

Strategies for Energy & Environment Business

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 **MITSUBISHI HEAVY INDUSTRIES, LTD.**

1. Market and Strategy for Energy & Environment Business

2. Individual Projects

- ✓ Smart Community
- ✓ Lithium-ion Battery Business
- ✓ Offshore Wind Turbines
- ✓ Solar Energy Power Generation
- ✓ Nuclear power
- ✓ IGCC/High-efficiency GT
- ✓ Alternative Fuel Business
- ✓ Geothermal and Hydro Energy
- ✓ Shipbuilding & Ocean Development Technologies
- ✓ Seawater Desalting Plants
- ✓ CO2 Recovery Technology

MHI's Energy & Environment Business Strategy

Market recognition

Transformation into a low-carbon society (economy) (green energy revolution) is a global trend.

A sign of the future global boom in **rebuilding the energy and environmental infrastructures**. Reform and investment will grow, primarily in the following four areas:



MHI's business opportunities

Meet social needs for the **rebuilding of energy and environmental infrastructure** with a wide range product technologies. This is an opportunity to grow our businesses.

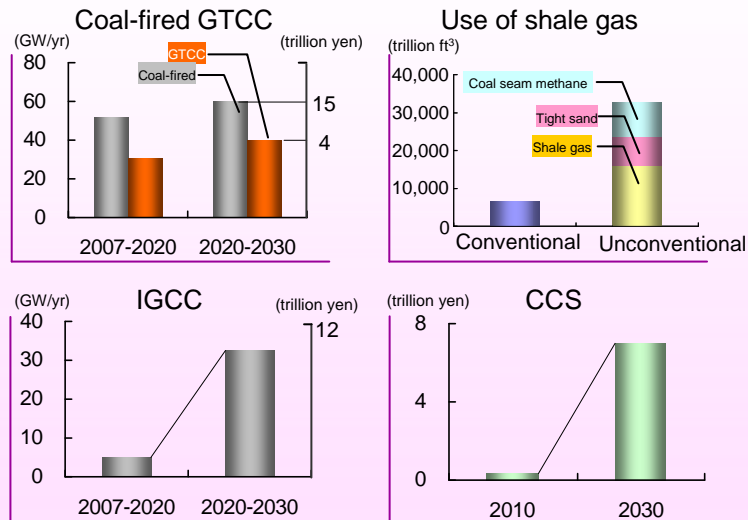
Keywords

- A) Expand using cross-divisional function and **integration**.
- B) Expand using **strategic alliances** (accelerate globalization)
- C) Create new products and businesses based on **key internal technologies**.

The Rapidly Growing Energy and Environmental Infrastructure Market

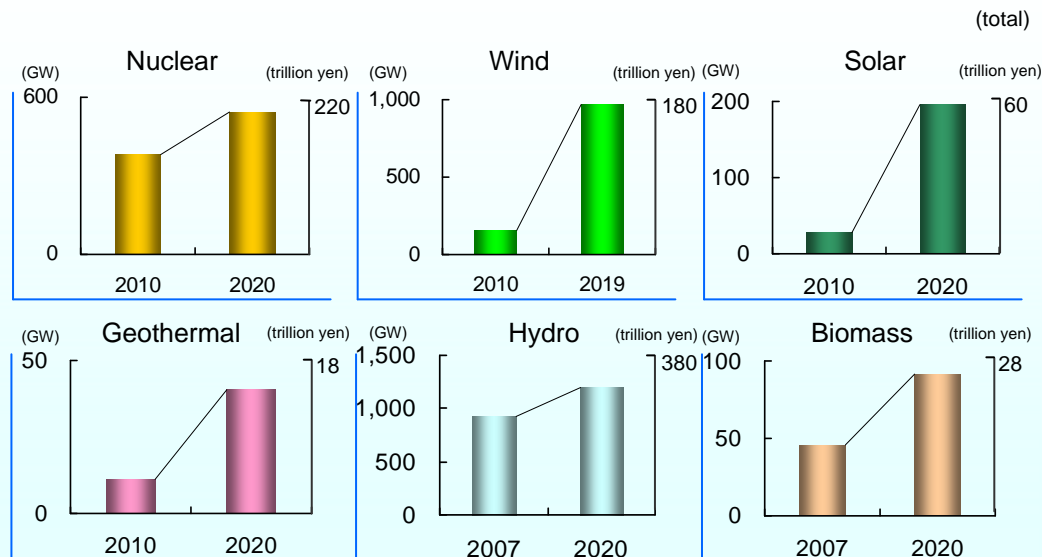
High-efficiency power generation (energy efficiency improvement)

Conventional power plants are strong majorly in China and India.
 Rapid growth of the markets for gas-fired GTCC, clean coal technology, CCS, etc. is expected.



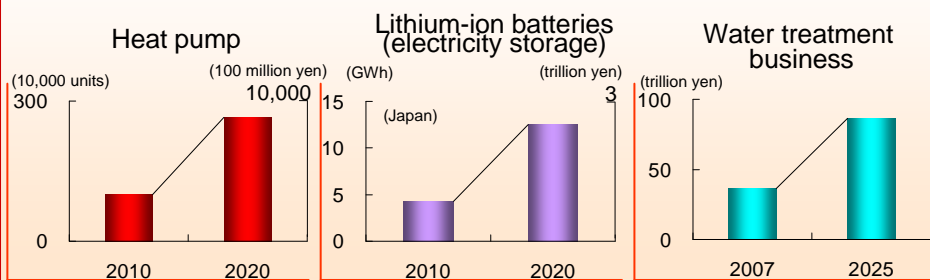
Carbon-free energy (alternative energy)

Use of carbon-free energy is expected to expand rapidly in the future.



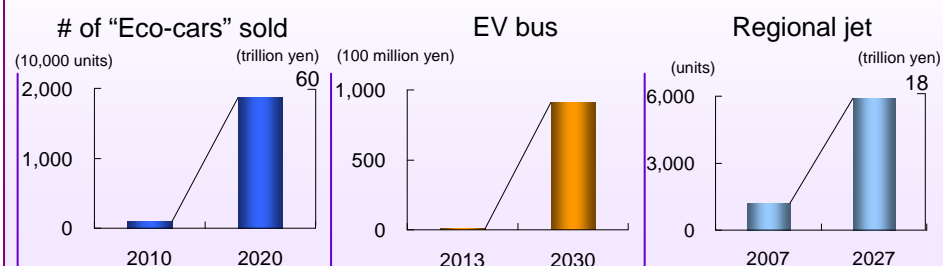
Energy management (energy saving technology)

Smart Community is a global 90 trillion-yen business



Innovative transport systems (modal shift)

Railroads is a 18 trillion-yen business until 2016.



Contributing to Achieve a Low-Carbon Society with MHI's Integration

➤ Responding to community needs for the rebuilding of energy and environmental infrastructure with a wide range of MHI product technologies to expand the business.

High-efficiency power generation (energy efficiency improvement)

- High-performance GTCC
- IGCC + CCS
- USC, A-USC
- High-efficiency gas engine
- GTCC + SOFC

GTCC: Gas Turbine Combined Cycle
IGCC: Integrated Coal Gasification Combined Cycle
SOFC: Solid Oxide Fuel Cell

Carbon-free energy (alternative energy)

- Nuclear power (APWR, ATMEA-1)
- Wind power (land, sea)
- Solar energy (sunlight to solar heat)
- Geothermal power
- Hydropower (pumping-up power generation)
- Biomass fuels
- Coal gasification/liquefaction (DME)

DME: Di-Methyl Ethel

Energy management (energy saving technology, infrastructure development)

- V2G, H2G (smart grid)
- Lithium-ion batteries (electricity storage)
- Eco-houses/buildings (HEMS, BEMS)
- High-performance heat pumps
- Organic EL lighting
- Seawater desalination (water infrastructure)
- Waste incineration plant

V2G: Vehicle to Grid
H2G: Home to Grid

Smart Community (advanced energy environment city)



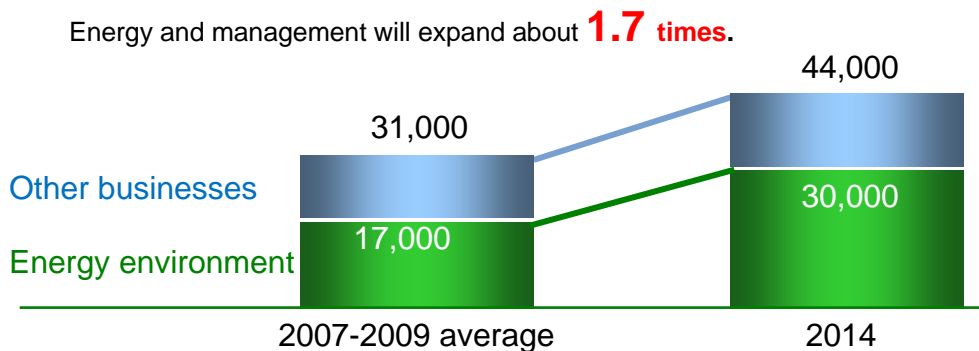
Innovative transport systems (model shift)

- MRJ
- Eco-ship (MEET, MERS)
- High-speed trains, LRT
- EV, EV buses
- ITS
- Hybrid fork

MRJ: Mitsubishi Regional Jet
MEET: Mitsubishi Marine Energy & Environmental Technical Solution System
MERS: Mitsubishi Energy Recovery System

Roadmap for Energy and Environment Business

➤ Using its integration, MHI is aiming to receive orders of JPY 3 trillion in the energy environment sector.



Key measures

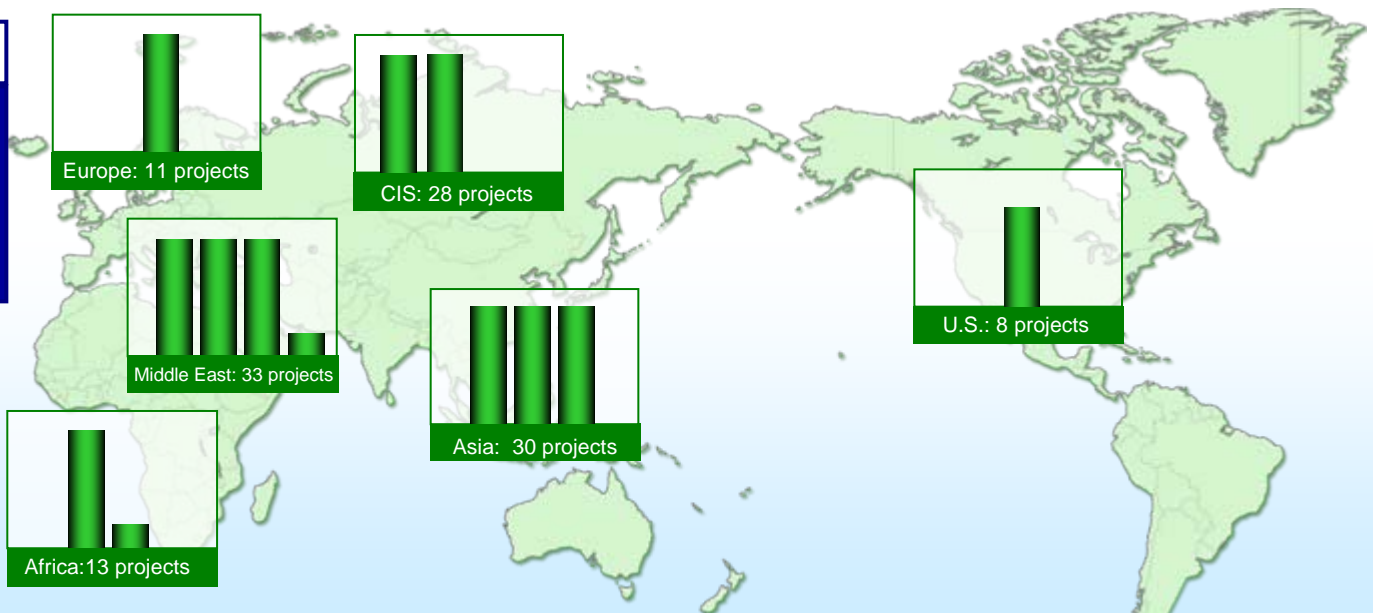
- A** Internal Integration
- B** Alliances
- C** Extension of key technology

Key projects at present		2010	2011	2012	2013	2014	2015	Focused measures
Smart Community	India DMIC F/S, etc.	→						A B
Lithium-ion batteries	EV bus, Hybrid fork	→						A B C
Offshore wind turbines	The U.K. Round 3, etc.			→				B A C
Solar heat GT	Australia CSIRO, South Africa, India, China			→				C B
Overseas nuclear power plants	U.S., Southeast Asia, Middle East, Europe	→						A B C
IGCC (+CCS)/high-efficiency GT	Australia ZeroGen, USA, China, Japan			→				C B A
Alternative fuels	Australia lignite drying, Iceland DME			→				A B C
Geothermal and hydro power generation	Africa, China	→						B A

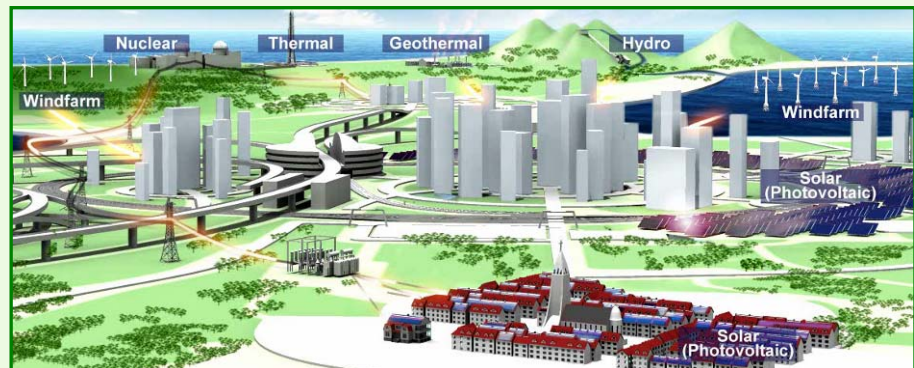
Size of the Smart Community Market

➤ As of the end of last year, development on a global scale of 940 billion US dollars (approx. 90 trillion yen) was planned and in progress.

- Current MHI projects**
- Iceland
 - China/various
 - Japan/METI public projects
 - India/Gujarat State
 - UAE/Masdar City



Sources: Construction Association of Korea (Dec. 2009), Nikkei Ecology, and JETRO Business News



Iceland
 Aim for zero-emission through the use of renewable energy, CO₂ recovery/synthetic fuel production, EV promotion, etc.



India
 The Delhi-Mumbai Industrial Corridor Plan is combined with the next-generation power network to perform a feasibility study and demonstration.

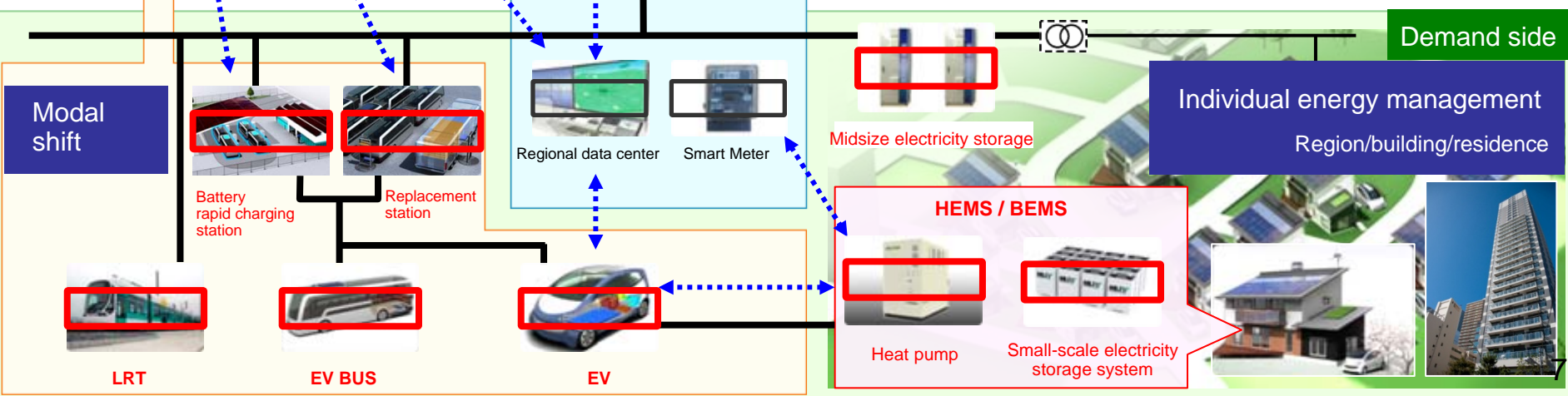
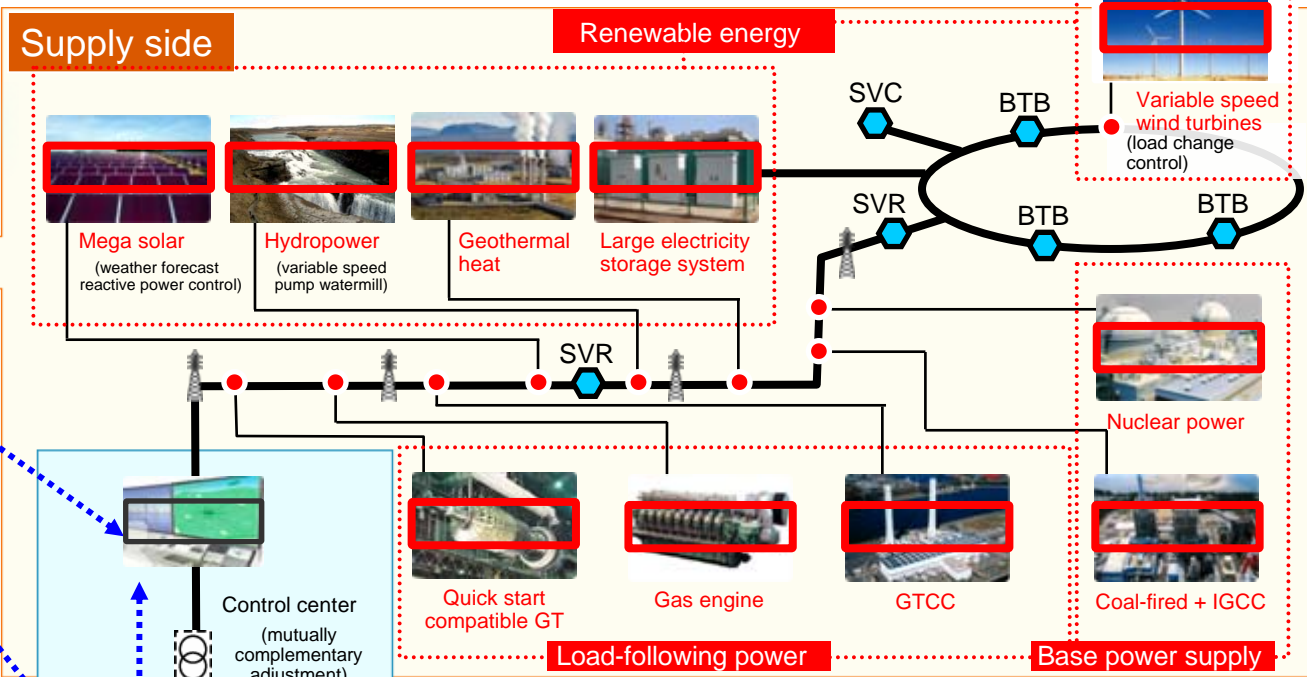
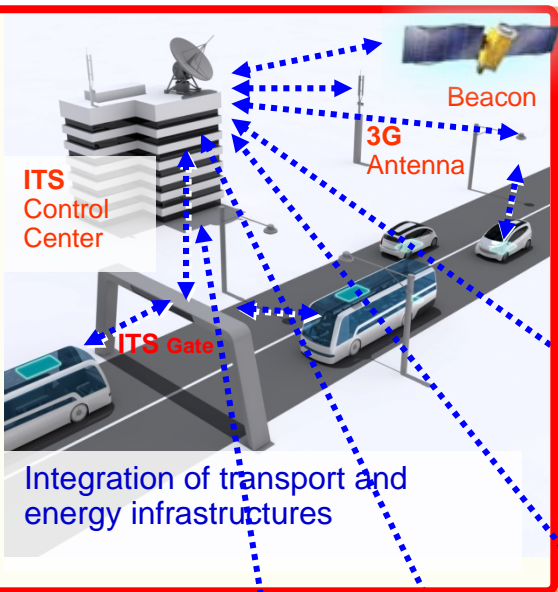


UAE
 Aim to build a zero-emission city in the desert in Masdar City.

Scope of MHI's Business in the Development of Smart Grid Infrastructure

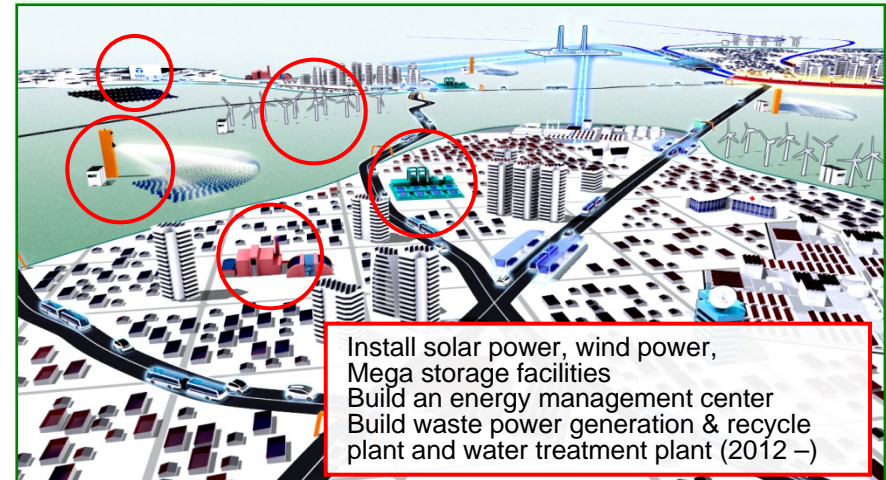
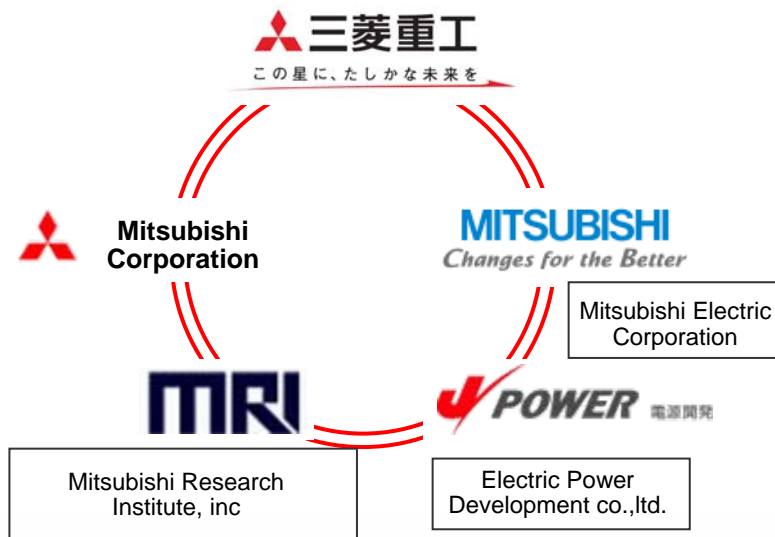
➤ Use MHI's product line in every direction to seize business opportunities.

 MHI-related products

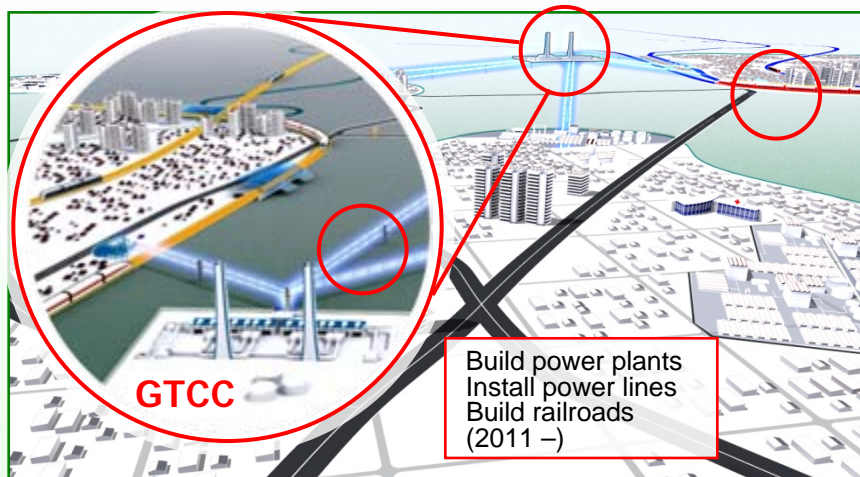


Overseas Smart Community Scheme (1/3)

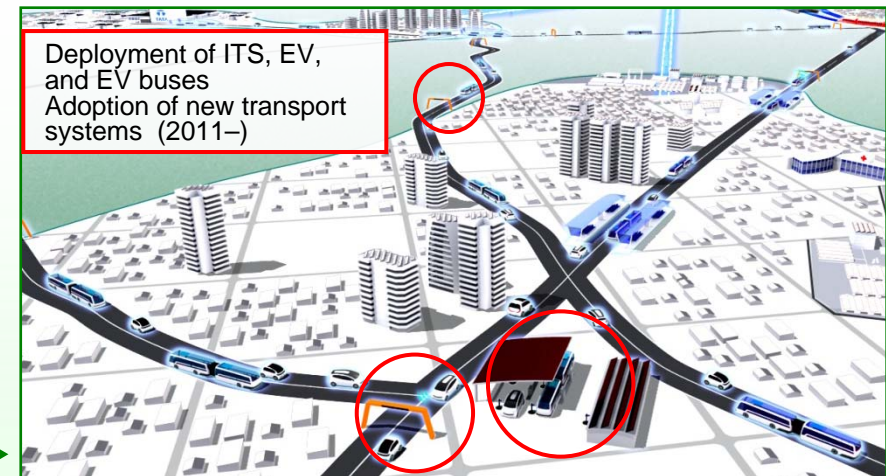
➤ Obtain FS of Changodar and Sanand, Gujarat State, India, from METI



Phase 3 Adopt and promote renewable energy



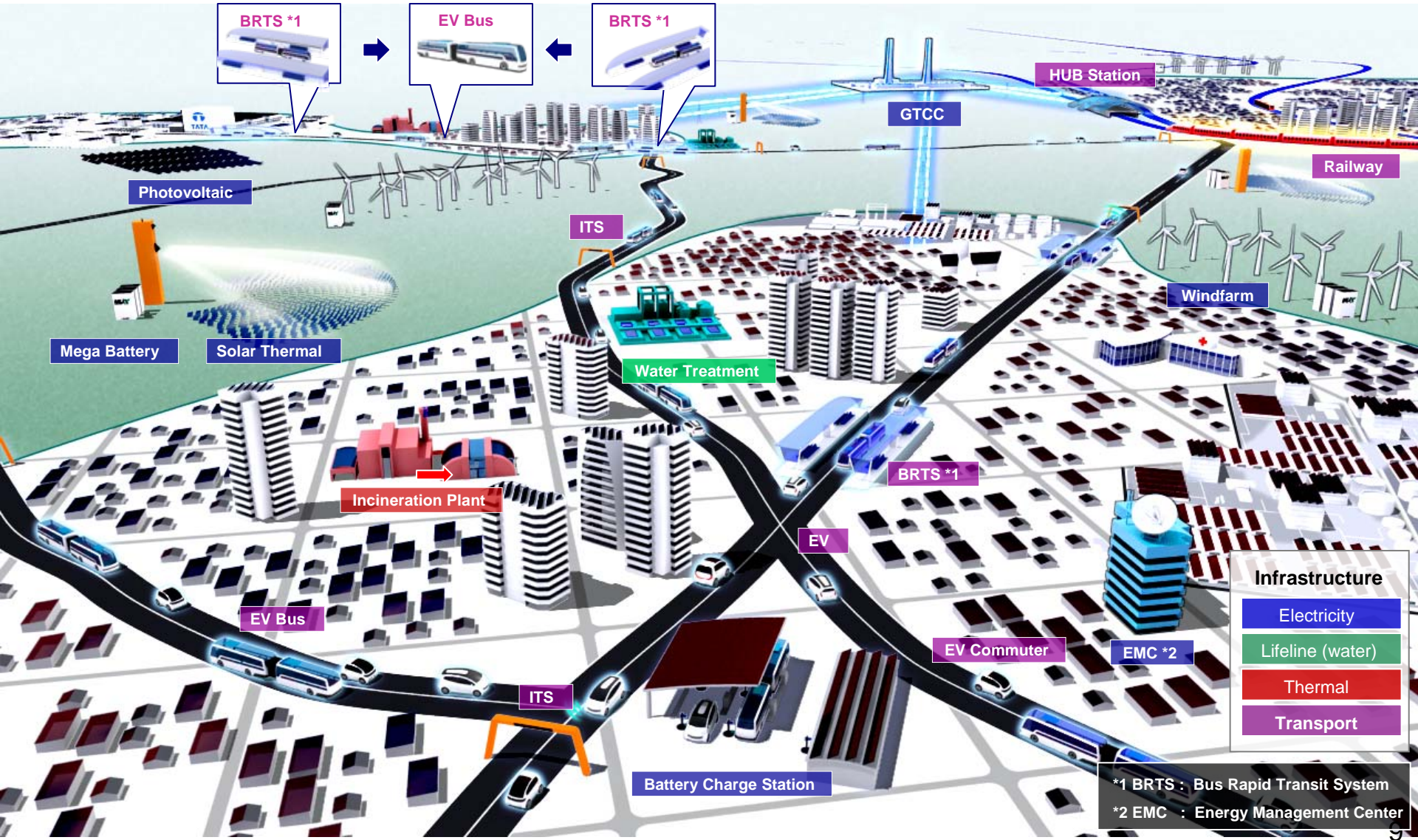
Phase 1 Improve key infrastructure



Phase 2 Promote the electrification of transport infrastructure

Overseas Smart Community Scheme (2/3)

➤ Promote the electrification of transport sector and the deployment of renewable energy on the basis of key infrastructures.



Infrastructure	
Electricity	Blue
Lifeline (water)	Green
Thermal	Red
Transport	Purple

*1 BRTS : Bus Rapid Transit System
 *2 EMC : Energy Management Center

Overseas Smart Community Scheme (3/3)

➤ Example of a Smart Community Concept

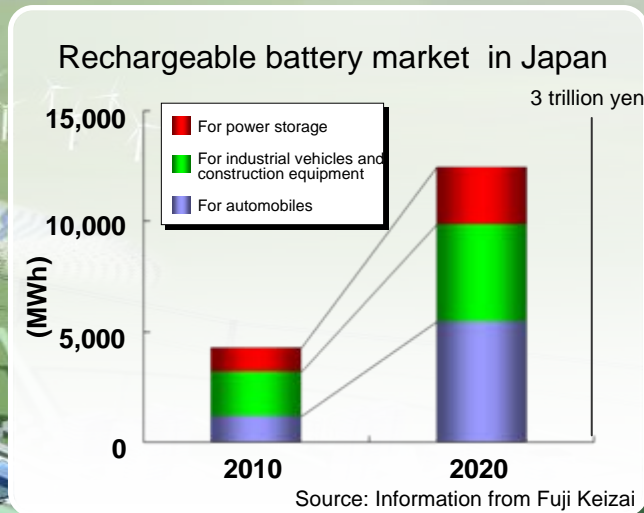
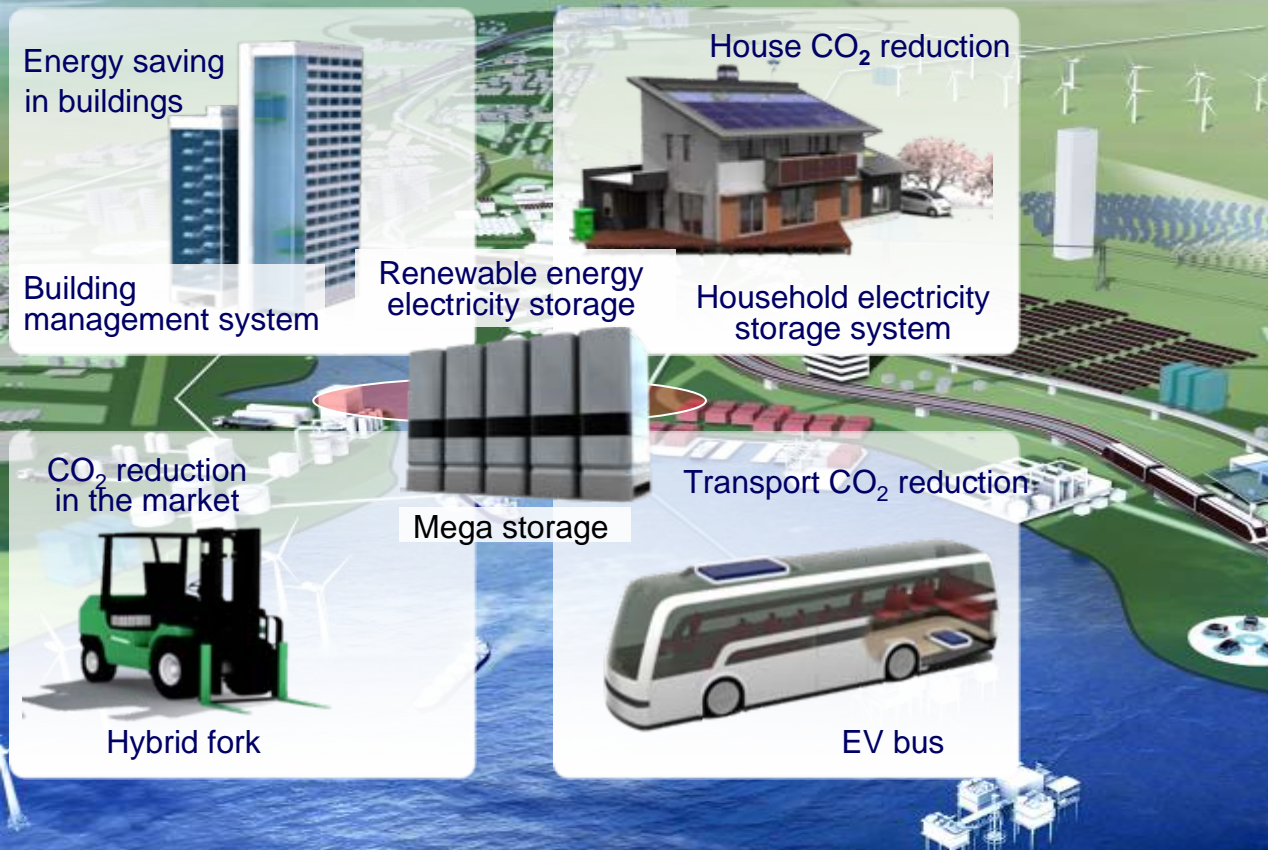
[Electrification of Transport] + [Stabilization of renewable energy]

= [Low carbon society]



Development of Lithium-Ion Battery Business (1/2)

- Use lithium-ion batteries for diverse purposes and grow the business
- While the growth of the lithium-ion rechargeable battery market is led by automotive applications, the demand for stationary batteries is also expected to gradually expand.

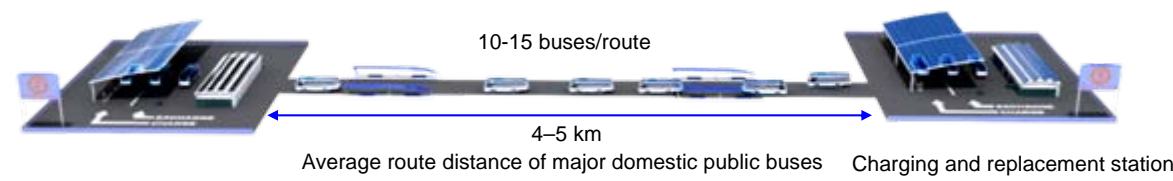
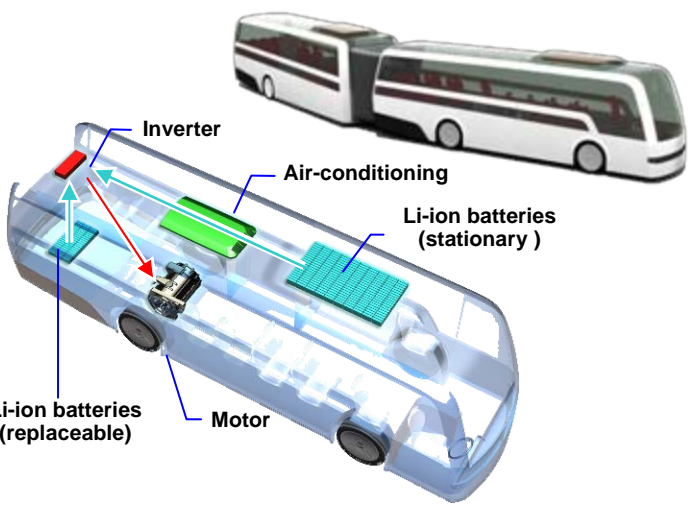


Schedule for development of lithium-ion battery business	2009	2010	2011	2012	2013
Demonstration plant (66 MWh)	Construction	Operation	Operation	Operation	Operation (Plan)
Full-scale mass production (200-300 MWh)			Construction (Plan)		Operation (Plan)

Development of Lithium-Ion Battery Business (2/2)

➤ Propose the electrification of public transport systems using general shuttle buses.

- 1 Annual benefit of running EV buses
Reduction of approx. **1.3 million yen/yr. units**
- 2 CO₂ emission benefit of EV buses
Reduction of approx. **50 t-CO₂/yr. units**
- 3 EV bus emits **zero** toxic substances



Local governments' efforts to develop a community for low-carbon emissions (proposal)

* Vehicle verification is conducted in cooperation with auto manufacturers.

	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013 -
Development process	Factor verification Complete	Test production (modification) system verification	Test production & operation, peripheral facility development	Durability, demonstration test	Sale

Global Development of Wind Turbines Business

- In the U.K., 32 GW for Round 3 only and a total of 47 GW of offshore wind turbines are scheduled to be constructed by 2020.
- Strengthen partnerships primarily in Asia, the U.S., and Europe and establish local production systems (a system with three major bases globally).
- Also consider the development of workboats for the construction of offshore wind turbines.

European base

Build a European development center
Strengthen partnerships and plan local production bases

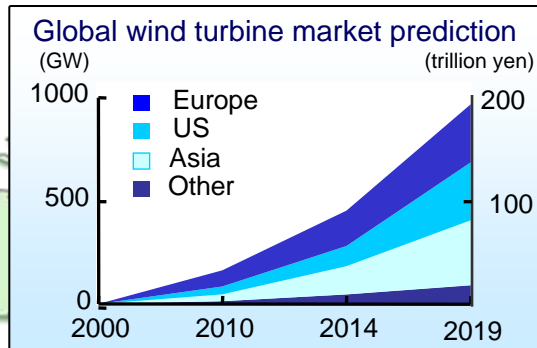
The offshore wind turbines market primarily in the U.K. 60-70 GW in 2020. 150 GW in 2030.

MPSE (UK)
MPSE (Germany)

Asian (China) base

Strengthen partnership in China

Asia: operation of 102 MW offshore wind turbines started near Shanghai, China, in 2010



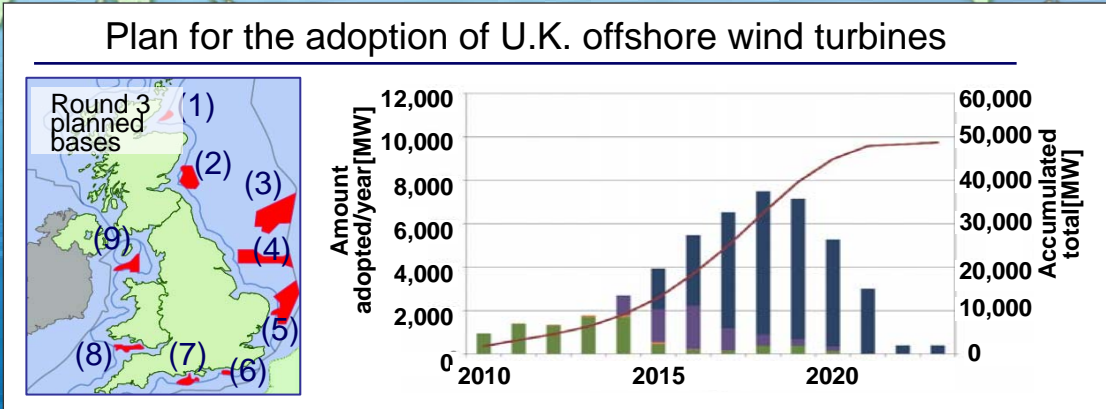
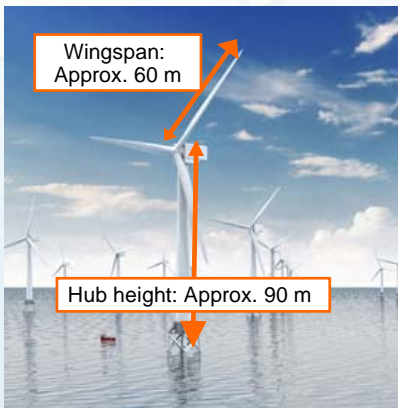
US base

Production started in 2011 at Nasser plant in Arkansas.

DOE plan is 54 GW offshore wind turbines in 2030

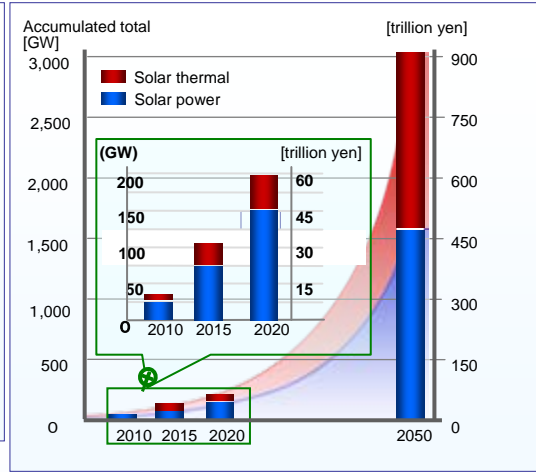
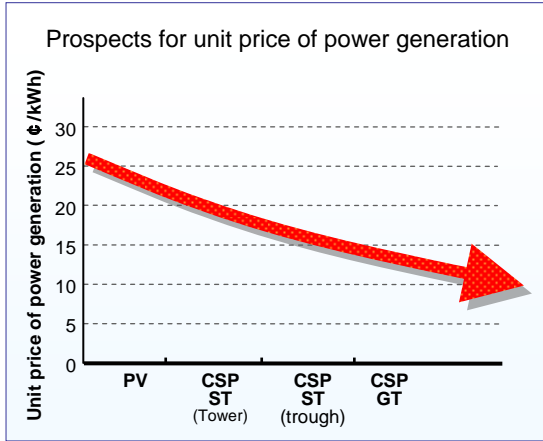
MPSA
Nasser plant in Arkansas
VienTek Blade plant

Currently developing 5-7 MW class models of offshore wind turbines in preparation for the European market

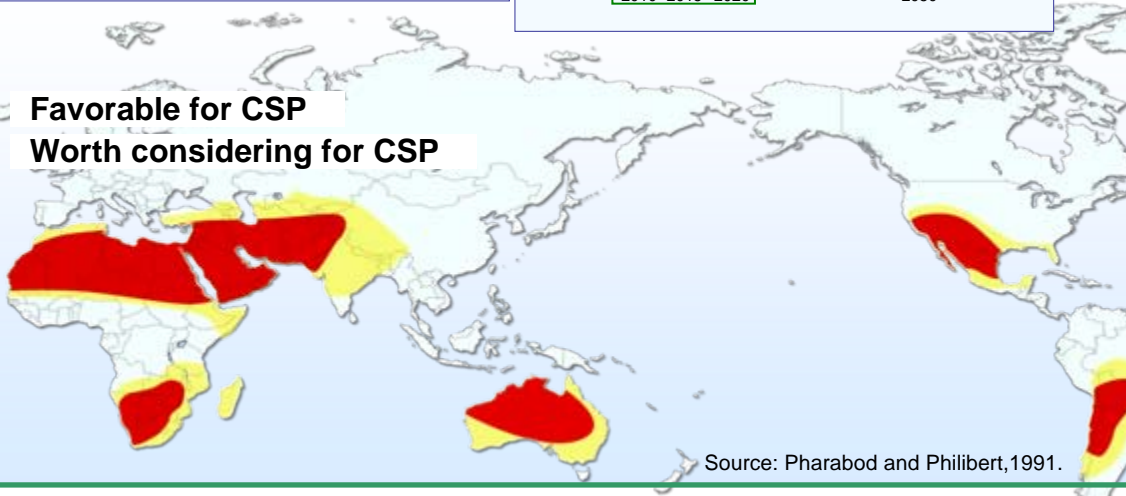


Development of Solar Energy Power Generation

- Solar thermal power generation (CSP) is expected to grow to the extent of solar photovoltaic power generation.
- Use ST, GT technologies to shift the focus to solar thermal power generation (CSP).



- Favorable for CSP
- Worth considering for CSP



Source: Pharabod and Philibert, 1991.

Solar thermal (CSP)

Gas turbine

Receiver

Heliostat

SEGS I
1985
14.7 MW

SEGS: Solar Electric Generating System Mojave desert in California

Steam turbine

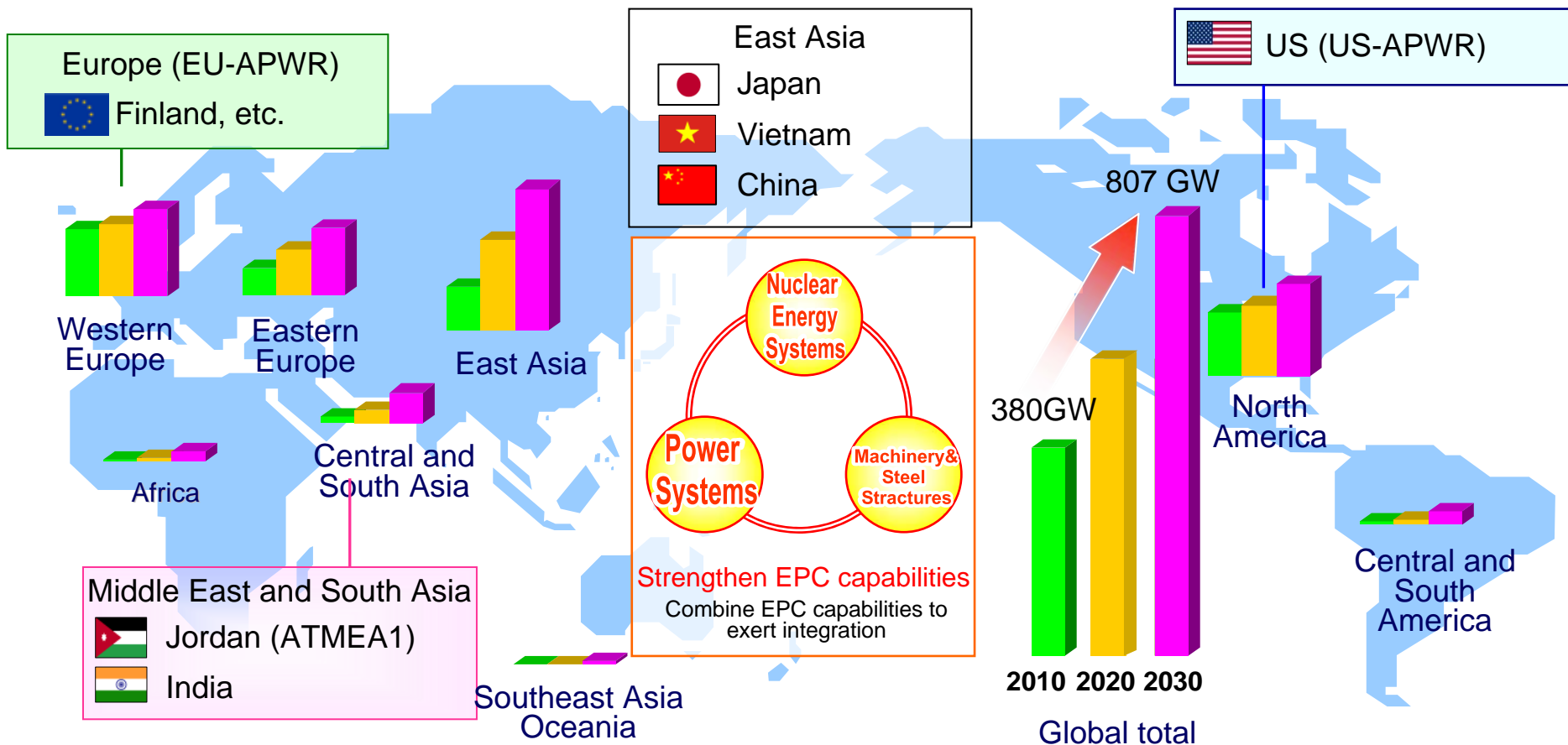


Solar thermal GT development plan	2010	2011	2012	2013	
Development schedule (proposal)	Detailed design		Demo machine demonstration test		
	Receive orders for and sell commercial machine				

Global Development of Nuclear Power

- Grow the business by combining and strengthening the system of annual two-plant production and the internal EPC function to match the scale of the global nuclear power market.
- Build secondary businesses in developed countries such as Japan, the U.S., Europe, etc. and in China and other countries
- Received 46 orders out of 54 contracts for component exports

Outlook for the capacity and development of global nuclear power generation

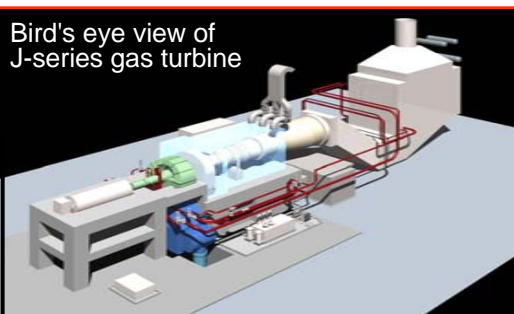


Horizontal Development of Gas Turbine Business

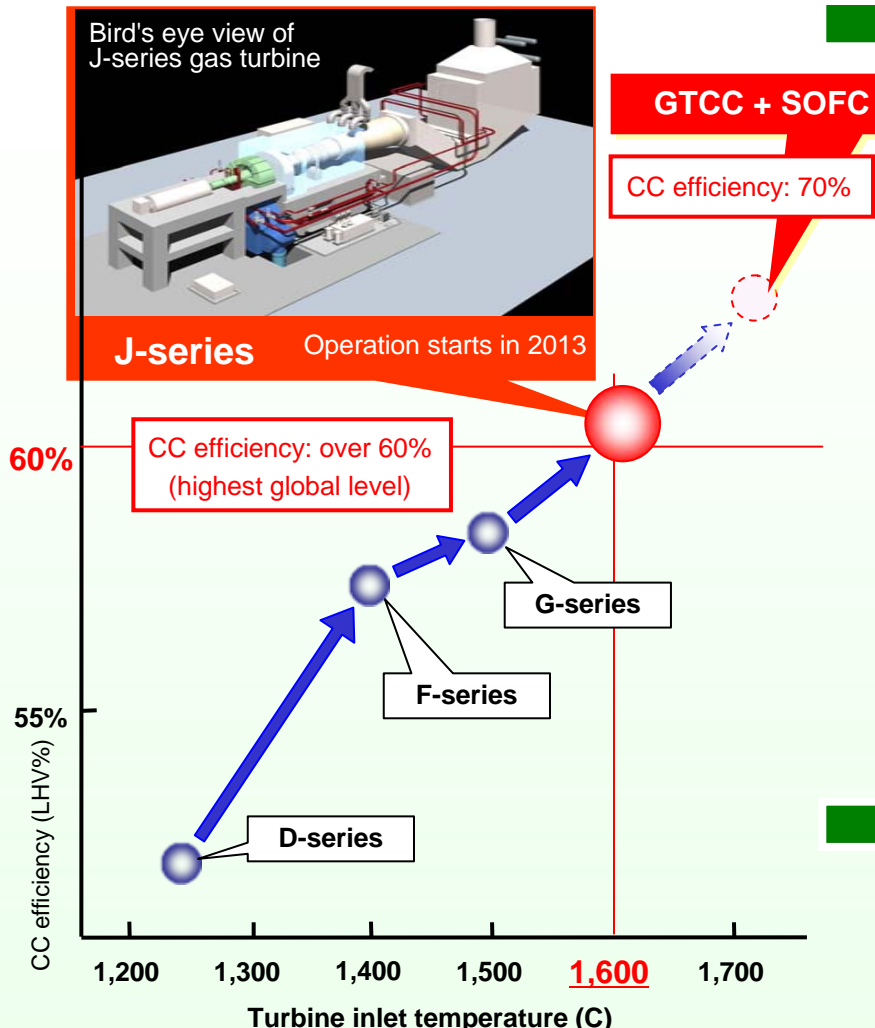
- Lead the world with high-efficiency technology (models expanded to include J-series)
- Higher efficiency with SOFC (successful small test model operation)

J-series GT

Bird's eye view of J-series gas turbine



J-series Operation starts in 2013



Increased gas recoverable reserves

Global reserves of shale gas amount to 16,000 trillion ft³, 25% of which is in North America. Medium-term plan for LNG imports in North America was 30%, but the development of shale gas facilitated positive prospects for self-sufficiency for the most part.



GTCC, IGCC, SOFC

Achieve high GT efficiency in key technologies to strengthen the competitiveness of GTCC, IGCC, and SOFC combined.

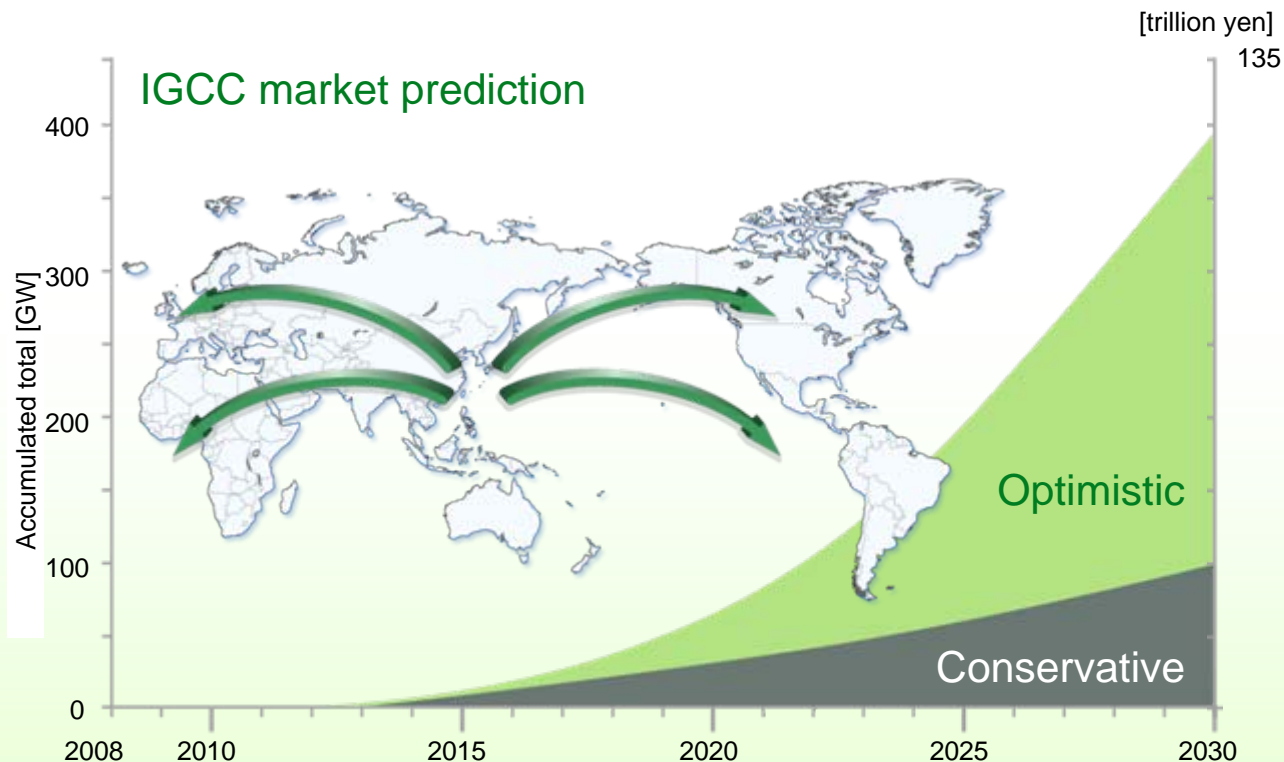


IGCC + CCS

- Participate in the development of IGCC+CCS by ZeroGen Pty Ltd, Australia, and receive PJ subsidies for FY2010 from the Japanese government.
- Anticipating the expansion of the IGCC market, particularly in China, grow the IGCC business to a global scale.



Items	ZeroGen spec.
Coal	Bituminous coal
Plant output (gross)	530 MW
Gas turbine	M701G2 x 1 (1 on 1)
CO ₂ recovery rate	65%
CO ₂ storage	Approx. 2-3 million tons/yr.



Source: EIA Emerging Energy Research

items	2008	2009	2010	2011	2012	2013	2014	2015	2016
ZeroGen milestones	Won order for pre-study	Won order for pre-FS	Win FEED order		EPC agreement			Start operation	Commercial operation
Stage 2: IGCC + CCS business development schedule	Scoping-Study	Pre-Study	FS	FEED	EPC Phase				commercial operation

Development of the Alternative Fuel Business

➤ Develop technologies applicable to diverse fuels

Lignite

Australia/DME*1

Gasify lignite and manufacture synthetic fuels. Export liquid fuels.



Indonesia/DME (plan)

Gasify low-grade coal and manufacture synthetic fuels

Biomass

Japan/bio-ethanol

Saccharify cellulose and manufacture bio-ethanol.



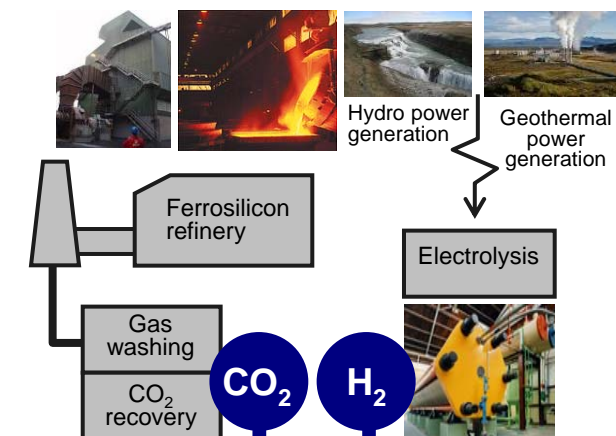
Slovenia/methanol

Methanol synthesis from biomass gasification

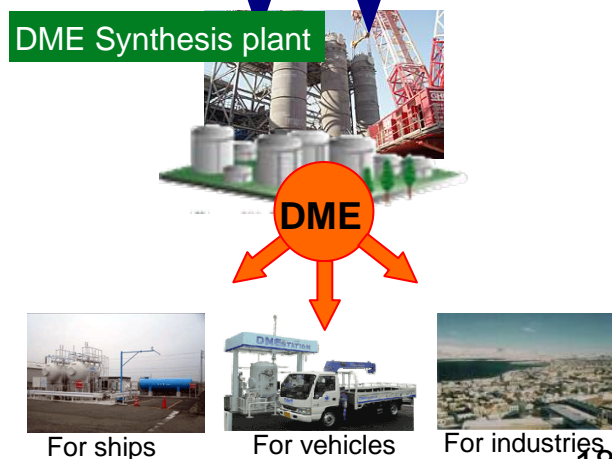


DME manufacturing process (Iceland)

Fuel manufacturing



DME Synthesis plant



CO₂ recovery

Iceland/DME

Recover CO₂/manufacture synthetic fuels from plant flue gas



liquefaction

F-LNG*2/natural gas

Offshore floating production storage and offloading unit



*1) DME: Di-methyl Ethel

*2) F-LNG: Floating LNG

Use of Geothermal and Hydro Energy

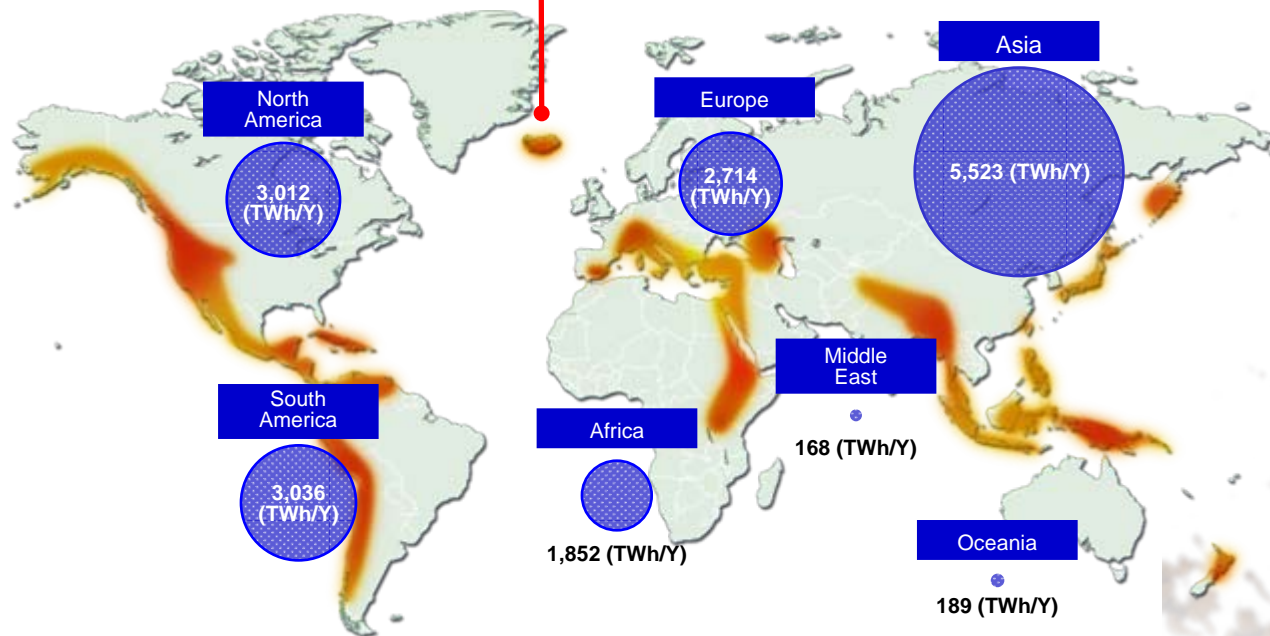
- Using the advantage provided by the leading global share, collaborate with Reykjavík Energy of Iceland in the geothermal power generation business to sign an MOU for global expansion (Southeast Asia, Africa, and the U.S.).
- In discussion with Australia concerning hot dry rock (HDR) power generation
- Step up alliances to match the growing market for hydro power.

Potential of geothermal and hydro power

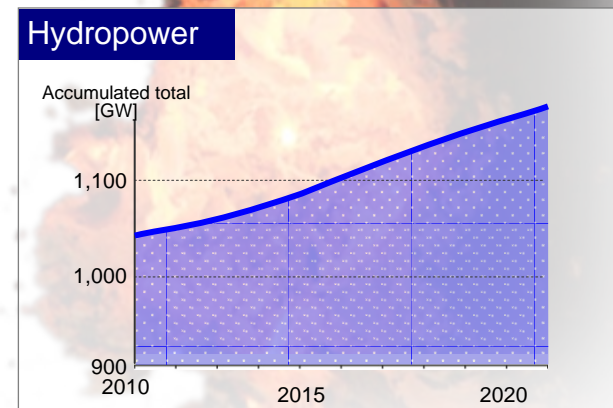
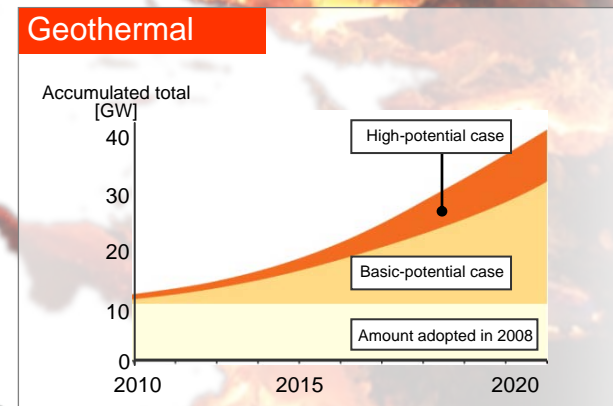


Sign an MOU with the Icelandic government

- Potential of geothermal energy
- Technologically possible development of potential hydro power



Geothermal and hydro power market prediction



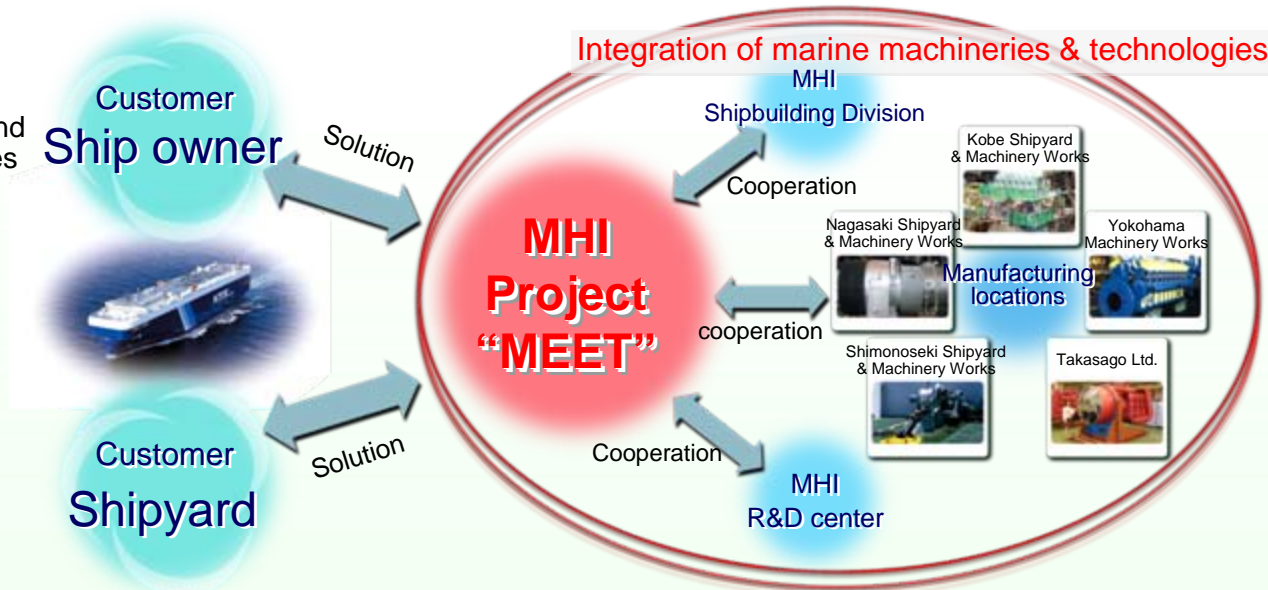
Initiatives in Shipbuilding & Ocean Development Technologies

- Combine the various marine products of MHI and use its integration to contribute to the achievement of a low-carbon society.

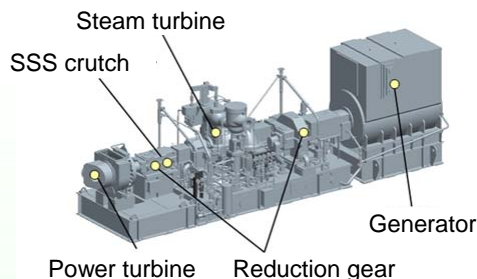
MEET Project

Integration of marine machineries and technologies to propose technologies that are friendly to the global environment.

MEET:
Mitsubishi Marine
Energy &
Environmental
Technical Solution System



MERS born from MEET



Use the vessel heat recovery system for the composite treatment of engine exhaust gas and achieve high-efficiency power generation (fuel efficiency improved by 10%)

MERS: Mitsubishi Energy Recovery System

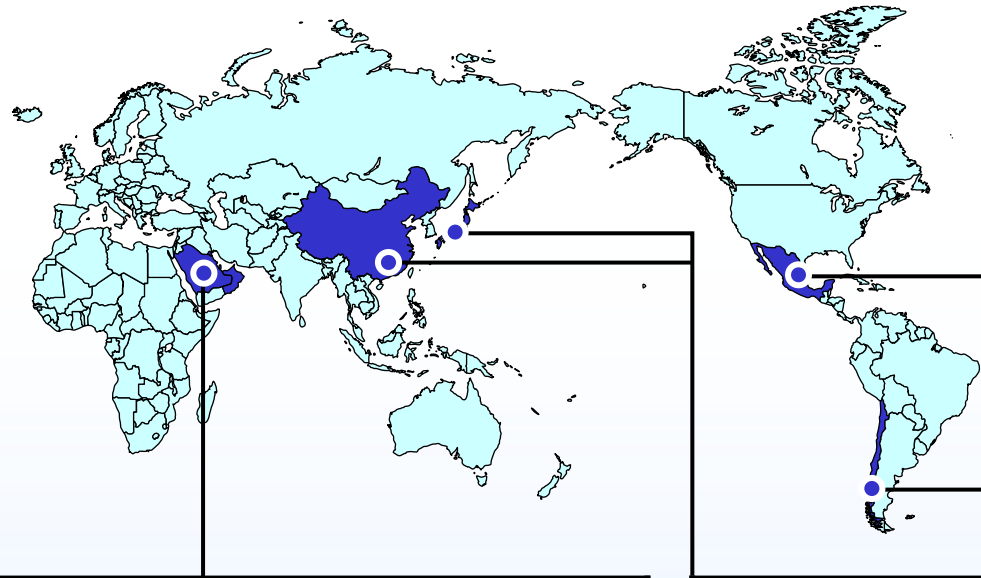
Achieve "Eco-ship"



Achieve the world's highest level of "Eco-ship" with a high operation rate (12% energy savings) using the air lubrication system

Seawater Desalting Plants

Start from selling individual plants based on rich delivery experience
 Develop into total solution water business



Saudi Arabia Shuqaiq
 216,000 m³/day

Country	Starting year	Total capacity [m ³ /d]	# of units
Saudi Arabia	1986	150	1
Saudi Arabia	1988	56,800	10
Saudi Arabia	1994	56,800	10
Saudi Arabia	1995	128,000	15
Kuwait	2000	5,400	2
Oman	2002	200	1
Qatar	2005	200	1
Saudi Arabia	2008	192,000	16
Saudi Arabia	Exp. 2010	216,000	16

Country	Starting year	Total capacity [m ³ /d]	# of units
Japan	1978	220	1
Japan	1981	453	1
China	1985	1,200	1
China	1986	1,200	1
Japan	1992	1,000	2
Japan	1995	400	1
Japan	1995	400	2
Japan	1995	350	1
Japan	1994	350	1
Japan	1995	100	1
Japan	1995	100	1
Japan	1996	600	1

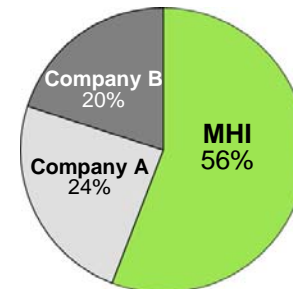
Country	Starting year	Total capacity [m ³ /d]	# of units
Chile	1985	300	1
Chile	1985	480	2
Mexico	2006	280	2

Efforts to Develop CO₂ Recovery Technology

- Take advantage of MHI's dominant share in products for chemical and general use
- Started demonstration experiments jointly with Southern Company of the U.S, operation to start in 2011



Share of commercial models of CO₂ recovery from global exhaust gas

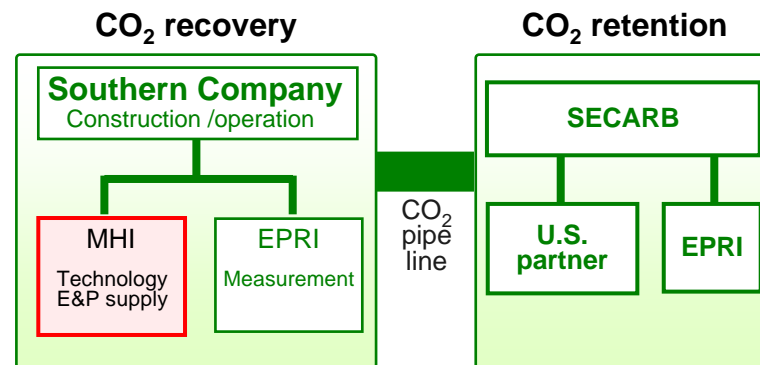


Joint demonstration experiments with Southern Company

EPRI: Electric Power Research Institute (EPRI)
SECARB: Southeast Regional Carbon Sequestration Partnership



Start-up	2011
Plant output	25MW
Capacity of recovered CO ₂	500 tons/day
Operation period	3-4 years



Items	2009	2010	2011	2012	2013	2014
Milestones	EPC ordering	Local construction start	CO ₂ recovery start			
Main process	Design	Procurement	Construction	Demonstration test		



Our Technologies, Your Tomorrow

