Strategies for Energy & Environment Business

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Director, Senior Executive Vice President

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2. MHI's Energy & Environment Strategies

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Green energy revolution is becoming the global mainstream.

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All nations and regions place "**social investment into energy and the environment**" at the core of their economic-stimulus measures.

Forming a low-carbon social infrastructure is a challenge shared globally.

- 20% renewable energy by 2020
- Invest €105 billion into green economy
- Allocate € 48 billion to environmental measures

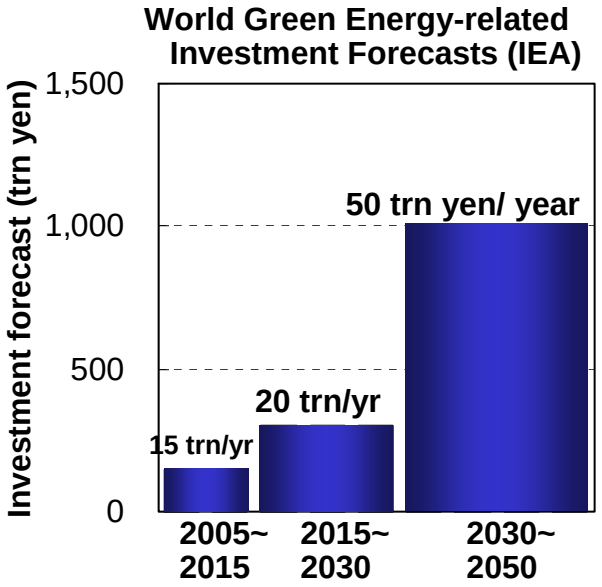
- Invest more than £100 billion into offshore wind power generation; create 160,000 jobs
- Promote £ 50 billion in investments into low-carbon sectors

- Planned investments totaling 4 trillion yuan (JPY 57 trillion)

- Environment market scale: JPY 120 trillion
- Create 2.8 million new jobs
- 40-fold expansion in photovoltaic power generation by 2030
- Introduce FIT (Feed-in Tariff) relating to photovoltaic power generation

Obama's "Green New Deal" policy

- Invest US$150 billion into clean energy; create 5 million new jobs
- Produce/launch 1 million PHEVs (Plug-in Hybrid Electric Vehicles)
- Achieve 25% renewable energy rate



Promising New Business Opportunities

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MHI possesses products and technologies that can respond to all of these demands. Applying its strengths in integration, it is adding speed to business expansion.

Contribute to creation of low-carbon social infrastructure

Nuclear power generation
- Nuclear power plants (APWR、ATMEA1)
- Fat breed reactor, nuclear fuel cycle

High-efficiency power generation
- GTCC Power Generation plant
- USC、A-USC
- IGCC + CCS
- High-efficiency gas engines
- Fuel cell + combined cycle
- CO_2 recovery system

Renewable Energy
- Wind turbines (onshore & offshore)
- Solar (photovoltaic & thermal) power generation
- Geothermal power generation
- Hydropower (including micro water wheel)
- Wave power, tidal power

Innovation in transportation system
- EV-related business
- ITS
- MRJ (Mitsubishi Regional Jet)
- Eco-ships
- LRT、HSST

Innovation in other infrastructures
- Seawater desalination
- Vegetable plants
- Alternative fuels (coal, bio)

Innovation in electricity infrastructure
- Smart grid
- Lithium-ion battery
- V2G (Vehicle to Grid)
- H2G (Home to Grid)

Energy-saving products
- Heat pumps
- Eco-houses
- Enhancement in Iron making efficiency

MHI's Energy & Environment Business Strategy

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Apply integration strengths to achieve business expansion

1. While putting strengths of existing businesses to good use, creation of next-generation businesses

GTCC, wind turbines, nuclear power, fertilizer plants, methanol plants, etc. → IGCC, CCS, solar (photovoltaic/heat), offshore wind turbines, EV related business, eco-houses, etc.

2. Expand business opportunities through comprehensive proposals of energy/environment-related products (policies)

Electricity provides in Iceland, Ukraine, Australia, United Kingdom, and others

3. Acceleration of global expansion (base network expansion, alliances)

Application of Comprehensive Capabilities through Integration of Product Operations

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Power Systems
(power generation technology)

Machinery & Steel Structures
(Chemical plants, CO_2 recovery technology, transportation system, etc.)

Nuclear Power
(Nuclear power generation technology)

Air-conditioning & Refrigeration
(Chillers, air-condtioners)

Shipbuilding
(shipbuilding, marine technology)

General Machinery & Special Vehicles
(Engines, turbochargers, forklift trucks)

IGCC+CCS
Lithium-ion batteries
Alternative fuel chains
Offshore wind turbines
Eco-friendly houses

Business Expansion through Integration

US/EU-APWR
Eco-friendly town

Sustainability Energy & Environment Strategic Planning Department

Nuclear power generation- use turbines
Hat pumps
Eco-friendly ships
Battery powered forklift trucks

MHI Group
Ryoju Estate, MHI Bridge & Steel Structures Engineering, MJK, and etc.

Examples of Integration Merits

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Development of new projects encompassing MHI product technologies

MHI technologies

Nuclear power


Power plant facility


EPC capability

IGCC+CCS


IGCC


CO_2 recovery

Offshore wind turbines


Wind turbines


Marine


Large-size cranes

Lithium-ion batteries


Batteries


Thin-film technology


Mass-production technology

EV-related business


Batteries

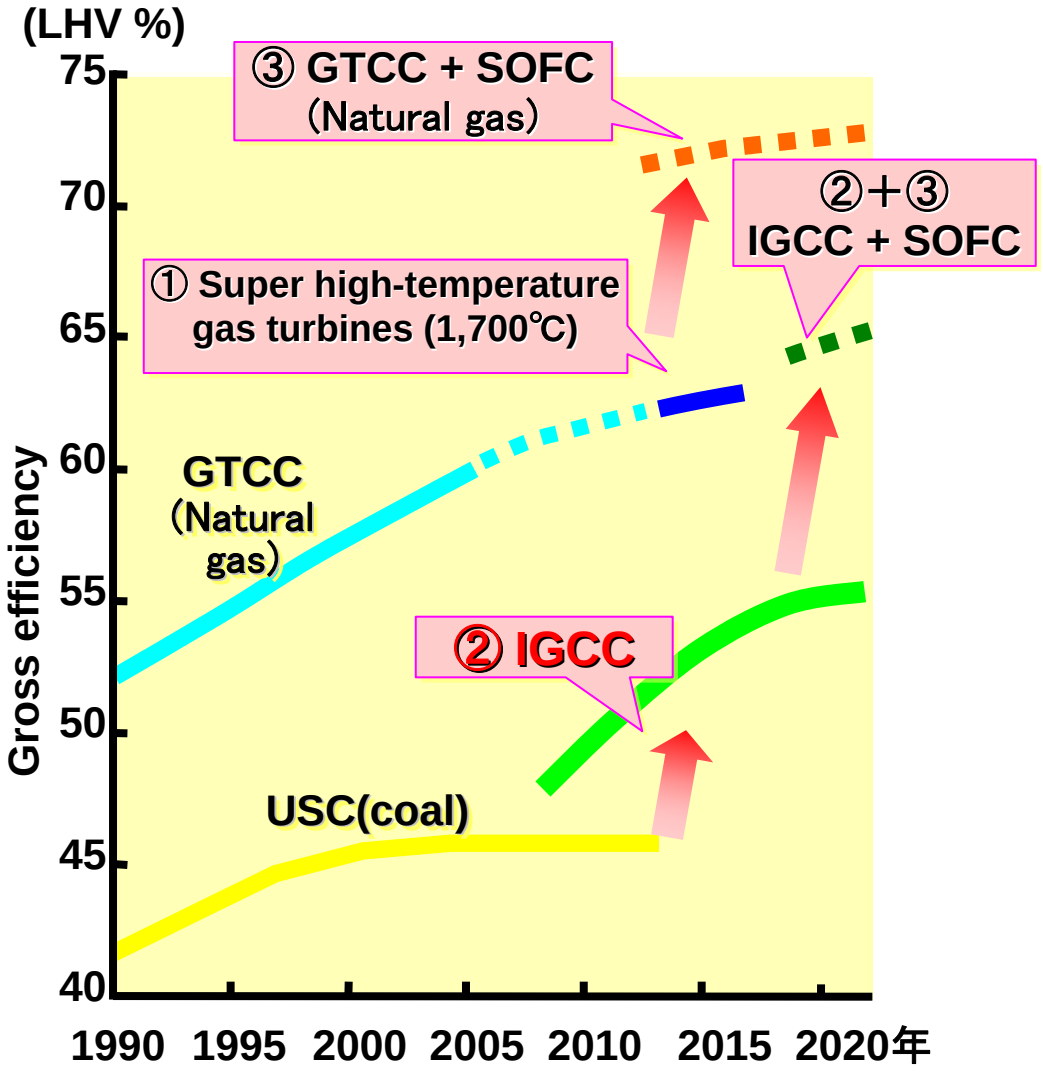

Motors


Air-conditioning

Integration Effcts

- **Full use of capacities in equipment manufacturing capacity and in-house EPC**
  - ＊EPC：Engineering, Procurement, Construction
- **Single responsibility in power generation technology and chemical process technology**
  - IGCC：Integrated coal Gasification Combined Cycle
  - CCS：Carbon Dioxide Capture and Storage
- **Wind turbine technology, marine technology, crane and bridge technology.**
- **Lithium-ion batteries, thin-film technology (paper printing), mass production technology (food machinery). One company possessing all technologies**
- **Technologies of energy, machinery and air-conditioning.**

Enhancement of Thermal Efficiency



Completion of J-series development
→Further enhancement of efficiency

① GTCC applying super high-temperature gas turbine (1,700 ℃ class)

② IGCC (Coal gasification)

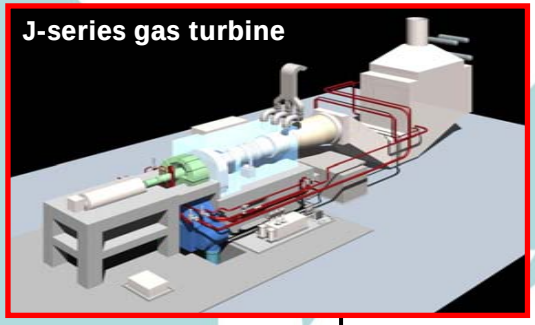
③ GTCC + SOFC (Hybrid cycle)

IGCC: Integrated coal Gasification Combined Cycle
SOFC: Solid Oxide Fuel Cell

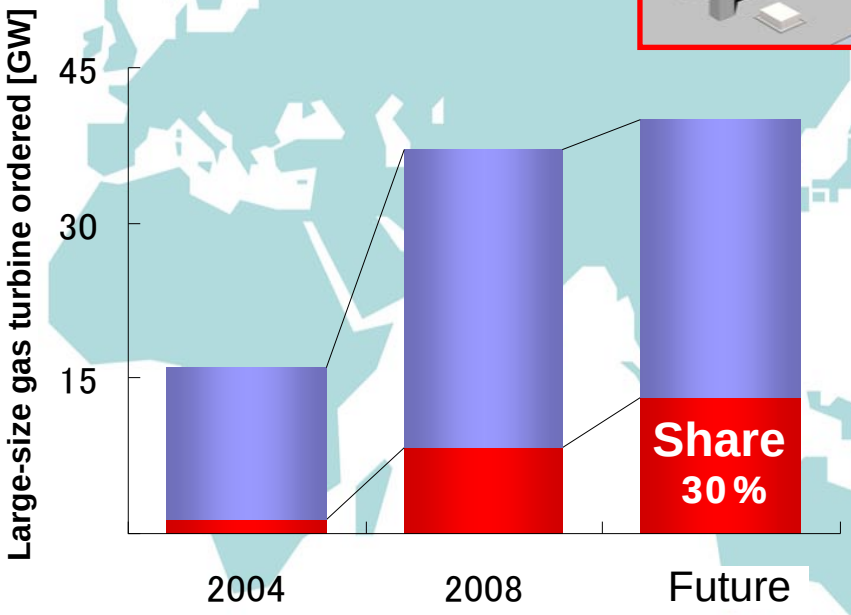
GTCC: Gas Turbine Combined Cycle
USC: Ultra Super Critical pressure Coal-fired plant

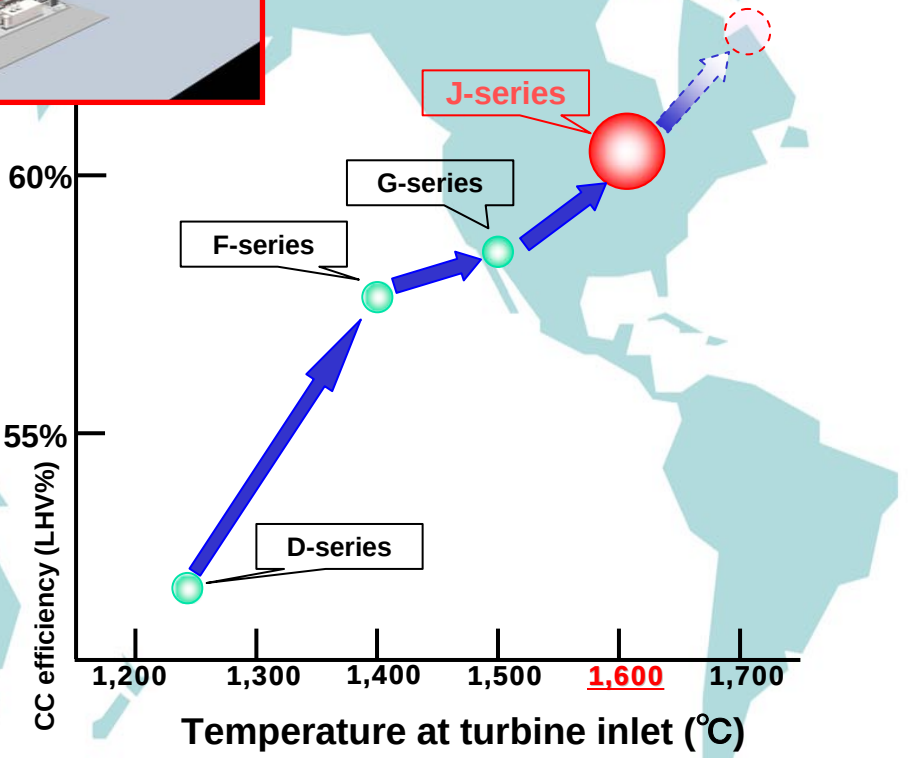
Global Expansion in Gas Turbine Business

- Development of J-series gas turbine completed
- Aiming for 30% market share through world's most advanced technologies and 50-unit/yr production system



CC efficiency：60%+
(World's highest level)





CCS（Carbon dioxide Capture & Storage）

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Fuel → **High-efficiency IGCC** → **CO_2 Separation/ recovery facility** → **CO_2 transportation (pipeline, etc.)** → **CO_2 Sequstration** Ocean sequestration & geological storage

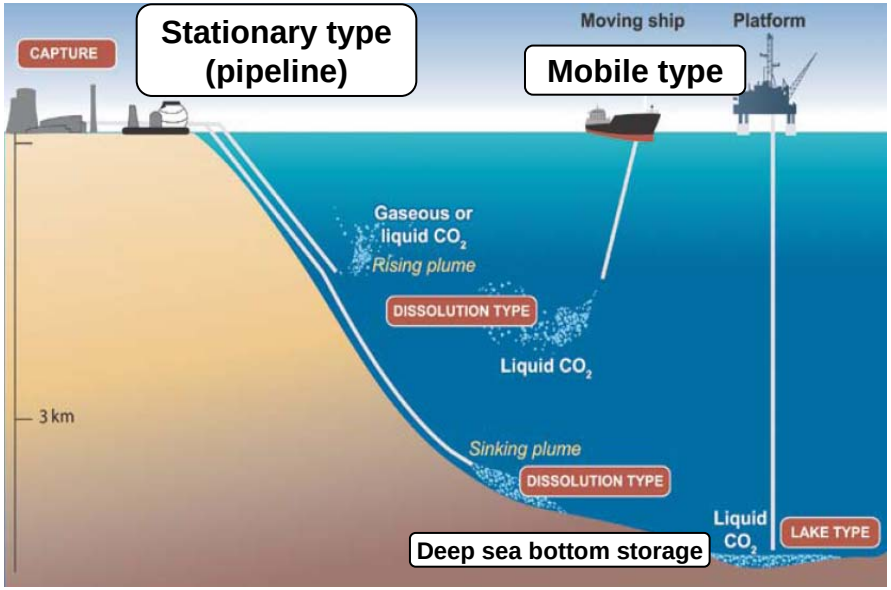
Achieved 2,000 hrs continuous operation at Nakoso

MHI's CO_2 recovery plant – enables CO2 recovery lower energy consumption

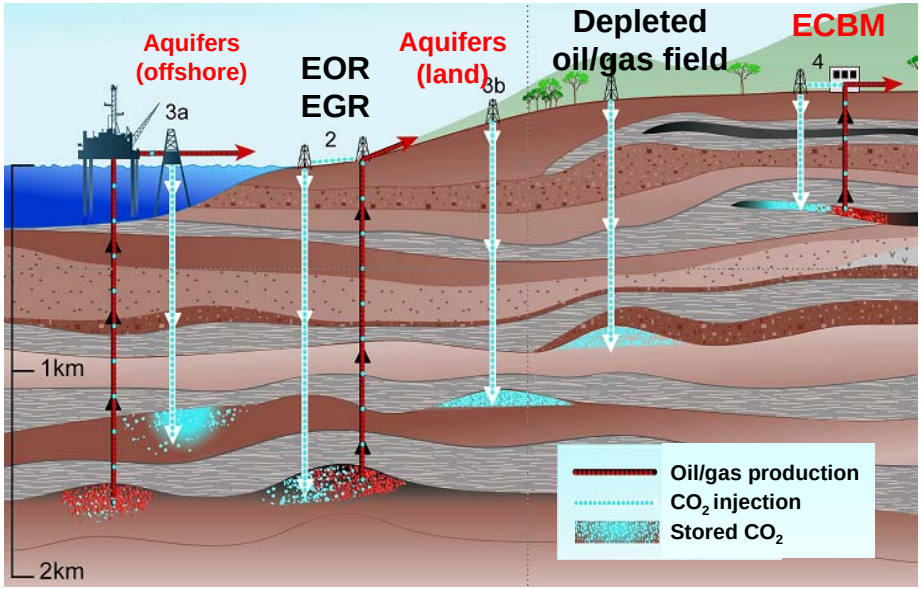
MHI's high-pressure CO_2 compressor delivered to CCS plant in Algeria

CO_2 storage methods

Ocean sequestration Under consideration



Geological storage In progress



source： Carbon dioxide Capture and Storage, IPCC Special Report 2005.09, http://arch.rivm.nl/env/int/ipcc/pages_media/SRCCS-final/IPCCSpecialReportonCarbondioxideCaptureandStorage.htm

IGCC＋CCS

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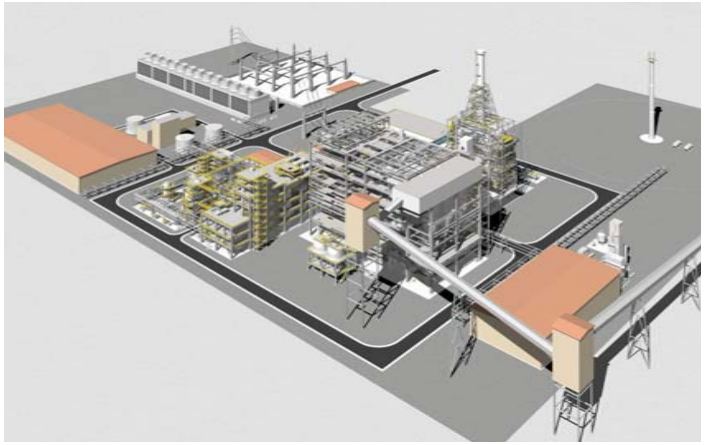
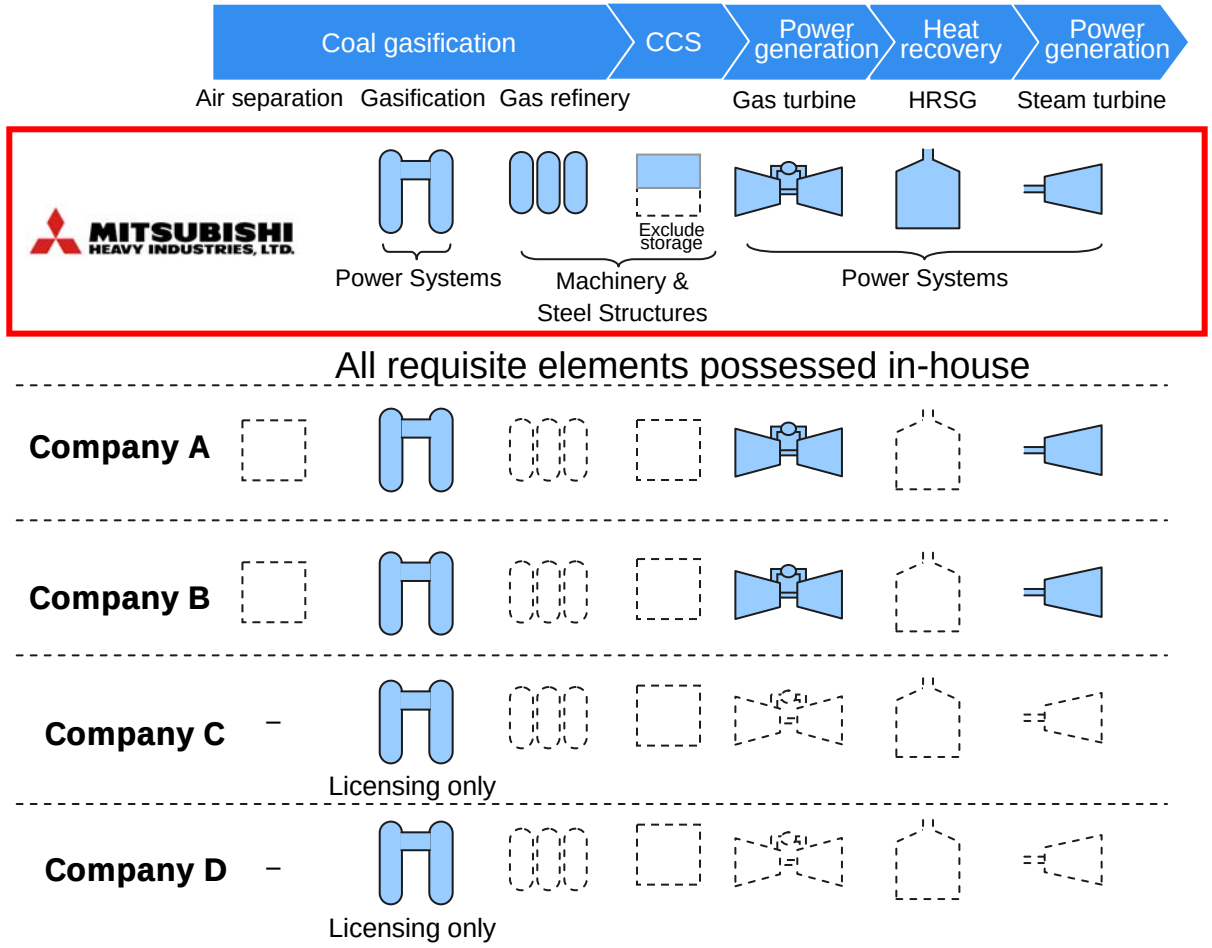
Acquisition of EPC plant engineering management capability globally, and promotion of integrated solutions business



Achieved 2,000 hour continuous operation at Nakoso



Integration of multiple segments under Sustainability Energy & Environment Strategic Planning Department

Globalization of Wind Turbine Business

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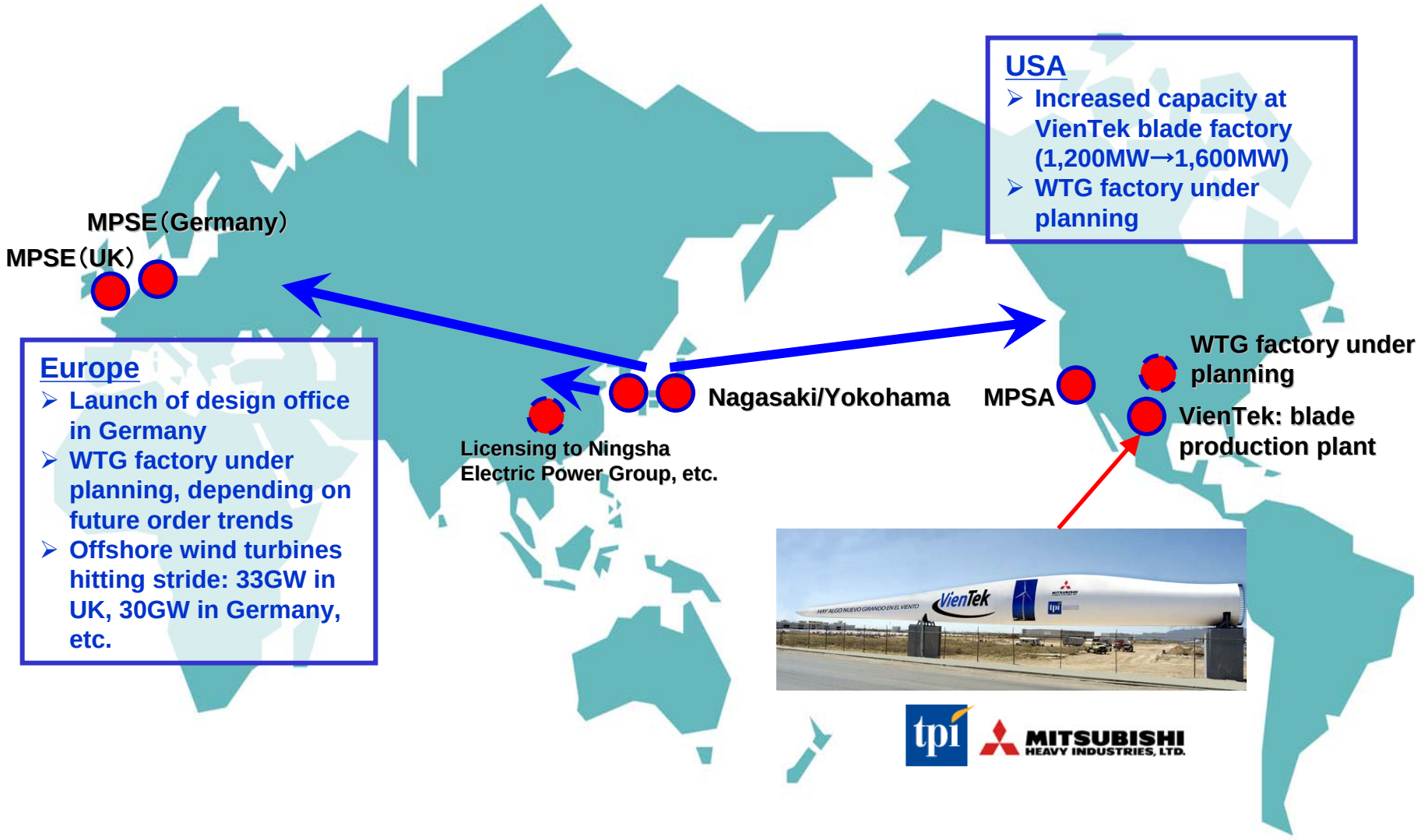
Promote globalization in order to respond to the rapidly expanding global market for wind turbines



USA
- Increased capacity at VienTek blade factory (1,200MW→1,600MW)
- WTG factory under planning

Europe
- Launch of design office in Germany
- WTG factory under planning, depending on future order trends
- Offshore wind turbines hitting stride: 33GW in UK, 30GW in Germany, etc.

Development of Nuclear Power Generation Technology (1)

■ US/EU-APWR

Large light water reactor with the world's largest output (1,700 MWe class)

US-APWR
1. Reactors chosen by Luminant in 2007 (2 units)
2. US DC/COL application docketed

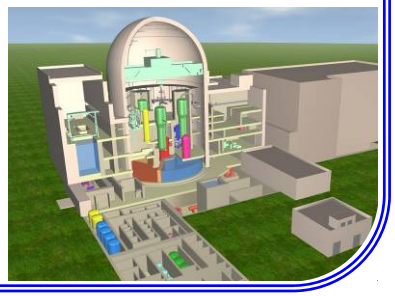
EU-APWR
1. Conformance certification application to European Utilities Requirements

DC: Design certification
COL: Combine license

■ ATMEA1

Globally compatible intermediate light water reactors (1,100 MWe class)

1. A joint venture established with AREVA in 2007
2. Combine the world's most advanced technologies of both companies.
3. Complete basic design and start sales promotion in 2009.



Full lineup

■ Domestic newly constructing plants

Domestic light water reactors

1. HEPCO Tomari No. 3 Reactor constructed (Latest 3rd generation reactor)

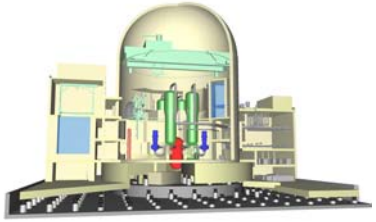
Domestic 24th PWR
Initial criticality in March this year expected to start operation in December

2. JAPCO Tsuruga No. 3 and No. 4 Reactors (Domestic largest class APWR)
Under safety review, expected to start operation in 2016 and 2017

■ Future reactors

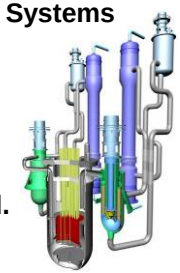
Next generation light water reactors

Participate in the national project.



Fast breeder reactors (FBR)

Mitsubishi FBR Systems established (2007)
Make Japanese technology adopted as a global standard.



Source: "JAEA-Research 2006-042", Fig. 2.1.1-4, p. 69 (2006)

Development of Nuclear Power Generation Technology (2)

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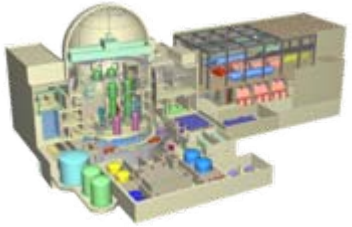
Effective use of existing nuclear plants, steady pace of new installations and expansions, achievement of nuclear fuel cycle

Domestic light water reactor plants

- After-sales services for existing plants
- Tomari No. 3 Reactor and Tsuruga No. 3 and No. 4 Reactors
- Next-generation new plants

Overseas light water reactor plants



- US/EU-APWR
- ATMEA1
- Overseas after-sales services

Nuclear fuel cycle

- Reprocessing plant

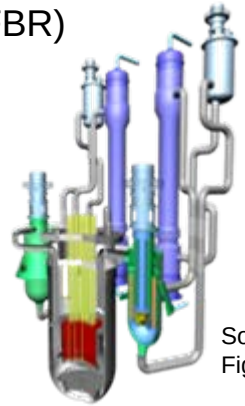
- MOX fuel plant

Fuel

Mitsubishi Nuclear Fuel CO., LTD.

Fast breeder reactor

(FBR)



Source: “JAEA-Research 2006-042”, Fig. 2.1.1-4, p. 69 (2006)

Development of Solar Thermal Gas Turbine

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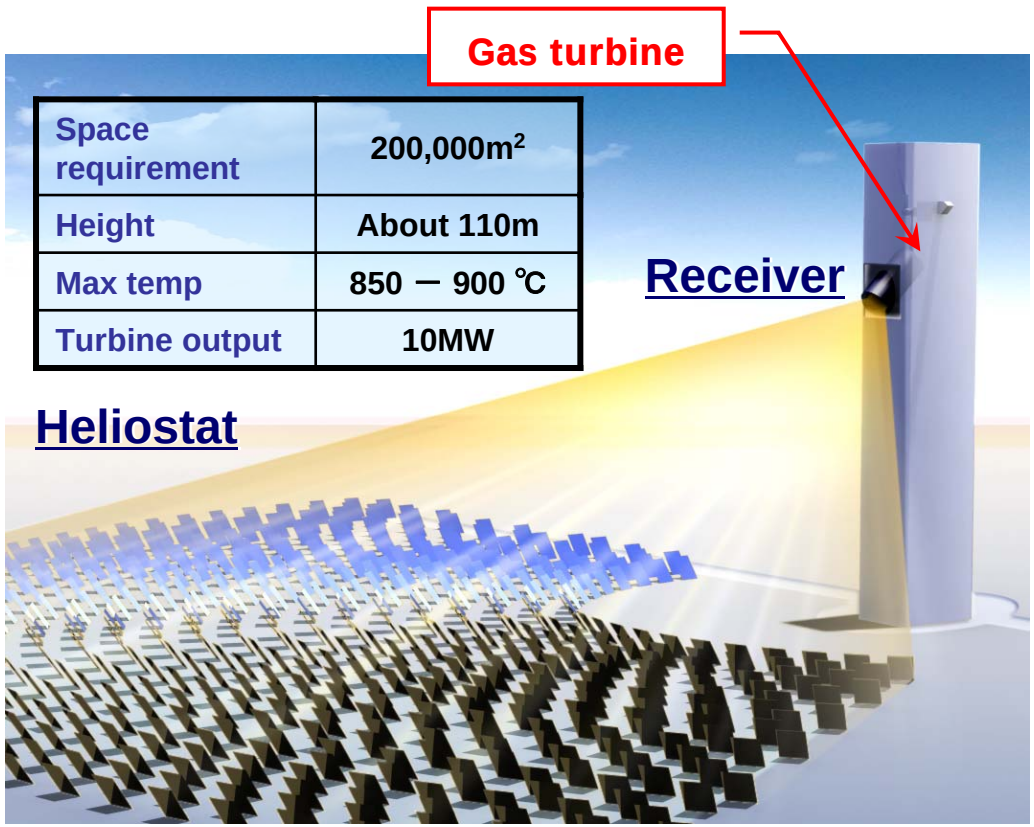
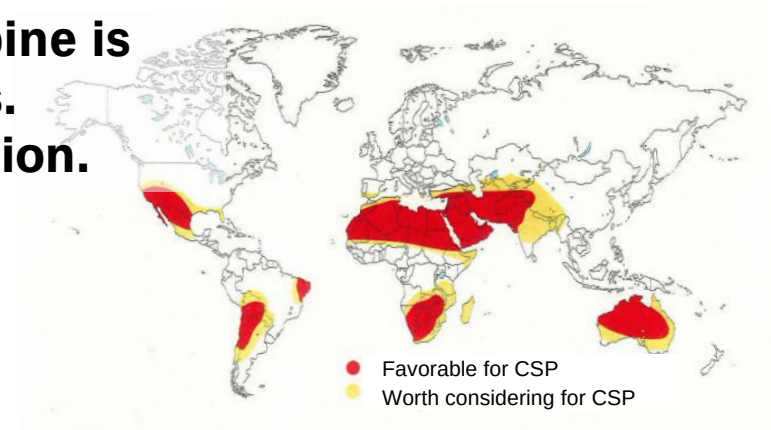
- **Power generated by solar thermal gas turbine is more efficient than with photovoltaic cells.**
- **No water is required during power generation.**

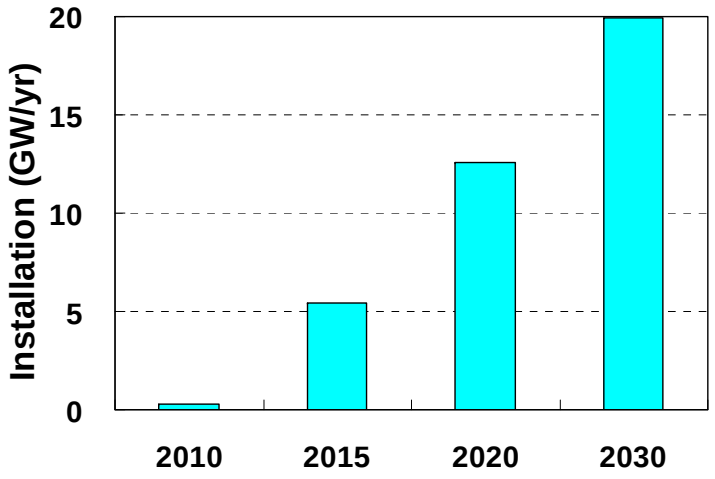


Space requirement	200,000m^2
Height	About 110m
Max temp	850 ー 900 ℃
Turbine output	10MW



Target market for solar thermal power gneration

Source: Pharabod and Philibert,1991.



Forecasts for annual demand for solar thermal power generation

Source: ESTIA and Greenpeace, Concentrating Solar Power Outlook 2009

Making comprehensive energy/environment policy proposals worldwide

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Proposals formulated to match each country's situation

Iceland

Proposal toward realization of zero-emission society

United Kingdom

Proposal for next-generation energy network

Ukraine

Energy infrastructure centered on coal-fired generation

Australia

Energy infrastructure centered on coal-fired generation

Solar thermal project making effective use of coal

Zero Emissions in Iceland

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Participating in Iceland's zero-emissions plan with DME synthesis targeting EVs and fishing vessels

Renewable Energy

Geotheramal/hydorpower

Energy conversion

Electricity

Recycling of CO_2 emissions into refined DME

Aluminum smelting

H2 production

Synthesized Fuel (DME)

Consumption

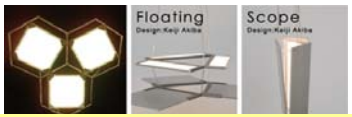
Electric Vehicles

Fishing vessels (/SUV)

Use of recycled CO_2 fuel means CO_2 emissions from fishing vessels are not counted

Use of DME in SUVs is also under consideration.

Fully controlled vegetable plant also to be proposed



Organic ELs, A/C equipment also used.

Energy Infrastructure Rebuilding Scheme, Future Business Scope

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Innovation in energy supply structure

Renewable energy expansion

Higher efficiency from thermal power plant

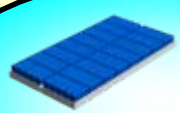
Coordination with existing power plant

Power grid stabilization equipment

Electric bus electricity storage by small-scale hydropower plant

Higher efficiency from nuclear power plant

Clean use of coal

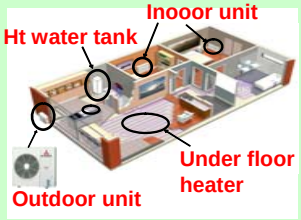


Electricity storage technologies

Smart grid concept

Innovation in energy consumption structure

"Eco Sky House" (Yokohama) home testing & verification
Heat pump hot water supply & A/C



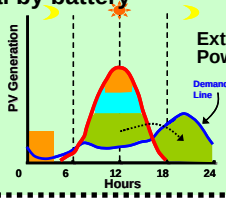
Electric bus

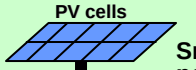
Parking

Battery station
(Inner-city emergency power source)

EV penetration testing

Photovoltaic power use time differential by battery





PV cells

Smart house as source of power generation

External Power

Smart power control

Heat pump hot-water supply system

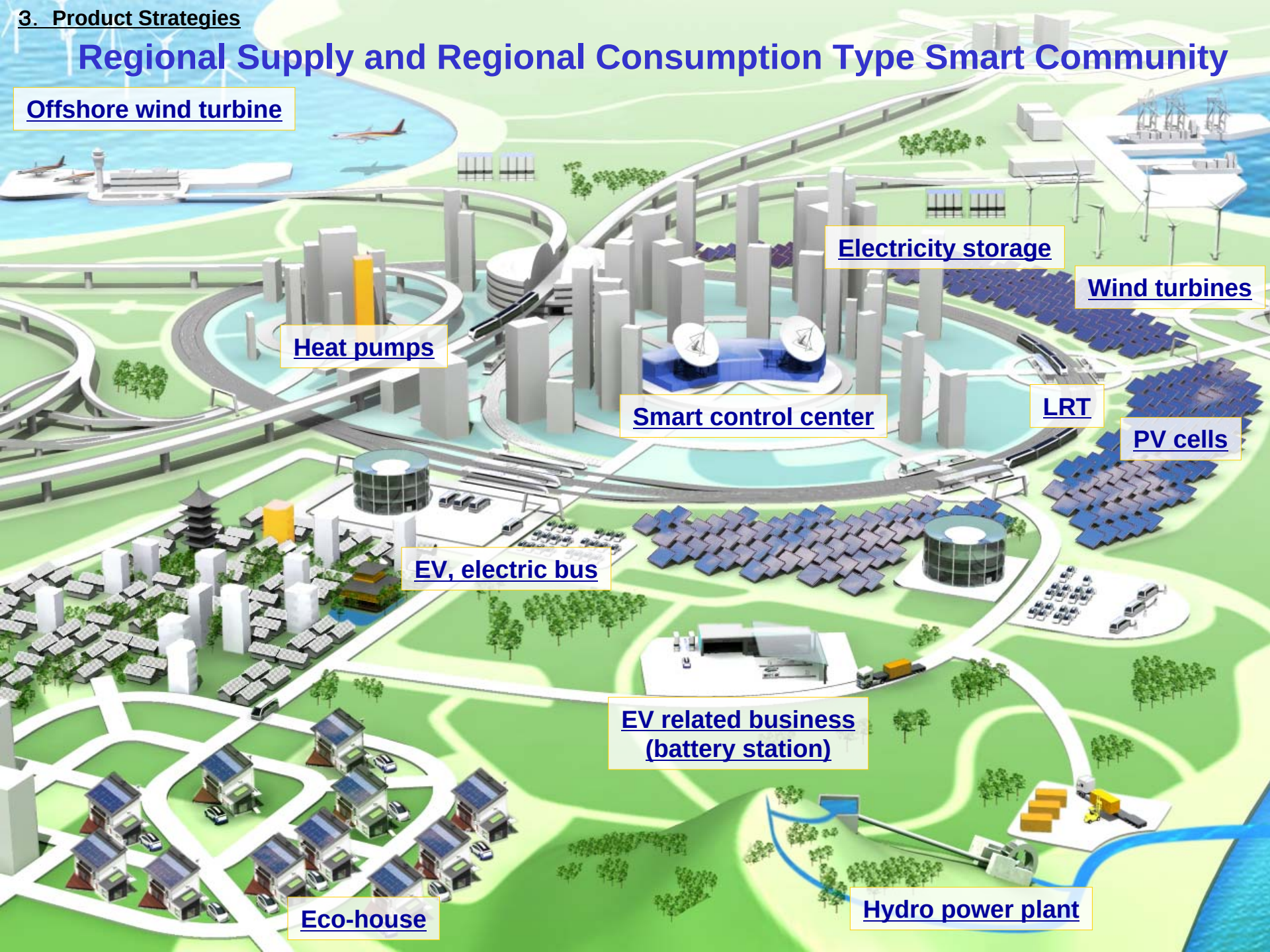
EV

Battery

Industrial vehicles

Review of urban transportation infrastructure

Regional Supply and Regional Consumption Type Smart Community



Benefits of Smart Communities

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By knowing the volume of mobile electricity storage of EVs, etc., affinity of grid and renewable energy is enhanced.

Gas stations serve as stations for charging/swapping EV and electric bus batteries, resulting in reforms in business formats, including employment opportunities.

Preservation and recycling

Comfort and convenience

Smart Community

Safety and security

Through use of renewable energy (wind, solar, hydro, etc.), harmonic co-existence with nature can be advanced.

Promoting electrification of urban transport enables use as an emergency power source.

Eco Sky House

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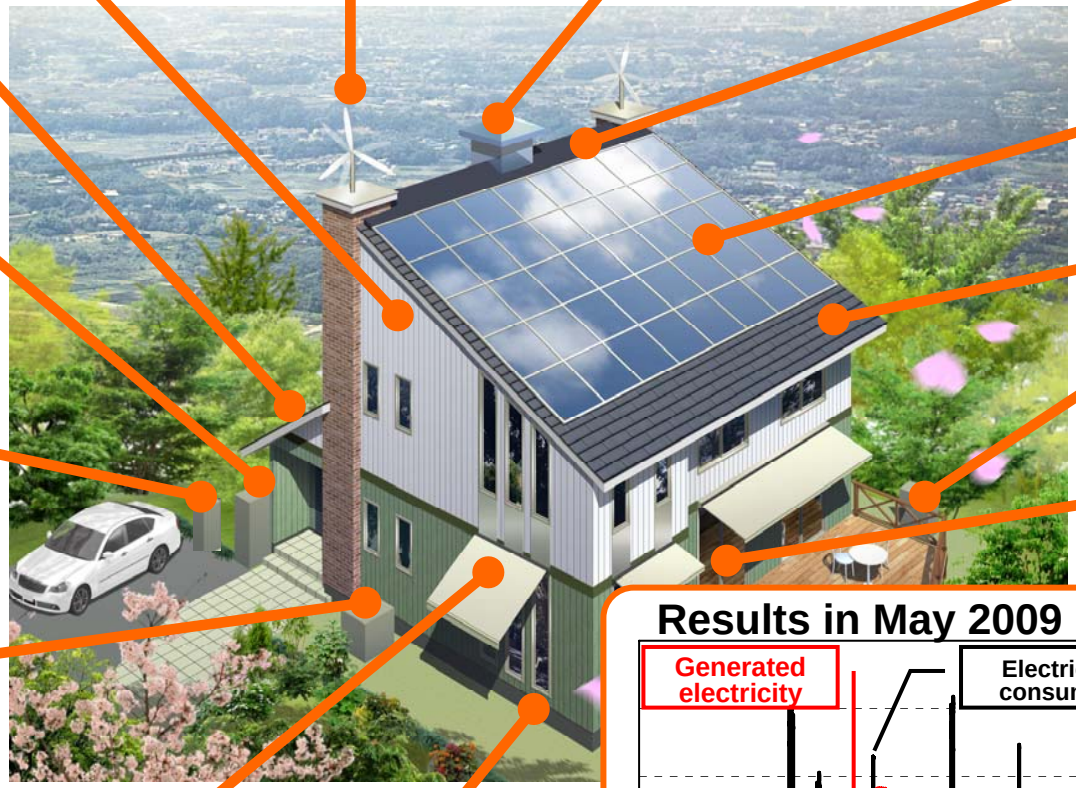
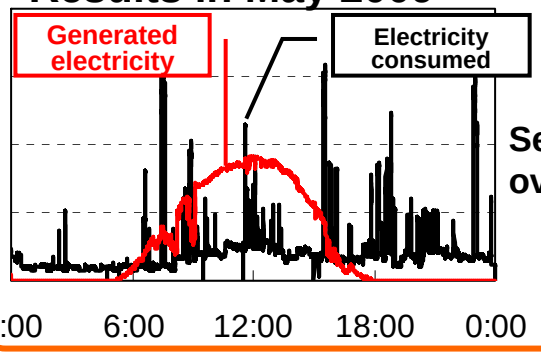
Energy conservation technologies come together to enable a major reduction in household energy consumption.

Key technology

- High thermal insulation
- Wind power generation system
- Solar ventilation (natural forced ventilation system using solar heat)
- New ventilation system
- Greening of roof/wall surfaces
- New tandem-type Photovoltaic cells
- Lithium-ion battery
- Hybrid system
- Heat-pump hot-water supply system
- V2H EV charger port
- Organic EL illumination
- Rainwater utilization system
- Exterior wall blind + water mister
- Underfloor thermal storage system



Results in May 2009



Self-sufficiency: over 100%

Investments in Major Businesses and Expansion into New Businesses

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	Item	Action, aim, etc.
Strengthening of existing businesses	➢ Gas turbines	Capex targeting launch of J-series and 50-unit/yr production system
	➢ Wind turbines (land)	Strengthening of production system at US factory and creation of jobs
	➢ Conventional thermal power plant	Establishment of JV and factory in India growth market
	➢ Nuclear power	Promotion of new plants, achievement of 2 plants/yr structure
	➢ Environment, chemical plants	Focus on fertilizer and methanol plants
	➢ Forklift trucks	Accelerated development of Chinese and emerging markets with start-up of factory in China
	➢ Turbocharger	Expansion of global production capacity with start-up of factory in Thailand
	➢ Centrifugal chillers	Enhancement of production capacity of Takasago Mahcinery Works
Response to new businesses	➢ IGCC（+CCS）	Realization of commercial plants, strengthening of gasifier production facilities
	➢ Nuclear fuel cycle	Reprocessing plants, MOX fuel plants, fast breeder reactors
	➢ Lithium-ion battery	Launch of initiative targeting mass production
	➢ Offshore wind turbines	Market expansion in Europe, etc. (max. 120GW by 2030)
	➢ CO_2 recovery system	Key components for achieving 50% cut in CO2 by 2050
	➢ Alternative fuels	DME synthesis by coal gasification, etc.
	➢ Eco-town, eco-house	Application of comprehensive capabilities to propose solutions to national governments, etc.
	➢ Hybrid forklift trucks	Lead the industry in energy saving and CO2 reductions through world's first commercialization

Growth Targets of Major Businesses

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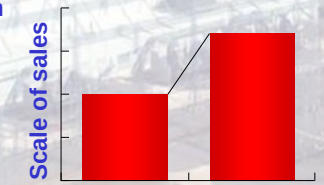
The Company is pursuing business expansion through capex and other strengthening measures.

Capex: capital expenditure

Gas turbine

- Acquisition of 30% market share through launch of J-series and 50-unit production system



IGCC

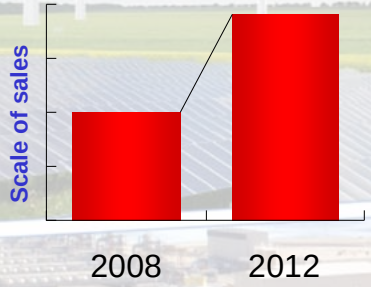
- Production System Expansion

Nuclear power

- Expansion of servicing, new plants and fuel cycle businesses, to achieve sales of JPY 600 billion after 10 yrs

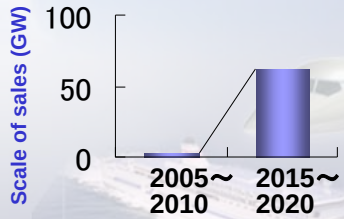
Wind power, solar and other renewable energy

- Wind power: response to sharp market expansion especially in US, Europe
- Solar: consider production increase (40MW/yr) while monitoring market trends

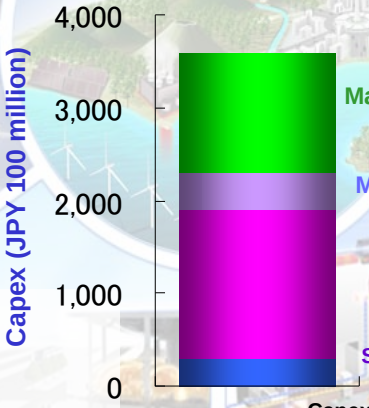


CO2 recovery system

- Business opportunity expansion through technologies responding to social demand to reduce CO2



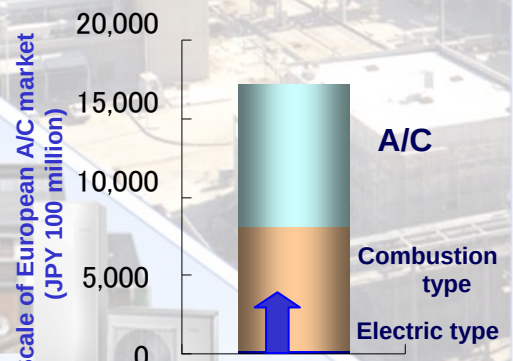
Capex in energy/environment since 2006



Capex: capital expenditure

Heat pumps

- Market for electric A/C with hot/cold-water supply systems expanding sharply, especially in Europe. Targeting development of that market.

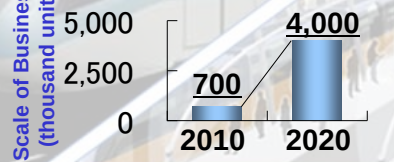


A/C: Air-Conditioners

EV-related business

- Considering entering EV-related business, a key component for shedding reliance on fossil fuels and promoting switch to electricity

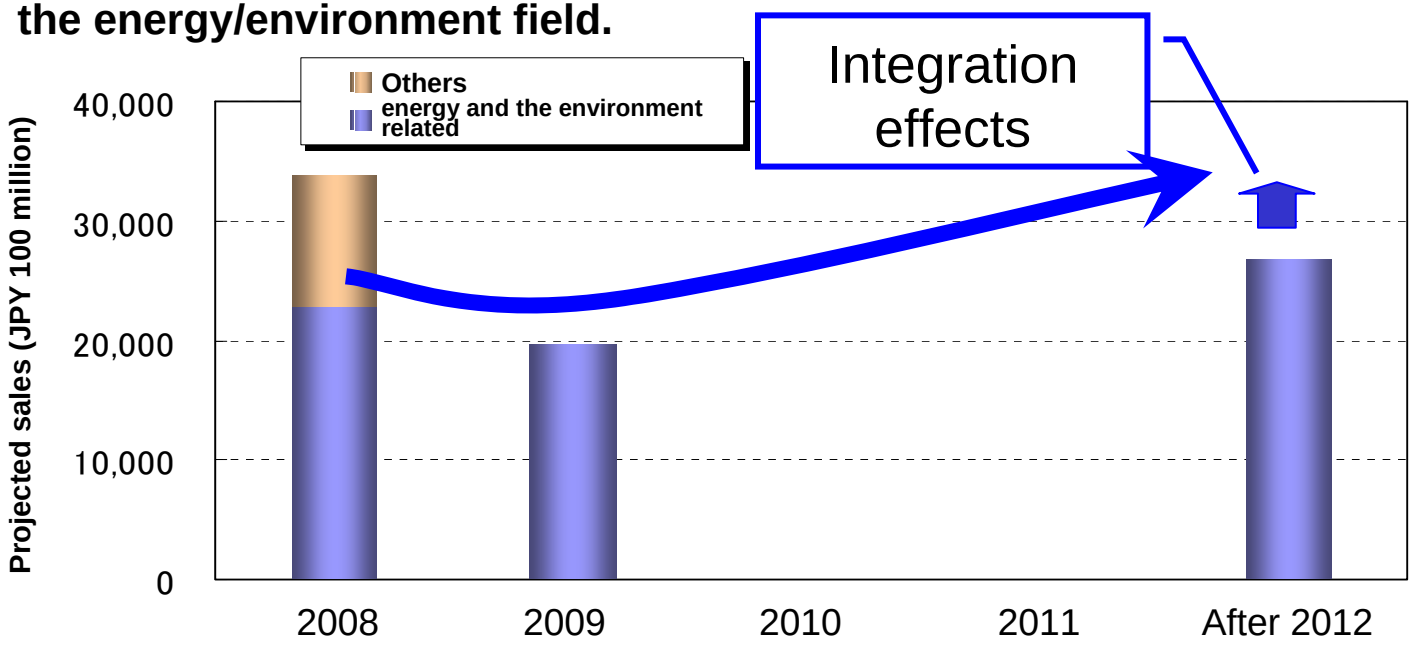
EV、HEV、PHEV



Lithium-ion battery

Road Map for Energy/Environment Business

Through merits and effects of integration, MHI is aiming for JPY 3 trillion in sales in the energy/environment field.



Examples of new projects by integration effects

- IGCC（+CCS） → After 2012
- Nuclear power (new construction, fuel cycle) → After 2012
- Lithium-ion battery → 2012～2015
- Offshore wind turbine → 2012～2015
- CO_2 recovery system → 2012～2015
- Alternative fuels → 2012～2015
- Eco-town, eco-house → ～2012
- Hybrid forklift trucks → 2009～

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