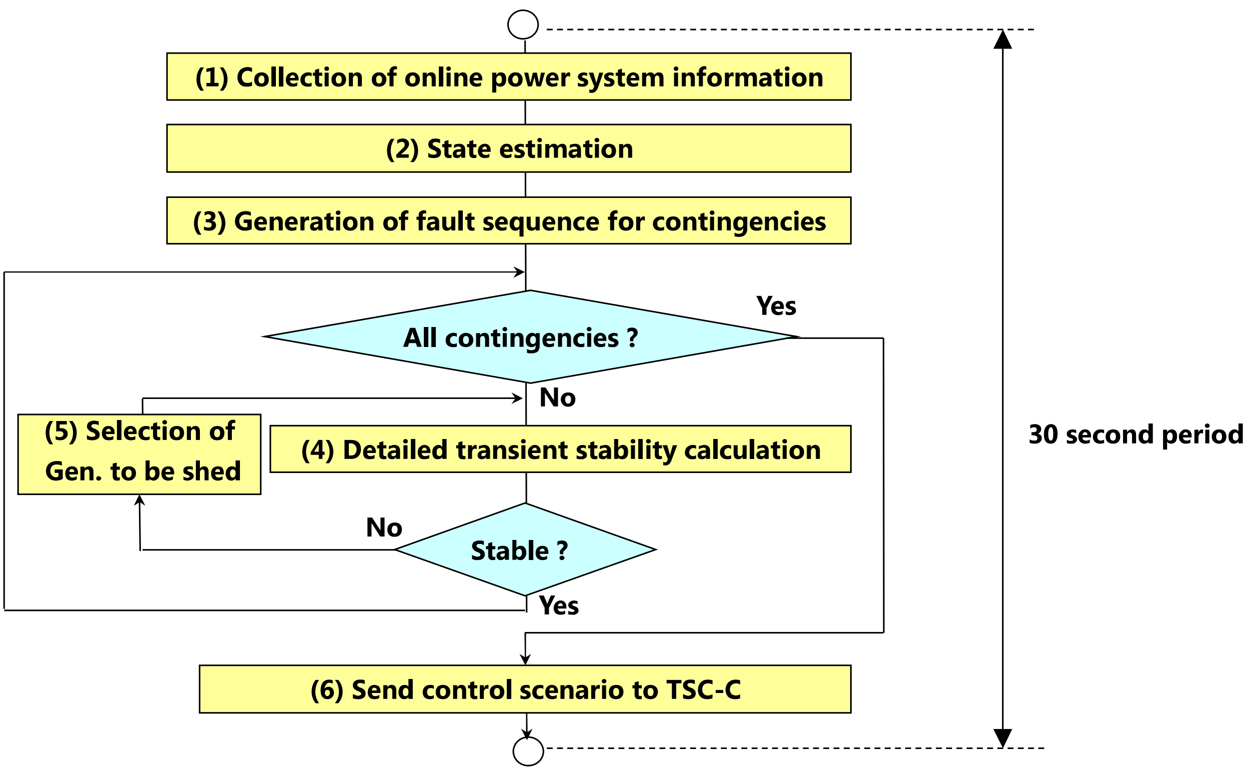
Comparison of Evaluation Type

	(2.1) On-line Stability Analysis Type	(2.2) Off-line Stability Analysis Type	(3) Behavior prediction type
Applicability	・Unable to cope with unexpected fault ・Stability control in conformity with power system connectivity and operation status ・Necessary for A high-speed and large capacity computer ・Unnecessary to reinforce a central processing unit with power system expansion.	・Unable to cope with unexpected fault ・Difficulty to cope with power system change ・An enormous off-line preliminary simulation is needed. ・Necessary to reinforce a central processing unit with power system expansion.	・Able to cope with unexpected fault ・Control in conformity with actual phenomenon. ・Unnecessary to reinforce a central processing unit with power system expansion.
Operability	・Optimal control amount calculated by on-line data. ・Less practical use restrictions ・Unnecessary to change SW with control target change	・Control amount calculated by pre-defined data. ・Severe practical use restrictions ・Necessary to change SW with control target change	・Control amount calculated after a power system fault occurs. ・Less practical use restrictions ・Unnecessary to change SW with control target change
Maintainability	Central processing Unit (2times／1year) Terminal Unit (Same as a general protection relay)	Same as a general protection relay (1time／6year)	Same as a general protection relay (1time／6year)
Cost	**Most expensive**	**Inexpensive**	**Expensive relatively**
Applicable power systems	・Loop system (Comlicated) ・Trunk power system	・Radial system ・Large-capacity power supply system	・Radial system ・Large-capacity power supply system
Control time	**150ms～350ms (From "Fault Occurring" to "Control Completion")**	**120～220ms (From "Fault Occurring" to "Control Completion")**	**250ms～350ms (From "Fault Clear" to "Control Completion")**

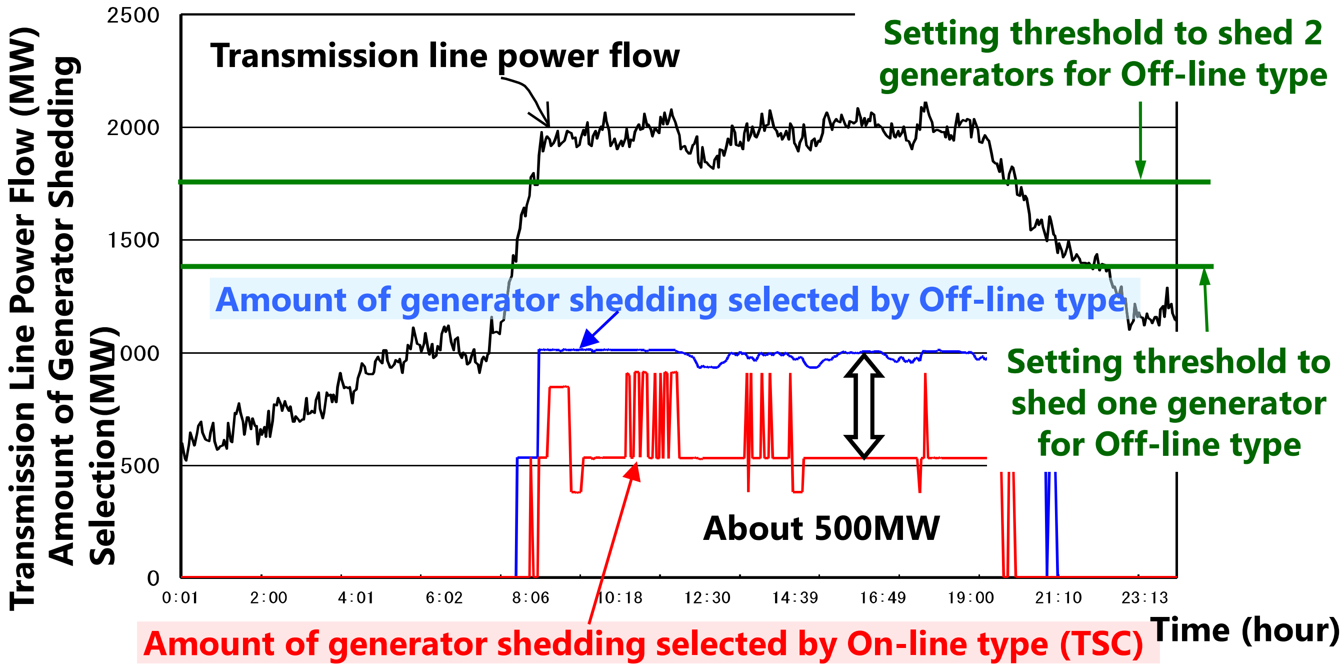
Transcient Stability Control (TSC) system – On-line Stability Analysis Type



Flow chart of TSC-P (Central Processing Unit)

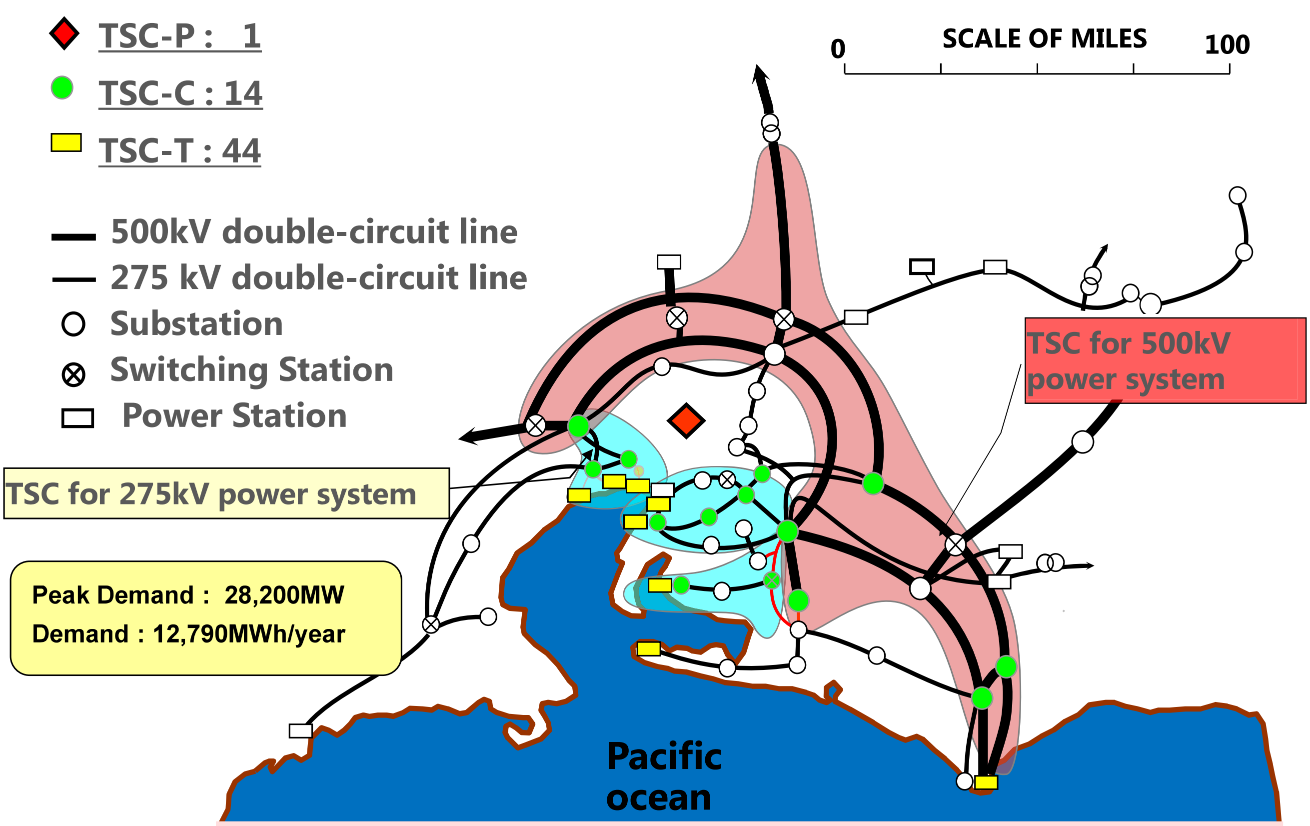


Optimal electric control by TSC System



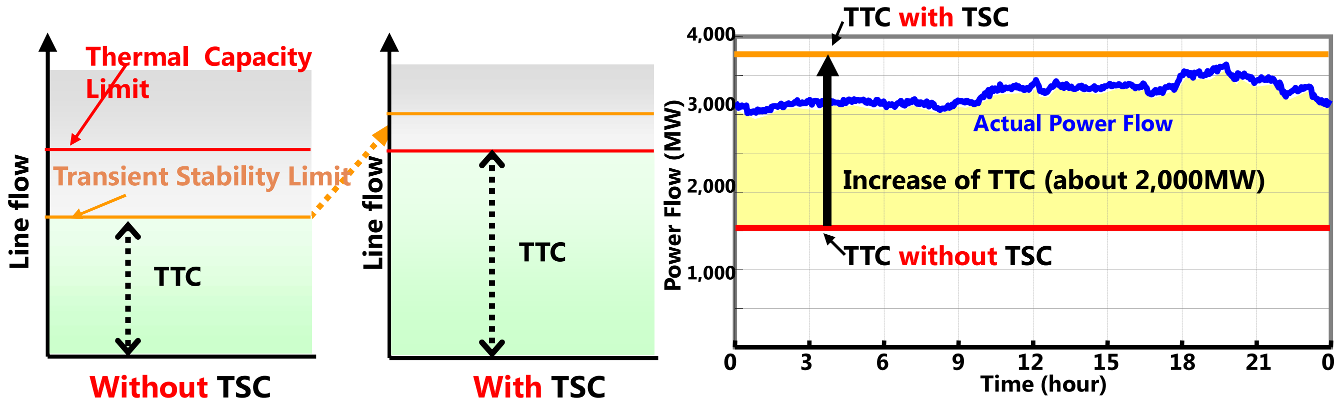
TSC enables optimal control of network operation which is changing

TSC for CEPCO (Chubu Electric Power Co.)



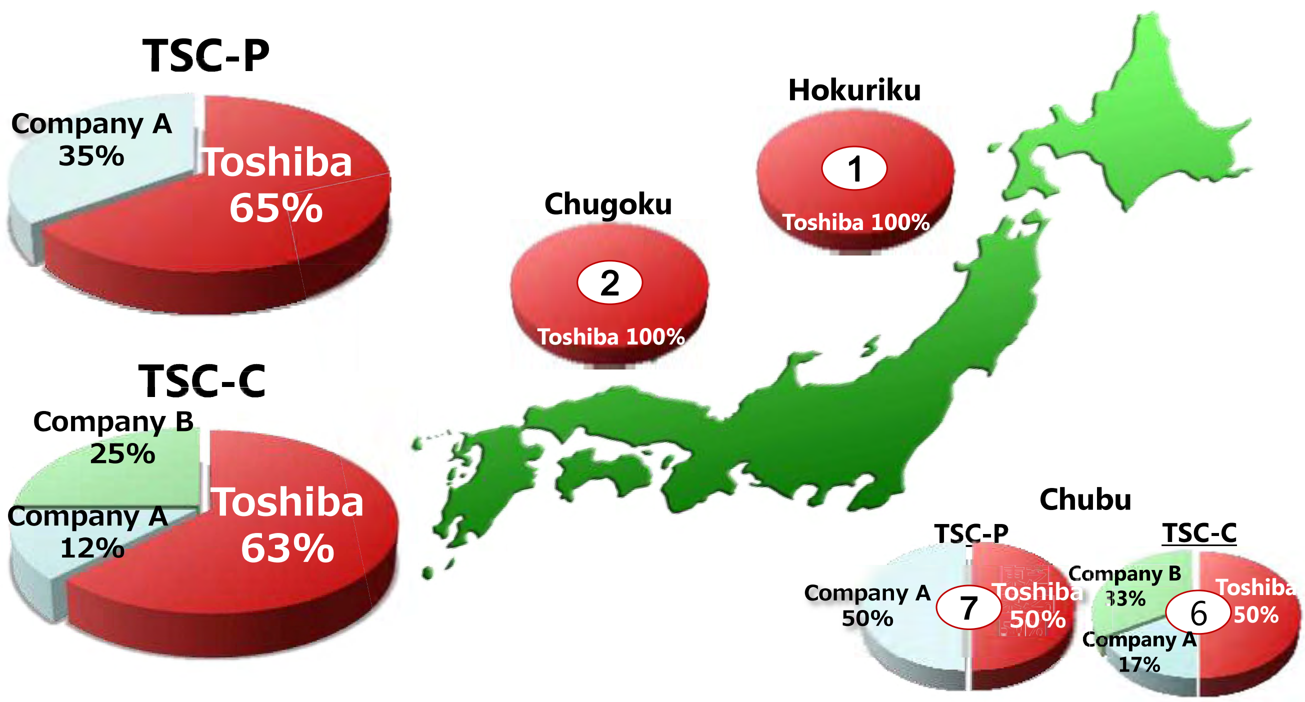
TSC for CEPCO (Chubu Electric Power Co.)

TTC(Total Transmission Capability) is determined by 2 limits.
- ✓ Thermal capacity limit.
- ✓ Transient stability limit.



- **Reduce CAPEX** of construction for new transmission lines
- **Reduce operation cost** by effective use of generators and reduced fuel cost
  - In the case of CEPCO, they achieved about 3% reduction
- **Prevention of wide-area blackout** by transient instability phenomena

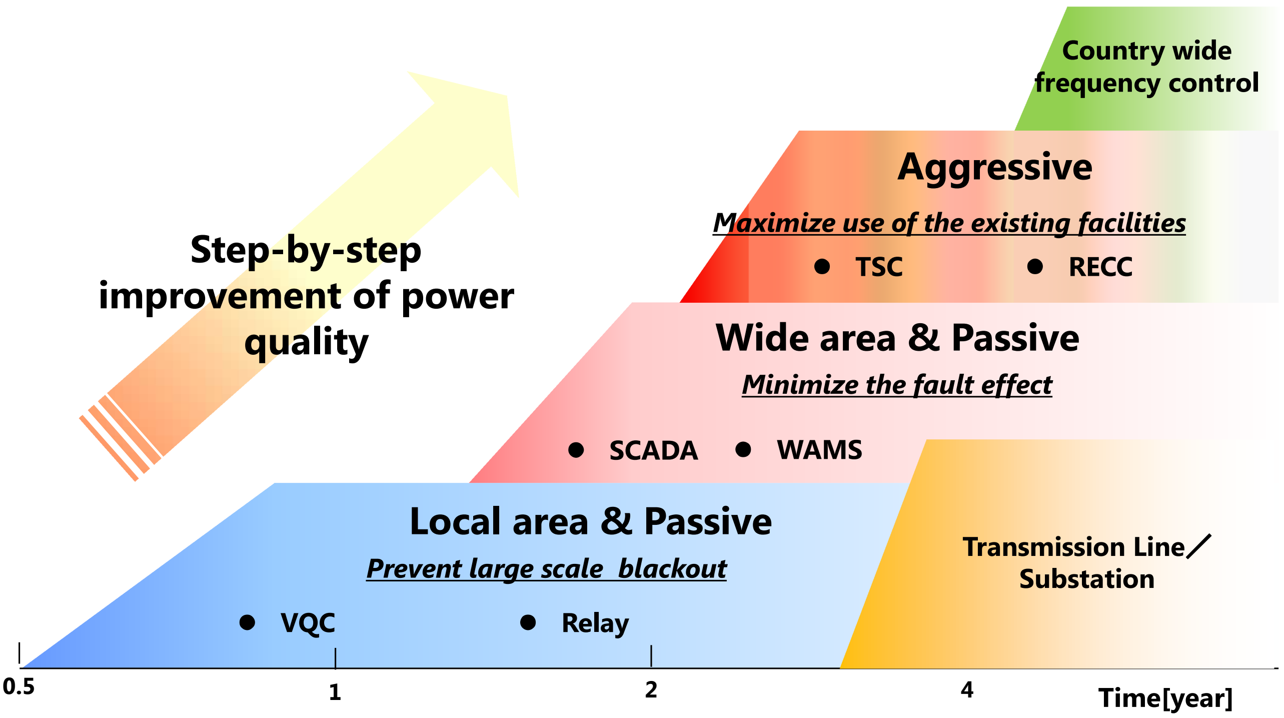
Delivery record of Grid stabilization system(TSC) in Japan



Topics

1. What is "Power System Stability Control System"?
2. **Installation Steps of TSC system**
3. Equipment for the grid stabilization
4. Conclusion

Roadmap of Solutions for the instability phenomena



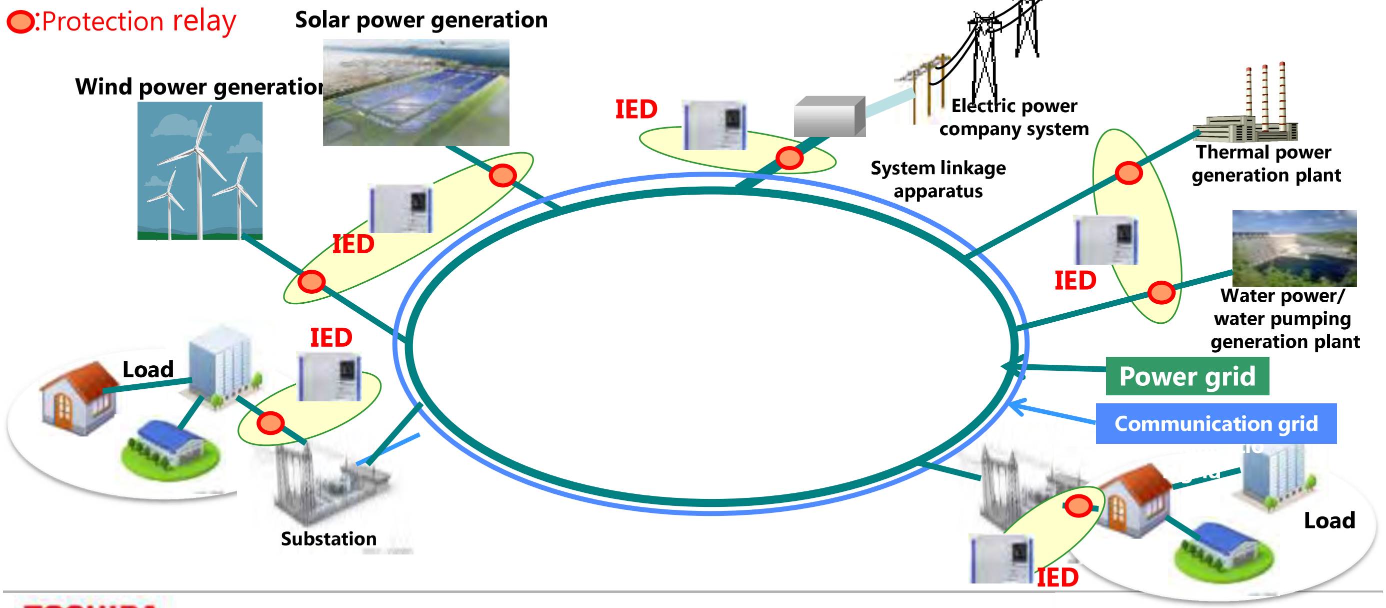
VQC : Voltage and Reactive Power Control
SCADA : Supervisory Control And Data Acquisition
WAMS : Wide Area Monitoring System

RECC : Renewable Energy Control Center
TSC : Transient Stability Control

1st step : Local Area Protection & Control (LAP)

- ✓ Protection and local control IED will be installed in some primary terminals.
- ✓ Frequency-based Load Shedding & Step-out Separation System by the IEDs.

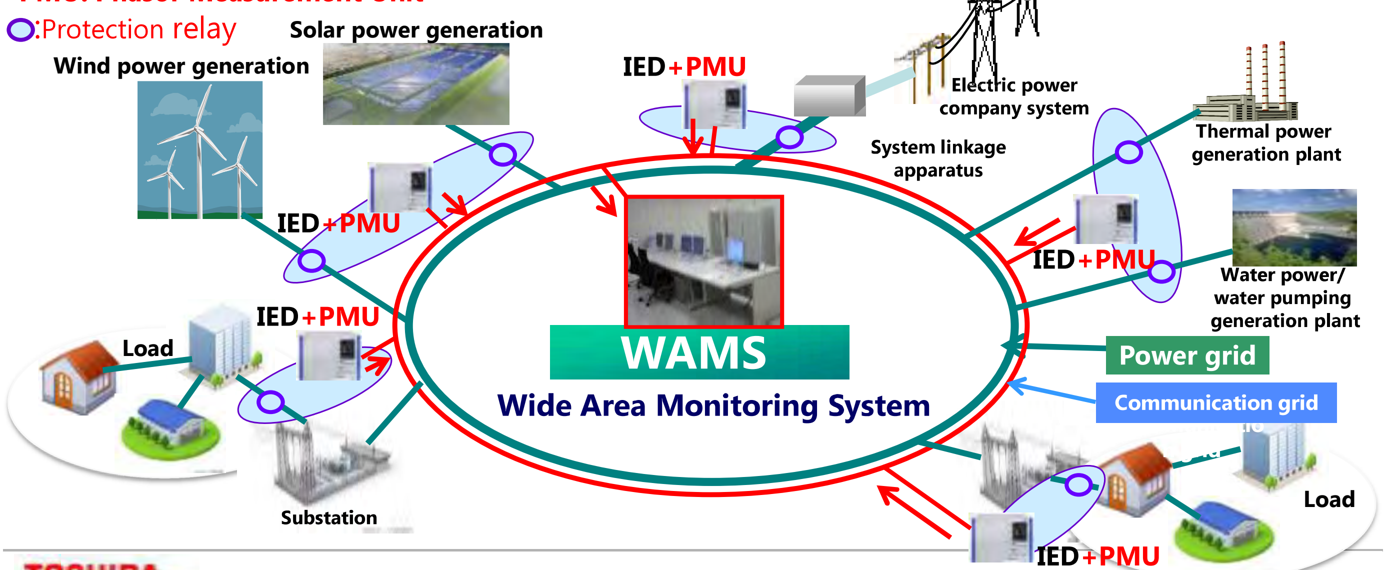
IED : Intelligent Electronic Device



2nd Step: Wide-Area Monitoring System (WAMS)

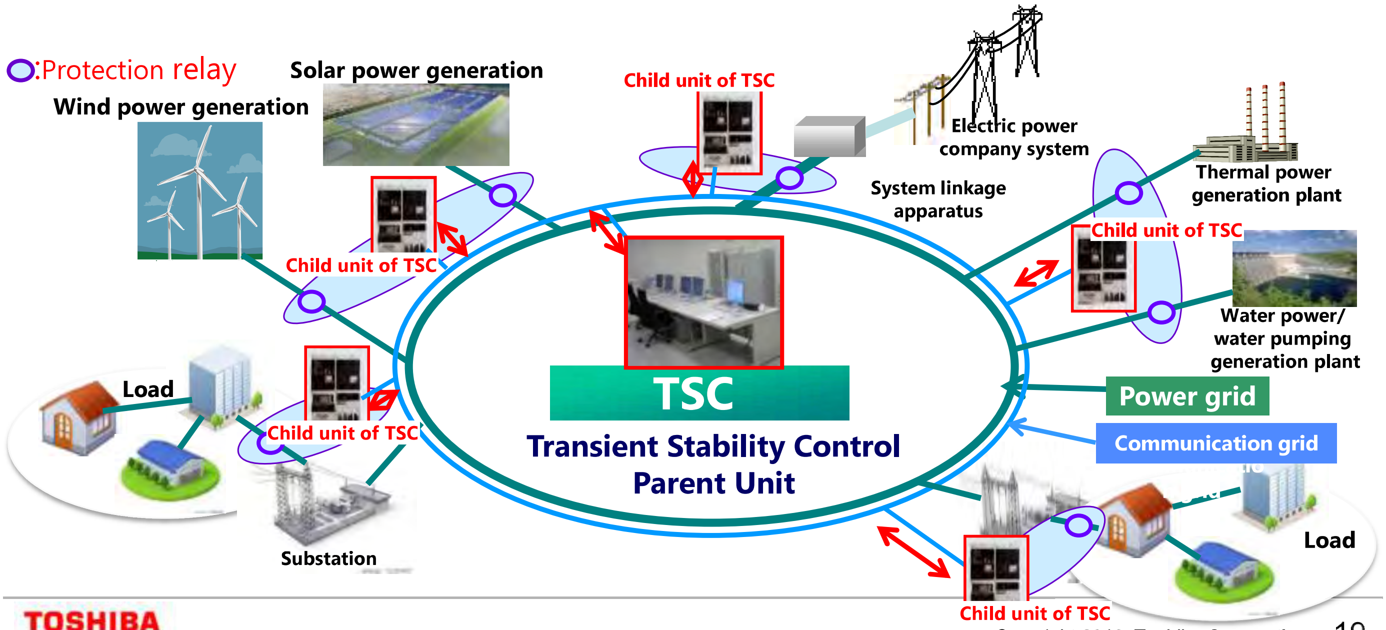
1. Synchro-phasor measurement and communication units will be implemented.
2. Measurement data is concentrated in the monitoring center (Monitoring Equipment) over communication network.
3. Real-time phase-angle monitoring to give alert and guide preventive operation against system disturbance which would causes instability and further wide-area black-out.

IED : Intelligent Electronic Device
PMU: Phasor Measurement Unit



3rd Step: Transient Stability Control(TSC) System

1. TSC system will be implemented based on the WAMS .
2. IEDs and PMUs are added receiving function that is to receive information from upper system of TSC (upper system of TSC is called "Parent unit" of TSC, and developed IED + PMU is called "Child unit" of TSC).
3. When the child units of TSC would find the accident, they shed the loads/generators based on the latest information from the parent unit.



Topics

1. What is "Power System Stability Control System"?
2. Installation Steps of TSC system
3. **Equipment for the grid stabilization**
4. Conclusion

Power Control Equipments

Location	Products / Method	Main Function	Main Effect
Power Station	AVR	Generator voltage control	Transient stability improvement
	PSS	Power oscillation damping	Dynamic stability improvement
	PSVR	Generator & Transformer voltage control	Voltage stability improvement
	EVA	Turbine valve fast closing	Transient stability improvement
Substation	VQC	Reactive power and voltage adjustment	Transmission capability improvement
	SVC	Reactive power and voltage control	Voltage stability improvement
	TVR		
	STATCOM		
Transmission line	TCSC (Thyristor-Controlled Series Capacitor)	Line reactance compensation	Transmission capability improvement
	HVDC (High Voltage Direct Current)	Long distance power transmission	Transmission capability improvement

AVR=Automatic Voltage Regulator
PSS=Power System Stabilizer
PSVR=Power System Voltage Regulator

EVA=Early Valve Actuation
STATCOM=STATic COMpensator
TVR= Thyristor Voltage Regulator

VQC=Voltage Q Control
SVC=Static Var Compensator

Power Control Equipment for substation

◇ Thyristor Voltage Regulator (TVR)

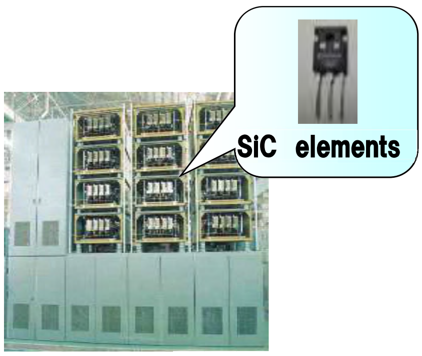
[Main Function]
Voltage control

[Main Effect]
Voltage stability improvement

<Characteristics>
The Response is faster than SVR (Step Voltage Regulator)
(Max 200ms)
Limitless tapchanger & Maintenance free
(Thyristor switch of contactless is used)

◇Static Compensator (STATCOM)

[Main Function]
Reactive power and Voltage Control



[Main Effect]
Voltage Stability Improvement

<Characteristics>
Turn-off Characteristics is better than SVC.
High efficiency and Size of miniaturization by SiC elements
(Internal power losses 1/4 and External dimensions 1/2)

Topics

1. What is “Power System Stability Control System”?
2. Installation Steps of TSC system
3. Equipment for the grid stabilization
4. **Conclusion**

Conclusion

- “Power System Stability Control System” performs to maintain the stability by optimal generator shedding in the case of power system fault.
- We think it is better to have step by step introduction of various equipment shown here and then aim the sophistication of overall network.

5. Expected project list

	Project Information
Project Name	Baynes Hydropower Project
Expected COY	Original 2024 -> 2026 (JICA Survey Team perspective)
Status	FS and EIA was conducted by the government of Namibia and the government of Angola (a consortium comprising Norsult (Norway), SwedPower (Sweden), Burmeister and partners (Namibia), and SOAPRO (Angola)) in 1998. Update of the study was conducted in 2012. (As of May 2013, by SADC) Ongoing Namibia and Angola negotiation Agencia Angola Press, Apr.16, 2016 (http://www.angop.ao/angola/en_us/noticias/economia/2016/3/15/Angolan-delegation-discusses-Baynes-hydroelectric-project,9740740e-48ae-4aaa-9bd6-8fef900f4f98.html)
Project Cost	1,300 MUSD (including environmental mitigation costs, but excluding associated infrastructure such as transmission line, roads, runway and telecommunications) (As of May 2013, by SADC)
Project scheme	The Government of Namibia and Angola have formed a permanent Joint Technical Commission (PJTC) (As of May 2013, by SADC)
Donors for Cooperation	N/A
Programme encouraged	SAPP Priority Project (2011) SADC RIDMP Project (2013, status = concept)
Others	Nampower website (http://www.nampower.com.na/Page.aspx?p=222) Ministry of Mines and Energy in Namibia website (http://www.mme.gov.na/directorates/energy/electricity/) SAPP C.C. Transaction advisory services for AnNa project was procured to consider it together with Baynes Project. (http://www.sapp.co.zw/docs/Untitled%20attachment%2000013.pdf)

Baynes Hydropwer (Angola – Namibia) Project Profile (2013) SADC

Source: Agencia Angola Press, Apr.16, 2016

Angolan delegation discusses Baynes hydroelectric project

Luanda - A delegation from the Ministry of Energy and Waters of Angola was last Wednesday in Namibia to continue the discussion about the hydroelectric Baynes project and proceed the presentation of results of feasibility studies in order to begin negotiations with the affected communities in the area where the project will be implemented.

The Angolan delegation was headed by the Energy and Waters minister, João Baptista Borges, and also comprised the Counsellor-Minister of the Embassy, Manuela Botelho, who, due to schedule issues, represented the ambassador Manuel Alexandre Duarte Rodrigues, while the minister of Mining and Energy of Namibia, Obth Kanjoze led the host delegation, which was made up by the deputy minister of Agriculture, Water and Forestry, Anna Shiweda.

The Namibian minister welcomed the Government of Angola and Namibia for having approved and allocated a budget to the Joint Permanent Technical Committee of the Cunene River Basin Committee for the development of the Baynes Hydroelectric project for the financial years 2014/2015 and 2015/2016.

The ministers approved the updates that were presented to them in the Hydro Baynes project, Rehabilitation Project of Calueque Dam and Trans-border projects of water supply to Cunene and it was considered a progress.

After considering the various reports, the ministers concluded that the monitoring committee of the Baynes project must mobilise all necessary resources during the months of April and May 2016, in order to begin in June 2016 with the completion of all pending studies.

On the Trans-border water projects of Cunene, the ministers stressed the strategic importance of the project being financed by KFW, to improve access to a supply of reliable, affordable and sustainable water by investing in the rehabilitation of infrastructure for water supply in Santa Clara, Ondjiva, and improve Calueque Oshakati water channel.

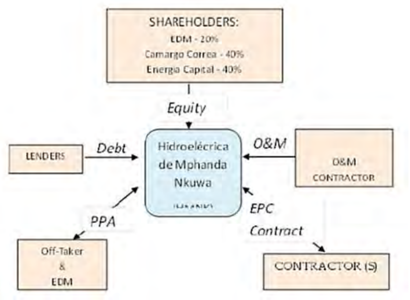
The ministers also affirmed the commitment of the Namibian Government to providing water to Santa Clara and Ondjiva as the current permanent provisions of the bilateral cooperation on the supply of water to Angolan settlements along the common border.

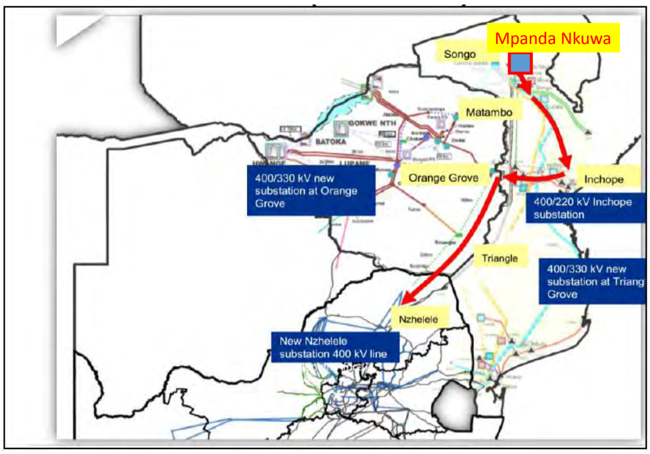
The government official also decided that NamPower should continue with the commitments with its Angolan counterpart with regard to improving the supply of electricity to Calai and Dirico municipalities in the south-eastern Cuando Cubango Province along the border with Namibia.

The ministers instructed the Commission to prepare a roadmap for the transformation of the technical forum into a River Basin Commission in accordance with the revised SADC Protocol on shared water courses.

The Joint Permanent Technical Committee is currently the only Commission that operates outside the framework of the SADC Protocol on watercourses

Expected Project -Generation Projects (1)-

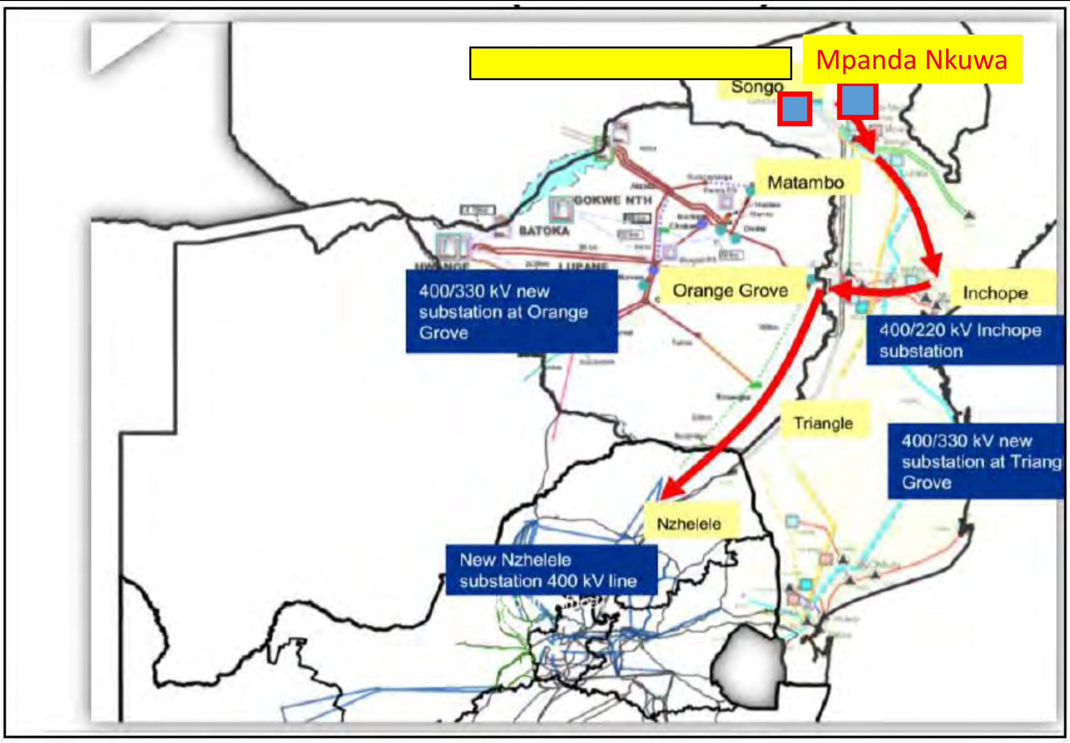
	Project Information
Project Name	Mpanda Nkuwa Hydropower Project
Expected COY	Original 2020 -> 2024 (JICA Survey Team perspective)
Status	FS and EIA were conducted by IPP. To be reviewed these studies. Ongoing the transferring process for developer by IPP to Mozambique Government. Top priority hydro project in Mozambique (As of 2016)
Project Cost	2,969 MUSD (exclude the transmission line) (As of May 2013, by SADC)
Project scheme	EDM, HCB and Government of Mozambique (Now negotiating parliamentary procedures) Former project structure is as follow. 
Donors for Cooperation	N/A
Programme encouraged	SAPP Priority Project (2011) Tripartite Inter-Governmental Authority on Development Corridor Programme (TICP) (2012) COMESA PIP (2010) Tripartite Regional Infrastructure Project Database (TRIPDA) (2013) SADC RIDMP Project and its Short term action plan (STAP) Project (2013, status = Financing) PIDA PAP 2020, PIDA PAP Shortlist (2014)
Others	The government of Mozambique points out that this project should be handled together with STE backbone project.



Source : JICA Study Team

Expected Project -Generation Projects (2)-

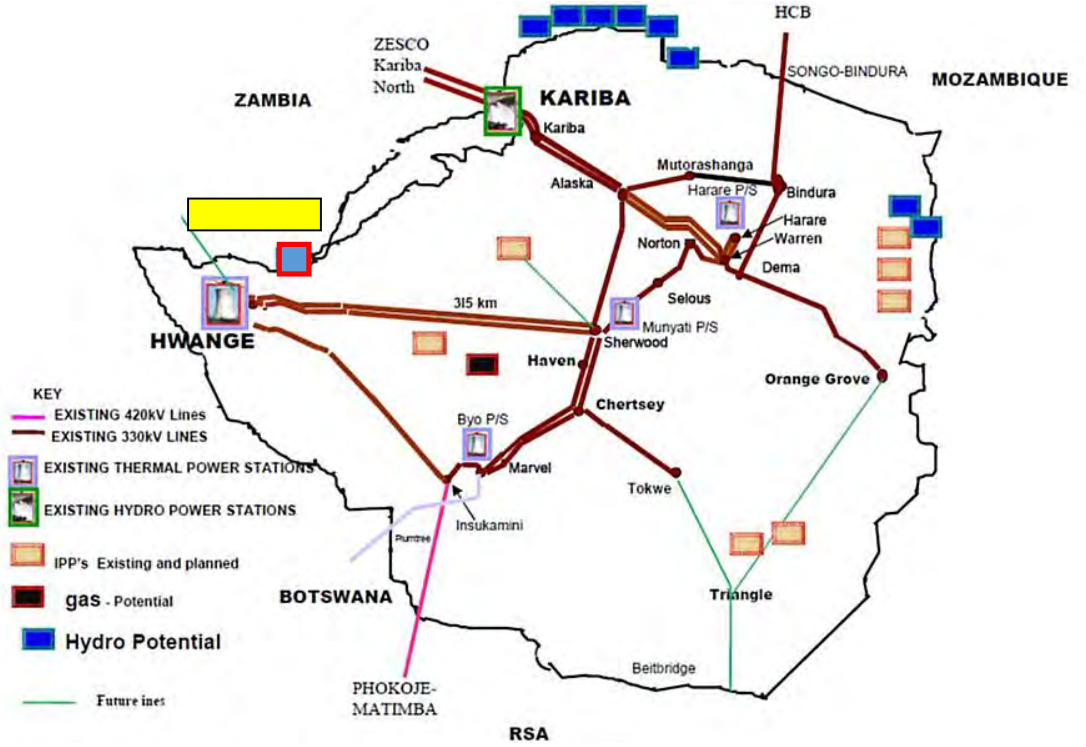
	Project Information
Project Name	Cahora Bassa Norte Hydropower Project
Expected COY	Original 2018 -> 2026 (JICA Survey Team perspective)
Status	The development should be done after the development of the Mpanda Nkuwa Hydropower Project. (As of 2016, comment from EDM and HCB)
Project Cost	800 Million USD (2008, from news article) Reference : 1,000 Million USD (2010, from web) http://www.construction-ic.com/HomePage/Projects?ReturnUrl=%2FProjects%2FOverview%2F150280%3Futm_source%3Dworldconstructionnetwork%26utm_medium%3DReferral%26utm_campaign%3DHCB%2B%25E2%2580%2593%2BCahora%2BBassa%2BHydroelectric%2BPower%2BPlant%2BNorth%2BCentral%2BExpansion%2B1245%2BMW%2B%25E2%2580%2593%2BTete&utm_source=worldconstructionnetwork&utm_medium=Referral&utm_campaign=HCB%20%E2%80%93%20Cahora%20Bassa%20Hydroelectric%20Power%20Plant%20North%20Central%20Expansion%201245%20MW%20%E2%80%93%20Tete
Project scheme	HCB
Donors for Cooperation	N/A
Programme encouraged	SAPP Priority Project (2011) SADC PIDMP Project and its STAP Project (2013, status = Feasibility Study in progress)



Source : JICA Survey team

Expected Project -Generation Projects (3)-

	Project Information
Project Name	Batoka Gorge Hydropower Project
Expected COY	2024 (JICA Survey Team perspective)
Status	FS, revising current situation, installed capacity is changed to 2,400 MW from 1,600MW ESIA, revising current situation Proposed Batoka Gorge Hydro-Electric Schema Project Managing Unit (PMU) (As of 2016)
Project Cost	Over 4,000 MUSD (condition is 1,600MW, as of May 2013, by SADC) Reference : The project estimated costs as at 2009 were 2,800 Million USD.
Project scheme	Zambezi River Authority (ZRA) and ZESCO (Zambia) and ZESA (Zimbabwe) (As of May 2013, by SADC)
Donors for Cooperation	WB, AfDB https://www.bloomberg.com/news/articles/2016-09-28/zambia-zimbabwe-pick-afdb-advisers-for-4-billion-batoka-plant
Programme encouraged	SAPP Priority Project (2011) TICP (2012), COMESA PIP (2010), TRIPDA (2013) SADC PIDMP Project and its STAP Project (2013, status = feasibility study in progress) PIDA PAP 2020, PIDA PAP shortlist (2014)



Source : JICA Survey Team

Source: Bloomberg, Sep.28, 2016

Zambia, Zimbabwe Pick AfDB Advisers for $4 Billion Hydro Dam

Zambia and Zimbabwe have appointed the African Development Bank as lead financial advisers for the construction of the 2,400-megawatt Batoka Gorge hydro-power project that's expected to cost $4 billion, an official said.

The two southern African nations face severe power shortages as years of under-investment are amplified by low water levels at the Kariba dam hydro-power station that they each rely on for about half of total supplies.

"Only yesterday, we were talking to the AfDB after Zambian and Zimbabwean governments appointed them as the lead financial arranger on this project," Munyaradzi Munodawafa, Chief Executive Officer of Zambezi River Authority, said Tuesday in Victoria Falls after touring Batoka Gorge.

The authority intends to build it on the same arrangement as the Kariba Dam was constructed, which involves loans, grants, with the two governments also funding it, he said.

Kariba Dam

Photographer: DeAgostini/Getty Images

Executives from both nations have been to Beijing and met officials from the China Export & Credit Insurance Corp, known as Sinosure, Export-Import Bank of China, contractors and individual financiers, Munodawafa said. Officials were also in France where there was "good reception and a lot of interest" during meetings with representatives from BNP Paribas SA, Societe General SA, the European Investment Bank, he said. In South Africa, there were talks with DBS Holdings Ltd., Barclays Africa Group Ltd., the International Finance Corp. and a consortium of local investors.

Financial mobilization for the project is scheduled to start in 2018, but could begin earlier than that, he said. The dam will have a capacity of 1.2 billion cubic meters of water on completion. Kariba, the world's biggest man-made reservoir by volume, holds 181 billion cubic meters of water.

"After we have completed Batoka Gorge, we will start planning for something at Devil's Gorge," Munodawafa said of the valley that's further upstream on the Zambezi River. "This is still a plan."

Other hydro plans in Africa include four dams for a total 850 megawatts in Cameroon, a 147-megawatt dam in Togo and the Democratic Republic of Congo is working on a 240-megawatt facility at Busanga.

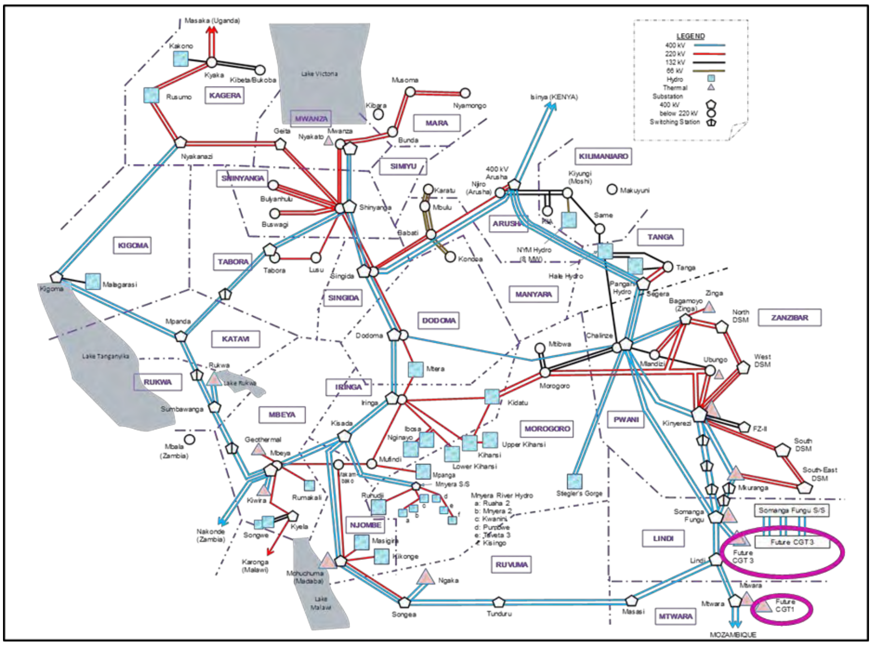
Expected Project -Generation Projects (4)-

	Project Information
Project Name	Tete 1,200MW Coal-fired Project
Expected COY	2022 (JICA Survey Team perspective)
Status	Preliminary Study was done by SUMITOMO Corporation in 2016.
Project Cost	2,208.8 Million USD (Project concept paper, September 2016, EDM&ZESCO)
Project scheme	The government of Mozambique and the government of Zambia are planning jointly proceed the project. (https://www.daily-mail.co.zm/?p=71035) (As of June 2016, news)
Donors for Cooperation	N/A
Programme encouraged	Inter-governmental MoU, Zambia and Mozambique (2016)
Others	

Source : Project concept paper, September 2016, EDM&ZESCO

Expected Project -Generation Projects (5)-

	Project Information
Project Name	Tanzania future gas-fired
Expected COY	N/A
Status	N/A
Project Cost	N/A
Project scheme	N/A
Donors for Cooperation	N/A
Programme encouraged	According to PSMP 2016, future gas-fired power projects are illustrated.
Others	



Source：PSMP 2016

District	Site Name	Coordinates (Easting & Northing)			Distance (to site - km)	
		Zone	X	Y	From BVS	From Sea
Mkuranga (BVS 13)	Site 1	-37	545072.04	9202457.05	18	4
	Site 2	-37	547567.85	9206259.91	23	4.6
	Site 3	-37	536504.23	9181334.59	25	1.7
Kilwa - Somanga (BVS Somanga)	Site 1	-37	529343.25	9066947.77	0.4	4
	Site 2	-37	530361.75	9066236.19	1.2	2.5
Lindi (BVS 03)	Site 1	-37	585970.59	8907107.29	35	0.6
	Site 2	-37	579510	8901078.7	27	0.37
Mtwara (BVS 01)	Site 1	-37	623142.7	8869147.26	13	0.8
	Site 2	-37	622974.56	8870502.97	20	4

Source : Tanesco

Expected Project -Generation Projects (6)-

	Project Information
Project Name	Mozambique future gas-fired
Programme encouraged	According to information from EDM, EDM is seeking partner(s) and project(s) for implementation.
Others	From inp (Instituto Nacional de Petroleo) website, northern Mozambique expects the development of gas-utilization.

No.	Source	Project Name	Developer		Location	Capacity [MW]	Investiment [MUSD]	Construction	Commercial Operation	Status
1	Gas	Trino	Trino	IPP	Gaza	100		2017	2019	Planned phase / no progress
2	Gas	Kuvaninga	Kuvaninga	IPP	Gaza	40	110.00	2014	2016	Commission in 2016
3	Gas	Engco	Engco	IPP	Gaza	120		2017	2019	Planning Phase
4	Gas	Mov Energy	Mov Energy	IPP	Gaza	78		2016	2018	Planning Phase
5	Gas	Palma	EDM/ENI	PPP	C. Delgado	75	130.00	2017	2020	Planning Phase
6	Gas	Temane	EDM	Public	Vilanculos	100		2018	2020	Planning Phase
7	Gas	Temane	EDM/Sasol	PPP	Vilanculos	400	750.00	2017	2020	Planning Phase
8	Gas	CTM Convertion	EDM	Public	Maputo	80	20	2016	2017	EDM Borad decided
9	Gas	CTM JICA	JICA	EDM	Maputo	100	170.00	2016	2018	Construction Phase
10	Gas	Electrotec	Electrotec	Public	Maputo	80		2016	2018	Planning Phase
11	Gas	EHSA	EHSA/EDM	PPP	Nacala	125	125.00	2018	2020	Concept Stage / exclude pipeline
12	Gas	EHSA	EHSA/EDM	PPP	Nampula	125	125.00	2018	2020	Concept Stage / exclude pipeline
13	Gas	EHSA	EHSA/EDM	PPP	Moma	50	50.00	2018	2020	Concept Stage / exclude pipeline
14	Gas	EHSA	EHSA/EDM	PPP	Quelimane	350	350.00	2018	2020	Concept Stage / exclude pipeline
15	Gas	EHSA	EHSA/EDM	PPP	Entre Lagos	500	500.00	2018	2020	Concept Stage / exclude pipeline
16	Gas	ENH/Shell	ENH/Shell	IPP	C.Delgado	80		2018	2020	Concept Stage

Source : EDM (October 2016)

REPÚBLICA DE MOÇAMBIQUE

MINISTÉRIO DOS RECURSOS MINERAIS E ENERGIA

ANÚNCIO

ENCERRAMENTO DE CONCURSO PARA ADJUDICAÇÃO DE GÁS NATURAL PARA O DESENVOLVIMENTO DE PROJECTOS EM MOÇAMBIQUE

Na sequência do lançamento do concurso a 26 de Agosto do ano corrente, para adjudicação de gás natural para o desenvolvimento de projectos em Moçambique, o Ministério dos Recursos Minerais e Energia anuncia que encerrou o concurso a 17 de Novembro corrente.

1. A cerimónia de abertura das propostas teve lugar no mesmo dia de encerramento do concurso, nas instalações do Instituto Nacional de Petróleo, pelas 15H45,
2. Foram recebidas propostas de 14 empresas para vários projectos, nomeadamente: Mitsui, Engro Fertilizer, Shell Mozambique BV, Electricidade de Moçambique, Yara International, Marubeni, GL-Africa Energy, Muinvest, Auto-Gás, Epsilon, Jiangsu SinochemConstruction Co.LTD, UNION-JNC-JSPDI-VBC-SAL Consortiun, Gas Nosu e MOTSE.SA,
3. A avaliação das propostas irá decorrer por um período de 21 dias,
4. A publicação de adjudicação será feita no dia 14 de Dezembro de 2016.

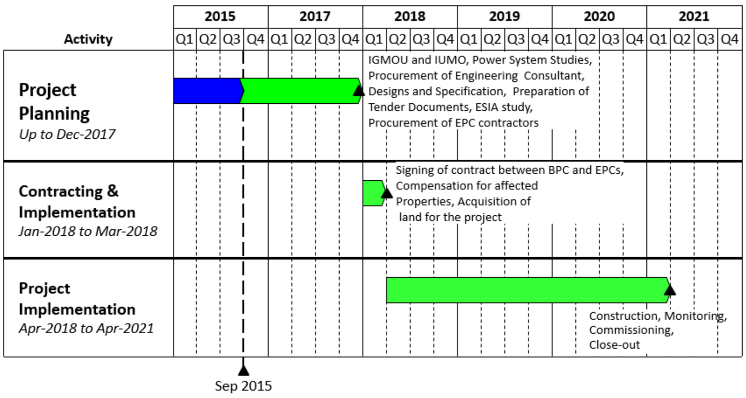
Maputo, 17 de Novembro de 2016

Source : inp Website

Expected Project -Transmission Line Projects (1)-

	Project Information
Project Name	BoSa Project
Expected COY	2021 - 2022
Status	FS, In progress, organized by DBSA with Infrastructure Investment Programme of South Africa (IIPSA), funded by EU. ESIA, In progress, ditto. (As of November 2016, by SAPP PAU)
Project Cost	N/A (As of November 2016, by SAPP PAU)
Superior Development Plan	SAPP Priority Project (2011)
Project Component	560km, 400kV
Project scheme	Probably, bifurcated, Eskom and BPC (As of 2016, by SAPP PAU)
Donors for Cooperation	N/A, Botswanan side will be implemented by own budget.
Programme encouraged	

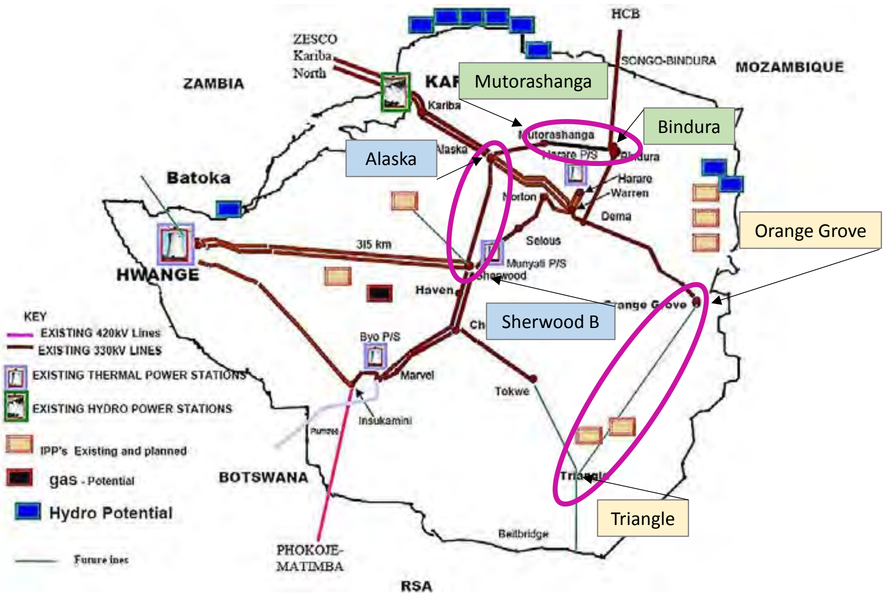
Source : JICA Survey Team



Source : BPC (2015)

Expected Project -Transmission Line Projects (2)-

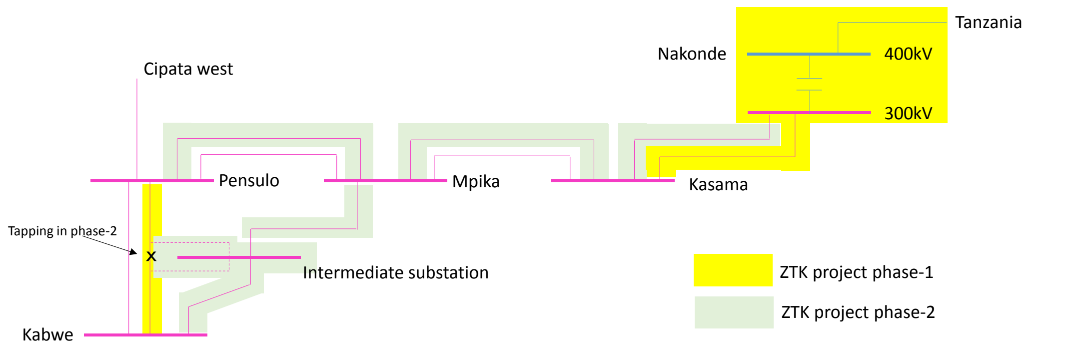
	Project Information
Project Name	CTC Project
Expected COY	2021-29 (JICA Survey Team perspective)
Status	FS, In preparation (Alaska - Sherewood) Project model, ZETDC (As of 2016, by SAPP PAU)
Project Cost	63.40 Million USD (Alaska - Sherwood) 146.0 Million USD (Orange Grove – Triangle) 32.80 Million USD(Bindura - Mutorashanga) (As of May 2016, ZETDC)
Superior Development Plan	SAPP Priority Project (2011)
Project Component	ZETDC
Project scheme	ZETDC
Donors for Cooperation	N/A
Programme encouraged	N/A



Source : ZETDC

Expected Project -Transmission Line Projects (3)-

	Project Information
Project Name	ZTK Project (Zambia Side)
Expected COY	2022 - 2023
Status	Phase -1 : Preparation for construction, and seeking the fund. Phase -2 : Seeking the fund (As of the end of 2016, ZESCO and WB)
Project Cost	Phase -1 : 492.9 Million ZMK (Nakonde – Kasama), N/A (Pensulo - Kabwe) Phase -2 : N/A (As of the end of 2016, ZESCO)
Superior Development Plan	SAPP Priority project (2011)
Project Component	ZESCO
Project scheme	ZESCO
Donors for Cooperation	Phase -1 : KfW, AfDB, EIB (Information from ZESCO) Phase -2 : N/A
Programme encouraged	North – South Power Transmission Corridor, PIDA PAP 2020, PIDA PAP Shortlist (2014), TRIPDA (2013)



Source : ZESCO

Expected Project -Transmission Line Projects (4)-

	Project Information
Project Name	ZiZaBoNa Project
Expected COY	2022 -2024 (JICA Survey Team perspective)
Status	FS, Completed ESIA, Completed Project model, SPV, allocation of shareholders are shown below, (As of 2016, SAPP PAU)
Project Cost	223 Million USD (As of November 2016, SAPP PAU)
Superior Development Plan	SAPP Priority Project
Project Component	Phase 1: Hwange-Victoria Falls-Livingstone line, utilizing the existing ZESA- NamPower 80MW PPA (15year) and the existing 220kV Livingstone-Zambezi –Caprivi lines Phase 2: Victoria Falls-Pandamatenga, 76 km 400kV Hwange – Victoria Falls, 101km 400kV Livingstone-Zambez, 231km 330kV
Project scheme	SPV (ZESA, ZESCO, BPC, NamPower, and others) (As of 2016, by SAPP PAU)
Donors for Cooperation	N/A
Programme encouraged	North – South Power Transmission Corridor, PIDA PAP 2020

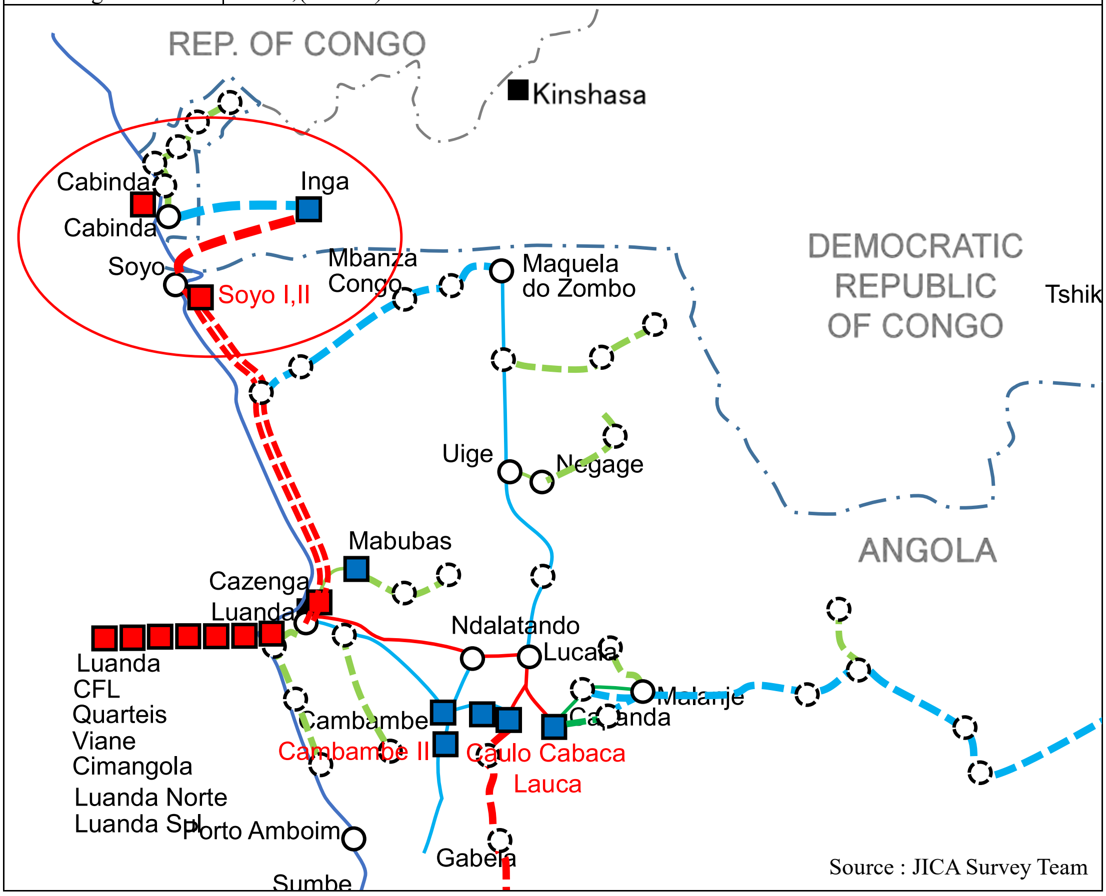
Source : SAPP PAU presentation (2016, SAPP PAU)

ZIZABONA SPV Shareholders	%
Botswana Power Corporation (BPC)	20%
NamPower	20%
ZESCO Limited	20%
ZESA Holdings	20%
Other Shareholders (Eskom and CEC)	20%
Total	**100%**

Source : Project Profile (2013, SADC)

Expected Project -Transmission Line Projects (5)-

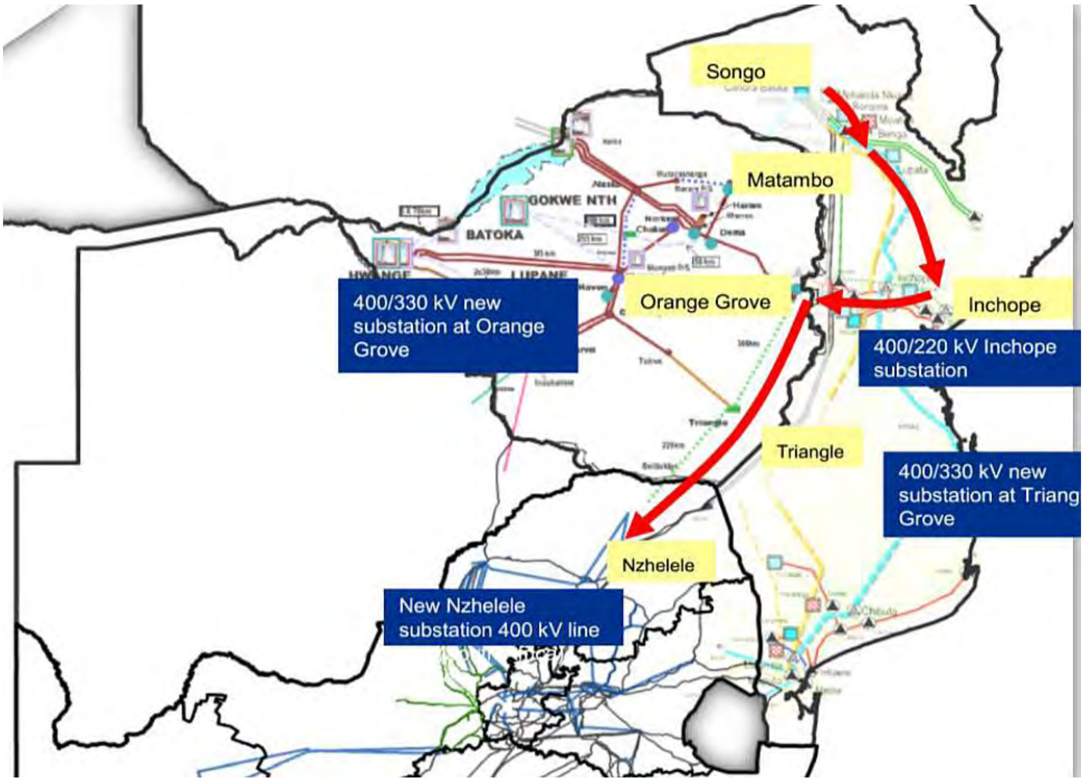
	Project Information
Project Name	DRC-Angola Project
Expected COY	2031 (JICA Survey Team perspective)
Status	N/A
Project Cost	N/A
Superior Development Plan	
Project Component	SNEL, RNT
Project scheme	Probably, bifurcated, SNEL and RNT
Donors for Cooperation	N/A
Programme encouraged	Central African Power Interconnection, *Economic Community of Central African States,(ECCAS)* NEPAD 2020



Source : JICA Survey Team

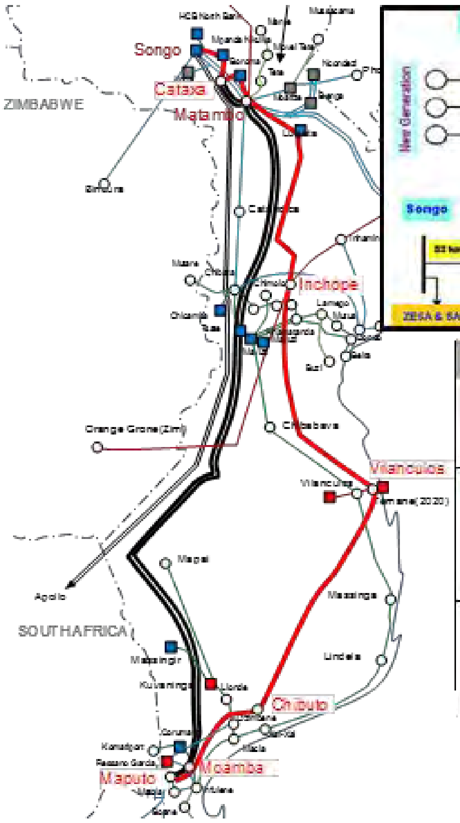
Expected Project -Transmission Line Projects (6)-

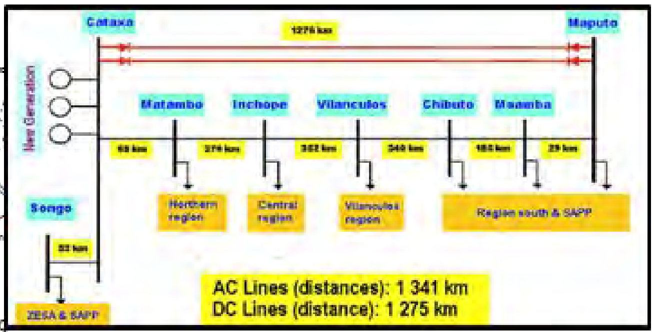
	Project Information
Project Name	MoZiSa Project
Expected COY	2022 – 2023 (JICA Survey Team perspective)
Status	FS in progress ESIA in progress (As of 2016, by SAPP PAU)
Project Cost	342.2 MUSD 132.2 MUSD Mozambique – Zimbabwe 210.0 MUSD Zimbabwe – RSA (As of November 2016, by SAPP PAU)
Superior Development Plan	SAPP Priority Project (2nd Zimbabwe – RSA interconnector, 2nd Mozambique – Zimbabwe Interconnector modified)
Project Component	Songo – Inchope, 400kV, N/A Inchope – Orange Grove, 400kV 170km 90 Million USD Orange Grove – Triangle, 400kV 300km 146 Million USD Triangle – Nzhelele, 400kV 220km 120 Million USD (As of May 2016 by ZETDC)
Project scheme	Tripartite (provision) : EDM, ZESA, Eskom (As of 2016, by SAPP PAU)
Donors for Cooperation	N/A
Programme encouraged	North – South Power Transmission Corridor, PIDA PAP 2020 (2nd Zimbabwe – RSA Interconnector)



Expected Project -Transmission Line Projects (7)-

	Project Information
Project Name	STE Project (HVAC, HVDC) Project
Expected COY	2024 (HVAC), 2025 (HVDC) (JICA Survey Team perspective)
Status	FS, Ongoing ESIA, Ongoing Project model, Not decided (As of 2016, by SAPP PAU)
Project Cost	2,800 Million USD (Not include 2nd HVDC as phase-2 construction) (As of May 2013, by SADC)
Superior Development Plan	SAPP Priority Project
Project Component	Shown in table as below.
Project scheme	EDM, HCB (As of 2016, by SAPP PAU)
Donors for Cooperation	Handled by SAPP-PAU funded by WB (IDA)
Programme encouraged	N/A



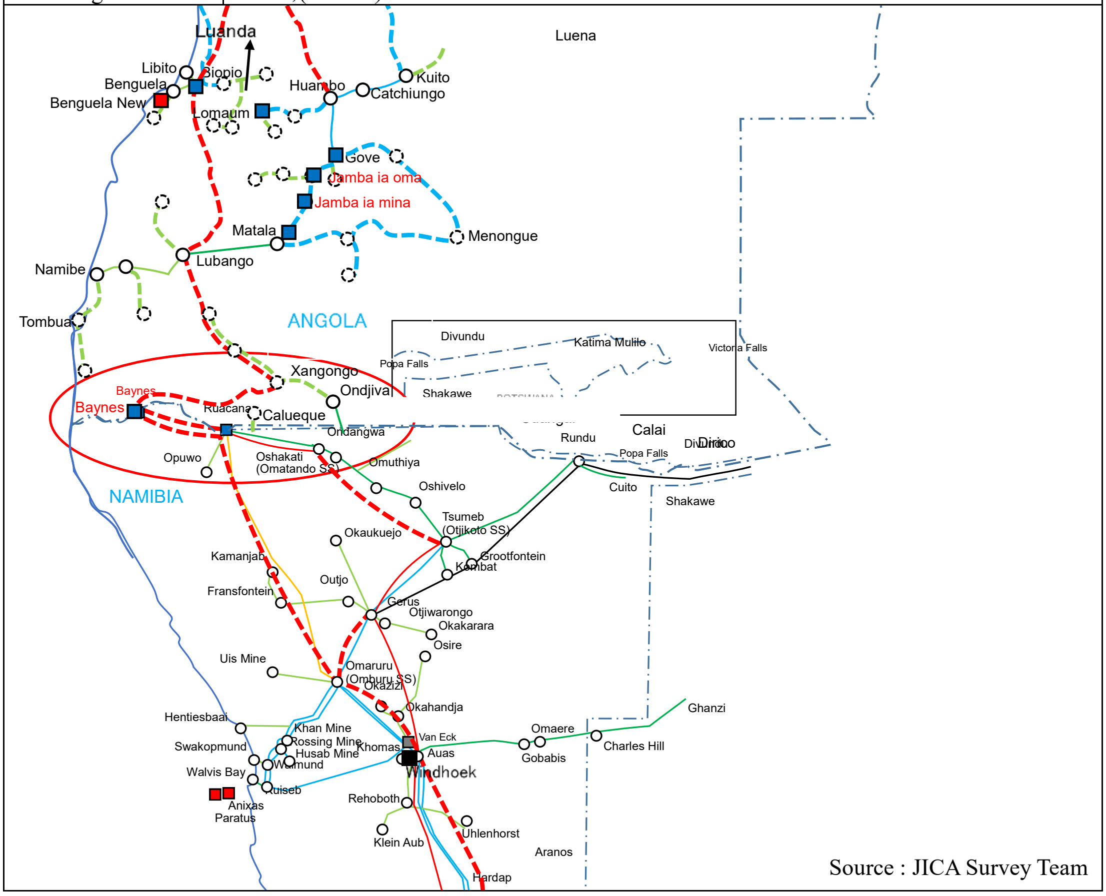


	Sections	Length (km)	Capacity (MW)	COY	Status
1	HVAC 400kV Songo - Cataxa	53	970	2020	FS done (2011)
	HVAC 400kV Cataxa - Matambo	65	970	2020	FS done (2011)
2	HVAC 400kV Matambo - Inchope	370	970	2020	FS done (2011)
3	HVAC 400kV Ichope - Vilaculos	352	970	2021	FS done (2011)
4	HVAC (phase 1) 400V Vilanculos - Maputo	554	970	2021	FS done (2011)
5	HVDC Phase I 535kV Cataxa - Maputo	1,276		2020	FS done (2011)
6	HVDC Phase II 535kV Cataxa - Maputo	1,276		2024	FS done (2011)

Source : JICA Survey Team

Expected Project -Transmission Line Projects (8)-

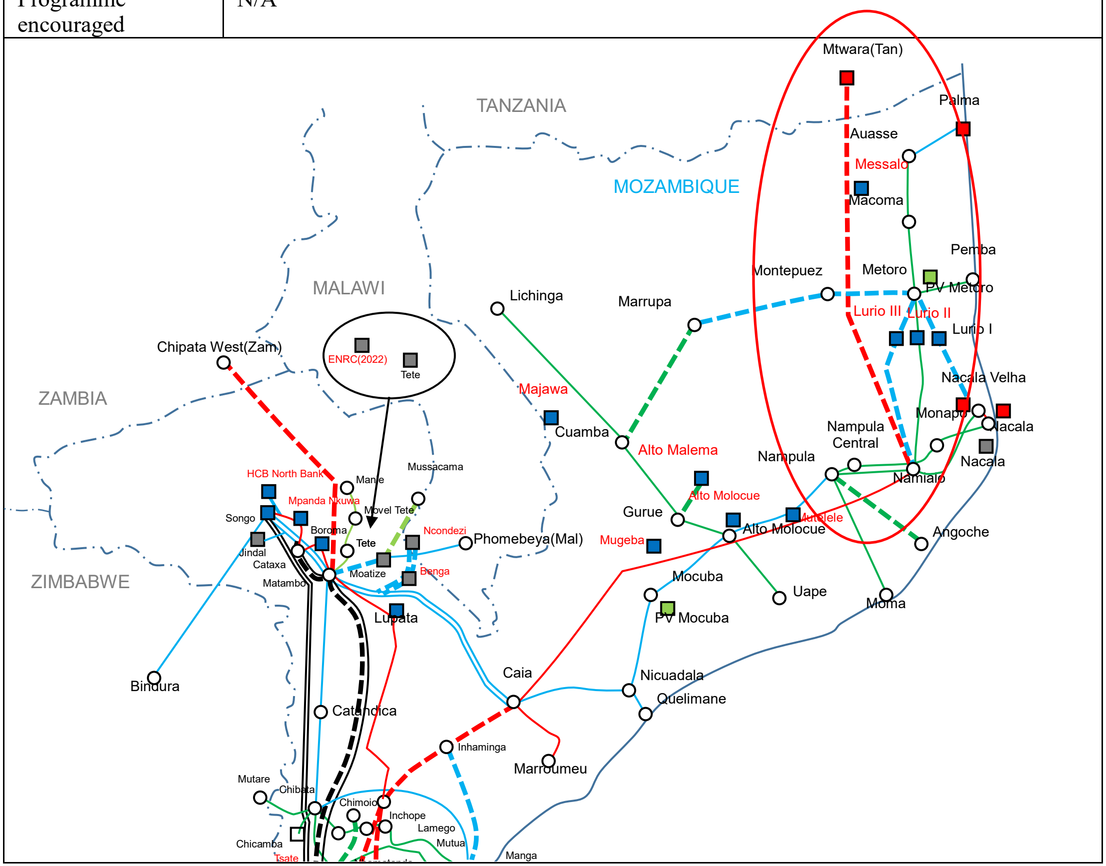
	Project Information
Project Name	Angola-Namibia Project
Expected COY	2026 (JICA Survey Team perspective)
Status	Preparation for transaction advisory service in progress. (As of the end of 2016, by SAPP C.C)
Project Cost	N/A
Superior Development Plan	SAPP Priority Project
Project Component	N/A
Project scheme	Probably, bifurcated, RNT and Nampower
Donors for Cooperation	N/A
Programme encouraged	Central African Power Interconnection, *Economic Community of Central African States,(ECCAS)* NEPAD 2020



Source : JICA Survey Team

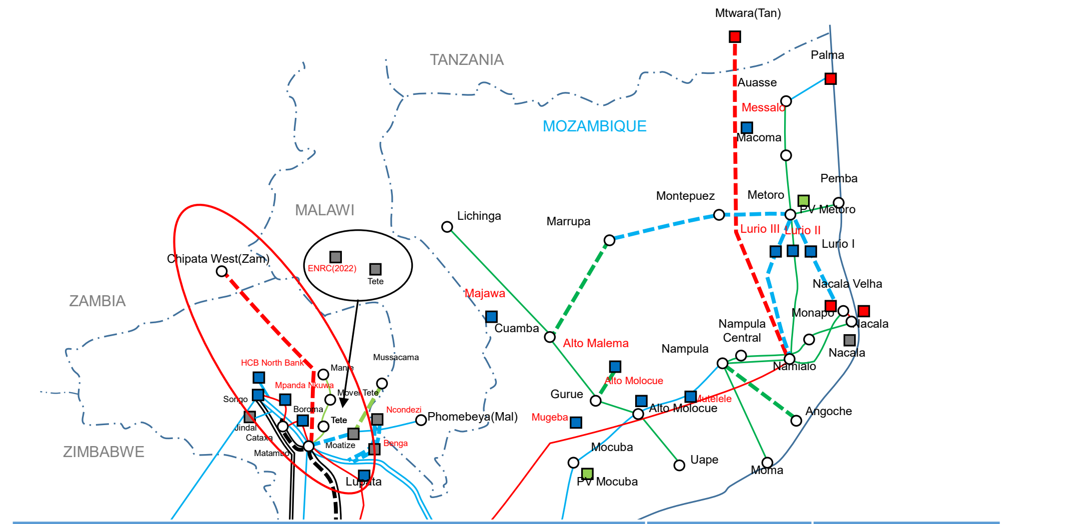
Expected Project -Transmission Line Projects (9)-

	Project Information
Project Name	Tanzania-Mozambique Project
Expected COY	2026 -2029 (JICA Survey Team perspective)
Status	Project teams are established (As of the end of 2016, by EDM, Tanesco)
Project Cost	N/A
Superior Development Plan	N/A
Project Component	N/A
Project scheme	Probably, bifurcated, EDM and Tanesco
Donors for Cooperation	N/A
Programme encouraged	N/A



Expected Project -Transmission Line Projects (10)-

	Project Information
Project Name	Zambia-Mozambique Project
Expected COY	2022 – 2023 (JICA Survey Team perspective)
Status	Project teams are established. Preparation for FS has been done by NEPAD (As of end of 2016, by SAPP C.C.)
Project Cost	330 Million USD Zambia side : 169 million USD Mozambique side : 161 Million USD (Project concept paper, 2016 EDM, ZESCO)
Superior Development Plan	N/A
Project Component	Tripartite, Eskom, ZETDC and EDM
Project scheme	Probably, bifurcated, EDM and ZESCO
Donors for Cooperation	N/A
Programme encouraged	North – South Power Transmission Corridor, PIDA PAP



Description of Activity	Start Date	End Date
Signing of IGMoU	17/3/2016	17/3/2016
Signing of IUMoU	17/3/2016	17/3/2016
Project Kick-off meeting	7/7/2016	8/7/2016
Appointment of Project members	8/7/2016	22/7/2016
Preparation of Project Concept Paper	11/7/2016	5/8/2016
Preparation of ToRs for Transaction Advisor, Feasibility Study and ESIA/RAP	11/7/2016	10/8/2016
Mobilisation of Funds for Project Preparation and Packaging	8/8/2016	1/2/2017
Procurement of Transaction Advisor (TA)	5/9/2016	3/3/2017
Execution of Feasibility Study and ESIA/RAP under TA	3/3/2017	26/2/2018
Commercial/Legal Closure by TA	3/3/2017	21/2/2019
Mobilisation of Funds for Project Implementation by TA	3/3/2017	21/2/2019
Procurement of Supervision Consultant	27/8/2018	21/2/2019
Procurement of EPC Contractors	24/9/2018	22/3/2019
Construction of Interconnector	25/3/2019	7/3/2022

Source : JICA Survey Team and Project concept paper (2016, EDM, ZESCO)

6. Index of collected information

This section is contained only index of collected information. The detail is stored on the attached disk.

	資料名	発行元	発行年月		ファイル識別番号		
SADC	SADC Regional Energy Access Strategy and Action Plan	SADC Energy Programme	2010	3	SADC	1	1
	The SADC Regional Infrastructure Master Plan	SADC	2013	5	SADC	1	2
	SADC Energy Programme and Projects	SADC	2006	10	SADC	1	3
	SADC Insrastructure Development Status Report for council and Summit	SADC	2009	9	SADC	1	4
	SADC Regional Insrastructure Development Maser Plan Executive Summary	SADC	2013	6	SADC	1	5
	SADC Regiona Infrastructure Development Master Plan Water Sector Plan	SADC	2012	8	SADC	1	6
	SADC Regiona Infrastructure Development Master Plan Energy Sector Plan	SADC	2012	8	SADC	1	7
	SADC Regional Strategy for Development of Statistics 2013 - 2018	SADC	2012	7	SADC	1	8
	SADC Energy Protocol	SADC	-	-	SADC	1	9
	ZiZaBoNa Transmission Project Project Information Momorandum	SAPP C.C, Norconsult	2013	3	SADC	2	1
	Central Transmission Corridor - Zimbabwe Project Profile	SADC	2013	5	SADC	2	2
	Mozambique - Malawi Interconnector Project Profile	SADC	2013	5	SADC	2	3
	Preliminary Project Information Memorandum Zambia Tanzania Kenya Power Interconnector	OPPPI	2013	5	SADC	2	4
	Mozambique Transmission Backbone Project Brief	SADC	2013	5	SADC	2	5
	Mphanda Nkuwa Hydropower Project	SADC	2013	5	SADC	2	6
	Inga 3 Power Project Project Brief	SADC	2012	5	SADC	2	7
	Batoka Gorge Hydropower Project Project Profile	SADC	2013	5	SADC	2	8
	Kafue Gorge Lower Hydropower Project Project Profile	SADC	2013	5	SADC	2	9
	Baynes Hydropower (Angola - Namibia) Project Profile	SADC	2013	5	SADC	2	10
SAPP	Introduction to SAPP	SAPP PAU	2016	6	SAPP	2	1
	Overview of the SAPP	SAPP	2013	3	SAPP	2	2
	SAPP Overview and Interconnections		2011	11	SAPP	2	3
	The Southern African Power Pool	Wilem Theron	2012	8	SAPP	2	4
	SAPP Transmission Project Briefs	SAPP	2013	6	SAPP	2	5
	SAPP Report to 5th Coordination Meeting of Power Pools in Africa	SAPP	2010	5	SAPP	2	6
	SAPP - Program for Accelerating Transformational Energy Projects	SAPP	2015	5	SAPP	2	7
	Update on RE Power in the SAPP	SAPP	2013	6	SAPP	2	8
	Analysis of Infrastructure for Renewable Power in Eastern and Southern Africa	SAPP	2015	-	SAPP	2	9
	Over the Transmission Hurdle	SAPP	-	-	SAPP	2	10
	Demand and Supply 2013	SAPP	2013	-	SAPP	2	11
	Transmission Projects in SAPP 2013	SAPP	2013	-	SAPP	2	12
	The West Power Corridor Project	SAPP	-	-	SAPP	2	13
	SAPP Generation Planning Criteria	SAPP	2011	11	SAPP	2	14
	SAPP Transmission Planning Criteria	SAPP	2012	1	SAPP	2	15
	Operating Guideline	SAPP	2014	2	SAPP	2	16
	Inter Governmental Memorandum of Understanding	SAPP	2006	2	SAPP	2	17
	Inter Utility Memorandum of Understaiding	SAPP	2007	4	SAPP	2	18
	Agreements beween Operating Members	SAPP	2008	5	SAPP	2	19
	Annual Report 2013	SAPP	2014	-	SAPP	1	1
	Annual Report 2014	SAPP	2015	-	SAPP	1	2
	Annual Report 2015	SAPP	2016	-	SAPP	1	3
	Monthly Report　2016/1	SAPP	2016	-	SAPP	1	4
	Monthly Report　2016/2	SAPP	2016	-	SAPP	1	5
	Monthly Report　2016/3	SAPP	2016	-	SAPP	1	6
	Monthly Report　2016/4	SAPP	2016	-	SAPP	1	7
	Monthly Report　2016/5	SAPP	2016	-	SAPP	1	8
	Monthly Report　2016/6	SAPP	2016	-	SAPP	1	9
	Monthly Report　2016/7	SAPP	2016	-	SAPP	1	10
	Monthly Report　2016/9	SAPP	2016	-	SAPP	1	11
	Monthly Report　2016/10	SAPP	2016	-	SAPP	1	12
	Monthly Report　2016/11	SAPP	2016	-	SAPP	1	13

	資料名	発行元	発行年月		ファイル識別番号		
RERA	Creating ans enabling Environment for Implemenntation of Power Sector Projects in the SADC Region	RERA	2009	7	RERA	1	1
	Technical Report : RERA Publication on Electricity Tariffs & Selected Performance Indicators for the SADC Region 2009	USAID	2010	5	RERA	1	2
	Technical Report : RERA Publication on Electricity Tariffs & Selected Performance Indicators for the SADC Region 2009	USAID	2011	8	RERA	1	3
	RERA & its Regional Initiatives on Energy Regulation and Security of Supply	RERA	2011	7	RERA	1	4
	Clean Energy Development in the Southern African Region	RERA	2012	12	RERA	1	5
	Restructuring of the Electricity Industry : Experience of Southern Africa	RERA	2012	11	RERA	1	6
	RERA : An Overview of Recent Developments in Southern Africa	RERA	2015	5	RERA	1	7
Angola	The National Energy Security Strategy and Policy	MoEAW	-	-	Ang	1	1
	Angola Energia 2025	MoEAW	2015	-	Ang	1	2
	National Strategy for the new Renewable Energies	MoEAW	2015	-	Ang	1	3
	Lower Cunene Hydropower Scheme Feasibility Study Report	-	1998	11	Ang	2	1
	Challenges of Angola Power System for the Periode 2013 - 2017	MoEAW	2015	9	Ang	2	2
	Technical Report : Southern African Development Community (SADC) Power Sector Review and Consultation Mission to Angola	USAID	2009	12	Ang	2	3
	Sustainable Energy for All, Rapid Assessment Gap Analysis Angola	UNDP	2015	9	Ang	2	4
	Investment Opportunities	MoEAW	2014	4	Ang	2	5
	Baynes Background Information Document	PJTC	2013	4	Ang	2	6
	Energy Sector Capacity Building Diannostic & Needs Assessment Study	AfDB	2014	-	Ang	2	7
	World Small Hydropower Development Report　2013	UNIDO	2013	-	Ang	2	8
	Japan - Angola Business Forum	ANiP	2014	6	Ang	2	9
	アンゴラ共和国の投資環境調査　2012年	JOGMEC	2012	10	Ang	2	10
Botswana	BPC Annual Report 2013	BPC	2014	-	Bot	1	1
	BPC Annual Report 2014		2015	-	Bot	1	2
	Public Notice North West Transmission Grid Project Update		2015	9	Bot	1	3
	Transaction Advisory Services for the Botswana - South Africa (BoSa) Transmission Interconnection project		2015	9	Bot	1	5
	The Energy Sector	BPC	2013	2	Bot	1	6
	Botswana Power Cooperation	BPC	2012	-	Bot	1	7
	Electricity Supply Industry in Botswana, Power Supply and Demand in Southern Africa		2013	4	Bot	1	8
	Botswana Power Development	African Energy	2015	3	Bot	2	1
	Sustainable Energy For All Rapid Assessment Gap Analysis	UNDP	2015	-	Bot	2	2
DR Congo	The Grand Inga Project	SNEL	2014	6	DRC	1	1
	Inga 3 Power Project	COMESA	-	-	DRC	1	2
	Power Status in African Power Pools Report	AfDB	2011	11	DRC	2	1
	World Small Hydropower Development Report 2013	UNIDO	2013	-	DRC	2	2
	The electricity supply industry in the Democratic Republic of the Congo	Journal of Energy in Southern Africa	2006	8	DRC	2	3
	Mining Industry Annual Report 2014	The Chamber of Business of the DRC Chamber of Maines	-	-	DRC	2	4
Lesotho	LEC Annual Report 2011	LEC	2011	—	Les	1	1
	Project Information Memorandum Lesotho Highlands Water Project Phase 2	SADC	2013	5	Les	1	2
	Agreement on Phase 2 of the Lesotho Highlands Water Project	Ministries	2011	8	Les	1	3
Malawi	Mini Integrated Resource Plan 2016 - 2020	DoE	2015	12	Mal	1	1
	Executive Exchange on Developing an Ancillary Service Market for SAPP	ESCOM	2014	-	Mal	1	2
	Financial Statement	ESCOM	2014	6	Mal	1	3
	Mozambique - Malawi Interconnector Project Brief	-	2013	5	Mal	1	4
	Energy Supply in Malawi ; Options and issues	Journal of Energy in Southern Africa	2015	5	Mal	2	1
	Business Opportunity in the Malawi Power Sector	Millennuum Challenge Corporation	2015	4	Mal	2	2
	An Overview of the Energy Sector in Malawi	Scinentific Reserch	2012	12	Mal	2	3

	資料名	発行元	発行年月		ファイル識別番号		
Mozambique	Unlocking Investment Opportunities in Mozambique	Investment Promotion Centre	2014	6	Moz	1	1
	Energy Sector Priorities Projects and Investment Opportunities	MoE	2010	-	Moz	1	2
	Strengthening Support for Regional Projects Background Note	IDA Resource Mobilization Department	2013	10	Moz	1	3
	Executive Exchange on Developing an Ancillary Service Market	EDM	2012	-	Moz	1	4
	Country Report	MoE	2013	6	Moz	1	5
	Master Plan Update Project, 2012 - 2027 Final Master Plan Update Report	EDM	2014	4	Moz	1	6
	Southern African Power Pool - MoZiSa Transmission Project Draft Inception Report	KPMG	2015	6	Moz	1	7
	Energia Politica energetica		-	-	Moz	1	8
	モザンビークの投資環境調査　2012年	JOGMEC	2012	9	Moz	2	1
	SISTEMA TARIFÁRIO DE ENERGIA ELÉCTRICA EM MOÇAMBIQUE	ECSI	2015	3	Moz	2	2
	The Electricity Sector in Mozambique	USAID	2015	2	Moz	2	3
	モザンビーク共和国における先進型高効率ガス発電設備に係る事業実施可能性調査報告書	METI	2014	10	Moz	2	4
	モザンビークにおける高効率石炭焚火力発電プラントに係る事業実施可能性調査	METI	2015	3	Moz	2	5
	Mozambique Renewables Readiness Assessment	IRENA	2012	-	Moz	2	6
	Energy Security in Mozambique	Trade Knowledge Network	2010	-	Moz	2	7
	モザンビーク国南部ガス火力発電所整備事業準備調査	JICA	2013		Moz	2	8
Namibia	Energy Demand and Forecasting in Namibia	Office of the President National Planning Commission	2013	-	Nam	1	1
	4th National Development Plan 2012/13 - 2016/17	Office of the President National Planning Commission	2012	-	Nam	1	2
	Generation Expansion Planning and Renewable Energy Integration initiatives in Namibia	ECB	2012	9	Nam	1	3
	Executive Visit on Developing an Ancillary Service Market	Nampower	2013	3	Nam	1	4
	National Integrated Resource Plan	ECB	2010	9	Nam	1	5
	Nampower Electricity Supply Update	Nampower	2013	5	Nam	1	6
	Nampower Annual Report 2014	Nampower	2015	-	Nam	1	7
	Nampower Annual Report 2015	Nampower	2016	-	Nam	1	8
	Project Completion Report - The Caprivi Interconnector	European Union Africa Infrastructure Trust Fund	2012	5	Nam	2	1
	Namibia's Energy Future	Konrad Adenauer Stiftung	2012	10	Nam	2	2
	Power Sector Reform and Regulation in Afriva - Namibia	Graduate School of Business, University of Cape Town	-	-	Nam	2	3
	Impact Assessment Case Studies from Southern Africa - Auas - Otjikoto - Lifa 400kV Transmission Line	Southern African Institute for Environmenta Assessment	2009	-	Nam	2	4

	資料名	発行元	発行年月		ファイル識別番号		
RSA	Transmission Development Plan 2015 - 2024	Eskom	2015	-	RSA	1	1
	Transmission Development Plan 2016 - 2025	Eskom	2016	-	RSA	1	2
	Transmission Development Plan 2016 - 2025 Public Forum	Eskom	2015	10	RSA	1	3
	Generation Connection Capacity Assessment of the 2022 Transmission Network	Eskom	2015	6	RSA	1	4
	Integrated Resource Plan for Electricity (IRP) 2010 - 2013 Update Report 2013	Department of Energy	2013	11	RSA	1	5
	Power Generation Technology Data for Integrated Resource Plan of South Africa	EPRI	2012	7	RSA	1	6
	National Development Plan 2030 Executive Summary	Department of Energy	-	-	RSA	1	7
	Gas Utilisation Master Plan	Department of Energy	2014	5	RSA	1	8
	Integrated Energy Plan Update Presentation for Public Meeting	Department of Energy	2016	11	RSA	1	9
	Integrated Resource Plan Update Presentation for Public Meeting	Department of Energy	2016	11	RSA	1	10
	Government Gazette, Nuclear Programme	Department of Energy, NERSA	2016	12	RSA	1	11
	Integrated Report 2016, List of fact sheet	Eskom	2016	–	RSA	1	12
	Integrated Report 2016, presentation	Eskom	2016	–	RSA	1	13
					RSA	1	14
	Renewable Energy IPP Procurement Programme Bid Window 3	DoE IPP Office	2013	11	RSA	2	1
	Eskom Holding SOC Limited	Eskom	2013	12	RSA	2	2
	The Strategic 2040 Transmission Network Study, The Assumption Paper	Eskom	-	-	RSA	2	3
	Unlocking Grid Capacity for the Energy Mix Proposed in the IRP	Eskom	2015	10	RSA	2	4
	Integrated Report 2016	Eskom	2016	3	RSA	2	5
	Presentation on Enectricity Supply in South Africa	Eskom	2013	6	RSA	2	6
	Transmission Network Strengtherning Requirementts associated with Renewable Potential	Eskom	2013	5	RSA	2	7
	The Strategic Network Development for Connection of RE IPPs in South Africa	Eskom	2015	9	RSA	2	8
	DEA National Corridors for Electricity Grid Infrastructure	Eskom, Enviwonmental Affairs	2014	2	RSA	2	9
	Trading in the Southern African Power Pool and Possible Coupling with the East African Power Pool	Eskom	2007	9	RSA	2	10
	South Africa's Renewable Energy IPP Procurement Program : Success Factors and Lessons	PPIAF (WB)	2014	5	RSA	3	1
	Grid Interration of Wind Energy in the Western Cape Final Report	Terna, Eskom	2009	12	RSA	3	2
	Workshop on Delivering Viable Wind Farm Projects	Eskom	2011	3	RSA	3	3
	南アフリカ共和国の環境政策と環境・エネルギー産業の現状	日本貿易振興会	2003	2	RSA	3	4
	Gridlocked, A long-term look at South Africa's Electricity Sector	Institute for Security Studies	2015	9	RSA	3	5
Swaziland	SEC Annual Report 2013/14	SEC	2014	—	Swaz	1	1
	Swaziland Renewable Readiness Assessment Report	IRENA	2014	12	Swaz	2	1
	Sustainable Energy for All Country Action Plan Final Report	Sustainable Energy for All	2014	5	Swaz	2	2
Tanzania	Power System Master Plan 2012 Update	Ministry of Energy and Minerals	2013	5	Tan	1	1
	Report of the Controller and Auditor General on the Financial Statements of Tanzania Electric Supply Company Limited for the Year Ended 31 December 2013	KPMG	2013	—	Tan	1	2
	Load flow diagram	Tanesco	—	—	Tan	1	3
	Currrent Status of Energy Sector in Tanzania	Tanesco	2013	3	Tan	1	4
	The Tanzania Development Vision 2025	Ministry	—	—	Tan	1	5
	EWURA 7th Annual Report	Enegry and Water Utilities Regulatory Authority	2013	6	Tan	1	6
	The Tanzania five Year Development Plan 2011/2012 - 2015/16	Ministry of Energy and Minerals	2012	6	Tan	1	7
	Investment Opportunities in the Energy Sector in the United Republic of Tanzania	Ministry of Energy and Minerals	2014	9	Tan	1	8
	Power System Master Plan 2016 Update	Ministy of Energy and Minearals	2016	12	Tan	1	9
	The Electricity Act 2008	Ministy of Energy and Minearals	2008	6	Tan	1	10
	The National Energy Policy 2003	Ministy of Energy and Minearals	2003	2	Tan	1	11
	The Electricity Industry Reform Strategy and Roadmap 2014 - 2025	Ministry of Energy and Minerals	2014	6	Tan	1	12
	Corpoate Business Plan 2016/17	Tanesco	2016	6	Tan	1	13
	Now It's Tanzania Offering Mazimum Returns on Investments	Tazania Investment Centre	2015	—	Tan	2	1
	Tanzania's Investment Prospectus	Sustainable Energy for All	2015	9	Tan	2	3
	Renewable Energy in Africa, Tanzania Country Profile	AfDB, Climate Investment Funds	2015	-	Tan	2	2
	FOURTH NATIIONAL REPORT ON IIMPLEMENTATIION OF CONVENTIION ON BIIOLOGIICAL DIIVERSIITY	Vice president's office, division of environment	2009	7	Tan	2	4

	資料名	発行元	発行年月		ファイル識別番号		
Zambia	The National Energy Policy	MEWD	2007	2	Zam	1	5
	Sector Report 2012-2013	ERB	2013	―	Zam	1	6
	General Description of the Electricity System	ERB	2010	―	Zam	1	7
	Hydropower Projects and Investment Opportunities in Zambia	MEWD	2013	4	Zam	1	8
	Investment Opportunities in the Energy and Water Sectors	OPPPI	2011	―	Zam	1	9
	Powering Zambia's Future	MEWD	2015	5	Zam	1	10
	Environmental Impact Statement for the Proposed Mumbwa - Kalumbila - Lumwana 330kV Project	ZESCO	2012	11	Zam	1	11
	Rsettlement and Compensation Plan for the Proposed Mumbwa - Kalumbila - Lumwana 330kV Double Bison Transmission line Project, Zambia	ZESCO	2012	11	Zam	1	12
	Environmental Impact Assessment Report for the Proposed Pensulo - Lusiwasi - Msoro - Chipata West 330kV Transmission line Project	ZESCO	2012	2	Zam	1	13
	Energy Policy in Zambia	MEWD	2015	7	Zam	1	14
	ZTK project diagram	ZESCO	2017	2	Zam	1	15
	Zambia, Land of Opportunities & Profits	Zambia Development Agency	2013	―	Zam	2	1
	Energy Sector Profile	Zambia Development Agency	2013	6	Zam	2	2
	NELSAP information	The Nile Basin Initiative	―	―	Zam	2	3
	CEC Annual Report 2014	CEC	2015	―	Zam	2	4
	Overview of the Copperbelt Energy Corporation (CEC) Business	CEC	2015	5	Zam	2	5
	Energy Secotr Profile	Zambia Development Agency	2014	11	Zam	2	6
	Overview of the Copperbelt Energy Corporation (CEC) Business	CEC	2014	10	Zam	2	7
Zimbabwe	ZPC Annual Report and Accounts 2011	ZPC	2012	-	Zim	1	1
	National Energy Policy Report	Ministries	2012	-	Zim	1	2
	National Energy Policy	Ministries	2012	-	Zim	1	3
	Power Generation Options	ZESA	2005	-	Zim	1	4
	Rehabilitation and Recovery in the Power Sector, AfDB Zimbabwe Report	AfDB	-	-	Zim	2	1
日本	アフリカビジネスへの視点と対応	METI 中東アフリカ部	2013	4	Jpn	1	1
	JICAアフリカ向け円借款の供与実績（2005～2013年）	JICA	2013		Jpn	1	2
	円借款　案件概要書（ザンビア南部地域送電網整備計画）	外務省	2015	2	Jpn	1	3
	アフリカにおけるJICAの鉱業・インフラ支援	JICA	2015	5	Jpn	1	4
	近年のアフリカ向け主要実績（JBIC承諾分）	JBIC	2015		Jpn	1	5
	JBIC Today - アフリカに対する取組	JBIC	2013	7	Jpn	1	6
	平成２５年度製造基盤技術実態等調査 （重電機器の輸出促進に関する調査）報告書	METI	2014	3	Jpn	1	7
	財政制度等審議会 財政投融資分科会参考資料	JICA	2012	11	Jpn	1	8
	ナミビア共和国全国電力開発計画調査　報告書	JICA	1998	9	Jpn	2	1
	ナミビア共和国全国電力開発計画調査　予備調査報告書	JICA	1996	11	Jpn	2	2
	モザンビーク共和国ナカラ回廊送電系統強化計画　準備調査報告書	JICA	2015	3	Jpn	2	3
	モザンビーク共和国南部ｶﾞｽ火力発電所整備事業　準備調査報告書	JICA	2013	3	Jpn	2	4
	モザンビーク共和国新エネルギー・再生可能エネルギー基礎情報収集・確認調査　報告書	JICA	2009	10	Jpn	2	5
	タンザニア連合共和国ダルエスサラーム送配電網強化計画（その２）　準備調査報告書	JICA	2014	1	Jpn	2	6
	アフリカ地域東アフリカ地熱開発に係る情報収集・確認調査　報告書（タンザニア）	JICA	2014	1	Jpn	2	7
	タンザニア連合共和国ダルエスサラーム送配電網強化計画（その１）　準備調査報告書	JICA	2013	1	Jpn	2	8
	アンゴラ共和国地方電力開発事業準備調査　　報告書	JICA	2011	12	Jpn	2	9
	マラウイ共和国テザニ水力発電所増設計画準備調査　報告書	JICA	2014	3	Jpn	2	10
	アフリカ地域太陽光を活用したクリーンエネルギー導入計画準備調査（マラウイ共和国）協力準備調査　報告書	JICA	2010	10	Jpn	2	11
	マラウイ国地方電化マスタープランに関するフォローアップ調査　報告書	JICA	2004	9	Jpn	2	12
	マラウイ国地方電化マスタープラン調査　報告書	JICA	2003	3	Jpn	2	13
	マラウイ共和国ンクラB-リロングウェB送電線建設計画事前調査　報告書	JICA	1989	1	Jpn	2	14
	ジンバブエ共和国太陽光発電利用地方電化計画予備調査　報告書	JICA	1996	6	Jpn	2	15
	ボツワナ国モルプール火力発電所リハビリ・環境対策事業準備調査　報告書	JICA	2011	11	Jpn	2	16
	ボツワナ国共和国太陽光発電利用農村電化計画予備調査　報告書	JICA	2000	2	Jpn	2	17
	太陽光を活用したクリーンエネルギー導入計画準備調査（レソト王国）協力準備調査　報告書	JICA	2011	2	Jpn	2	18
	アフリカ地域（南部／東部アフリカ）電力セクター域内協力にかかるプロジェクト研究　報告書	JICA	2008	11	Jpn	2	19
	ザンビア国電力開発マスタープラン調査　報告書	JICA	2010	2	Jpn	2	20
	ナミビア共和国経済開発支援に係る基礎情報収集・確認調査　報告書	JICA	2011	11	Jpn	2	21
	アフリカ地域南部アフリカ諸国における民間セクター活性化のための技術協力の役割　報告書	JICA	2005	10	Jpn	2	22

	資料名	発行元	発行年月		ファイル識別番号			
Misc	Planning Issues for Newly Industrialized and Deveoping Countires (Africa)	CIGRE	2012	-		Misc	1	1
	Coal prospects in Botswana, Mozambique, Zambia, Zimbabwe and Namibia	IEA	2013	12		Misc	1	2
	Africa Energy Outlook	IEA	2014	-		Misc	1	3
	Regional Power Status in African Power Pools Report	ICA	2011	11		Misc	1	4
	Baseline Renewable Energy Database for the COMESA Region	COMESA	2012	3		Misc	1	5
	Power-Sector Reform and Regulation in Africa	WB	2013	7		Misc	1	1
	EAPP Regional Power System Master Report	Eastern Africa Power Pool	2014	12		Misc	1	7
AfDB	Southern Africa Regional Integration Strategy Paper 2011 - 2015	AfDB	-	-		AfDB	1	1
	Angola Country Strategy Paper	AfDB	-	-		AfDB	1	2
	Botswana Country Strategy Paper	AfDB	-	-		AfDB	1	3
	DR Congo Country Strategy Paper	AfDB	-	-		AfDB	1	4
	Lesotho Country Strategy Paper	AfDB	-	-		AfDB	1	5
	Malawi Country Strategy Paper	AfDB	-	-		AfDB	1	6
	Mozambique Country Strategy Paper	AfDB	-	-		AfDB	1	7
	RSA Country Strategy Paper	AfDB	-	-		AfDB	1	8
	Swaziland Country Strategy Paper	AfDB	-	-		AfDB	1	9
	Tanzania Country Strategy Paper	AfDB	-	-		AfDB	1	10
	Zambia Country Strategy Paper	AfDB	-	-		AfDB	1	11
	Zimbabwe Country Strategy Paper	AfDB	-	-		AfDB	1	12