Document 5

Management Strategies of Integrated Energy Companies

January 31, 2018

Agency for Natural Resources and Energy

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Review of statements from previous sessions

2nd Session - Friday, September 29th, 2017

Dr. Paul Stevens (Distinguished Fellow, The Royal Institute for International Affairs, UK)

- The long-term demand for petroleum is overrated. The energy transition from hydrocarbon to electricity will accelerate. The reasons for the transition are climate change and technological innovation (cost reduction of renewable energy, EV).
- There is a high possibility that instability will increase in the Middle East based on the financial instability of the various Middle Eastern countries in the context of a decreasing global dependence on the region, in addition to the uncertainty caused by the Trump regime.

Mr. Adam Siminski (Chair for Energy and Geopolitics, Center for Strategic and International Studies, US)

- Emerging nations drive primary energy consumption worldwide.
- Demand for coal will remain unchanged (possibility of decline), there will be rapid growth in renewable energy and natural gas. Gradual increase in nuclear energy.
- Japan's low energy self-sufficiency and dependence on thermal power are severe issues from a national security viewpoint. Diversifying energy sources to increase diversity is critical.
- The U.S. greatly reduced CO2 emissions without ratifying the Kyoto Protocol. Its withdrawal from the Paris Agreement is not a major problem.

Review of statements from previous sessions

3rd session - Monday, November 13rd, 2017

Mr. Michael Shellenberger (CEO of Environmental Progress, U.S.)

- Increasing density is the megatrend of energy choices (Wood → Coal → Oil → Uranium)
- The social acceptability of nuclear power is critical. Social acceptability will increase through innovative technologies (accident resistant fuel, etc.).
- Unlike nuclear and hydro power, solar and wind power have weak correlation to CO2 emission intensity. (Introduction is not linked to CO2 reduction)
- Germany's dependence on coal continues, and achieving ▲40% by 2020 is likely to be difficult.

Jim Skea (Professor of Sustainable Energy, Imperial College London, UK)

- The UK realized a substantial reduction by shifting from coal-fired to gas, but achieving the reduction targets of the latter half of the 2020s (▲51% from 2023 - 2027) currently appears difficult. Innovation (hydrogen, CCS, etc.) is critical to achieve the goal.
- Rather than focusing on a single technology, it is important to promote "competition between technologies."
- The UK government is soliciting and supporting research program proposals for next-generation small modular reactors (SMRs) from the private sector as a national project.
- Germany is providing excessive support for renewable energy, and it must be made more effective.

*** Dr. Claudia Kemfert (Head of Energy, Transportation, and Environment, German Institute for Economic Research, Germany**

(Only materials provided, not attending on the day)

- Investment in low-energy, renewable energy, and EV is necessary for a major reduction in CO2 emissions.
- It is possible to realize a 100% renewable energy system.
- Energy efficiency that crosses sectors is necessary, such as using excess electricity for hydrogen conversion.

Review of statements from previous sessions

4th session – Friday, December 8th, 2017

Mr. Christopher D. Gould (Senior Vice President, Exelon Corporation)
Mr. Ralph L. Hunter, Jr. (Managing Director and Chief Operating Officer, Exelon Nuclear Partners)

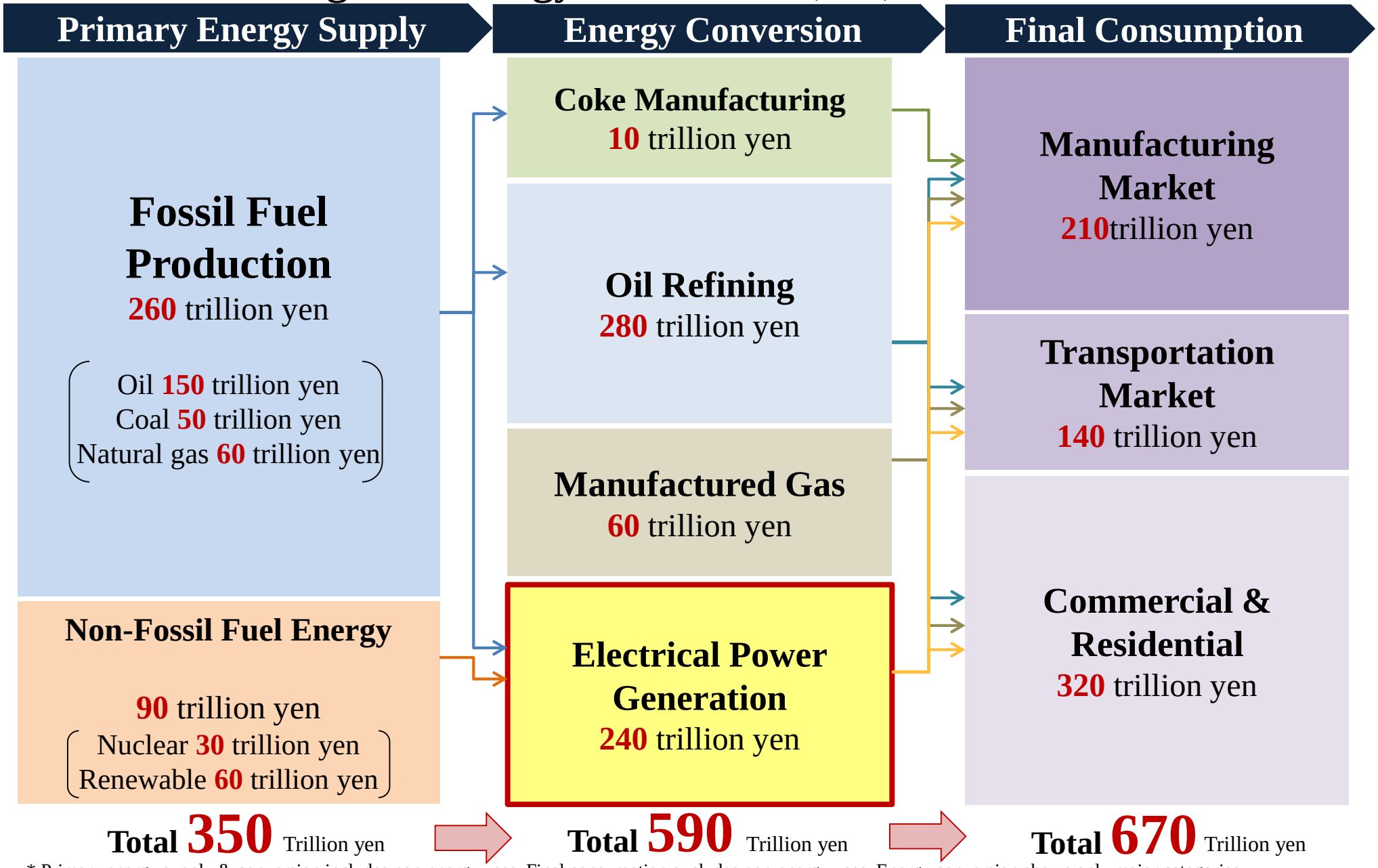
- High capacity factor knowhow for nuclear reactors (at least 90%) drives competitiveness.
- Growth funded by corporate value enhancement from raising capacity factor of nuclear reactors at acquired companies.
- Electricity is no longer a simple commodity as reliability, resilience, environmental capabilities, and other aspects provide value; market design that fairly assesses these values is important.
- Small Modular Reactor (SMR) might offer benefits in cost and safety.

Mr. Matthias Bausenwein (General Manager for Asia Pacific, Ørsted, Denmark)
Ms. Yichun Xu (Head of Market Development Asia Pacific, Ørsted, Denmark)

- Global leader in offshore wind power; integrated handling of development, construction, ownership, and operation.
- Increasing business focus by allocating proceeds from selling non-core businesses (hydropower, gas-fired thermal power, and onshore wind power) to the strategic business (offshore wind power) .
- Cost savings points for offshore wind power are economies of scale from larger wind turbines, equipment and system standardization in multiple projects, and global procurement from multiple companies.
- Requires commitment by the government to market cultivation over the medium term and clear rules for general sea areas; deployment of clusters in suitable areas fosters a supply chain for the area and contributes to further cost savings.

Current status of major companies

Estimation of the global energy market size (2015)



* Primary energy supply & conversion includes non-energy uses. Final consumption excludes non-energy uses. Energy conversion shows only major categories.
* Market size represents approximate figures of energy balance multiplied by assumed unit price.
(ex. Electricity generation: 10 yen/kWh, Electricity for industry: 15 yen/kWh)

Source: IEA World Energy Balance etc.

Overview and power source composition of major enterprises (as a group)

	Europe / North America					Japan	
	Engie (France)	EDF (France)	Enel (Italy)	Ørsted (Denmark)	Exelon (U.S.)	Tokyo Electric Power Co.	Kyushu Electric Power
Sales (Units: trillion yen)	9.4	10.1	10.2	1.5	3.6	6.1	1.8
Ratio of overseas	64%	47%	48%	75%	NA	2%	NA
Power generation mix: Renew-able	19% (Hydro:15%)	6% (Hydro:6%)	31% (Hydro:23%)	45% (Wind:45%)	3% (NA)	5% (Hydro:5%)	10% (Hydro:8%)
Power generation mix: Nuclear	6%	81%	14%	0%	89%	0%	14%
Power generation mix: Thermal	75% (Gas:58%)	12% (NA)	55% (Coal:30%)	55% (Coal:36%)	8% (NA)	95% (Gas:72%)	76% (Coal:42%)

* Values are in 2015, including international group companies.
* Ratio of coal for Ørsted is estimated from the fossil fuel mix including heat
* Breakdown of thermal power for Japanese companies are estimated from "Electric Supply Plan 2016"

Source: SPEEDA, Annual report etc.

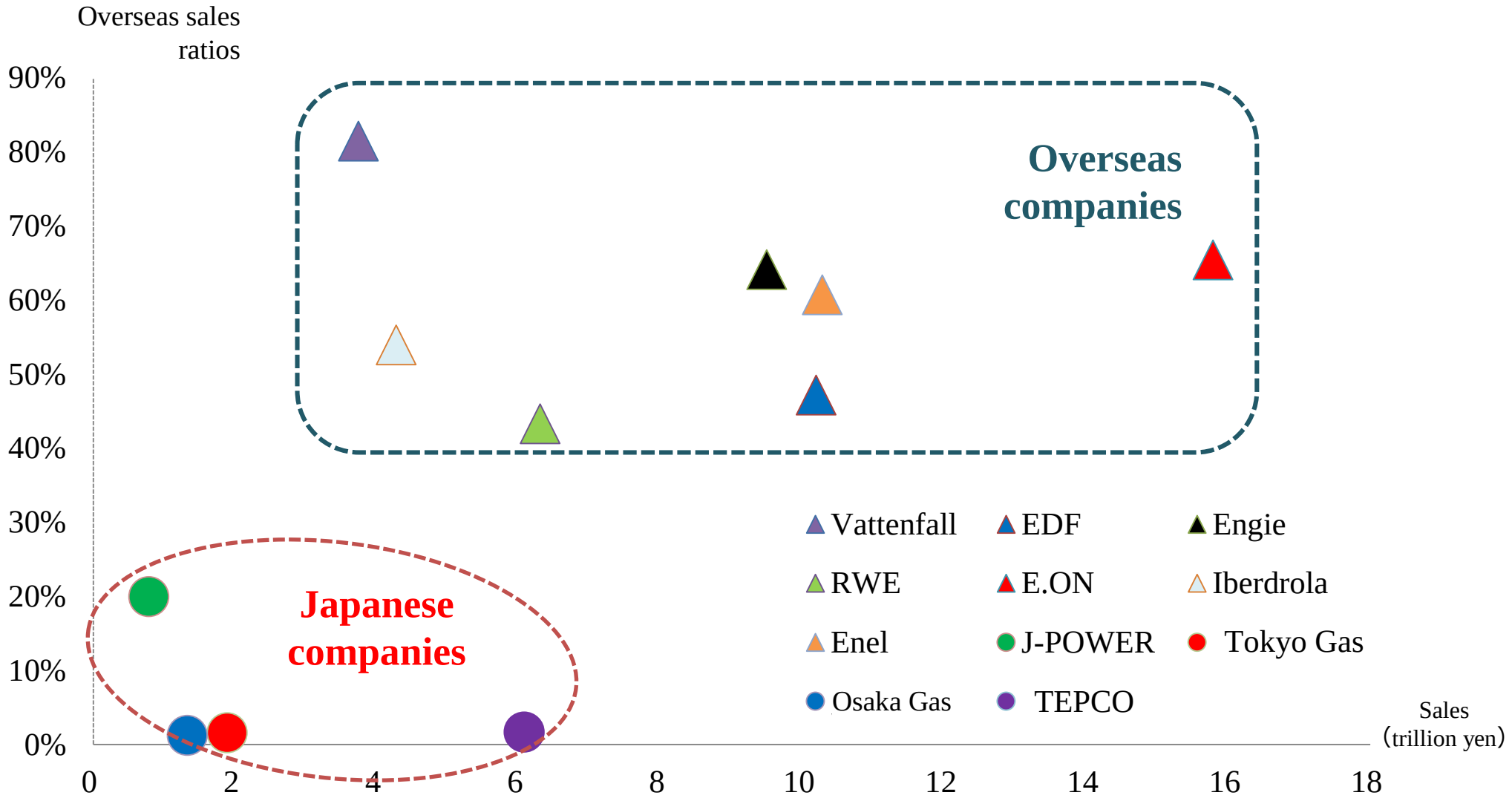
Overview of major oil companies

	Overseas					Japan
	ExxonMobil (US)	Shell (UK, Netherlands)	BP (UK)	Saudi Aramco (Saudi Arabia)	Iran National Oil (Iran)	INPEX
	US and European oil majors			Middle East national oil companies		Upstream
Oil/gas prodction volume	**4.1**mn BD	**3.3**mn BD	**3.2**mn BD	**14**mn BD	**7.8**mn BD	**0.5**mn BD
Sales (Upstream vs. middle/downstream)	**25**trn yen (3：22)	**25**trn yen (3：22)	**20**trn yen (2：18)	**97**trn yen	**28**trn yen	**0.9**trn yen
Corporate strategies						
Oil/Gas development	Balanced approach	Shift to gas		Domestic only, key revenue source		Increasing investment
	Gas ratio of overall production volume			Oil and gas income ratio of national revenue		
	49% →42% (2012→2017)	47% →49% (2012→2017)	37% →60% (2017→2025)	72% (2015)	37% (2015)	1mn BD target (first half of the 2020s)
	※Only BP has set clear future goals					
Oil refinery/ sales	Global supply chain development			Export growth		
	Percentage of crude-oil processing capacity by region			Export ratio of oil product	Separately established a national company	2% of total investment value
	N. America: 44% Europe: 33% Asia：18% Middle East: 4%	N. America: 40% Europe: 31% Asia: 26% Africa: 3%	N. America: 40% Europe: 46% Asia: 9% Africa: 5%	25% →45% (2011→2016)		Pipeline LNG terminal (domestic) only
New fields (Ex.)	From Jan. 2016 Biofuel R&D	Oct. 2017 Acquired an EV charging services company	Dec. 2017 Entering solar power business	Dec. 2017 Possible US LNG initiative?	—	2015 Indonesia geothermal development

※ 2016 values; Iran's oil and gas revenue from 2015

Source: Energy Intelligence, SPEEDA, and corporate annual reports

(Reference) Energy company sales and overseas sales ratios (2015)

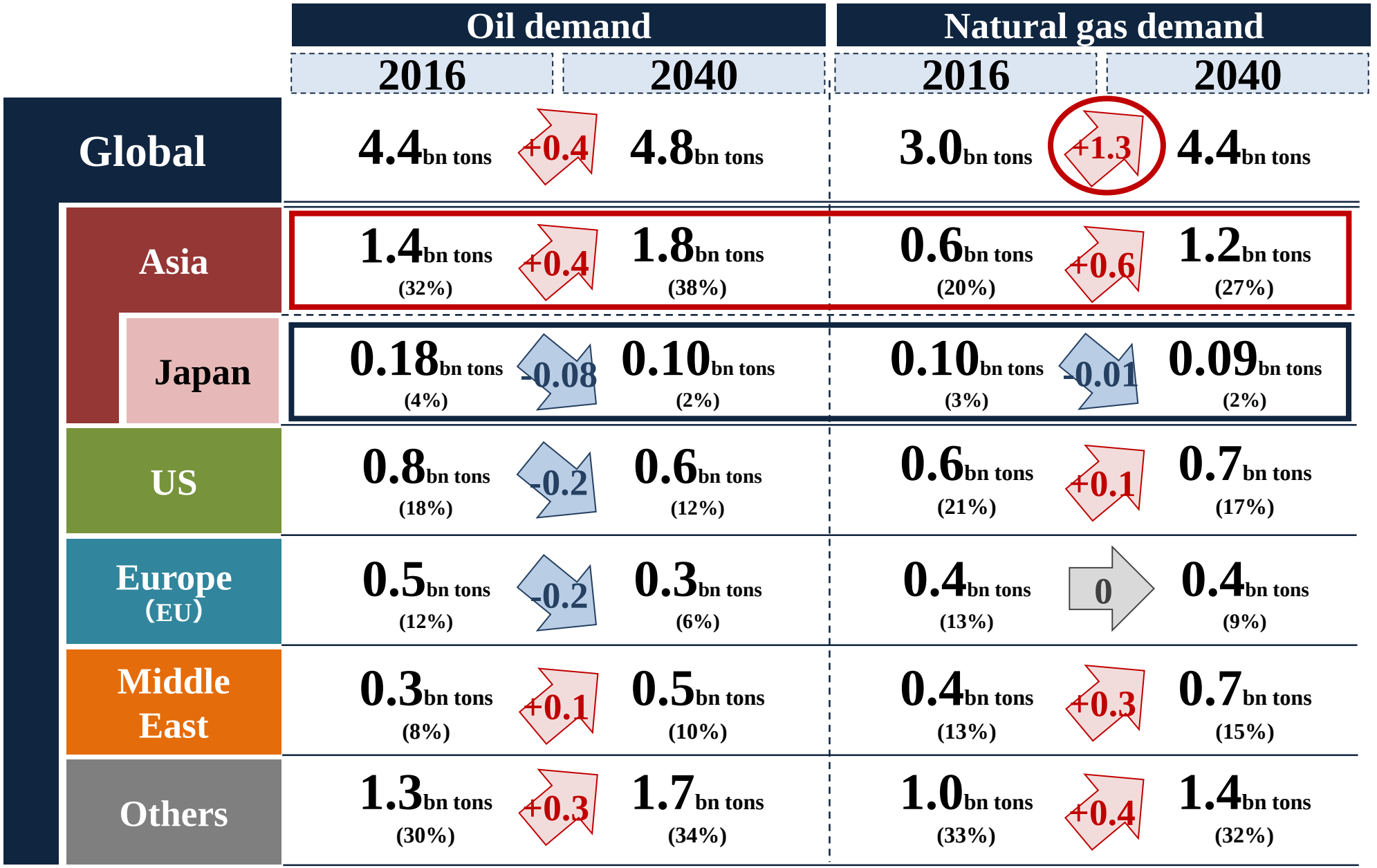


※State Grid Corporation of China is the world's largest over 30 trillion yen (overseas ratio not disclosed)

Source: Prepared from company annual reports and other materials

Energy resources market trends

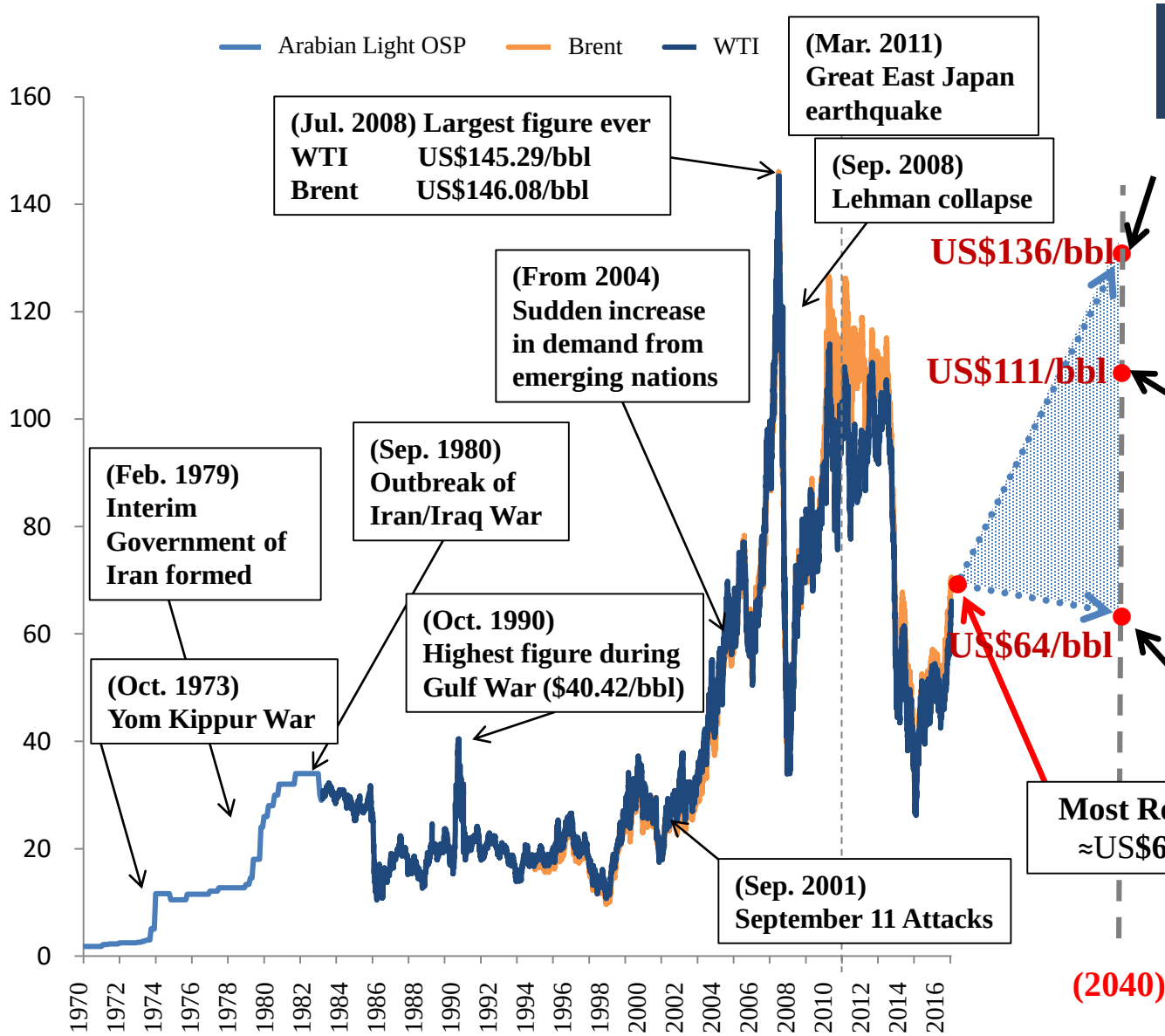
Approach to the growing Asian market is a key factor in corporate strategies



※Totals might not match due to rounding
※% in parentheses are shares of global demand; unit is tons of oil equivalent

Source: Based on World Energy Outlook 2017 materials
（2040 shows New Policies Scenario values）

The oil price continues to change, and most recently is at US$65/bbl.



Oil Demand (2040)	EV & PHV (2040)
5.5 billion tons (Transported: 3.4 billion)	70 million units (approx. 3% in total)
Decreasing 0.7 billion tons in total, Of which 0.5 billion tons in Transportation (approx. 70%)	
4.8 billion tons (Transported: 2.9 billion)	280 million units (approx. 14% in total)
Decreasing 1.5 billion tons in total, Of which 1.2 billion tons in Transportation (approx. 80%)	
3.3 billion tons (Transported: 1.7 billion)	870 million units (approx. 44% in total)

* Scenarios in WEO2016
$136/bbl: Current Policies Scenario
$111/bbl: New Policies Scenario
$64/bbl: Sustainable Development Scenario

*In 1983 both the WTI futures (NYMEX) and blend futures (IPE, currently ICE) were listed.
*Price was per-barrel, demand was crude oil equivalent
*Unit of EV & PHV is an example of factors of oil demand decrease

Source: WEO2017

National Efforts towards EV Expansion

	Main Targets and Statements	Stocks of automobiles In 2015	Quantitative Targets for EVs and PHVs			
			2016	2020	2030	2040
Japan	**Aim at 20~30% share for EVs and PHVs by 2030** (Ministry of Economy, Trade and Industry)	**80 million**	**150,000 (cumulative)**	**1 million (cumulative)**	**20~30% (new car sales)**	
United Kingdom	**End Gasoline and Diesel Car Sales by 2040*1** (Department for Transport and Department for Environment, Food and Rural Affairs	**40 million**	**90,000 (cumulative)**	**1.5 million (cumulative)**		**End of gasoline and diesel car sales**
France	**End GHG-emitting Car Sales by 2040※1** (Nicolas Hulot, Ecology Minister)	**40 million**	**80,000 (cumulative)**	**2 million (cumulative)**		**End of gasoline and diesel car sales**
Germany	**Diesel and Gasoline Cars do not exist on the German Government's Agenda** (government spokesperson)	**50 million**	**70,000 (cumulative)**	**1 million (cumulative)**	**6 million (cumulative)**	
China	**A Portion of Production*2 must be EVs, FCVs, and PHVs from 2019** (Ministry of Industry and Information Technology)	**160 million**	**650,000 (cumulative)**	**5 million (cumulative)**	**80 million (cumulative)**	
United States (California)	**A Portion of Sales*3 must be ZEVs*4 (HVs will not be eligible from 2018)** (California)	**25 million**	**560,000 (cumulative)**	**1.5 million (cumulative)** ※target for 2025		

※1 End of PHV and HV sales has not been mentioned. ※2 2019 10%,2020 12% ※3 2020 6% (only for EV&FCV) ※4 Zero Emission Vehicles(EV・FCV・PHV)

Electricity market trends

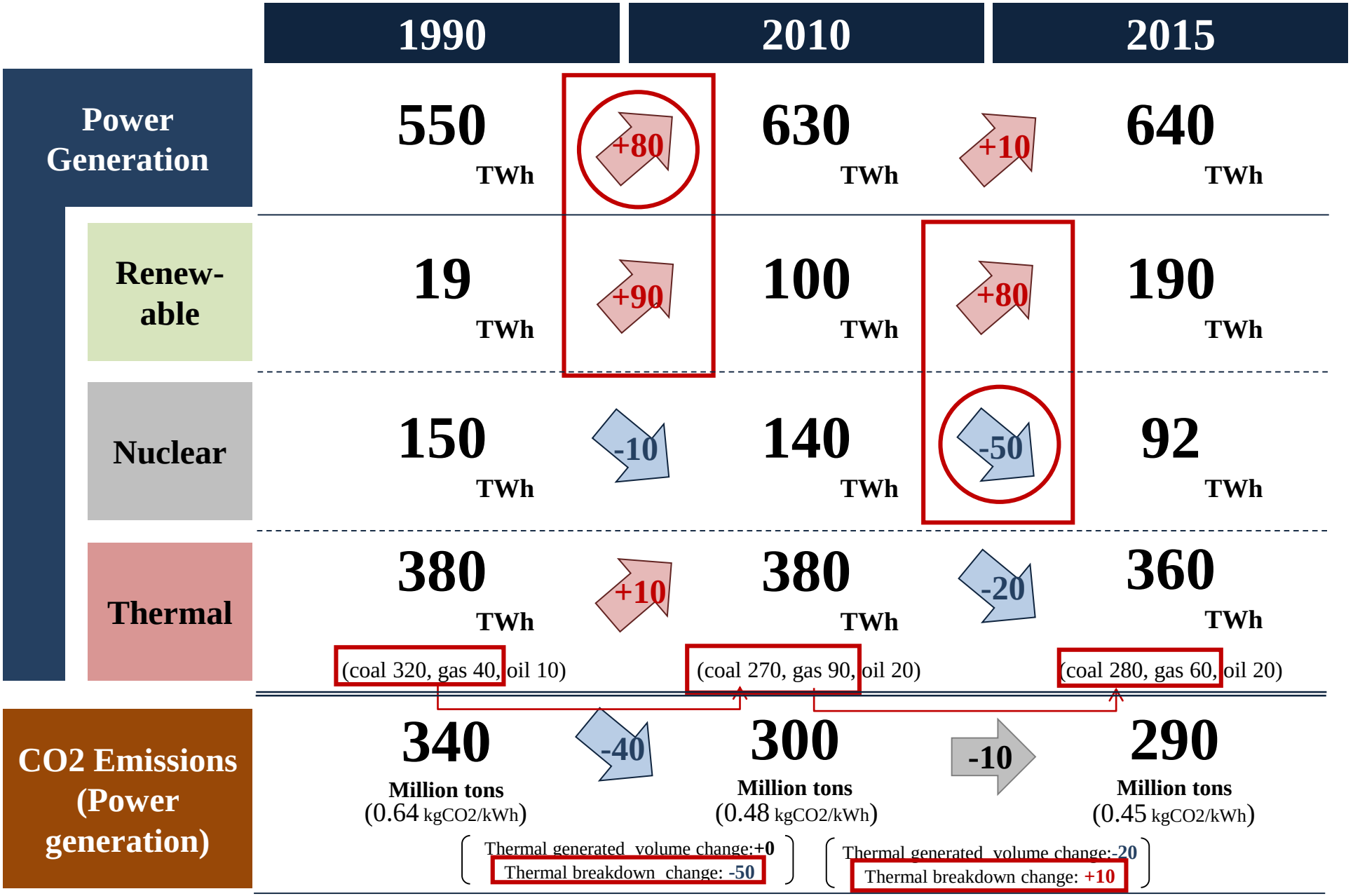
The electrical power market is expanding, flexibility on fossil power is required

	2016	2040 (IEA outlook)			
		NDC target level *1		Paris Agreement target level *2	
		Power generation	Market scale change *3	Power generation	Market scale change *3
Electric power generation (Global)	**24,000** TWh	**39,000** TWh	**+150** Trillion yen	**36,000** TWh	**+120** Trillion yen
Renewable energy	**6,000** TWh	**16,000** TWh	**+100** Trillion yen	**23,000** TWh	**+170** Trillion yen
PV Wind	**1,300** TWh (PV: 300 Wind: 1000)	**7,400** TWh (PV: 3200 Wind: 4300)	**+61** Trillion yen	**12,200** TWh (PV: 5300 Wind: 7000)	**+121** Trillion yen
Nuclear power	**3,000** TWh	**4,000** TWh	**+10** Trillion yen	**5,000** TWh	**+20** Trillion yen
Thermal power	**16,000** TWh	**20,000** TWh	**+40** Trillion yen	**8,000** TWh	**-80** Trillion yen

*1 New Policies Scenario *2 Sustainable Development Scenario
*3 Market size transition from 2016 -> 2040 (Market size estimated with an assumption of 10 yen / kWh)

Source: IEA WEO2017

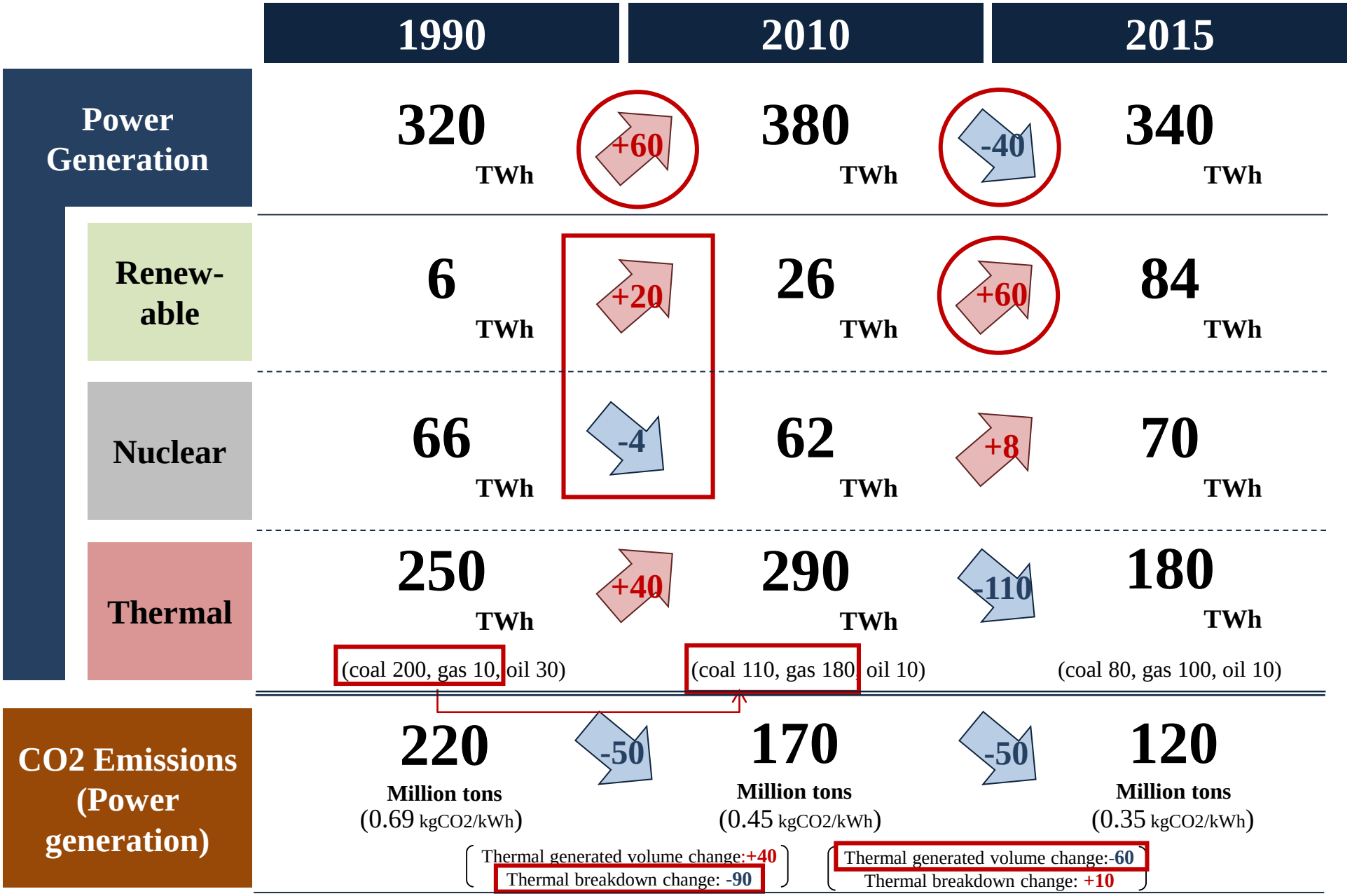
Transition of Germany's CO2 emissions from power generation



*Numbers are rounded. Totals may not match due to rounding errors.

Source: Produced from IEA Energy Balances, CO2 Emissions from Fuel Combustion

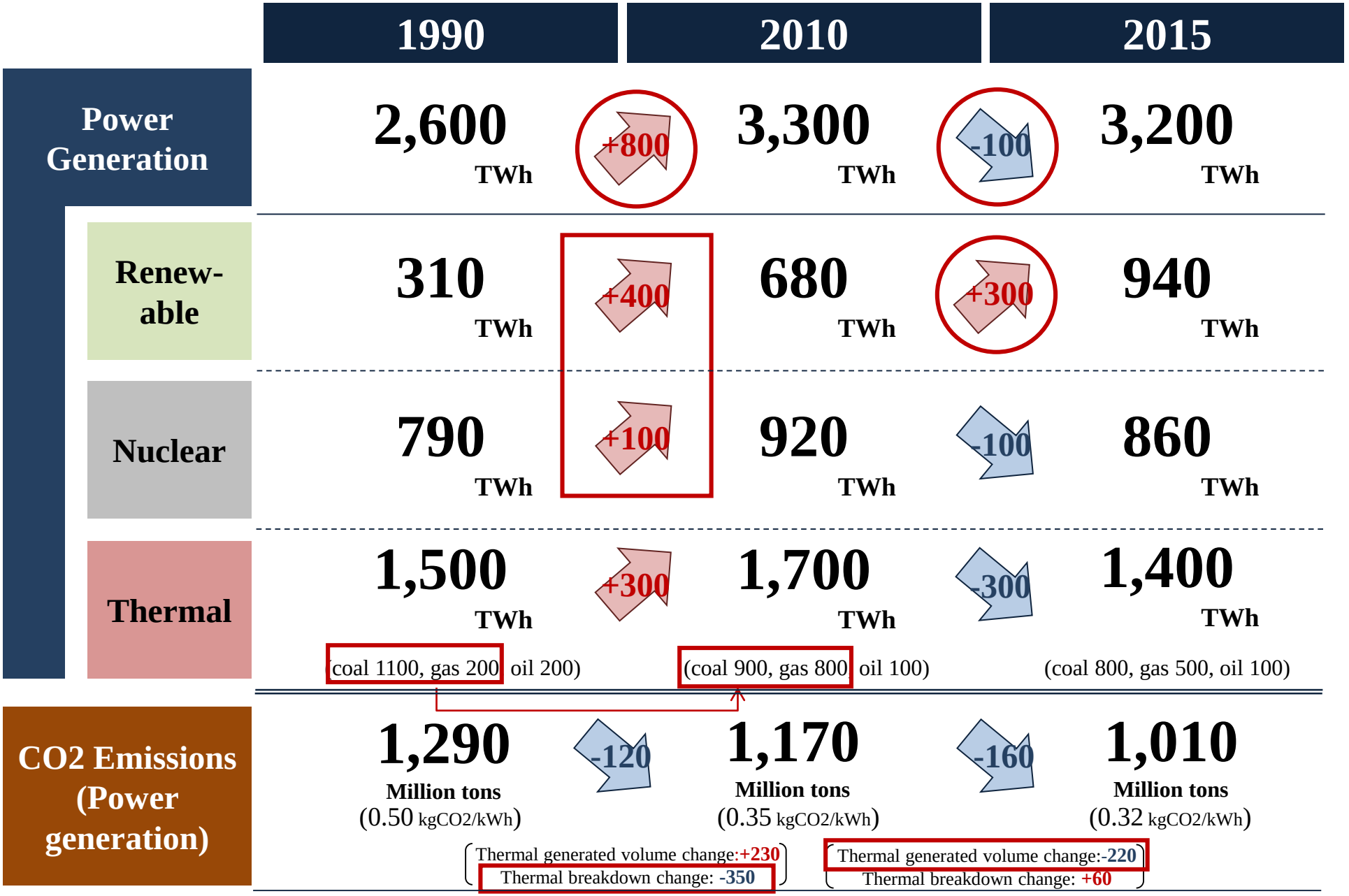
Transition of the UK's CO2 emissions from power generation



*Numbers are rounded. Totals may not match due to rounding errors.

Source: Produced from IEA Energy Balances, CO2 Emissions from Fuel Combustion

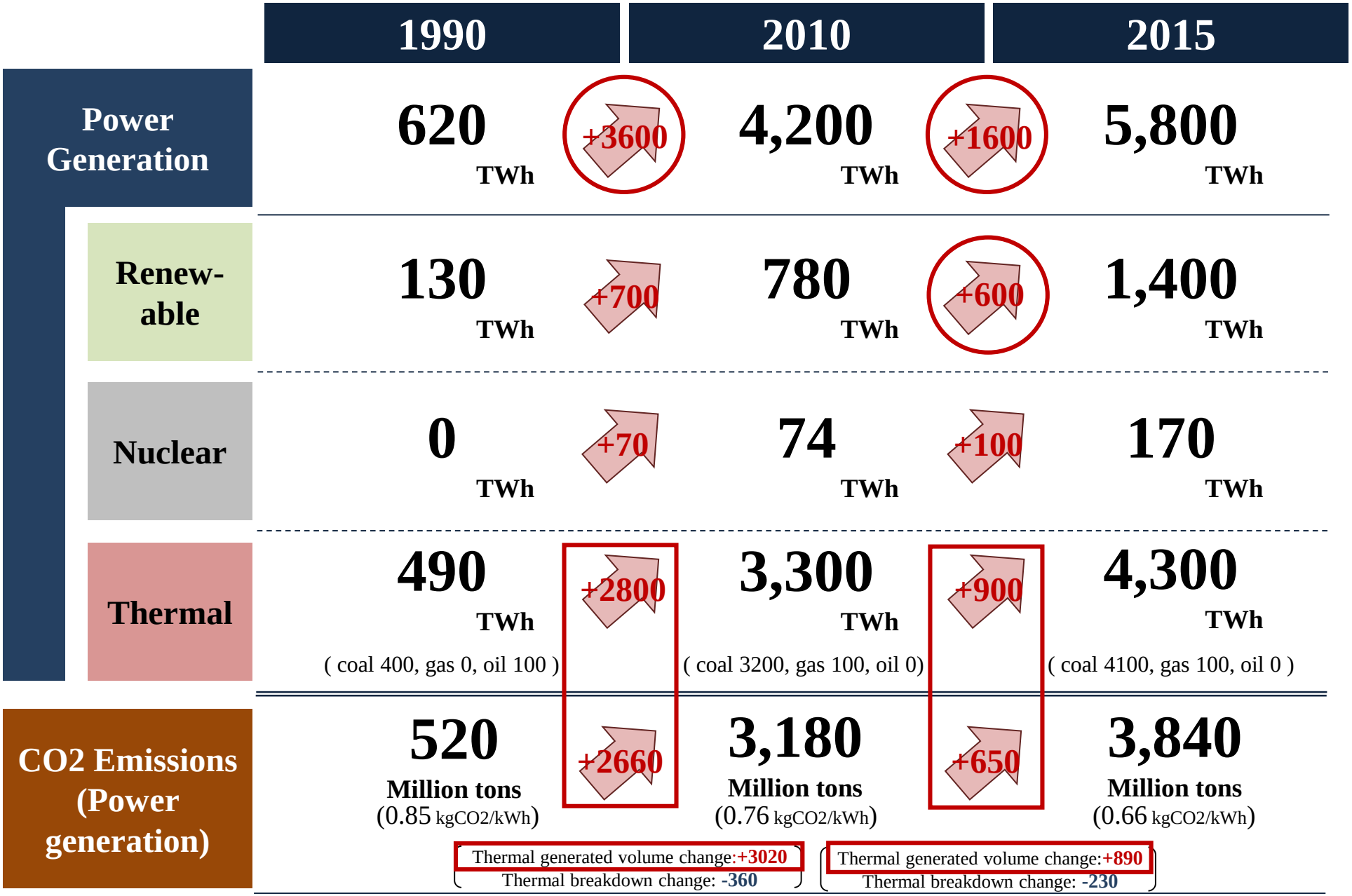
Transition of the EU's CO2 emissions from power generation



*Numbers are rounded. Totals may not match due to rounding errors.

Source: Produced from IEA Energy Balances, CO2 Emissions from Fuel Combustion

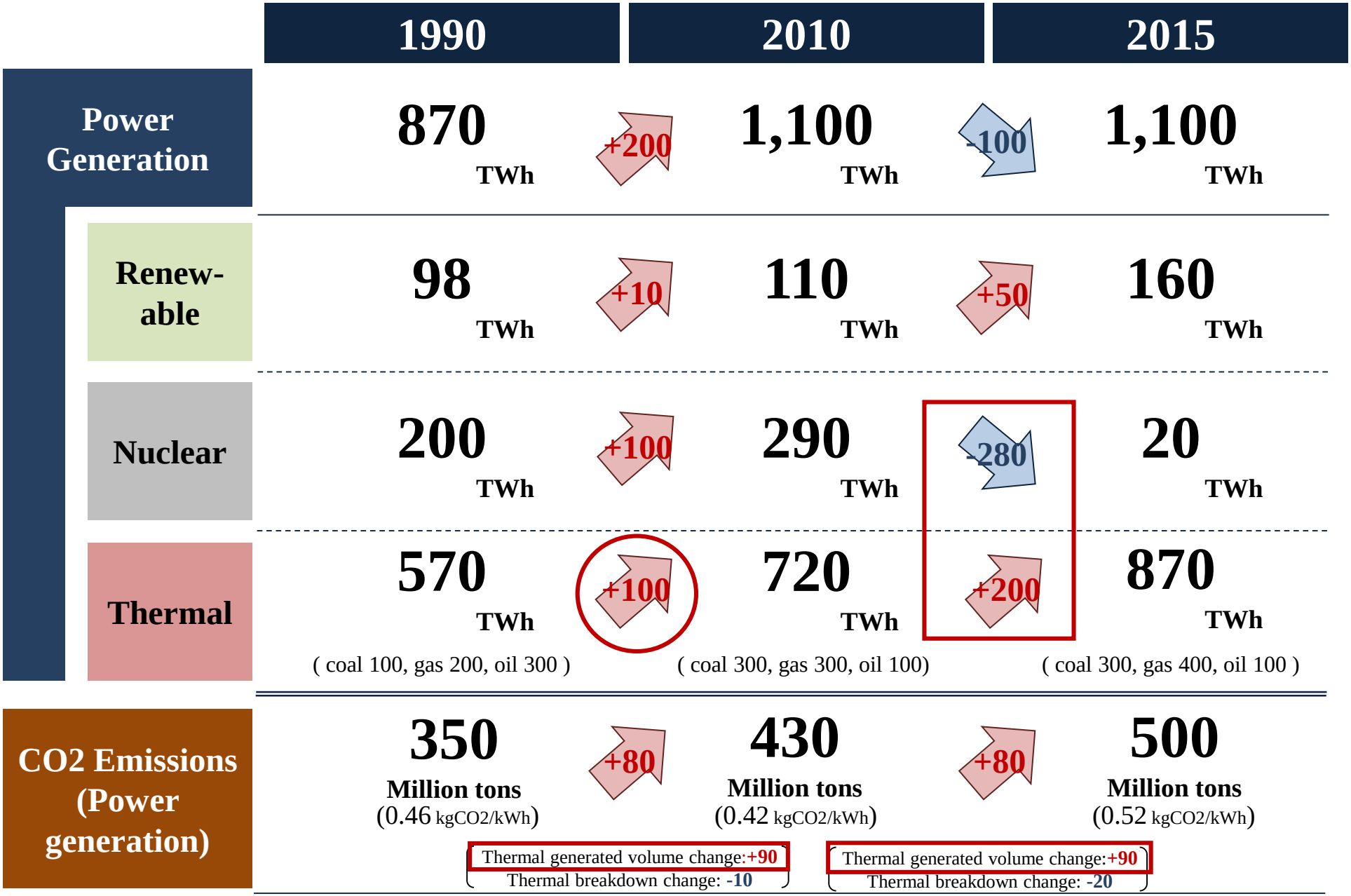
Transition of the China's CO2 emissions from power generation



*Numbers are rounded. Totals may not match due to rounding errors.

Source: Produced from IEA Energy Balances, CO2 Emissions from Fuel Combustion

Transition of the Japan's CO2 emissions from power generation



* Numbers are rounded. Totals may not match due to rounding errors.
* Definition of kgCO2/kWh in METI and IEA may be different.

Source: METI statistics, IEA Energy Balances etc.

(Reference) Comparison of the power business environments between Japan, Europe and the U.S.

		U.S.	Europe	Japan
Market overview	Market scale (Power Demand)	**3,800 TWh** TX:390 NY:150 CA:260 IL:140 (TWh)	**3,000 TWh** Germany:570 UK:330 France:470 Denmark:30 (TWh)	**1,000 TWh**
	Zero-emission Proportion	**33%** Nuclear: 19% Wind: 4% PV: 1% Hydro: 6%	**56%** Nuclear: 27% Wind: 9% PV: 3% Hydro: 11%	**17%** Nuclear: 2% Wind: 1% PV: 5% Hydro: 8%
Business environment	Retail Liberali-zation	**Varies by state** * Liberalization started in earnest from 2000 Entirely liberalized: 13 states *1 + Washington DC Partially liberalized: 6 states *2 * 1: New York, Illinois, Texas, etc. * 2: California, Nevada, etc.	**Entirely liberalized** 1996: First Energy Directive (Partial liberalization) 2003: Second Energy Directive (Complete liberalization)	**Entirely liberalized** 2000: Partial liberalization (Large scale factories, etc.) 2004: Partial liberalization (Medium scale factories, etc.) 2005: Partial liberalization (Small scale factories, etc.) 2016: Complete liberalization
	Generation/ Transmission Separation (System Operators)	**Varies by state** 1996: FERC Order 888: Recommended establishment of Independent System Operators (ISO) 1999: FERC Order 2000: Requested establishment of Regional Transmission Organizations (RTO)	**Legal separation *3 or Separation of property rights** 1996: Separation of accounting (First Energy Directive) 2003: Legal separation (Second Energy Directive) 2009: Legal separation or separation of property rights (Third Energy Directive)	**Vertical integration -> Legal separation** *** Planned for 2020 (TEPCO conducted in advance)**
	Key zero emission related policies	**Varies by state** Implementation of tax measures, etc. by the federal government	**Varies by country** EU Goal: Raise renewable energy comprise 27% of final consumption by 2030	**FIT** **Sophisticated Methods of Energy Supply Structures Act, etc.**

*3 Two options exist: "1. Entrust power grid operation to an independent system operator," or "2. Secure the independence of the power system operation function through an independent power transmission operator"

(Reference) Electrical power business environment of the U.S.

		U.S.			
		Texas	California	New York	Illinois
Market overview	Market scale (Power Demand)	390 TWh	260 TWh	150 TWh	140 TWh
	Zero-emission Proportion	19% (Nuclear: 9% Wind: 11% PV: 0.1% Hydro: 0.2%)	40% (Nuclear: 9% Wind: 6% PV: 8% Hydro: 7%)	55% (Nuclear: 32% Wind: 3% PV: 0.1% Hydro: 19%)	56% (Nuclear: 50% Wind: 6% PV: 0% Hydro: 0%)
Business environment	Retail Liberali-zation	Entirely liberalized 1999: Act to restructure state power operators (Separation of generation, transmission/distribution, retail) 2002: Start of retail liberalization	Partially liberalized * Non-home use liberalized 1998: Start of complete liberalization 2001: Power crisis -> Halt to liberalization 2010: Restart of partial liberalization	Entirely liberalized 1998 - 2000: Start of liberalization at each power company	Entirely liberalized 2002: Start of complete liberalization 2005: End of upper price limit regulation
	Generation/ Transmission Separation (System Operators)	Independent System Operator (ISO) ERCOT Established 1996	Independent System Operator (ISO) CAISO Established 1998	Independent System Operator (ISO) NYISO Established 1999	Regional Transmission Operator (RTO) MISO Established 1996 Certified RTO 2001
	Key zero emission related policies	RPS (1999~) * RECs can be purchased	RPS (2002~) * RECs can be purchased ZEV regulation (2012~) * Constant rate of total car sales is required to be sales of ZEVs	Zero Emission Credits (2017~) * Utilities are required to procure REC and ZEC	RPS (2008~) * RECs can be purchased Zero Emission Credits (2017~) * Utilities are required to procure ZEC

※REC: Renewable Energy Credit ZEC:Zero Emission Credits ZEV: Zero Emission Vehicle

(Reference) Electrical power business environment of Europe