

Outlook for Alternative scenarios

I. Asian Countries

The Institute of Energy Economics, Japan (IEEJ)

*Please note this outlook was finalised before the day of East Japan Great Earthquake, thus does not reflect any impacts of the event.



I. Scenario settings and assumptions

Concept of the alternative scenarios

BAU Scenario -- continuation of current market situation and policies

- Energy efficiency improvement will continue, based on the historical trend.
- For nuclear power and renewable energy projects, only those in actual construction or confirmed projects are being accounted for.

Maximum Impact Scenario -- the maximum success of energy efficiency and diversification policies

- Assumes that the most ambitious energy policy targets of each country will be achieved.

Strong Policies Scenario

- Assumes more moderate achievement of policies than the Maximum Impact Scenario.

List of technologies considered in the alternative scenarios

Countries all over the world more strengthen the numerous measures contributing to ensuring energy security and mitigating global warming issues. Combined with that, technological development and international transfer of technology will be promoted and advanced technology internationally becomes commercially available as a result.

<u>Regulation, National target, SSL etc.</u>	<u>Promotion of R&D, International Cooperation</u>
Carbon tax, Emissions Trading, RPS, Subsidization, FIT, Efficiency Standard, Automobile Fuel Efficiency Standard, Low Carbon Fuel Standard, Energy Efficiency Labeling, National Target etc.	Encouragement of Investment for R&D, International Cooperation on Energy Efficient Technology, Support on Establishment of Efficiency Standard

【Demand Side Technology】

- **Industry**
Best available technology on industrial process such as steel making, cement, paper, oil refinery etc. become internationally penetrated
- **Transport**
Clean energy vehicles (high fuel efficient vehicle, Hybrid vehicle, Plug-in hybrid vehicle, Electric vehicle, Fuel cell vehicle) globally expand.
- **Building**
Efficient electric appliance (Refrigerator, TV etc.), High efficient water-heating system (heat-pump etc.), Efficient air conditioning system, Efficient lighting, Strengthening heating insulation

【Supply Side Technology】

- **Renewable**
More expansion of Wind, PV, CSP, Biomass power generation, Bio-fuel
- **Nuclear**
Acceleration of more nuclear power plant, Enhancement of operating ratio
- **High Efficient Fossil-fired Power Plant**
More expansion of Coal-fired power plant (USC, IGCC, IGFC), Natural gas MACC
- **CCS**
Introduction in power generation (coal-fired, gas-fired) and industrial sector

Assumptions on the alternative scenarios

Industry Sector :

- Maximum Impact Scenario : Energy efficiency of major industries (steel, chemicals, etc.) continue to improve, to reach the current level of advanced OECD countries in 2035.
- Strong Policies Scenario : The speed of improvement is assumed to be slower than MIS (70% efficiency improvement rates).

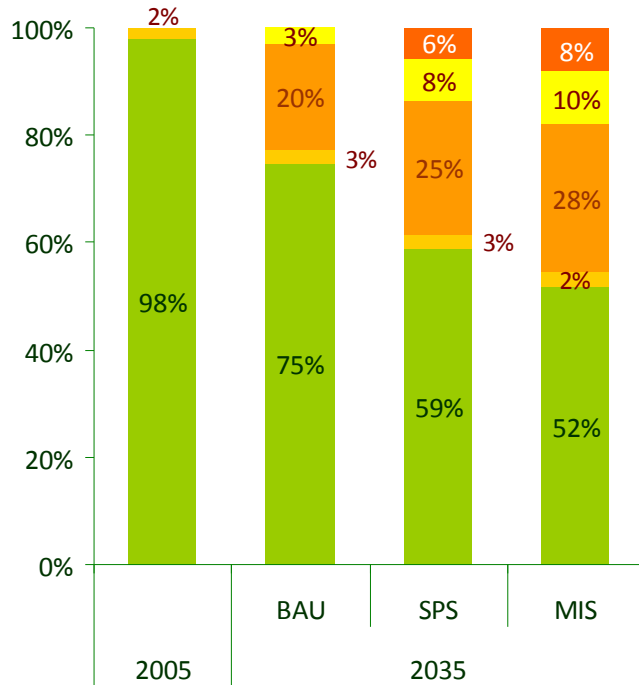
Buildings Sector :

- Maximum Impact Scenario : All appliances meet the highest efficiency standard currently applicable in OECD countries.
- Strong Policies Scenario : 70% of all appliances meet the highest efficiency standard.

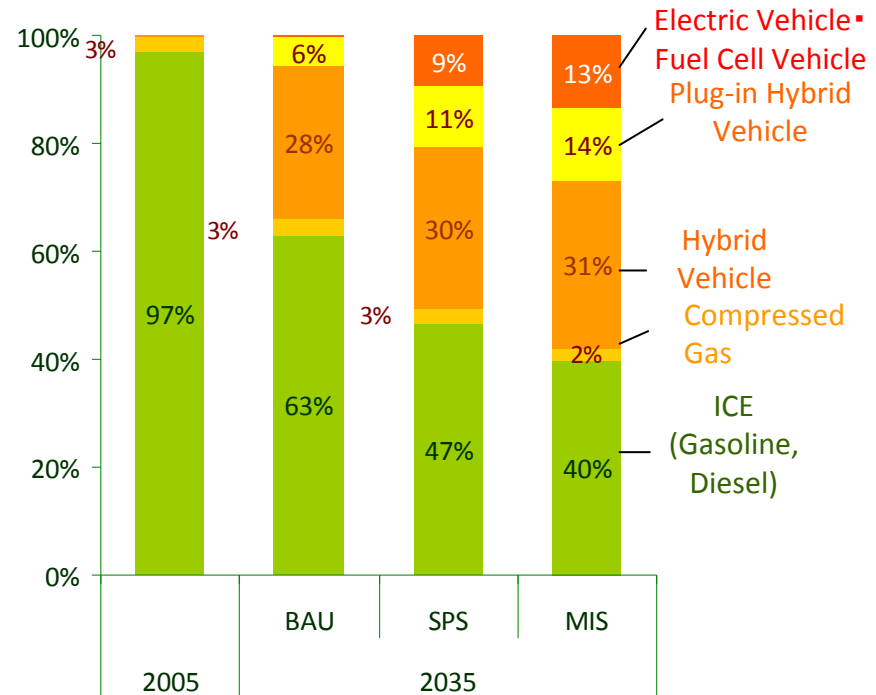
Assumptions on the alternative scenarios

Transport Sector : MIS and SPS:
 Clean energy vehicles will account for approximately 50% and 40% of total stocks in 2035.

The Share of Vehicle Stocks by Type (World)



The Share of Vehicles' Annual Sales by Type (World)

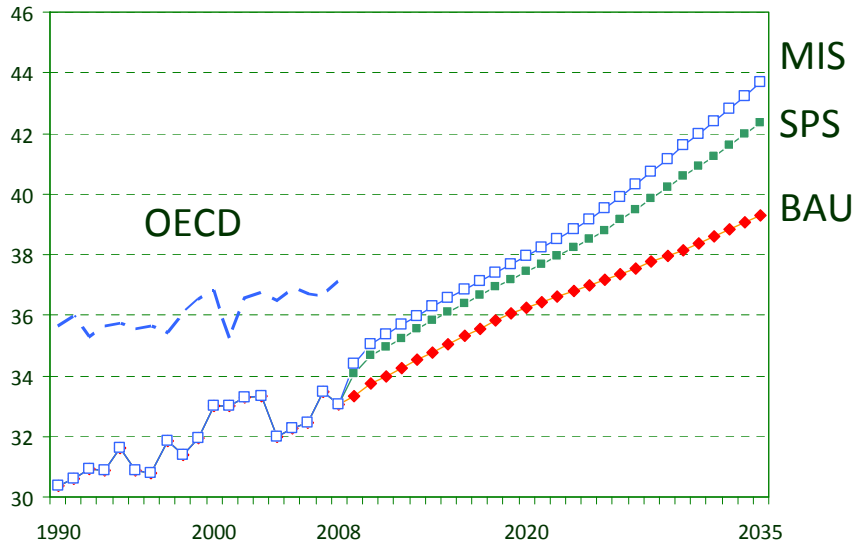


Assumptions on the alternative scenarios

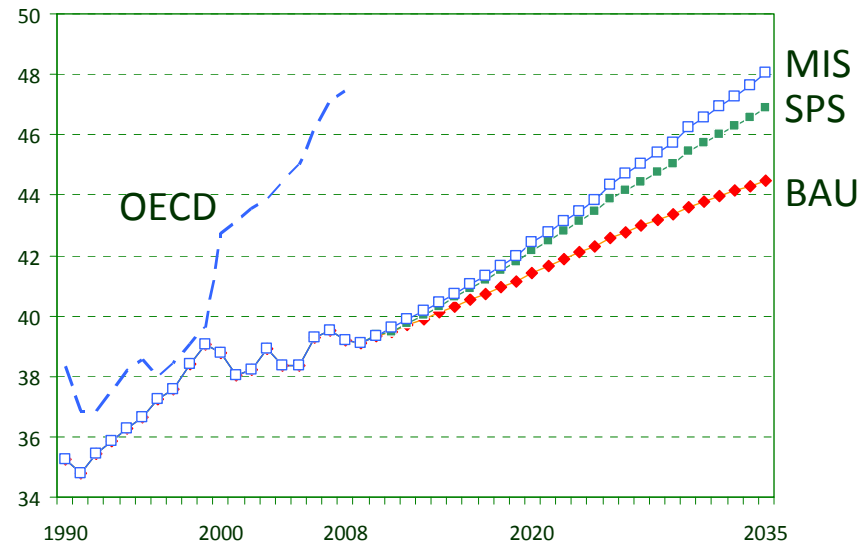
Power generation:

- Maximum Impact Scenario : The best technologies are applied to all newly build power plants.
- Strong Policies Scenario : The best technologies are applied to 70% of newly build power plants.

Coal (Asia)

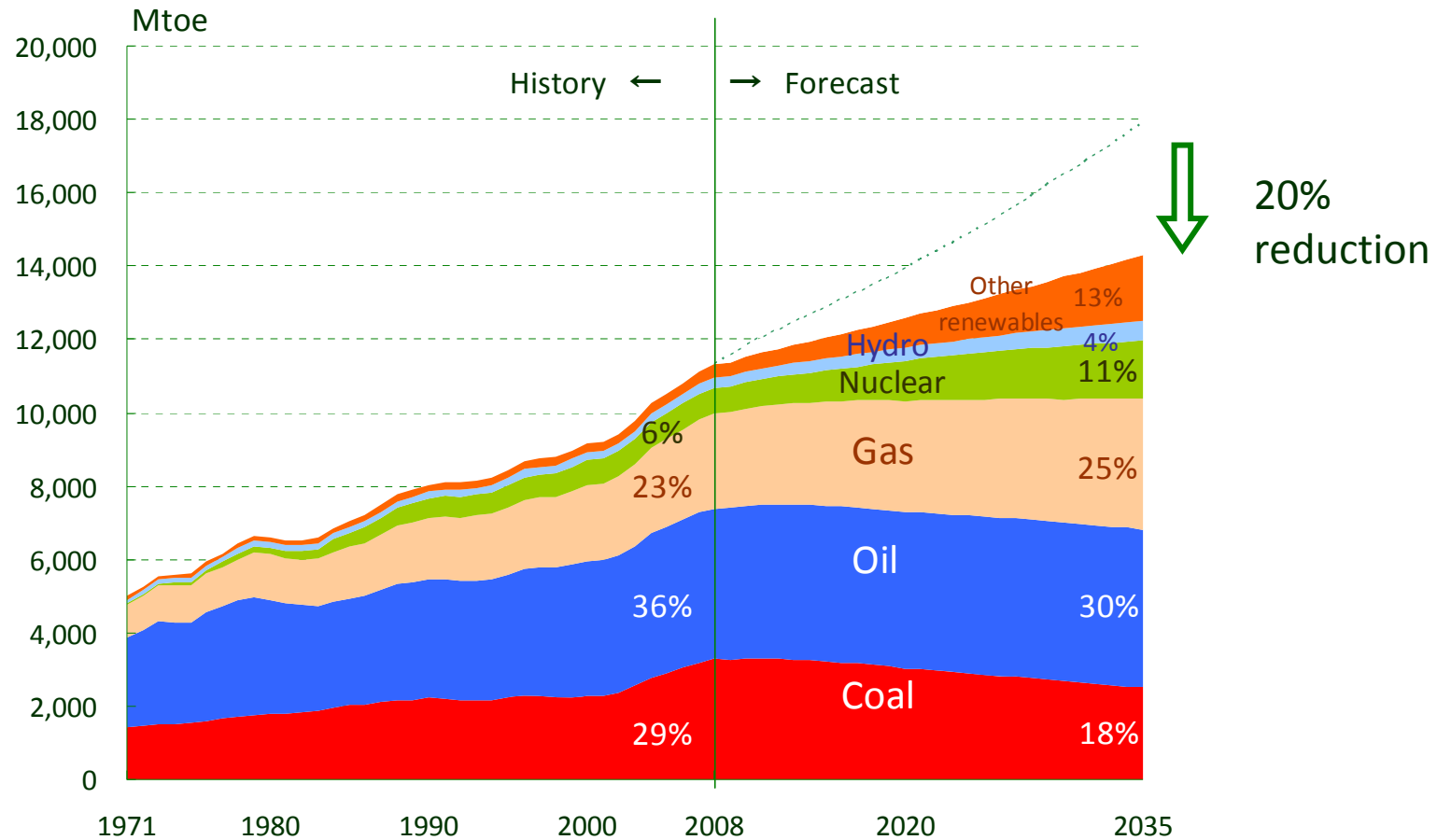


Natural gas (Asia)



II. Energy Outlook for Asia / World

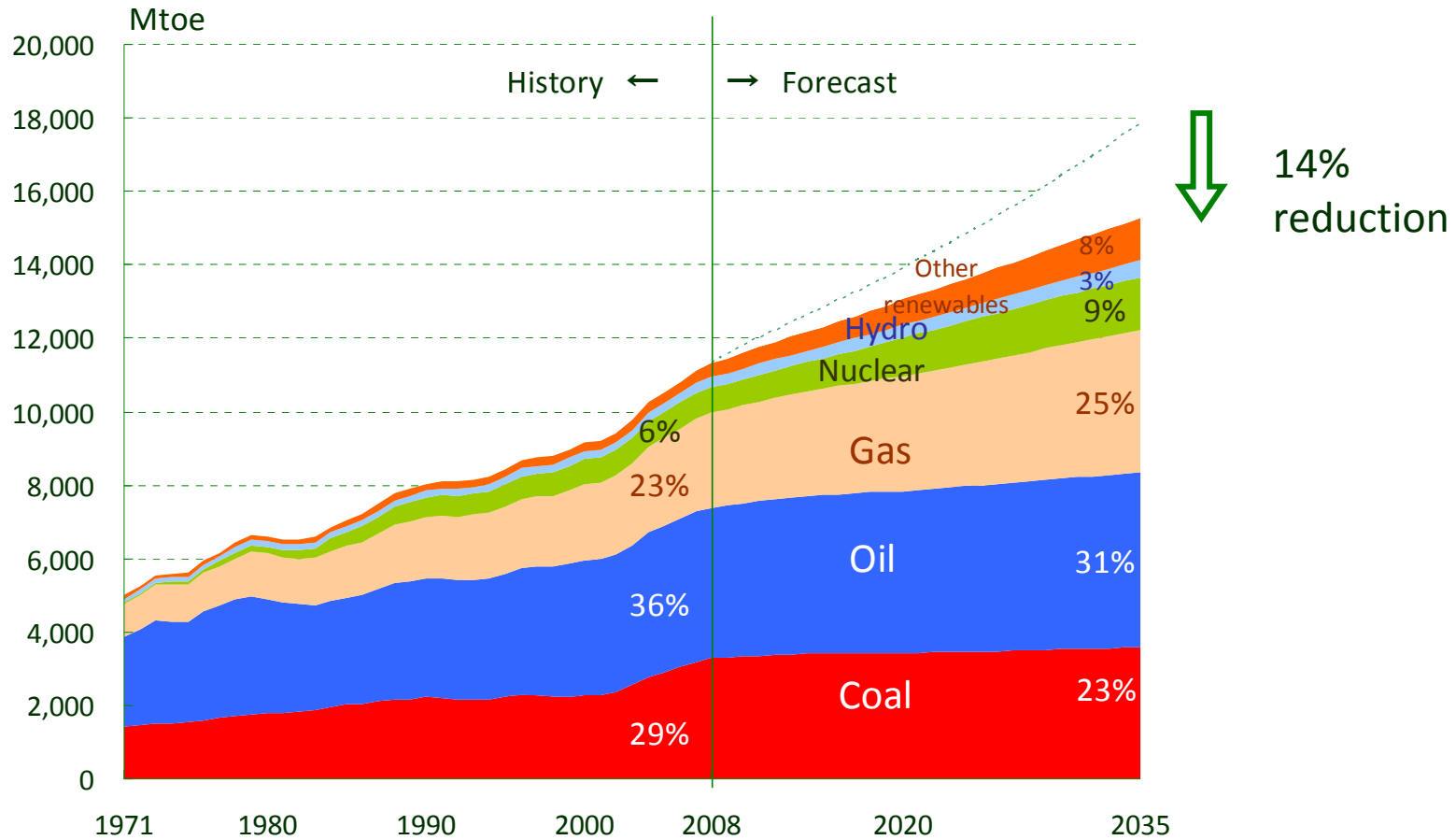
Primary Energy Demand (World : MIS)



■ In the Maximum Impact Scenario (MIS), world primary energy demand will be reduced by 20% in 2035 from the BAU scenario. Coal has the greatest potential for reduction.

■ The shares of nuclear and renewable will rise significantly (from 6% to 11% and from 5% to 16% respectively). But even in 2035, fossil fuels account for the largest part of global primary energy supply.

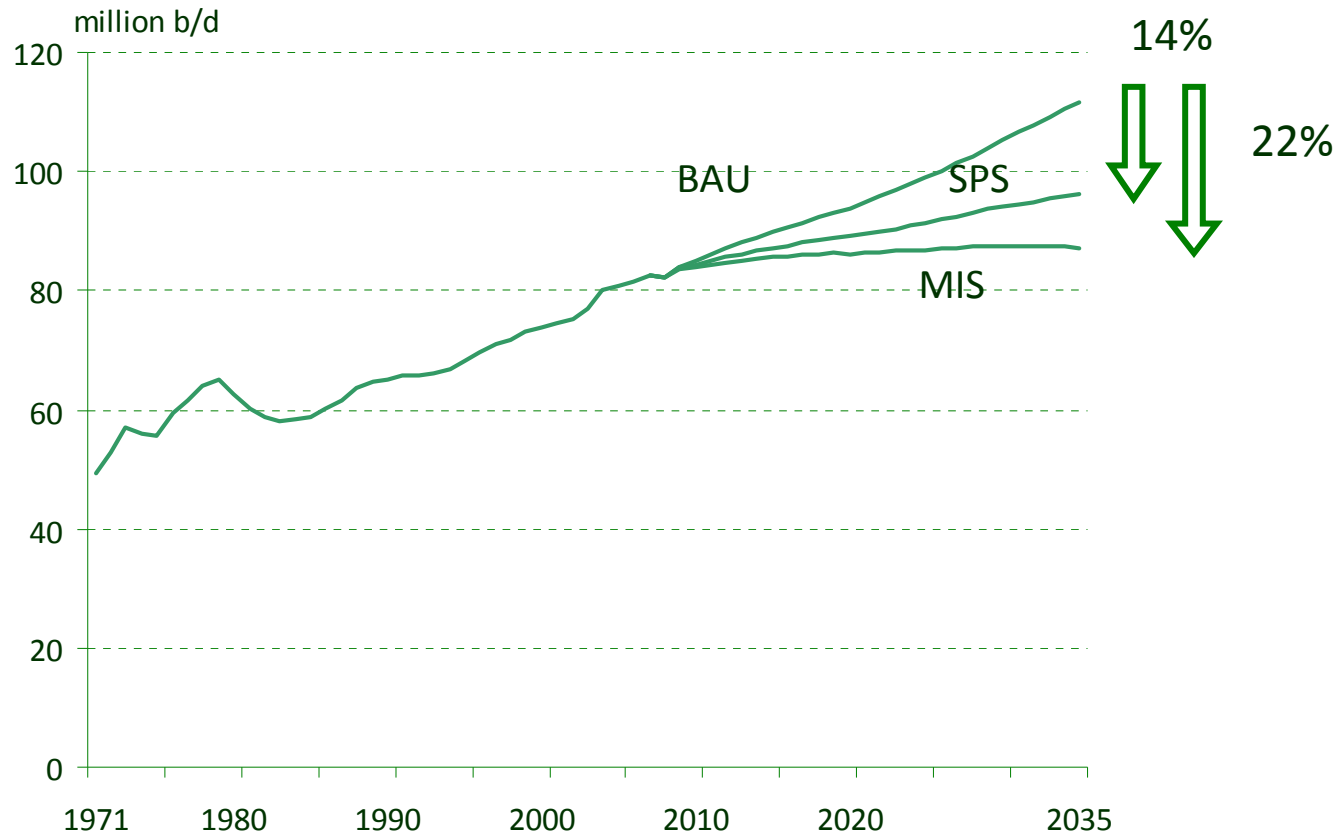
Primary Energy Demand (World : SPS)



■ In the Strong Policies Scenario (SPS), world primary energy demand will be reduced by 14% from BAU.

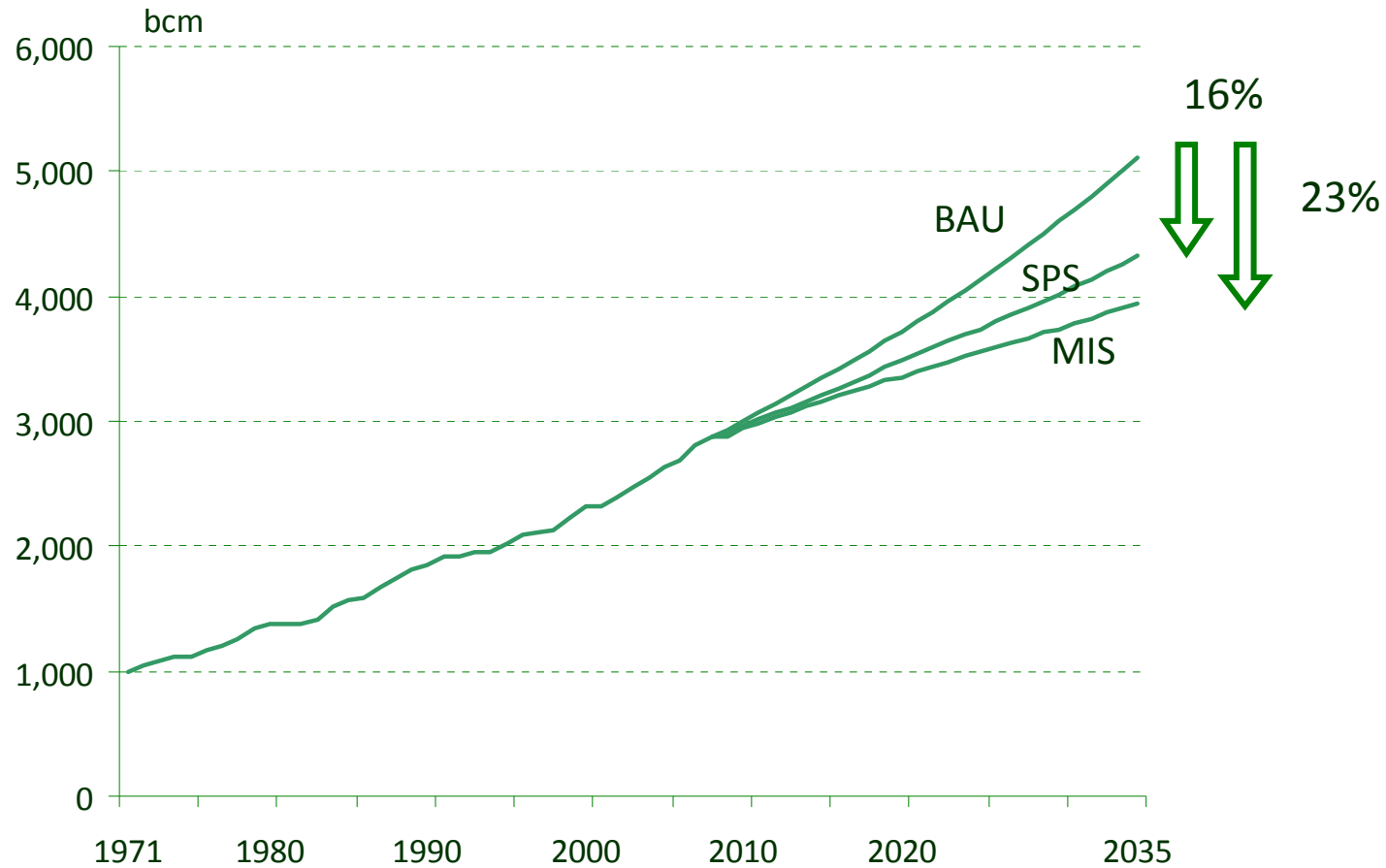
■ The share of non-fossil energy will be 20% in 2035.

Oil Demand (World)



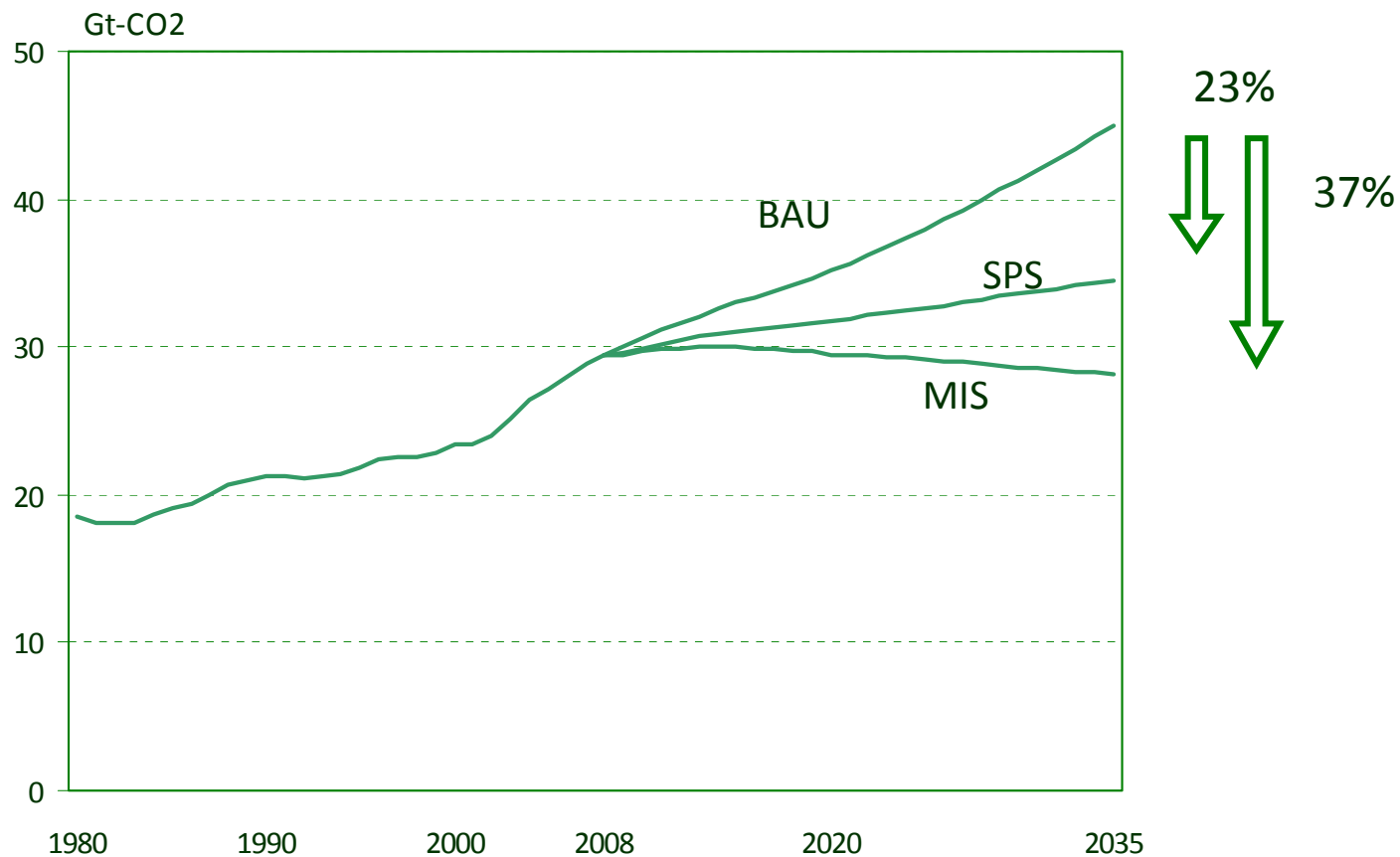
- World oil demand will be reduced by 22%(MIS) and 14%(SPS) from BAU.
- In MIS, global oil demand will remain flat at 87 million b/d until 2035.

Natural gas Demand (World)



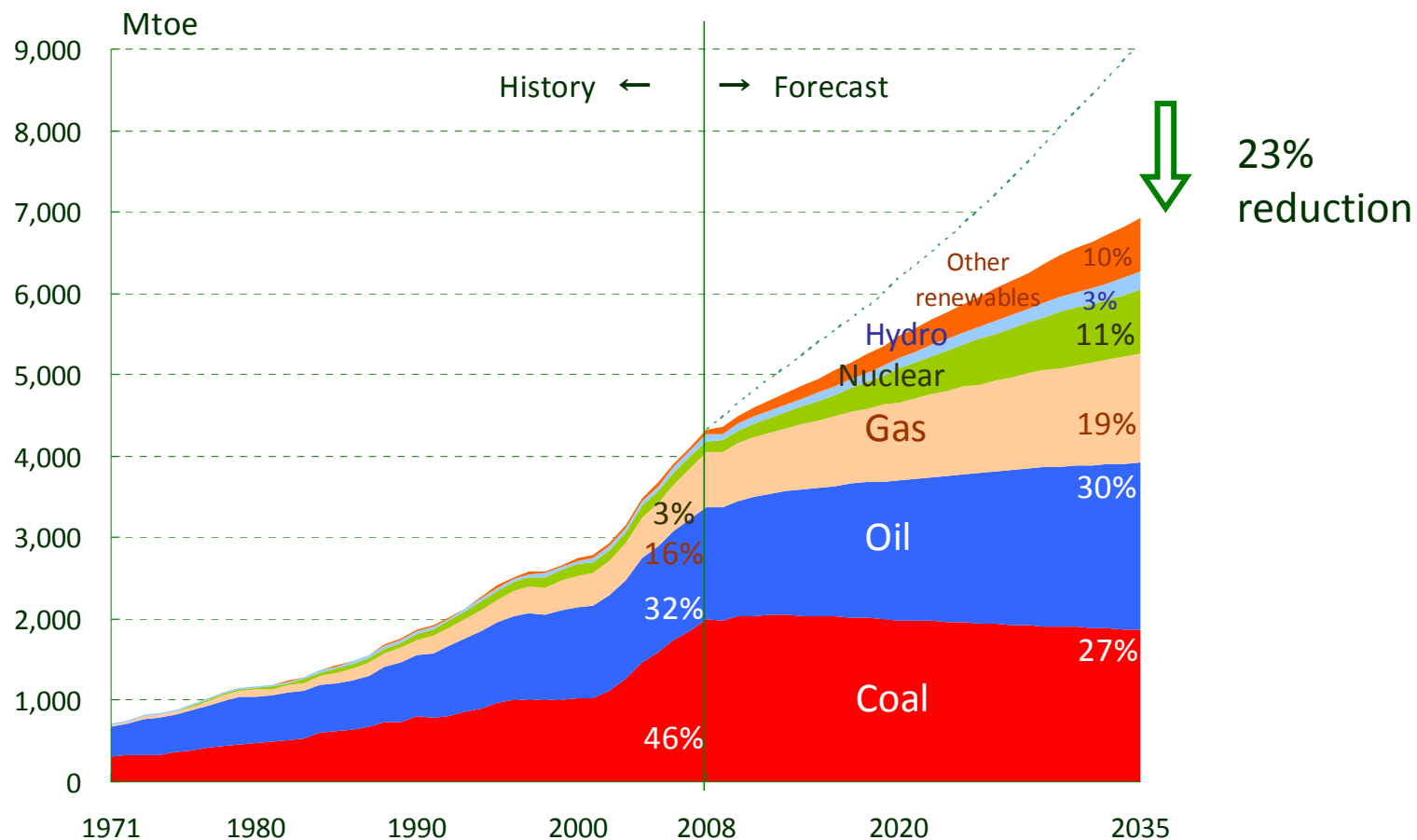
- World natural gas demand will be reduced by 23%(MIS) and 16%(SPS) from BAU.
- Even in MIS, natural gas demand will continue to grow, and reaches 4000 bcm in 2035.

CO₂ emissions (World)



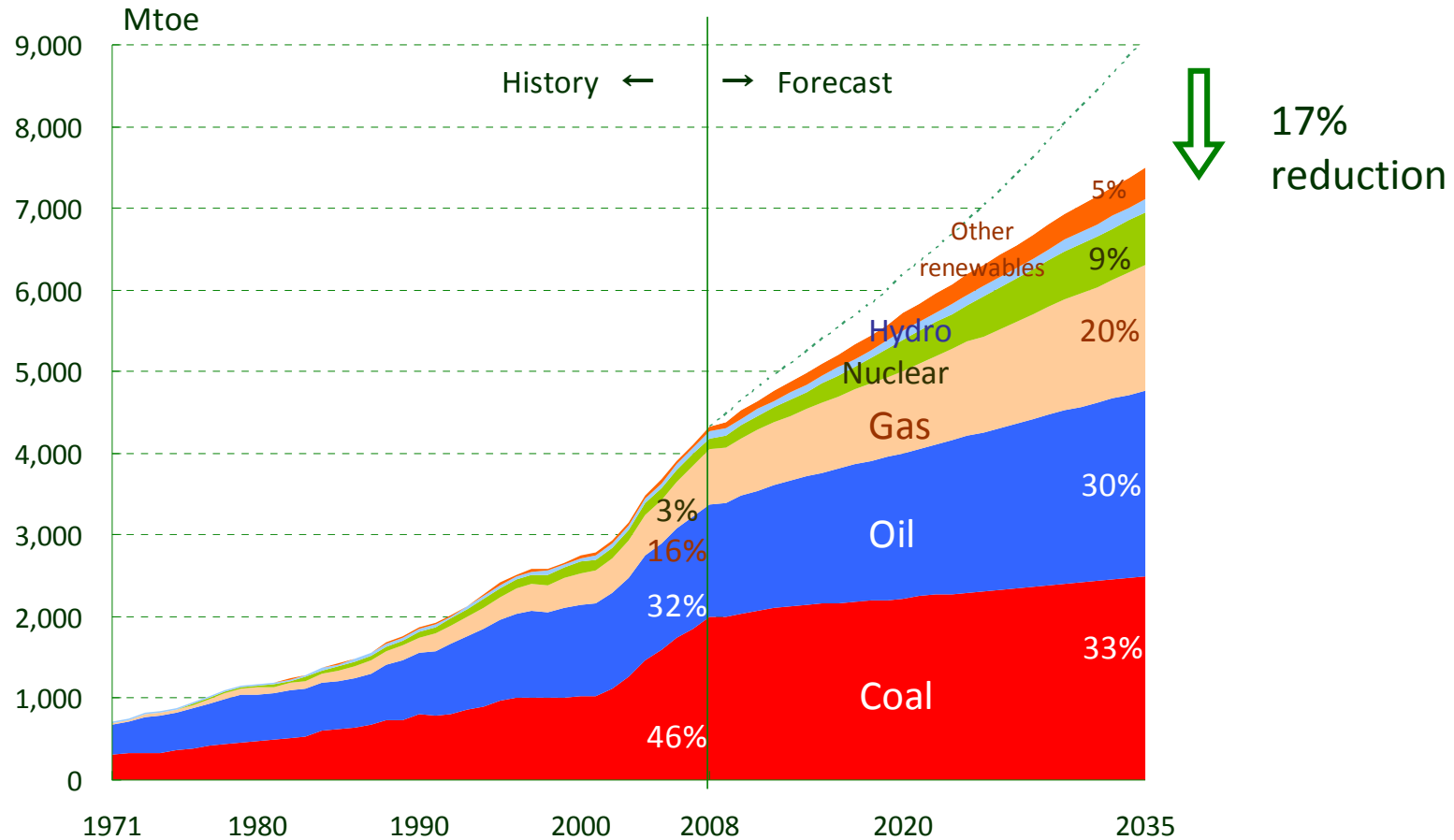
- Energy-related CO₂ emission will be reduced by 37%(MIS) and 23%(SPS) from BAU.
- From the current level(2008), CO₂ emission increase by 2035 will be +53%(BAU), +17%(SPS) and -4%(MIS).

Primary Energy Demand (Total Asia : MIS)



- In Asia, primary energy demand in MIS will be reduced by 23% in 2035 from BAU. Coal has the greatest potential for reduction.
- The share of non-fossil energy in primary energy mix will be 24% in 2035.

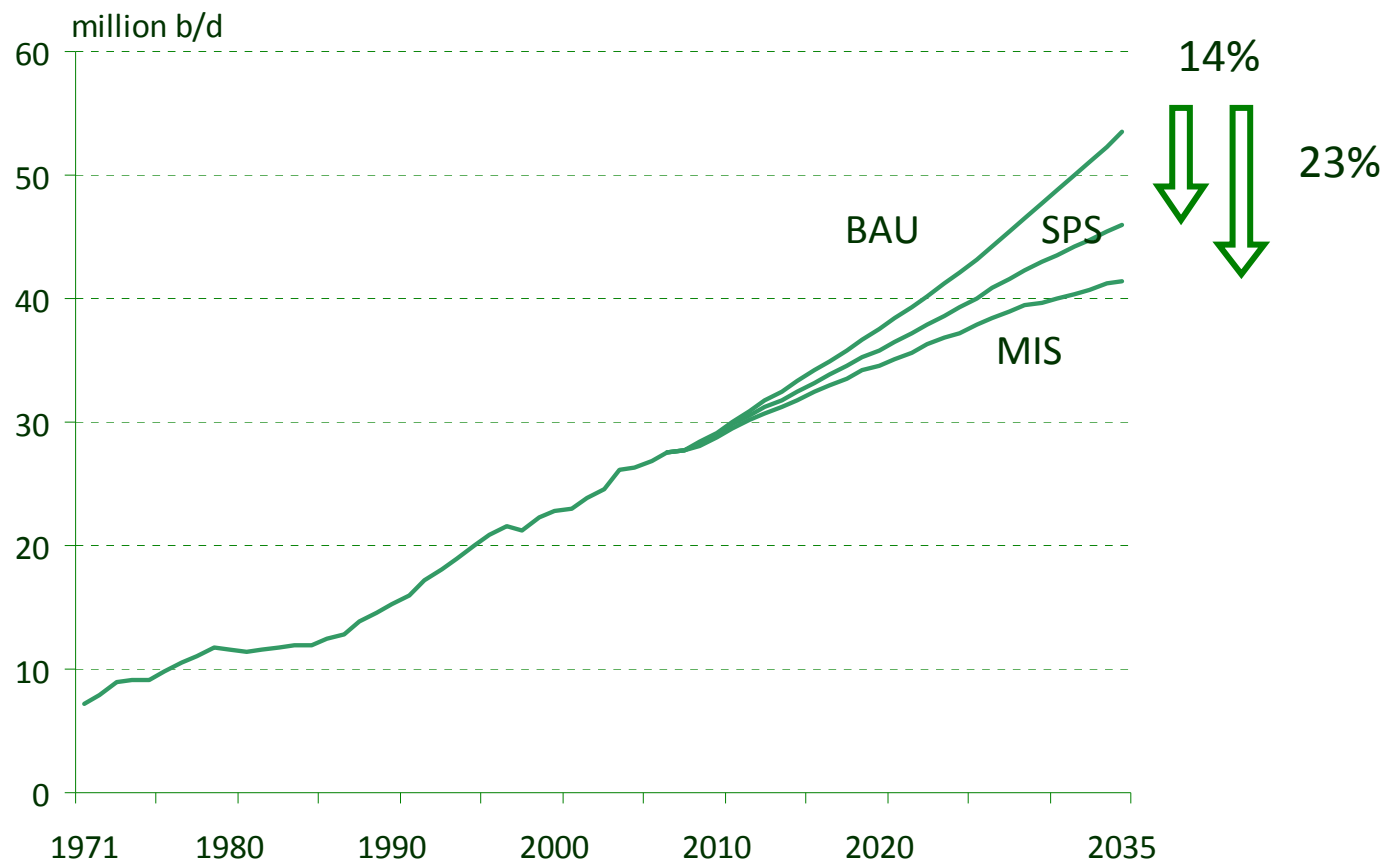
Primary Energy Demand (Total Asia : SPS)



■ In SPS, primary energy demand in Asia will be reduced by 17% in 2035 from BAU. In this scenario, coal consumption will continue to increase towards 2035.

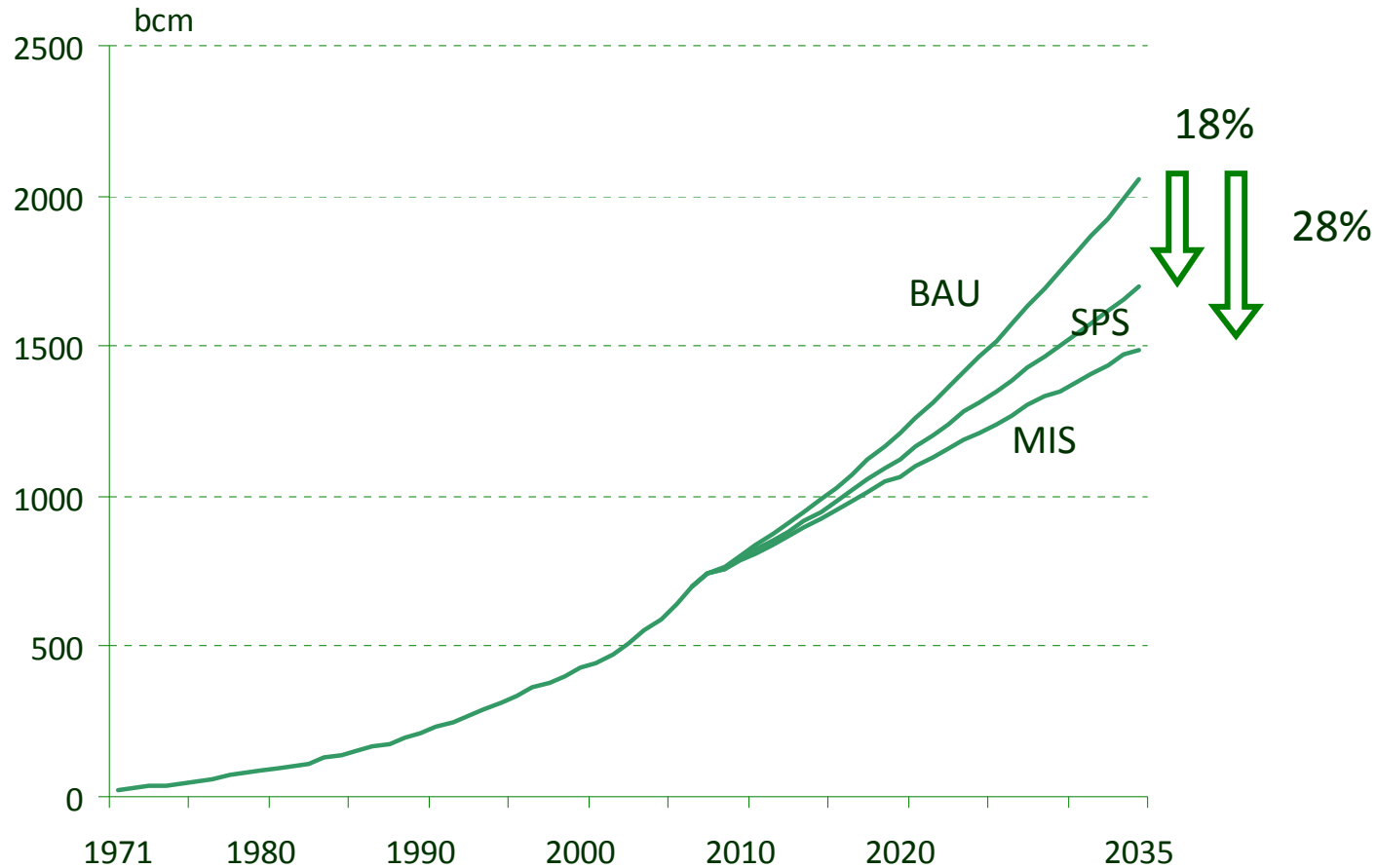
■ The share of non-fossil energy in primary energy mix will be 16% in 2035.

Oil Demand (Total Asia)



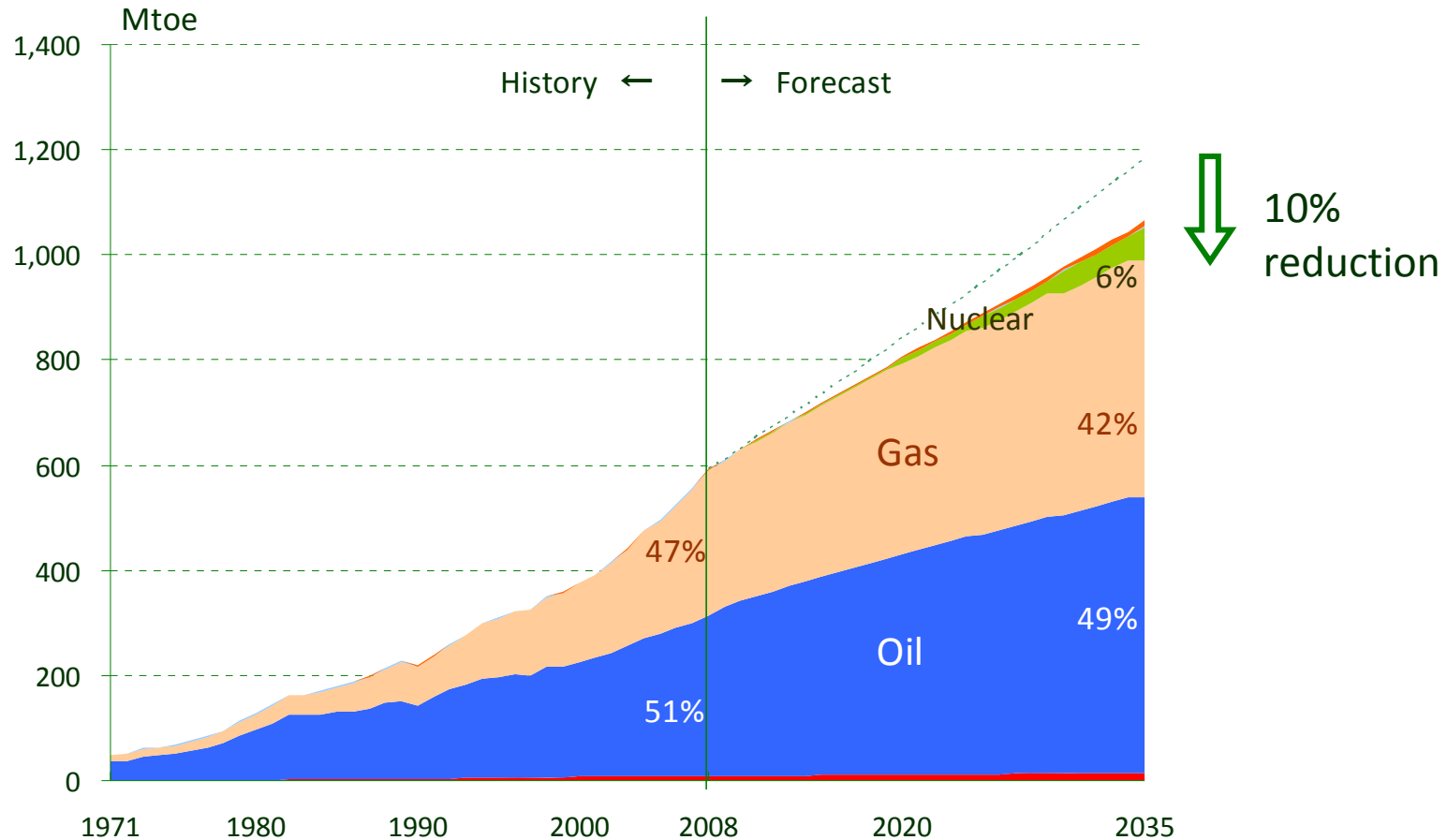
- Oil demand in Asia will be reduced by 23%(MIS) and 14%(SPS) from BAU.
- In MIS, oil demand will increase from 28 million b/d in 2008 to 41 million b/d in 2035.

Natural gas Demand (Total Asia)



- Natural gas demand in Asia will be reduced by 28%(MIS) and 18%(SPS) from BAU.
- Even in MIS, natural gas demand will show a steep increase, from 700 bcm to 1,500 bcm(2.1-fold increase).

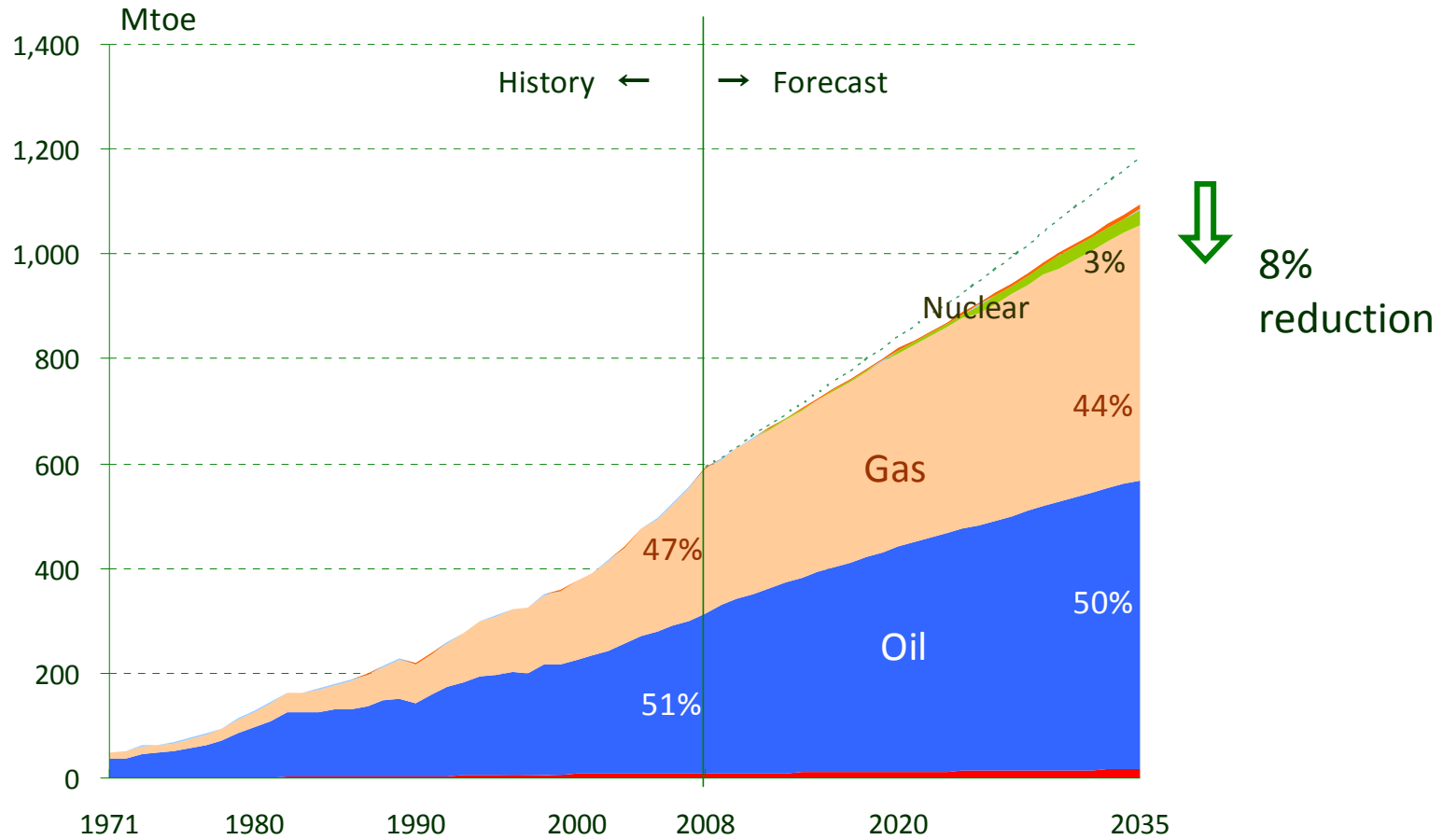
Primary Energy Demand (Middle East : MIS)



■ In Middle East, primary energy demand in MIS will be reduced by 10% in 2035 from BAU.

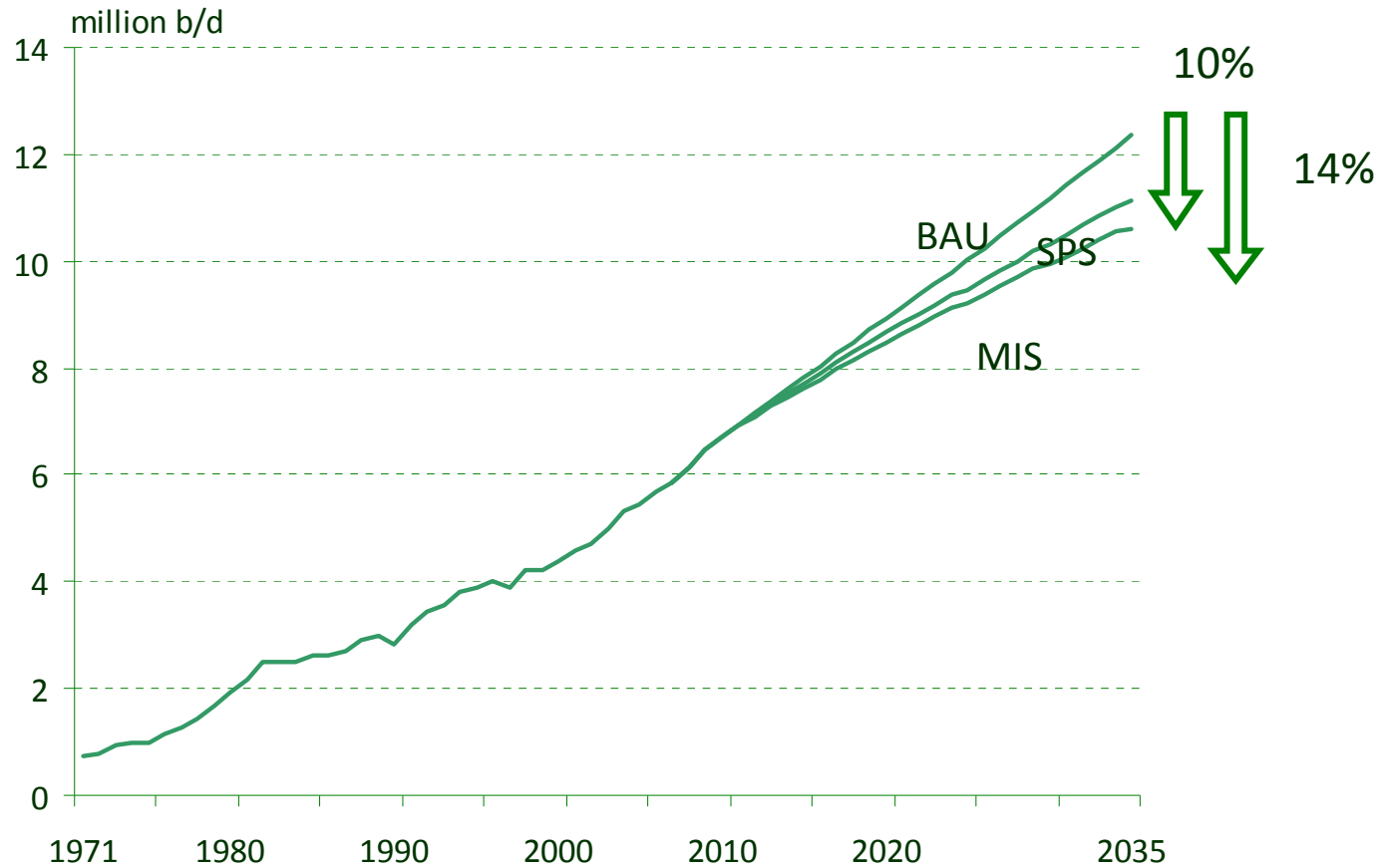
■ Nuclear and renewable share will be as much as 7% in 2035.

Primary Energy Demand (Middle East : SPS)



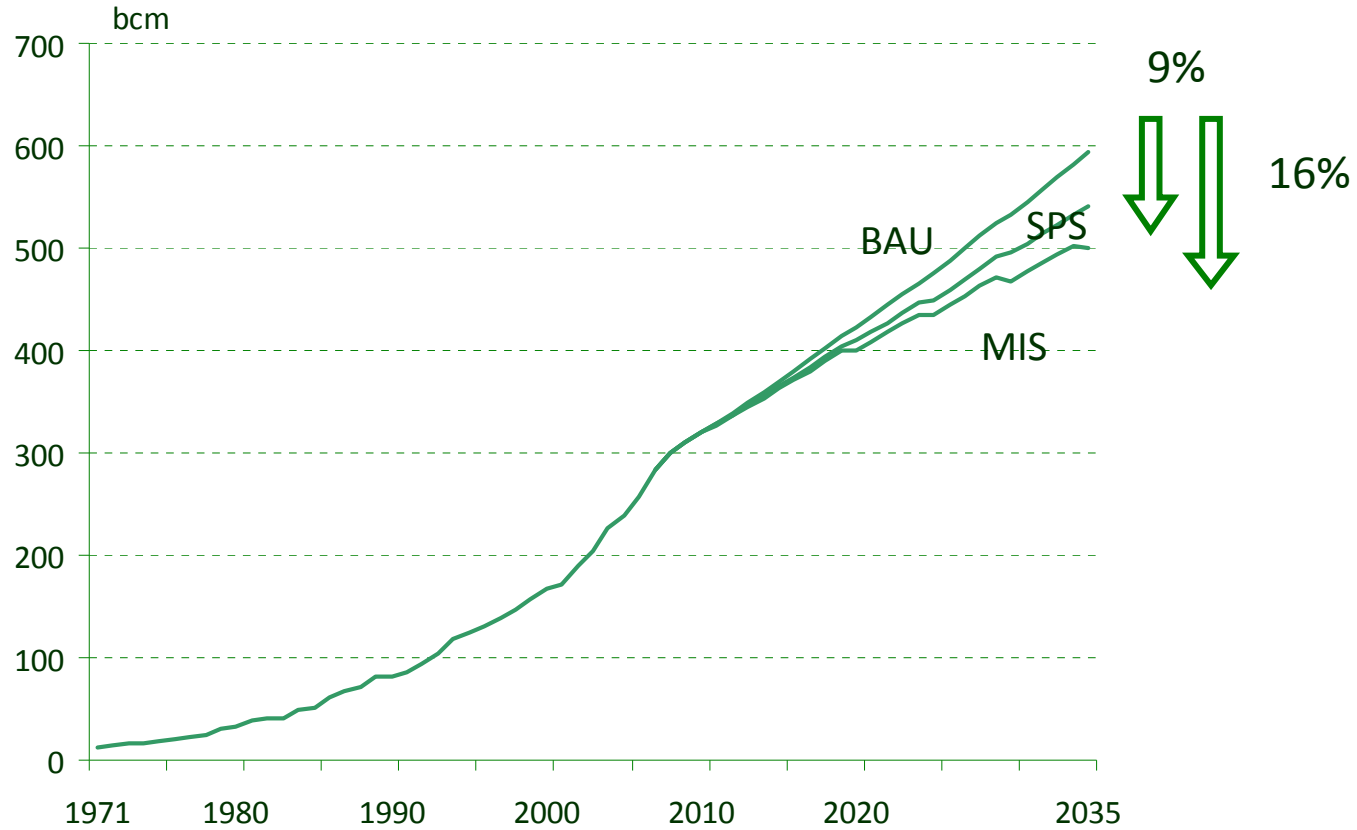
- In SPS primary energy demand will be reduced by 8% from BAU.
- The share of Nuclear and renewable in combination will be 4% in 2035.

Oil Demand (Middle East)



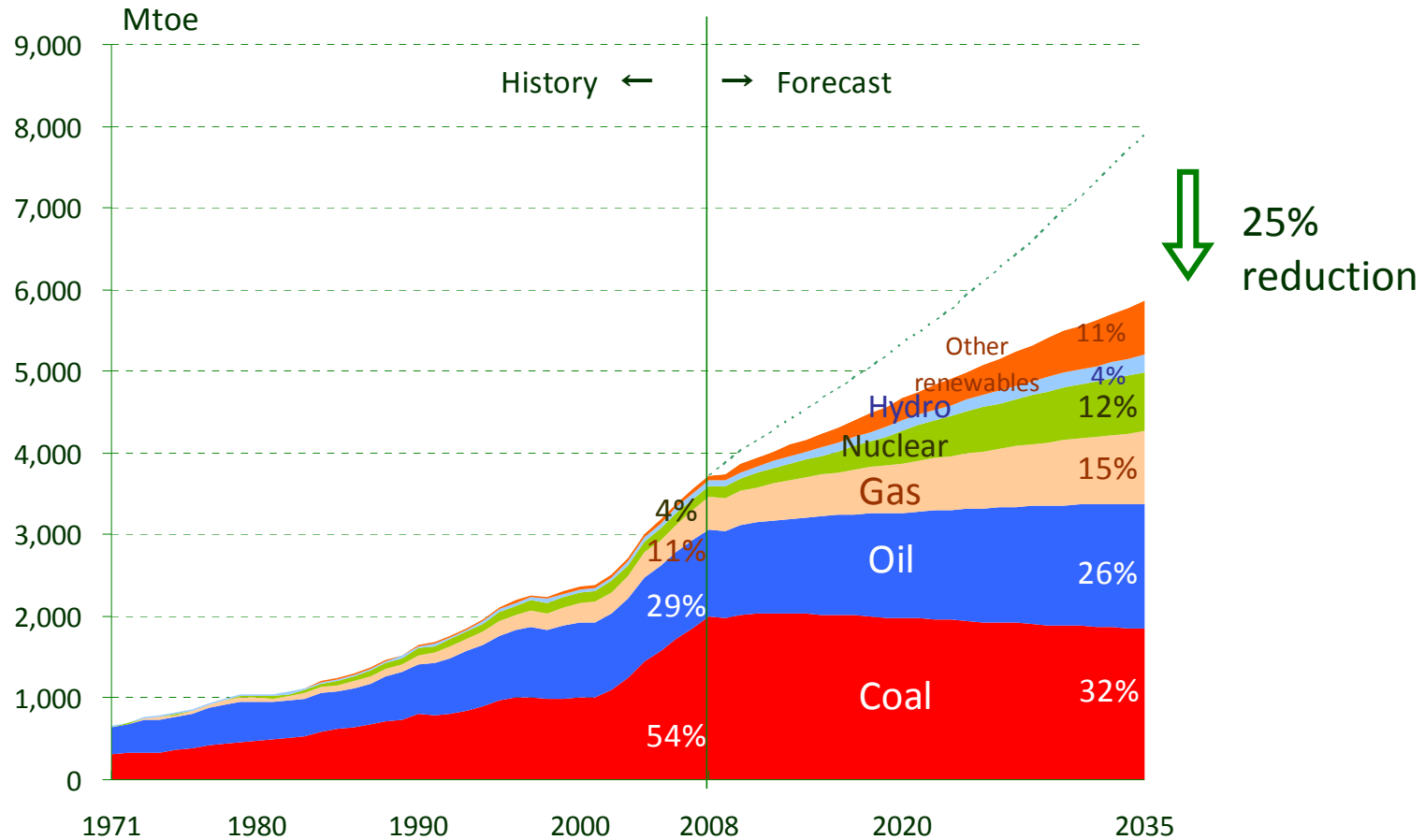
- Oil demand in Middle East will be reduced by 14%(MIS) and 10%(SPS) from BAU.
- In MIS, oil demand will increase from 5.9 million b/d in 2008 to 11 million b/d in 2035.

Natural gas Demand (Middle East)



- Natural gas demand in Middle East will be reduced by 16%(MIS) and 9%(SPS) from BAU.
- In MIS, natural gas demand will increase from 300 bcm to 500 bcm(1.7-fold increase).

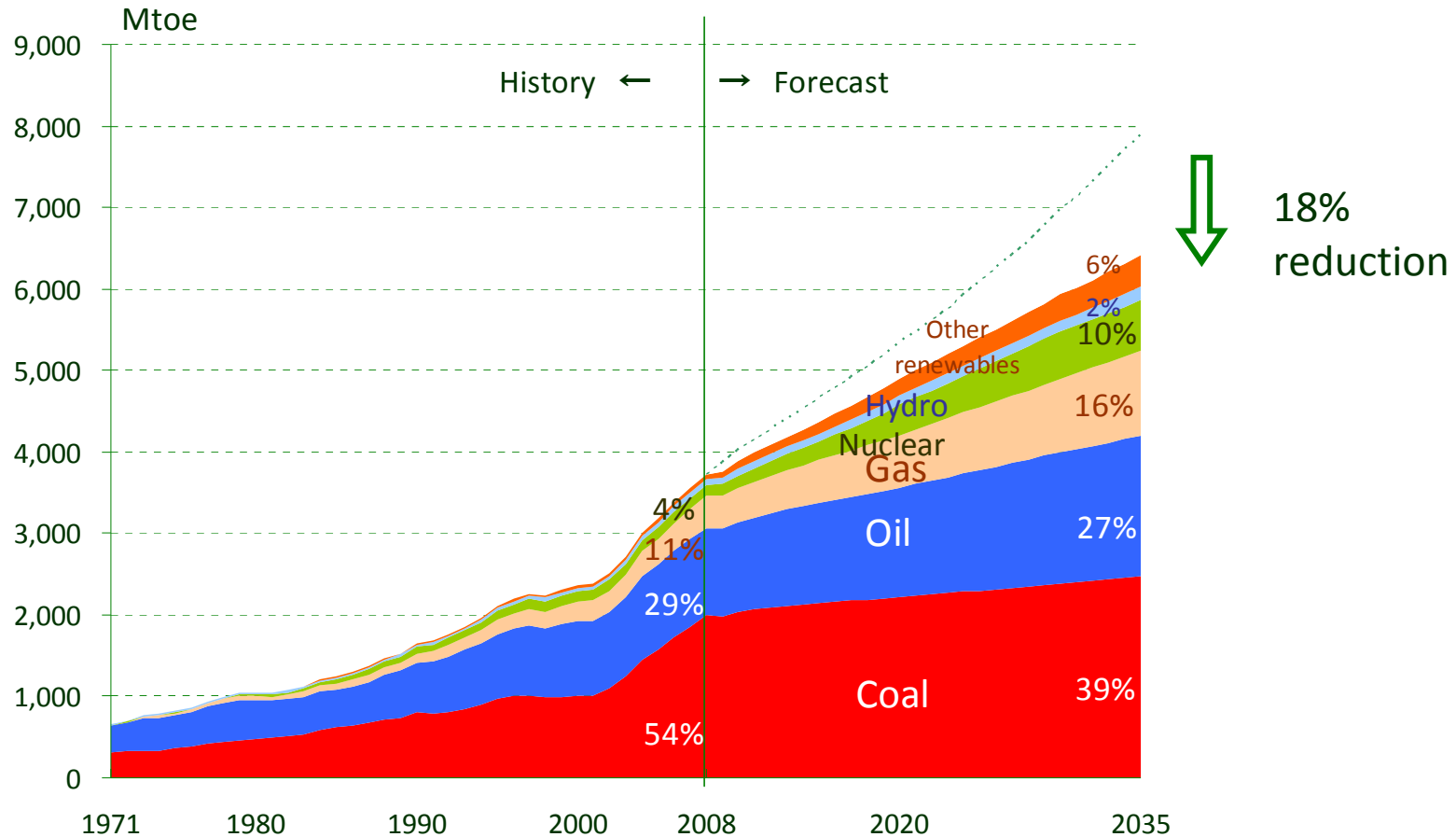
Primary Energy Demand (Asia Excl. Middle East : MIS)



■ In Asia excluding Middle East, primary energy demand in MIS will be reduced by 25% in 2035 from BAU.

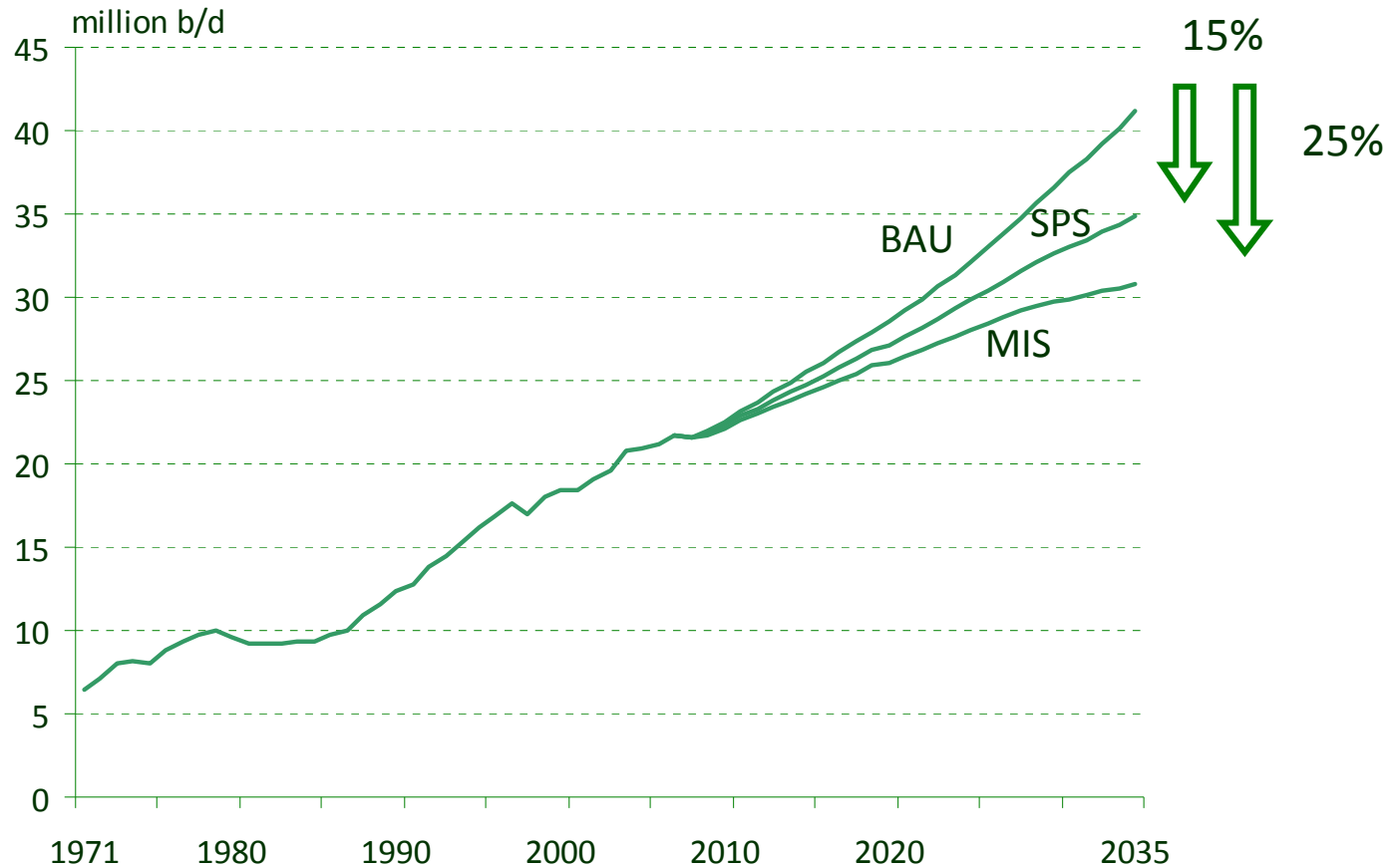
■ The share of non-fossil energy in primary energy mix will be 27% in 2035.

Primary Energy Demand (Asia Excl. Middle East : SPS)



- In SPS, primary energy demand in Asia will be reduced by 18% in 2035 from BAU.
- The share of non-fossil energy will be 18% in 2035.

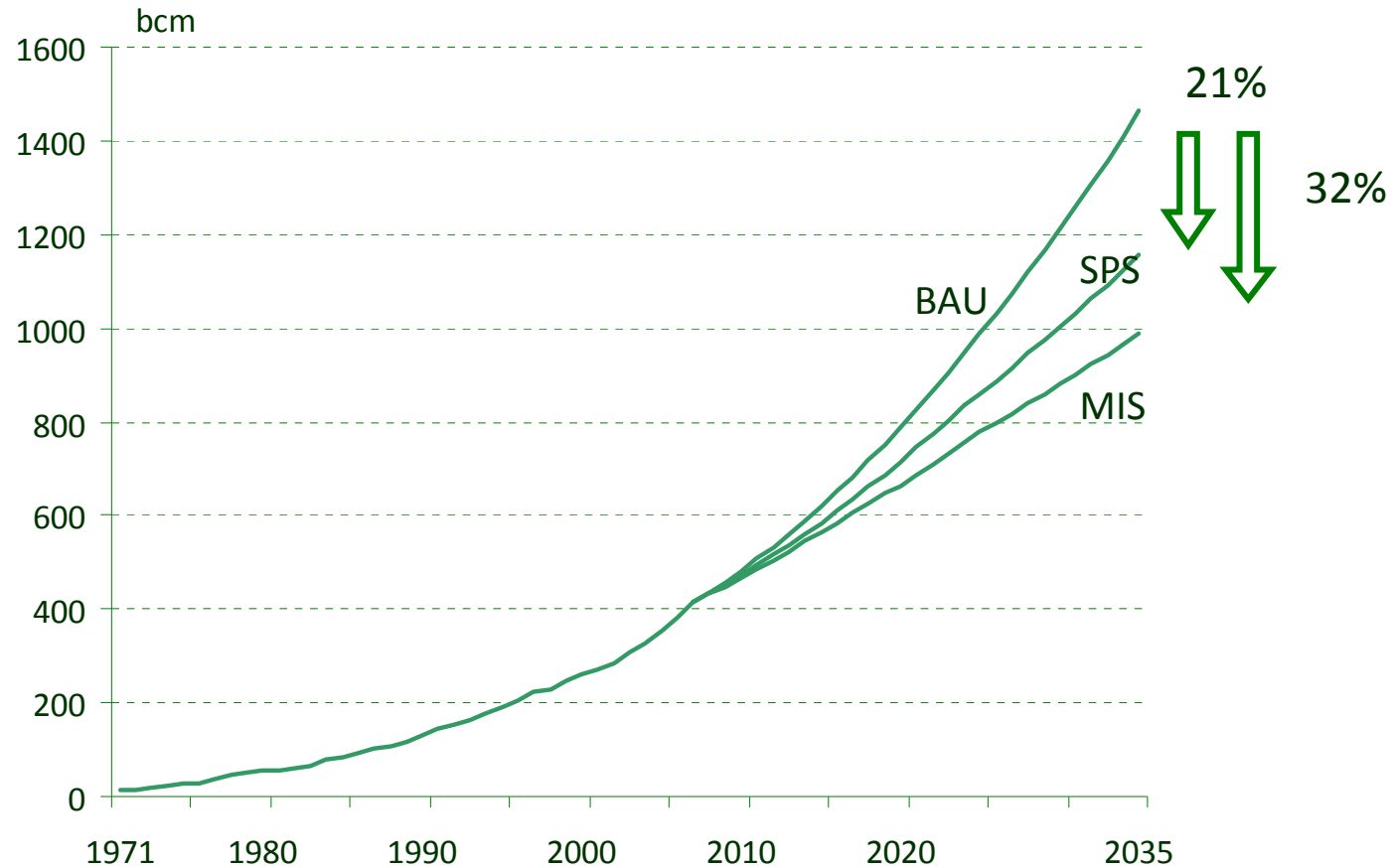
Oil Demand (Asia excl. Middle East)



■ Oil demand in Asia excluding Middle East will be reduced by 25%(MIS) and 15%(SPS) from BAU.

■ In MIS, oil demand will increase from 22 million b/d in 2008 to 31 million b/d in 2035.

Natural gas Demand (Asia excl. Middle East)



■ Natural gas demand in Asia excluding Middle East will be reduced by 32%(MIS) and 21%(SPS) from BAU.

■ In MIS, natural gas demand will increase from 410 bcm to 990 bcm(2.4-fold increase).



III. Energy Outlook for China

Assumptions : Nuclear

China

Generation Capacity, GW

	2007	2020	2030
BaU	9	48	80
Maximum Impact	9	80	130
Strong Policies	9	74	120

Power Generation, TWh

		2020	2030
BaU		354	595
Maximum Impact		595	967
Strong Policies		547	893

- We assume 80GW in 2020, which is an input from ERI, for the Maximum Impact Scenario.
- More moderate deployment is assumed for the BAU and Strong Policies Scenarios.

Assumptions : Renewable

China

Hydor Power Generation, TWh

	2008	2020	2035
BAU	585	810	1,088
Strong Policies	585	810	1,088
Maximum Impact	585	1,097	1,397

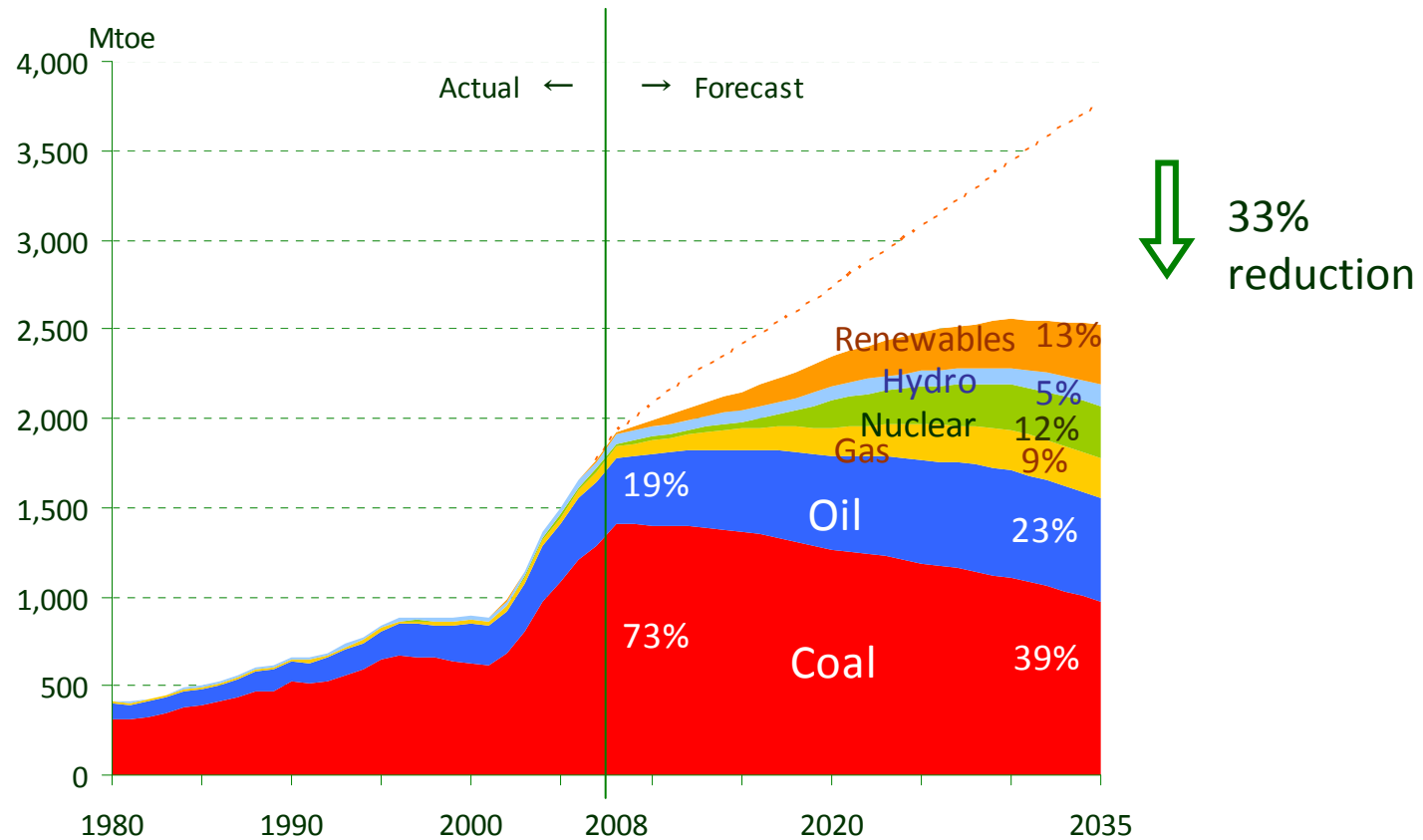
Wind, Solar etc. Power Generation, TWh

	2008	2020	2035
BAU	15	291	383
Strong Policies	15	377	580
Maximum Impact	15	497	1,546

- For BAU and Strong Policy scenarios, we used the Assumption of IEEJ Outlook (output from IEEJ Renewable model : “Reference Scenario” and “Technologically Advanced Scenario”).
- For the Maximum Impact Scenario, we assumed the same level of deployment as IEA’s 450 Scenario.

Maximum Impact Scenario : Primary energy demand

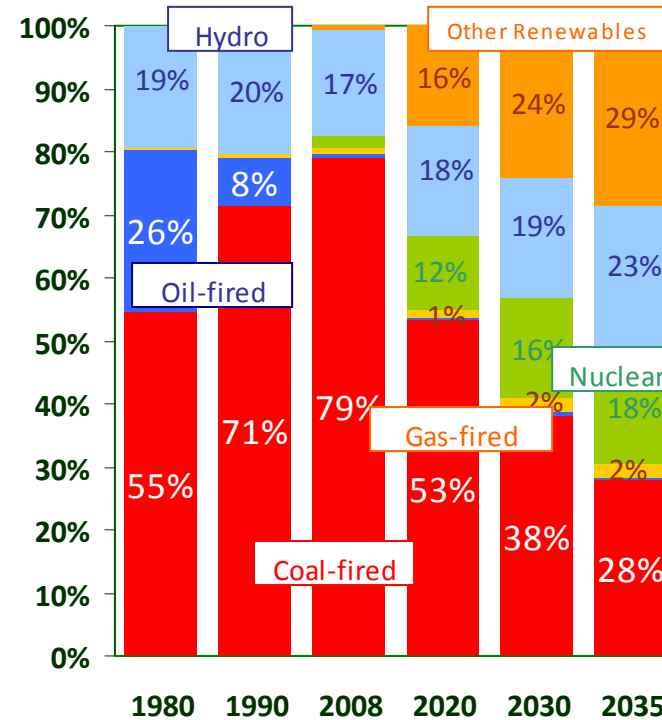
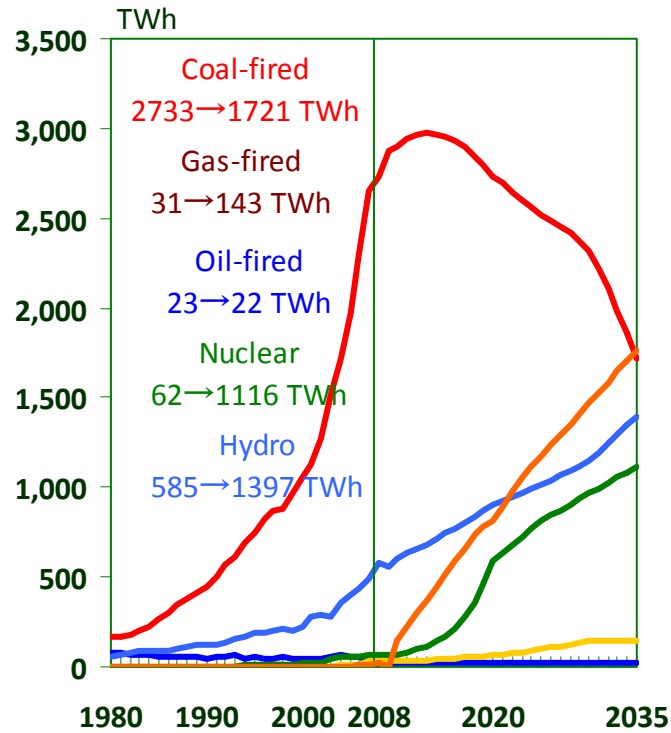
China



- Total primary energy demand will be reduced by 33% from the BAU scenario.
- In this case, coal consumption will decrease because of energy saving and large-scale deployment of nuclear and renewable energy.
- Total fossil fuel consumption will also peak before 2020.

Maximum Introduction Scenario : Electricity generation

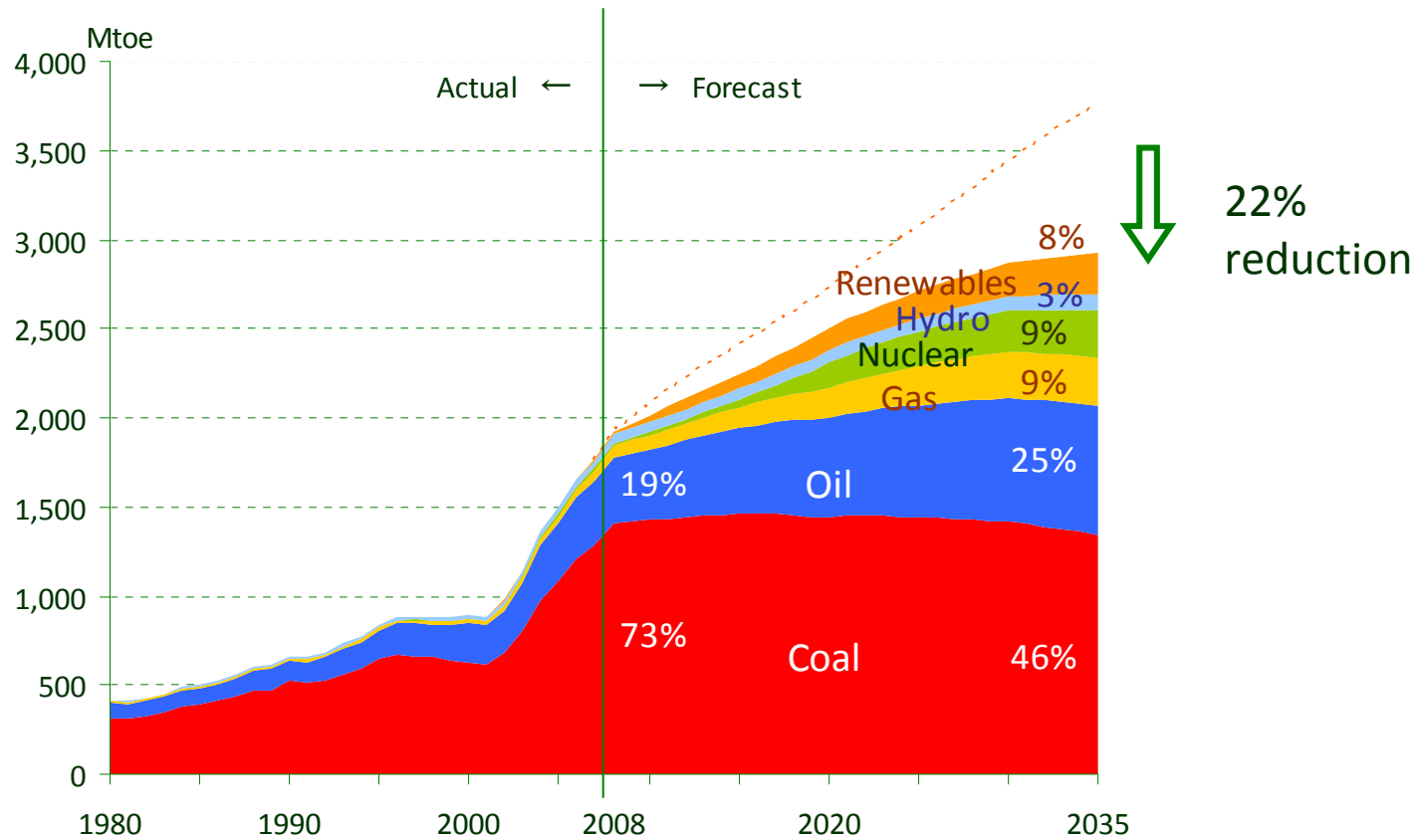
China



- Because of large scale deployment of nuclear and renewables, the share of coal-fired generation will decline to 28% in 2035.
- The share of zero emission power generation will reach 69% in 2035.

Strong Policies Scenario : Primary energy demand

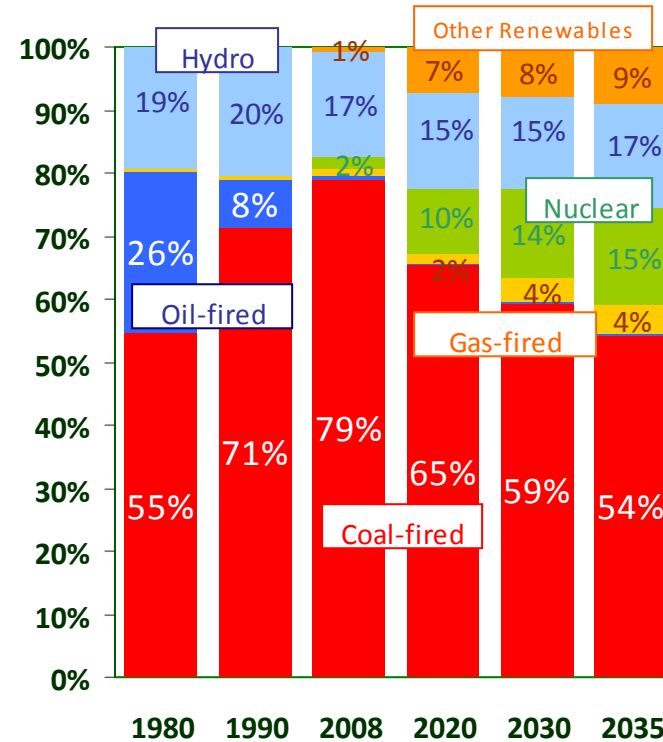
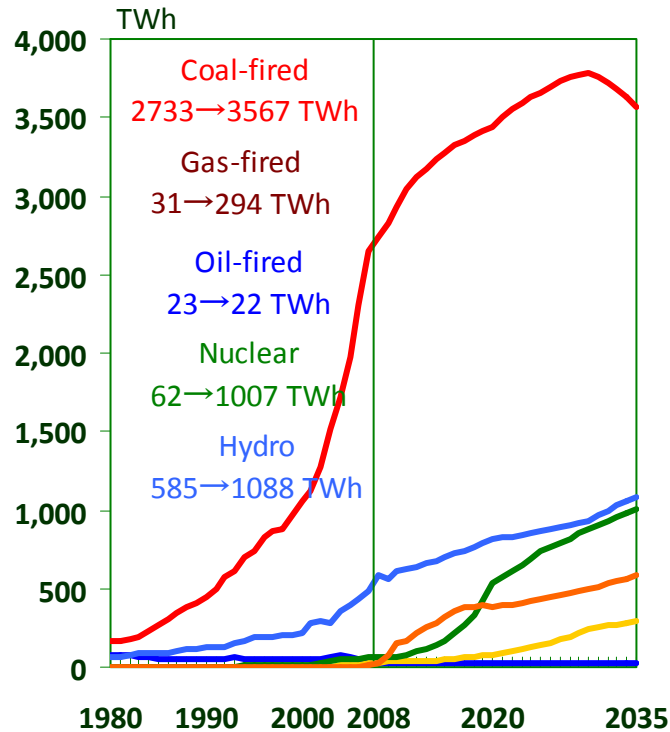
China



- Total primary energy demand will be reduced by 22% from the BAU scenario.
- Coal consumption will slightly decrease even in this scenario.

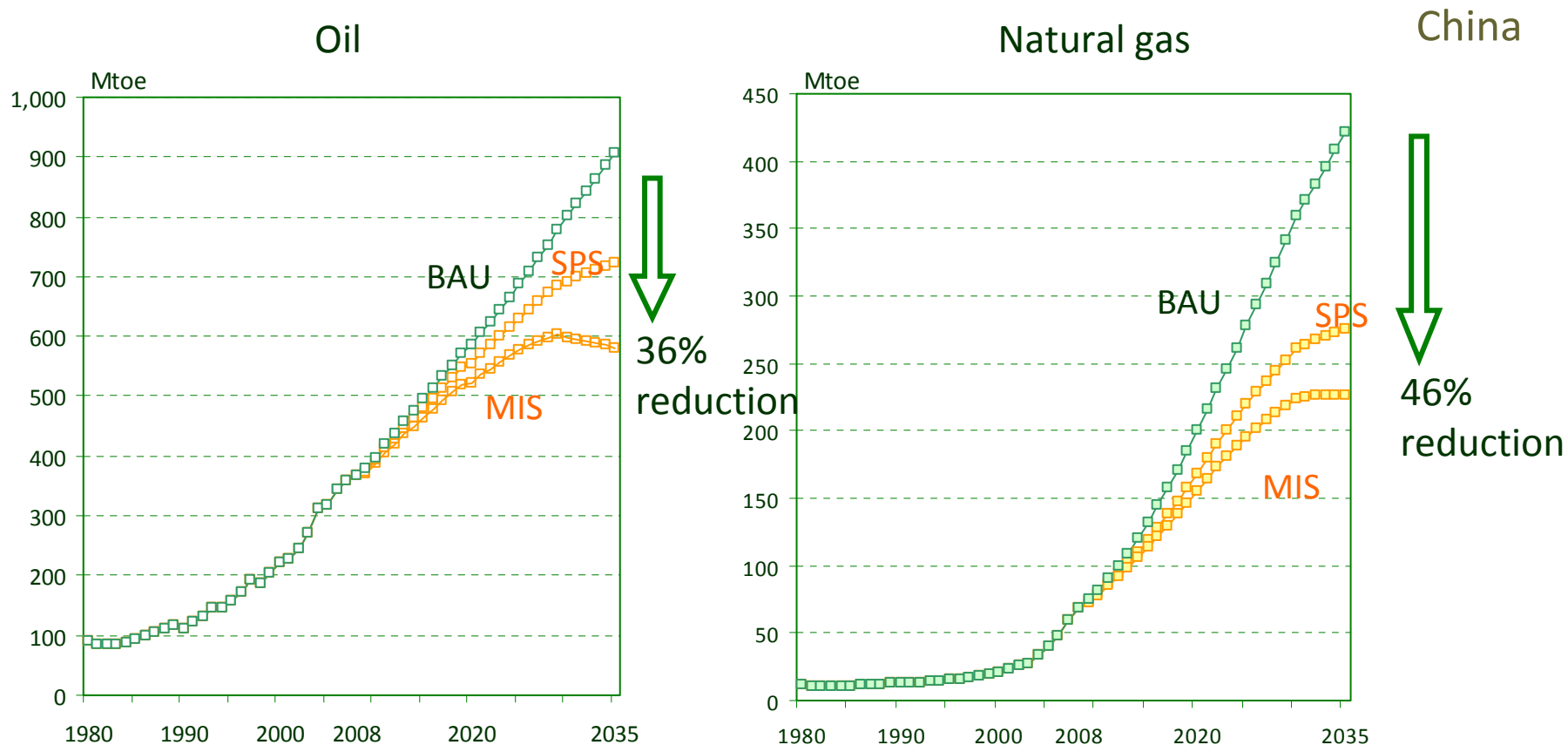
Strong Policies Scenario : Electricity generation

China



- In the Strong Policies Scenario, coal-fired generation will peak around 2030. But its share will remain more than 50%.
- The share of zero emission power generation will be 41% in 2035.

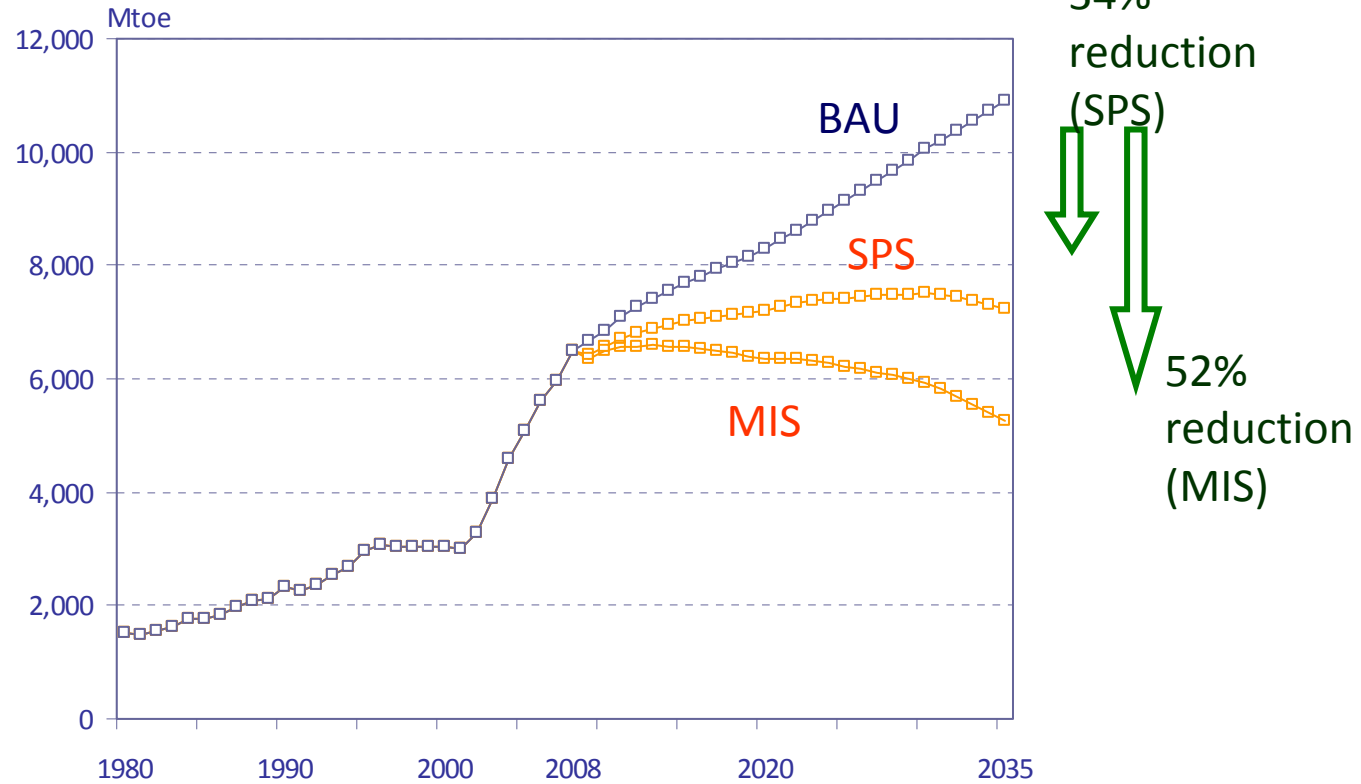
Oil and natural gas consumption



- Oil consumption will be reduced by 36% in MIS.
- China uses most part of natural gas for industry and buildings, thus has a large potentials for reduction in natural gas demand.
- Natural gas reduction depends on fuel switching.

CO₂ Emission

China



- CO₂ emission will be reduced by 34% (SPS) and 52% (MIS) from BAU in 2035.



IV. Energy Outlook for India

Assumption : Nuclear

India

Generation Capacity, GW

	2008	2020	2030
BaU	4	20	33
Maximum Impact	4	25	61
Strong Policies	4	23	47

Power Generation, TWh

		2020	2030
BaU		123	204
Maximum Impact		154	375
Strong Policies		138	289

- We assume moderate nuclear deployment for the BAU scenario(33 GW in 2030).
- LWRs is assumed to be constructed by foreign companies, and PHWRs to be constructed domestically.
- For the MIS, we assume nuclear deployment will achieve the highest plan of nuclear power (375 TWh in 2030).

Assumption : Renewable

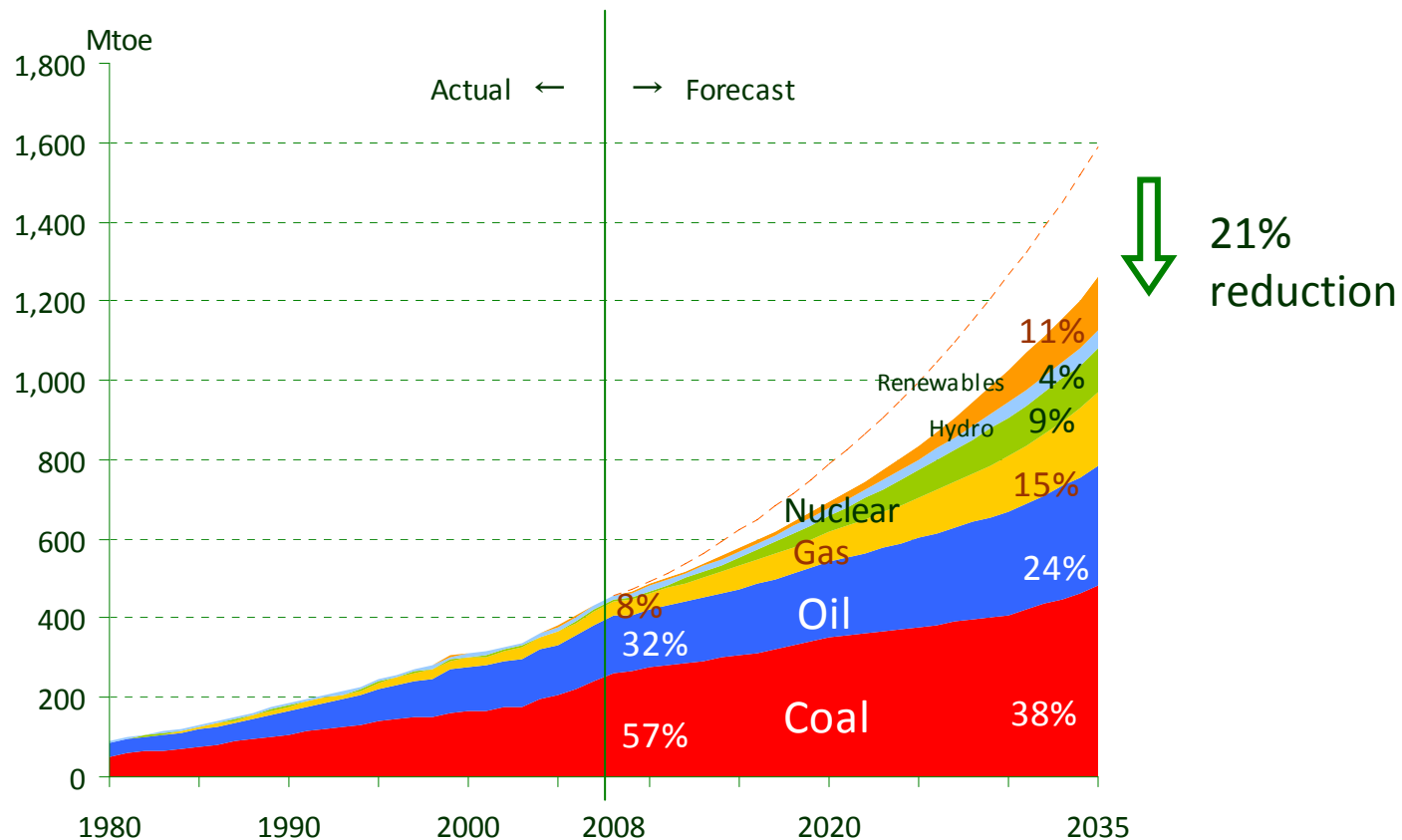
India

	PPAC Input	Maximum Impact assumption (2035)		
	Potentials, GW	GW	Load Factor	TWh
Solar	10	10	12%	11
Wind	30	30	20%	53
Biomass	50	30	50%	131
Hydro	–	–	–	520

- With PPAC input data for renewable generation capacity potentials, we set solar, wind and biomass generation capacity in 2035 to be 10GW, 30GW and 30GW each.
- For hydropower, we assumed the same level as IEA's 450 scenario (114 TWh in 2008 -- > 520 TWh in 2035) .
- For BAU and SPS, we used the Assumption of IEEJ Outlook (output from IEEJ Renewable model), that is 331TWh (BAU) and 369TWh (Strong Policies) in total in 2030.

Maximum Impact Scenario : Primary energy demand

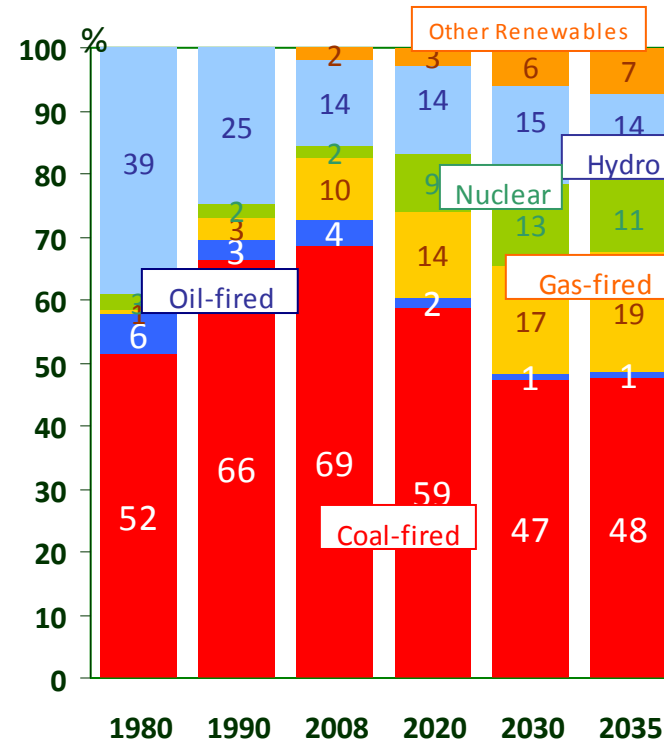
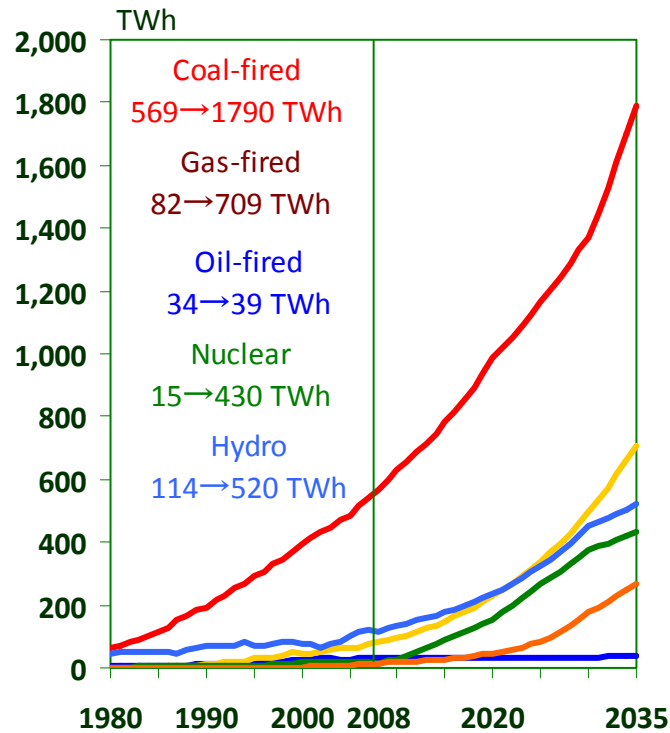
India



- Total primary energy demand will be reduced by 21% from the BAU scenario.
- Even in this case, the share of renewables will remain rather small (about 11% in 2035). Coal remains to have the largest share.

Maximum Introduction Scenario : Electricity generation

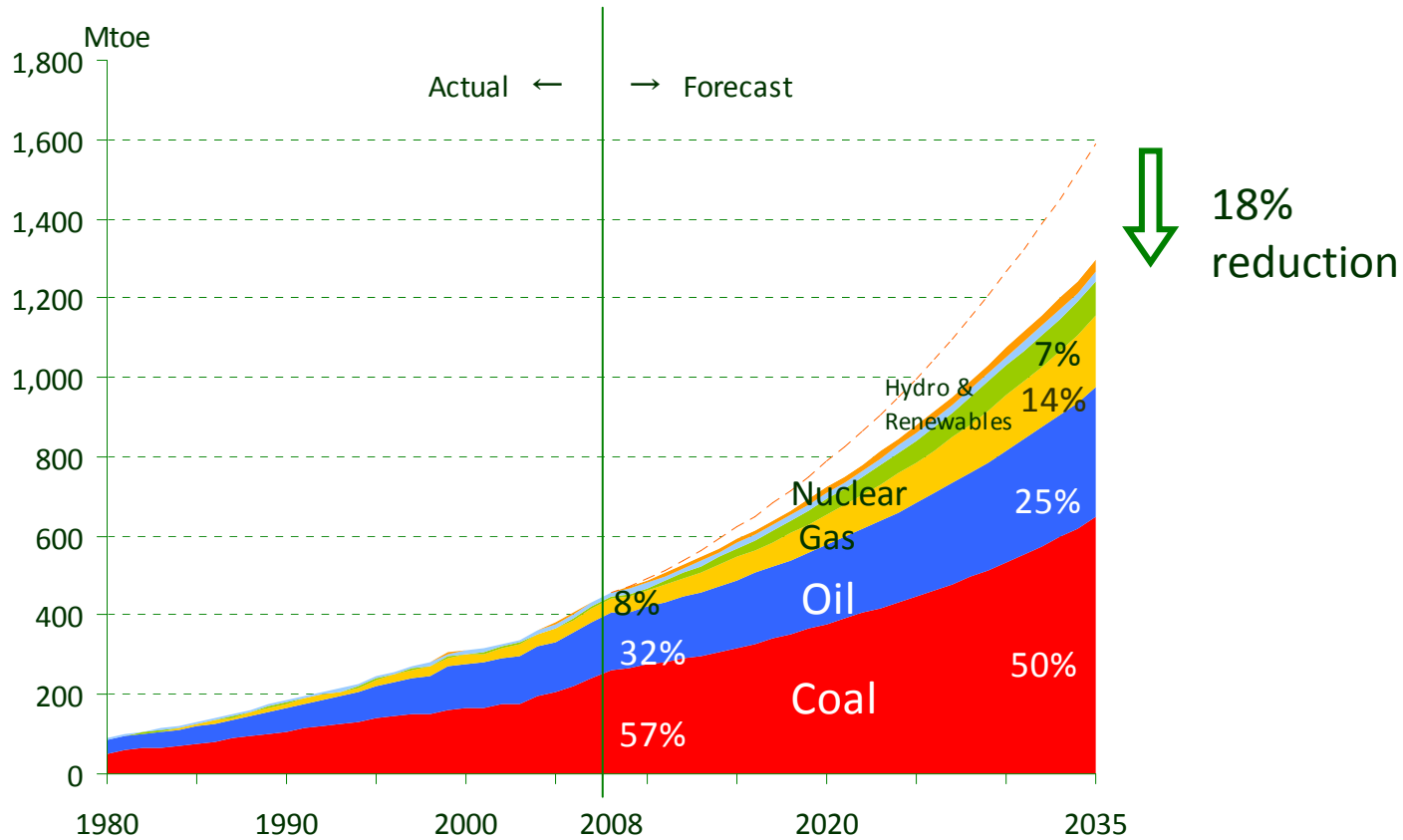
India



- The share of coal-fired generation will decline to 48% in 2035.
- Hydro and other renewable energy will increase their share.
- Zero emission power generation share (Nuclear, hydro and renewables) will be as large as 32% in 2035.

Strong Policies Scenario : Primary energy demand

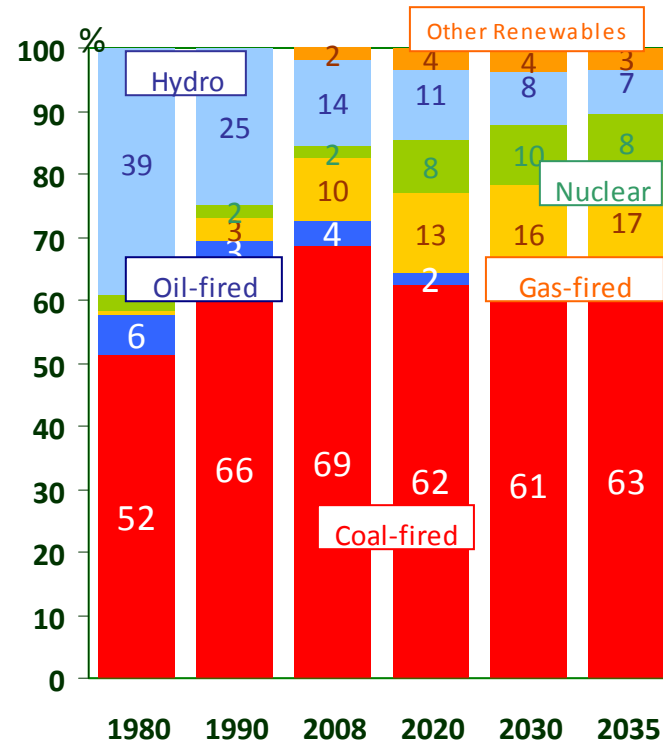
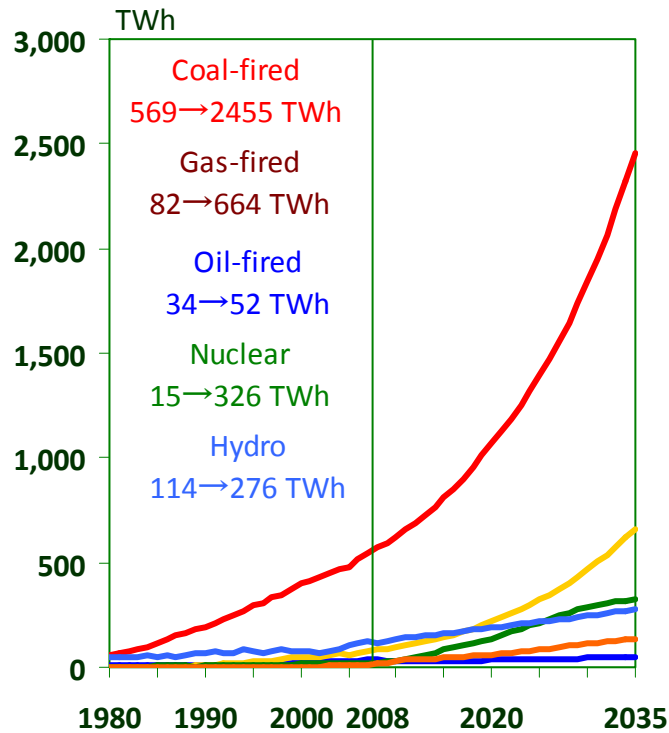
India



- Total primary energy demand will be reduced by 18% from the BAU scenario in 2035.
- The share of hydro and renewable in total will be only about 4% , and that of nuclear will be 7%, while that of coal will be 50%.

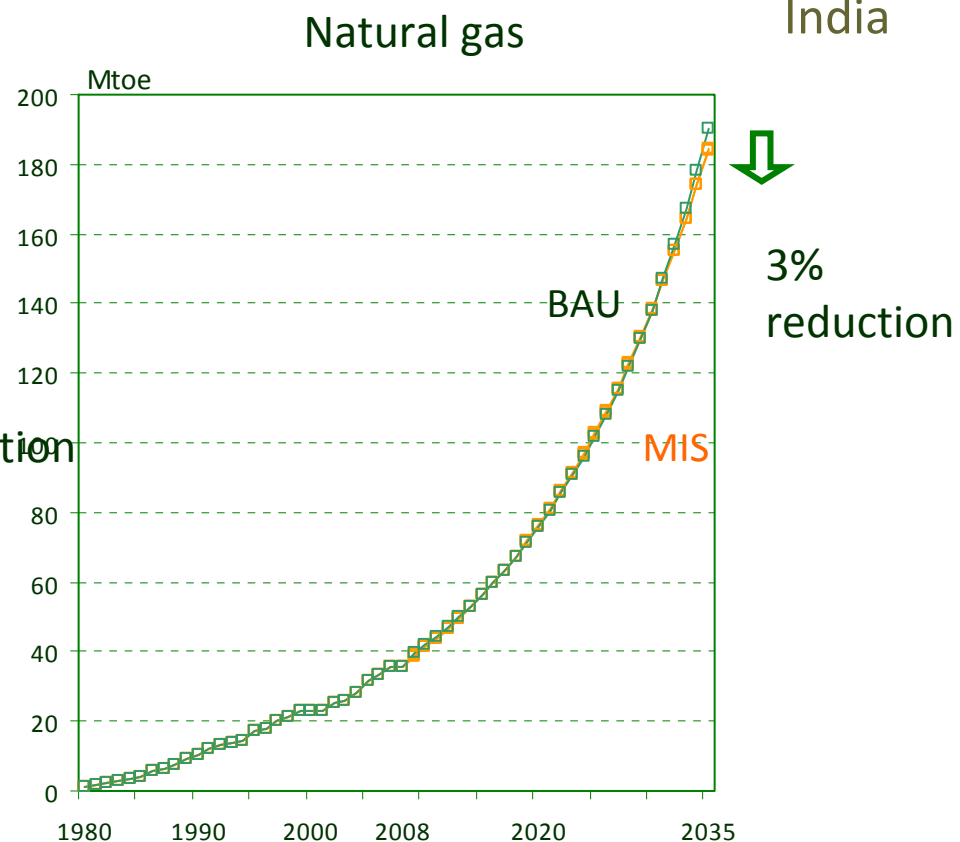
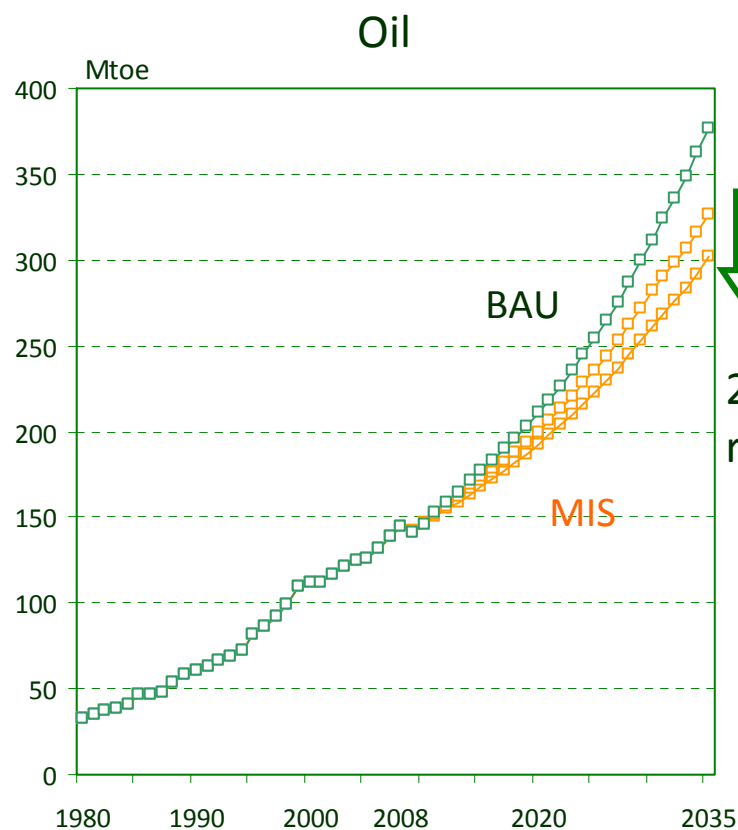
Strong Policies Scenario : Electricity generation

India



- The share of coal-fired generation will be over 60% even in 2035.
- The share of Zero emission power generation will be about 19% in 2035.

Oil and natural gas consumption

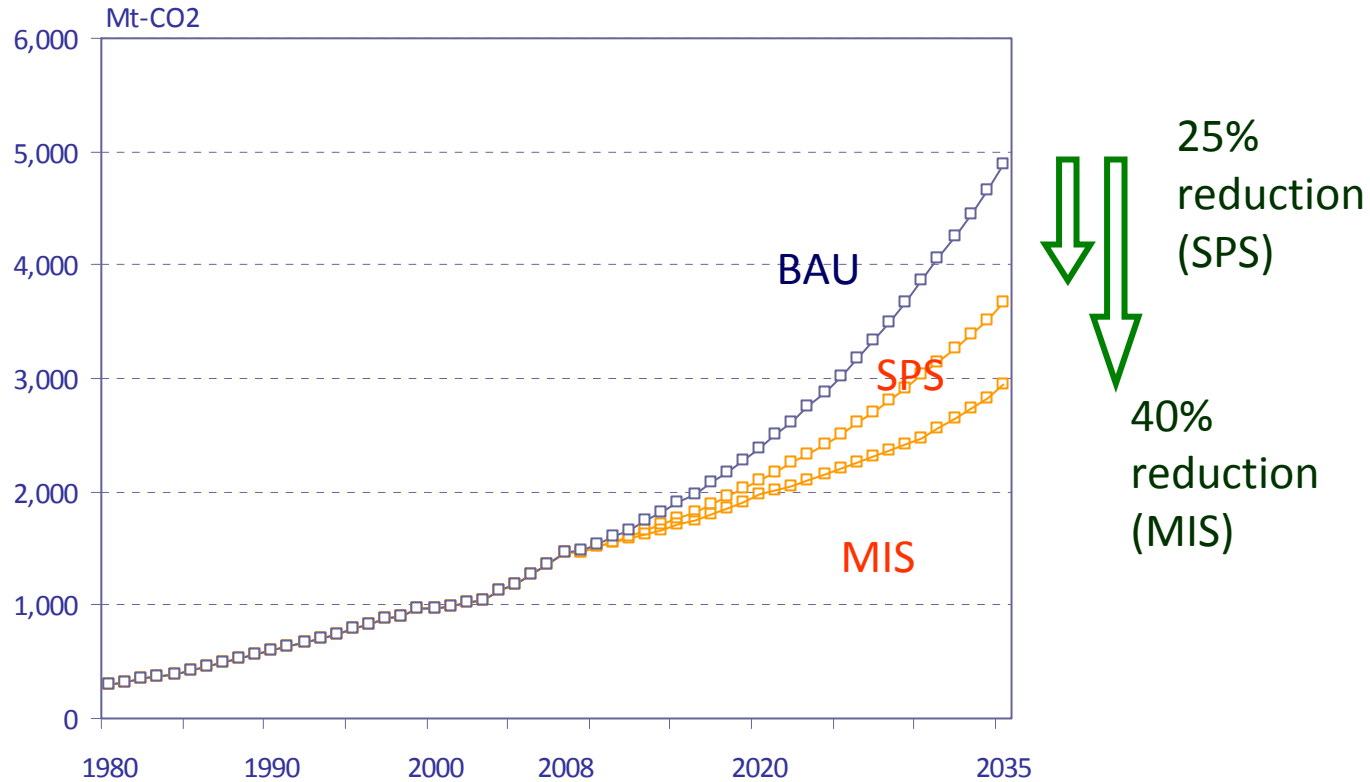


- Oil consumption will be reduced by 20% in 2035 in the Maximum Impact Scenario. Most reduction will come from those in the transport and industry sectors.

- Reduction in natural gas demand will be relatively small due to shift from coal to gas.

CO₂ Emission

India



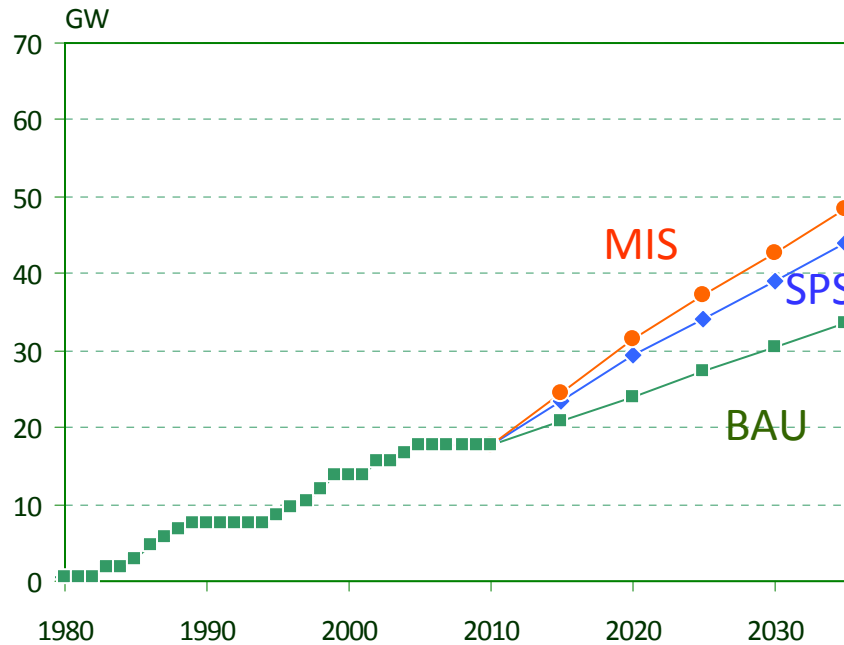
- CO₂ emission will be reduced by 25% (SPS) and 40% (MIS) from the BAU scenario in 2035. But Even in the Maximum Impact Scenario, CO₂ emission will keep growing.



V. Energy Outlook for South Korea

Assumption : Nuclear

South Korea



(GW)	2010	2020	2030	2035
BAU	18	24	30	34
MIS	18	32	43	48
SPS	18	29	39	44

- KEEl prospects 43GW nuclear capacity in 2030 (MIS).
- BAU assumes the historical trend of nuclear power plant construction will continue until 2035.

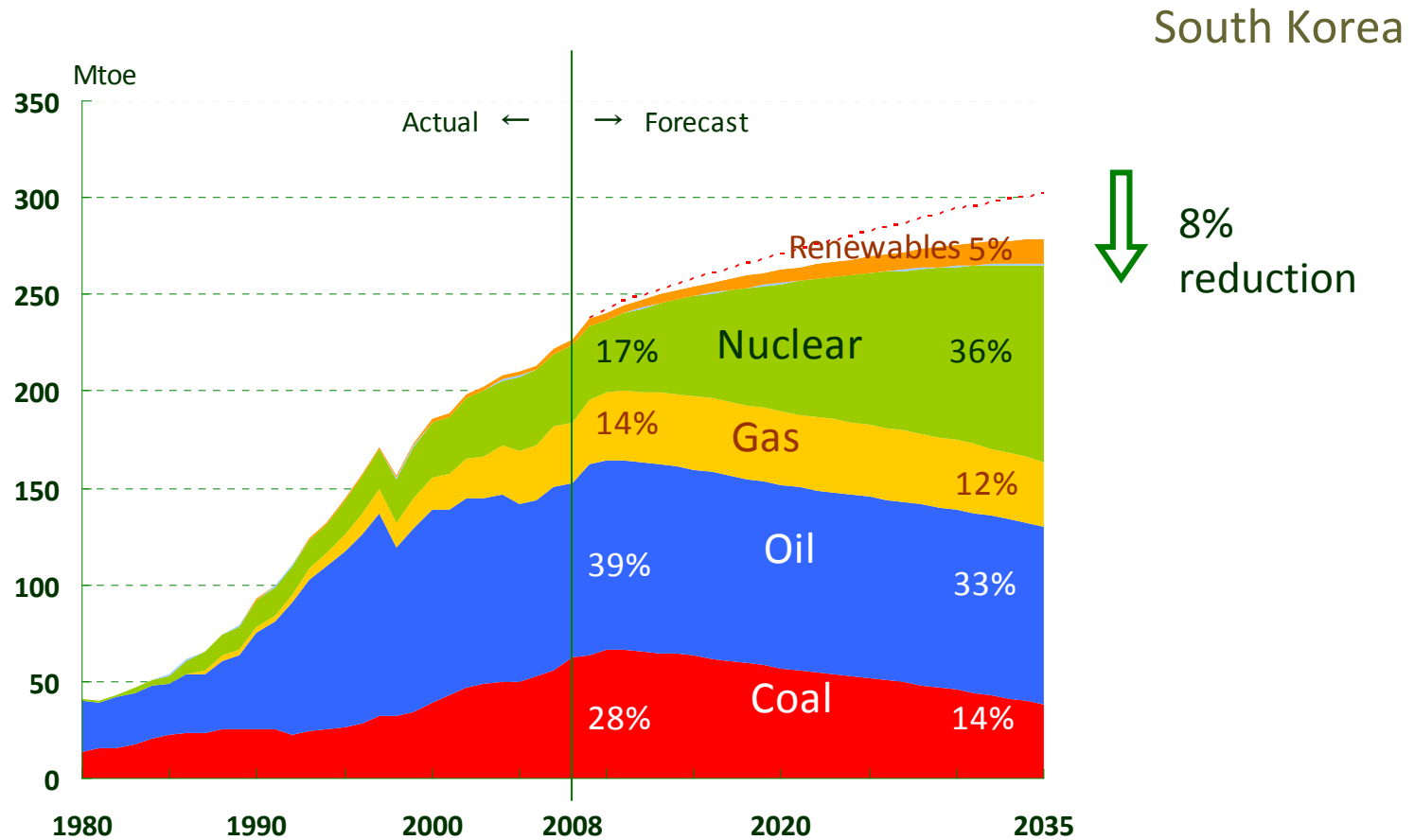
Assumption : Renewable

South Korea

Renewables (Hydro, Wind, Solar etc.) Power Generation, TWh			
	2008	2020	2035
BAU	5	10	25
MIS	5	20	66
SPS	5	11	50

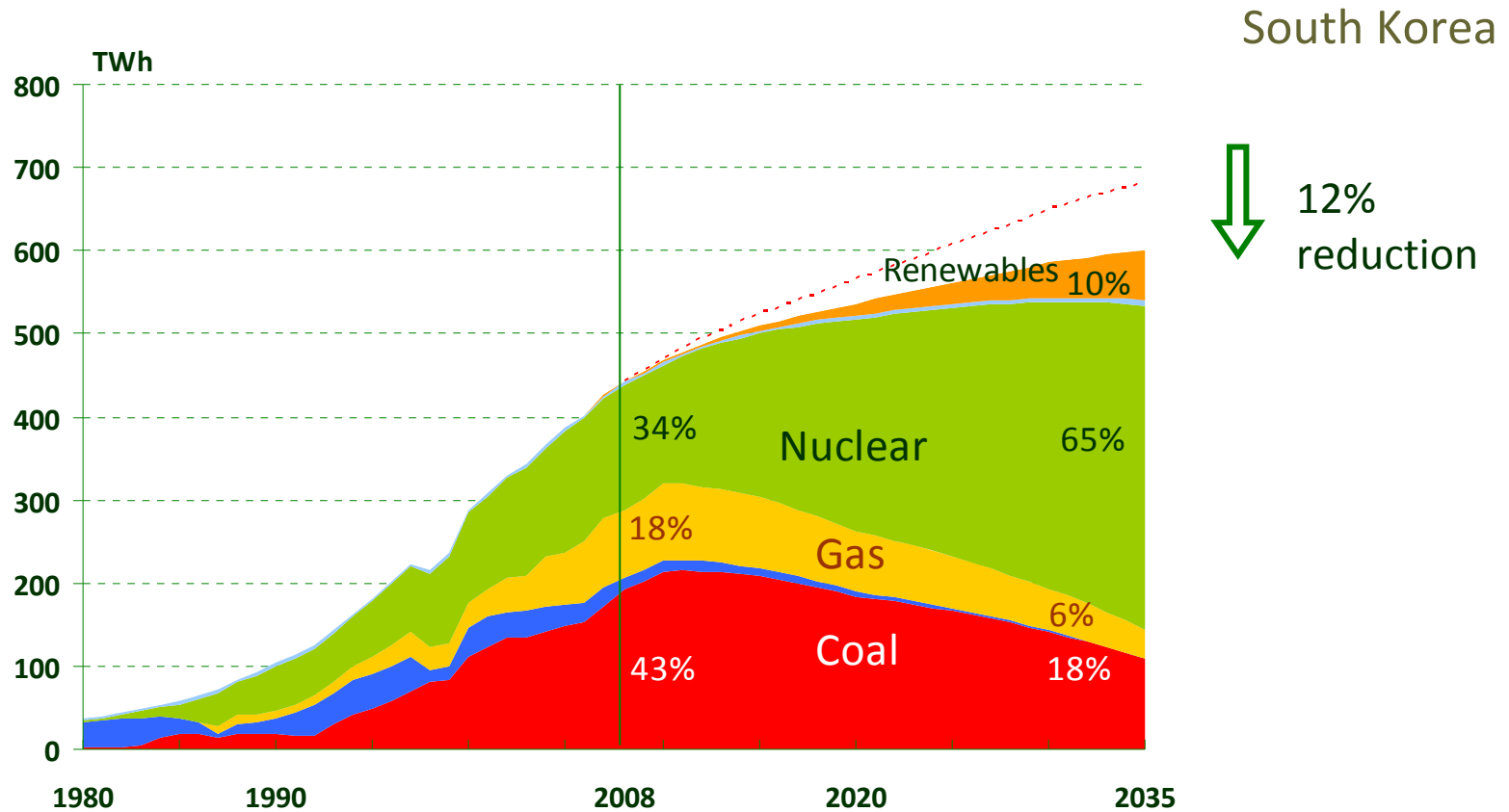
- For BAU and SPS, we used the assumption of IEEJ Outlook (output from IEEJ Renewable model), which is 25TWh for BAU and 66TWh for SPS in 2035.
- For the MIS, we assume the same level of deployment as IEA's 450 Scenario.

Maximum Impact Scenario : Primary energy demand



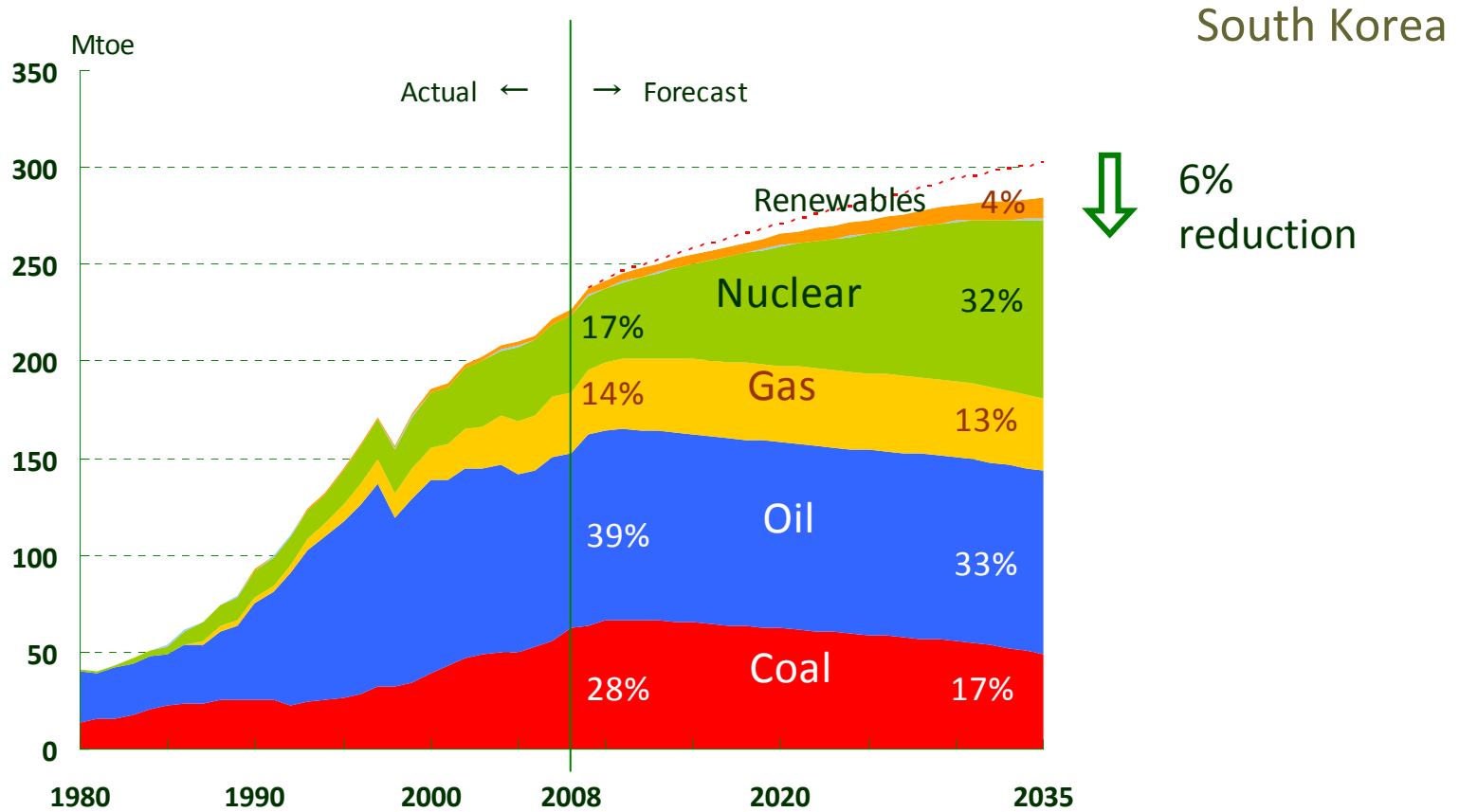
- Total primary energy demand will be reduced by 8% from BAU.
- The share of nuclear will reach 36% and that of fossil fuel will decline to 60% in 2035.

Maximum Impact Scenario : Electricity generation



- In MIS, electricity generation will be reduced by 12% in 2035.
- The share of nuclear power in the electricity generation mix will reach 65%, and that of fossil fuel will be 24%. Especially natural gas use will be reduced.

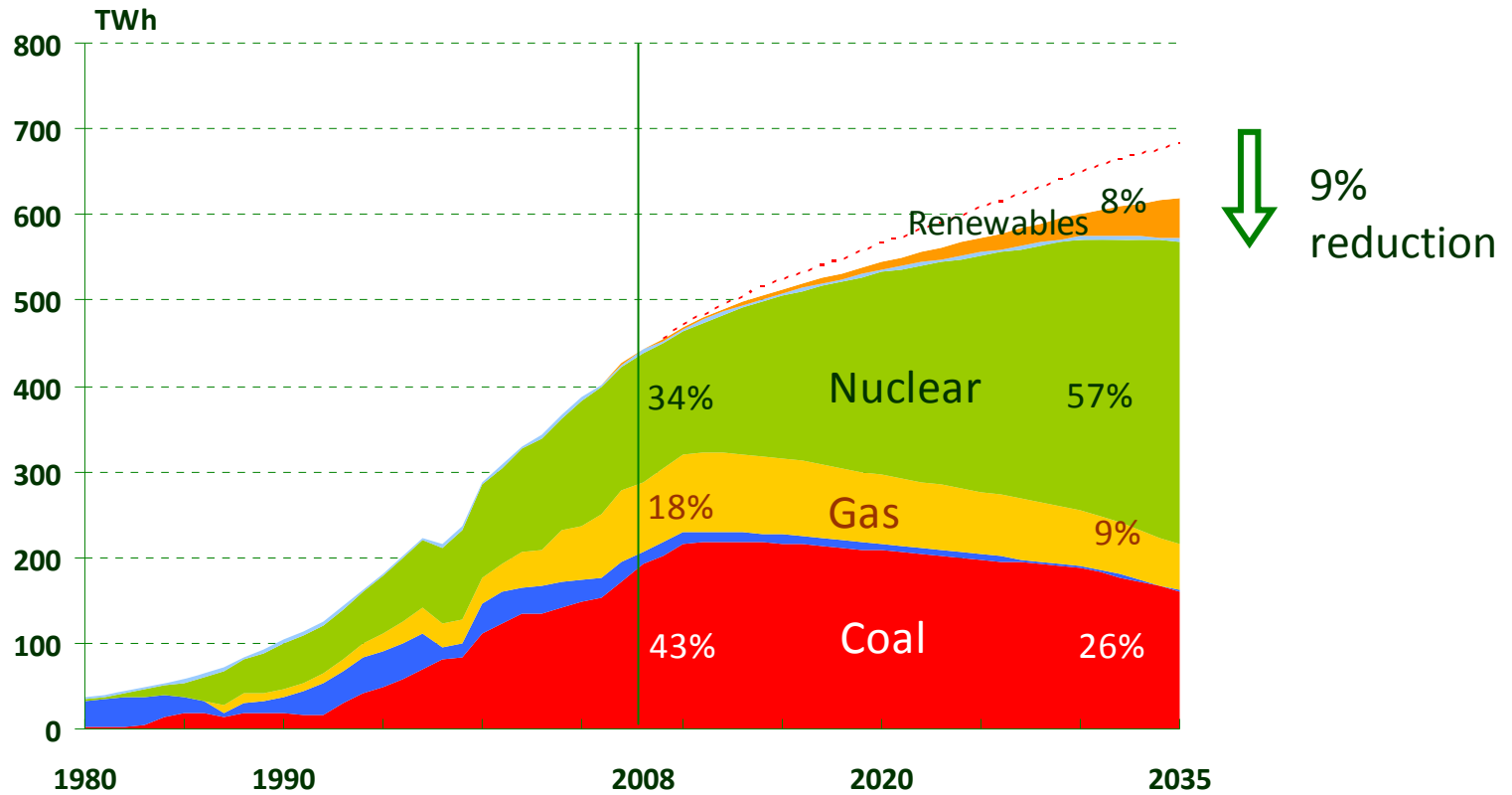
Strong Policies Scenario : Primary energy demand



- Total primary energy demand will be reduced by 6% from BAU in 2035.
- The share of nuclear will be 32%, and that of fossil fuel will be 64%.

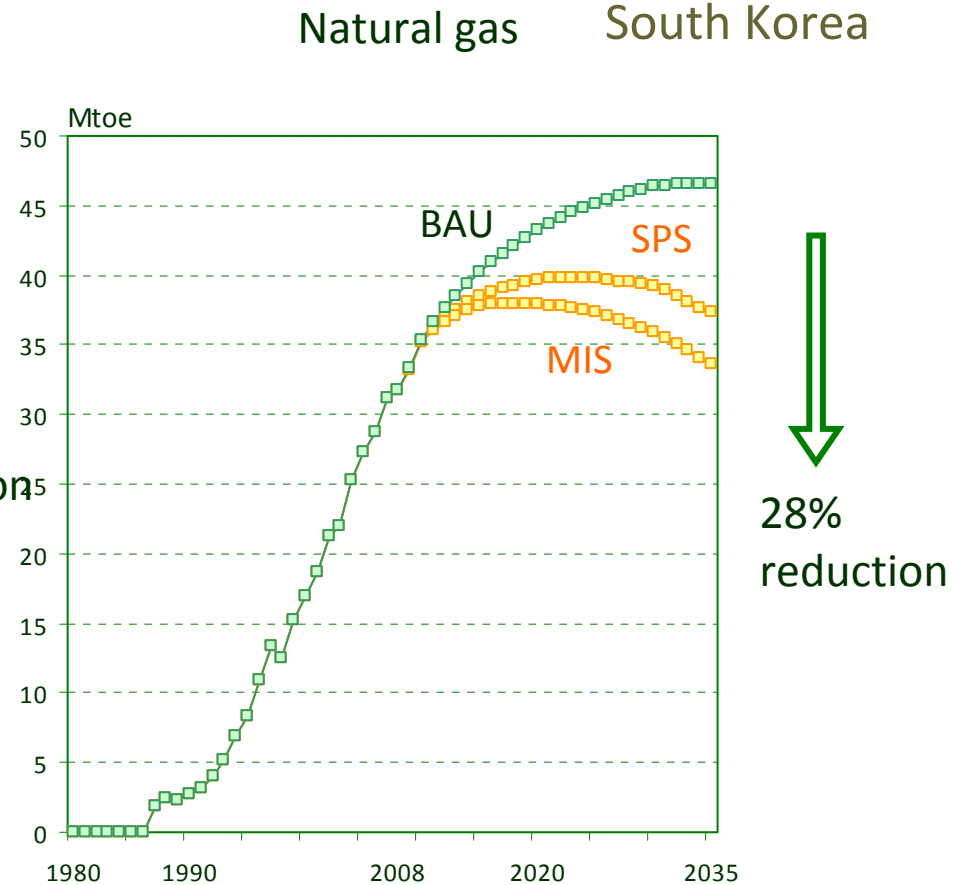
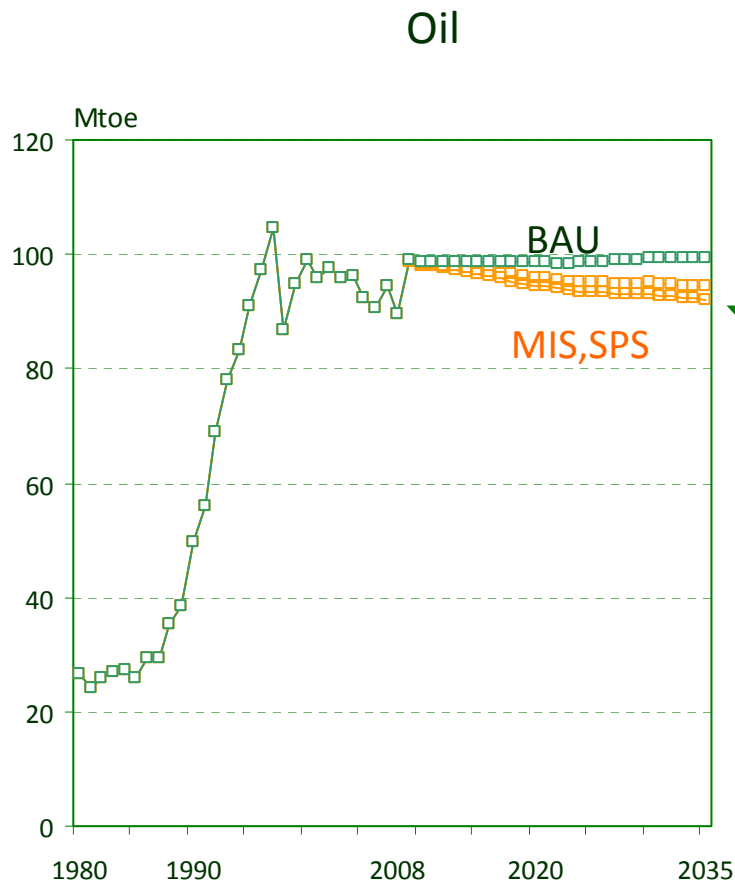
Strong Policies Scenario : Electricity generation

South Korea



- Electricity generation will be reduced by 9% in 2035 in SPS.
- The share of nuclear will be 57%, and that of fossil fuel will be only 35%.

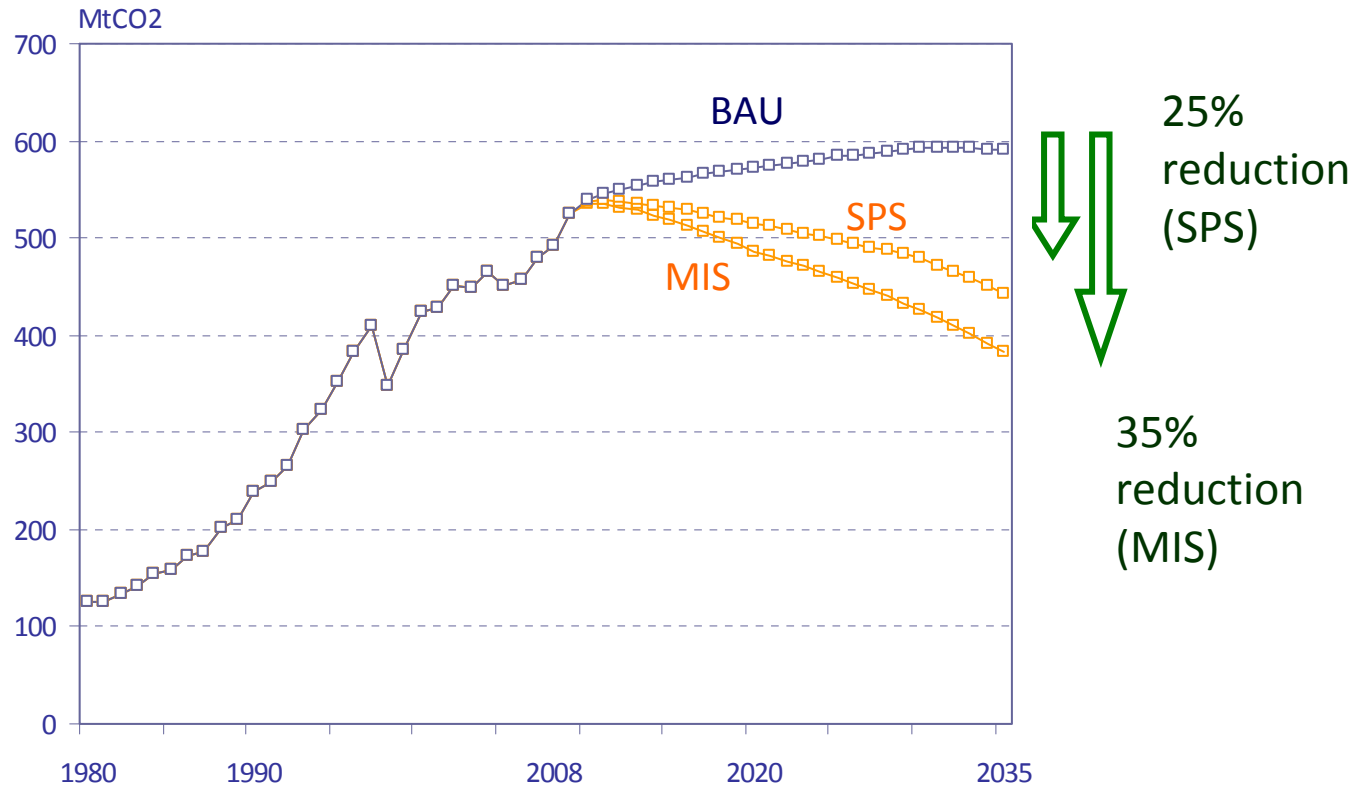
Oil and natural gas consumption



- Oil consumption will decrease in the future and will be reduced by 7% from BAU in 2035 in MIS.
- In MIS, natural gas consumption will peak before 2020 and then decrease towards 2035.

CO₂ emissions

South Korea



- CO₂ emission will be reduced by 35%(MIS) and 25%(SPS) from BAU in 2035.
- From 2008 to 2035, CO₂ emission will increase by 20% in BAU, while it will decrease by 10% and 22% in SPS and MIS.



VI. Energy Outlook for Japan

Assumption : Maximum Impact Scenario

Japan

Basic Energy Plan (approved by the Cabinet in June 2010)

Nuclear Power

- Construct 9 units by 2020, more than 14 units by 2030.
- Load factor target : 85% in 2020, 90% in 2030.

Renewable energy

- 10% in primary energy mix (2020) – Introduction of FIT system.
- 3% bioethanol in 2020.

Other Policies

- Clean energy vehicles share (sales) : 50% by 2020, 70% by 2030.
- Halve CO₂ from the residential sector by 2030.
- Fuel switching from coal, oil to natural gas.

By implementing these policies, CO₂ from energy use is targeted to be reduced by more than 30% from 1990 level.

Nuclear : construction plan

Japan

Operator	Plant Name	Output (10 ⁴ kWe; gross)	Date of Starting Construction	Date of Starting Operation	Reactor Type
Touhoku	Namie Odaka	82.5	FY H28	FY H33	BWR
	Higashidori-2	138.5	after FY H28	after FY H33	ABWR
Tokyo	Fukushima I-7	138.0	Apr. H24	Oct. H28	ABWR
	Fukushima I-8	138.0	Apr. H24	Oct. H29	ABWR
	Higashidori-1	138.5	Dec. H22	Mar. H29	ABWR
	Higashidori-2	138.5	after FY H26	after FY H32	ABWR
Chubu	Hamaoka-6	140 class	FY H27	after FY H32	ABWR
Chugoku	Shimane-3	137.3	Dec. H17	Dec. H23	ABWR
	Kaminozeki-1	137.3	Jun. H24	Mar H30	ABWR
	Kaminozeki-2	137.3	FY H29	FY H34	ABWR
Kyushu	Sendai-3	159.0	FY H25	FY H31	APWR
J-Power	Ohma	138.3	May H20	Nov. H26	ABWR
JAPC	Tsuruga-3	153.8	Oct. FY H22	Mar. H29	APWR
	Tsuruga-4	153.8	Oct. FY H22	Mar. H28	APWR
Total 19.308 GWe					

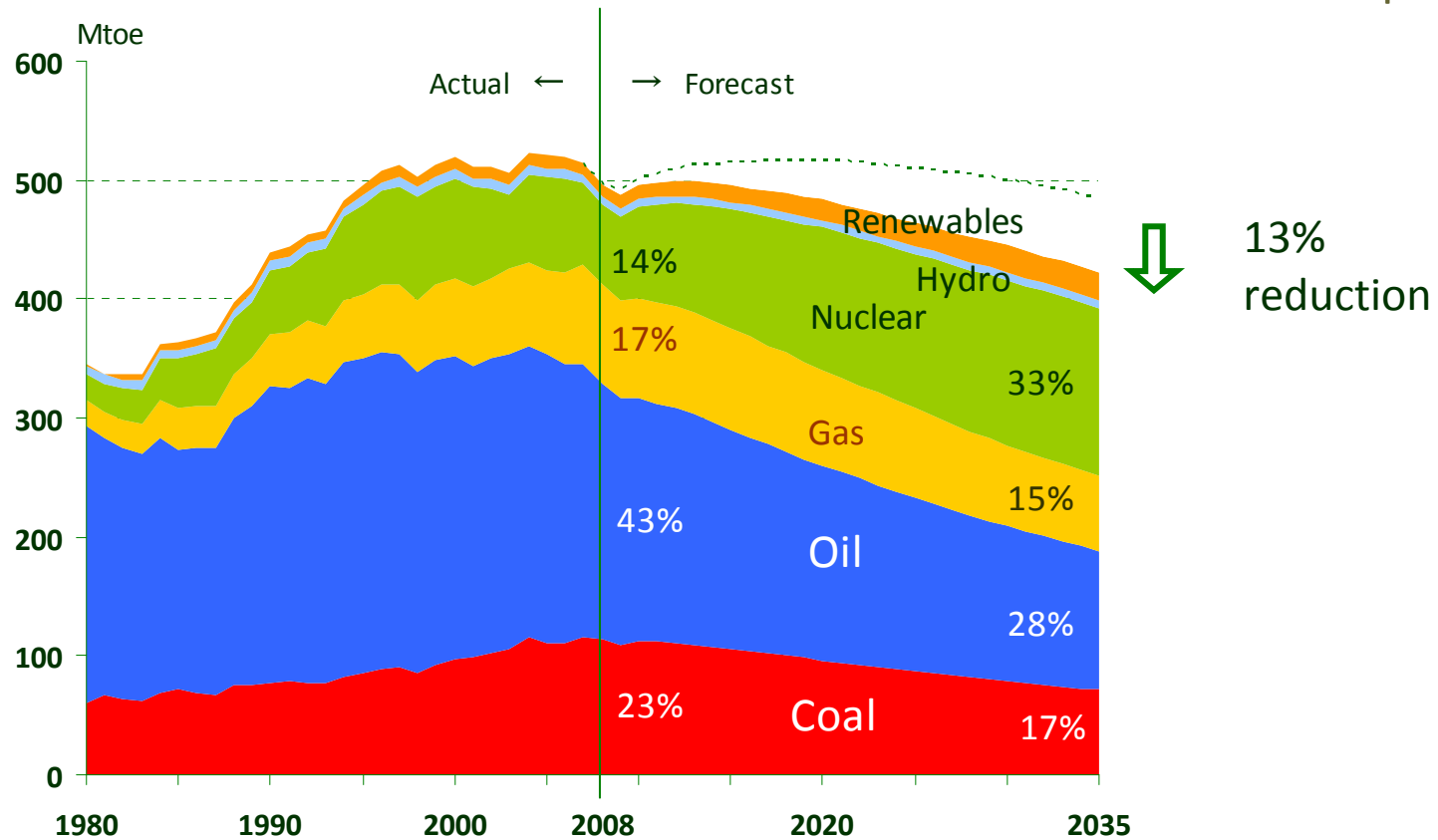
H12 (Heisei 12) = 2000

H22 (Heisei 22) = 2010

- 14 Units, 19.3GW capacity is planned to be constructed by 2030.

Maximum Impact Scenario : Primary energy demand

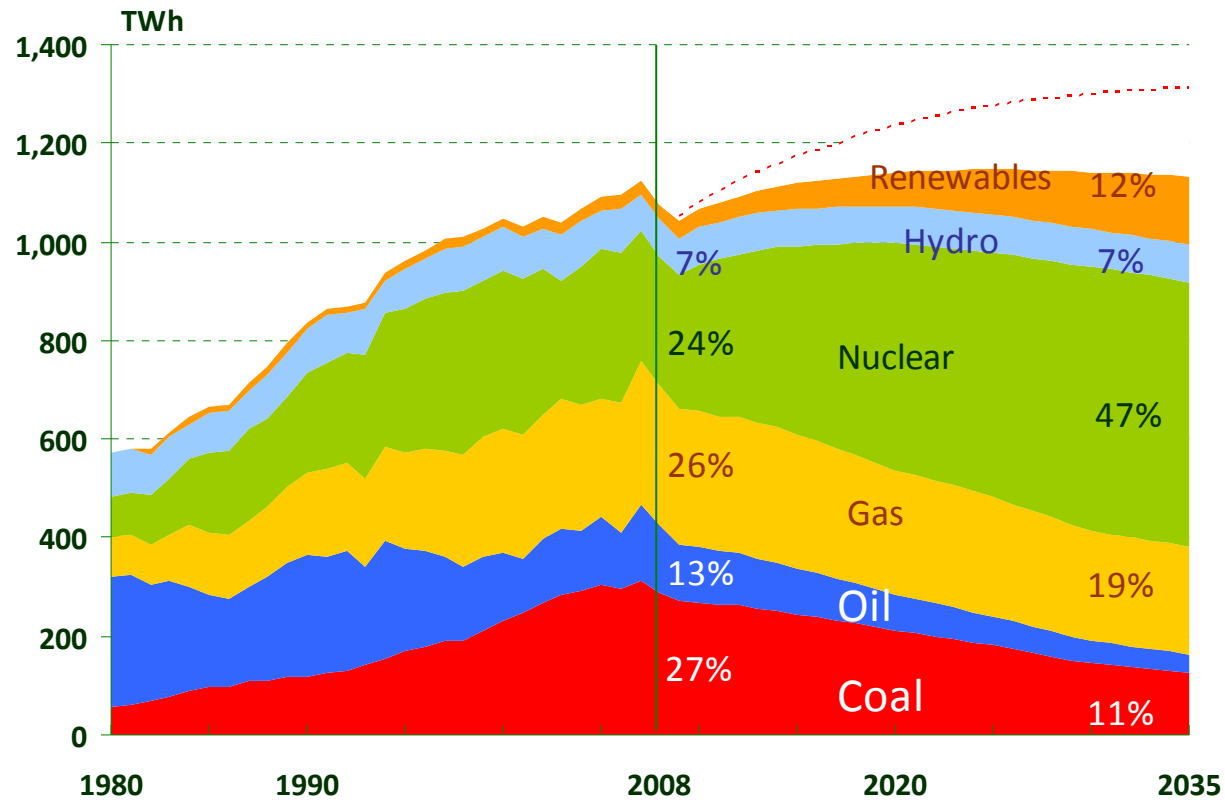
Japan



- Total primary energy demand will be reduced by 13% from the BAU scenario.
- Renewable and hydro will have 8% share in TPE in 2035. The share of fossil fuel will decrease to 60%.

Maximum Impact Scenario : Electricity Generation

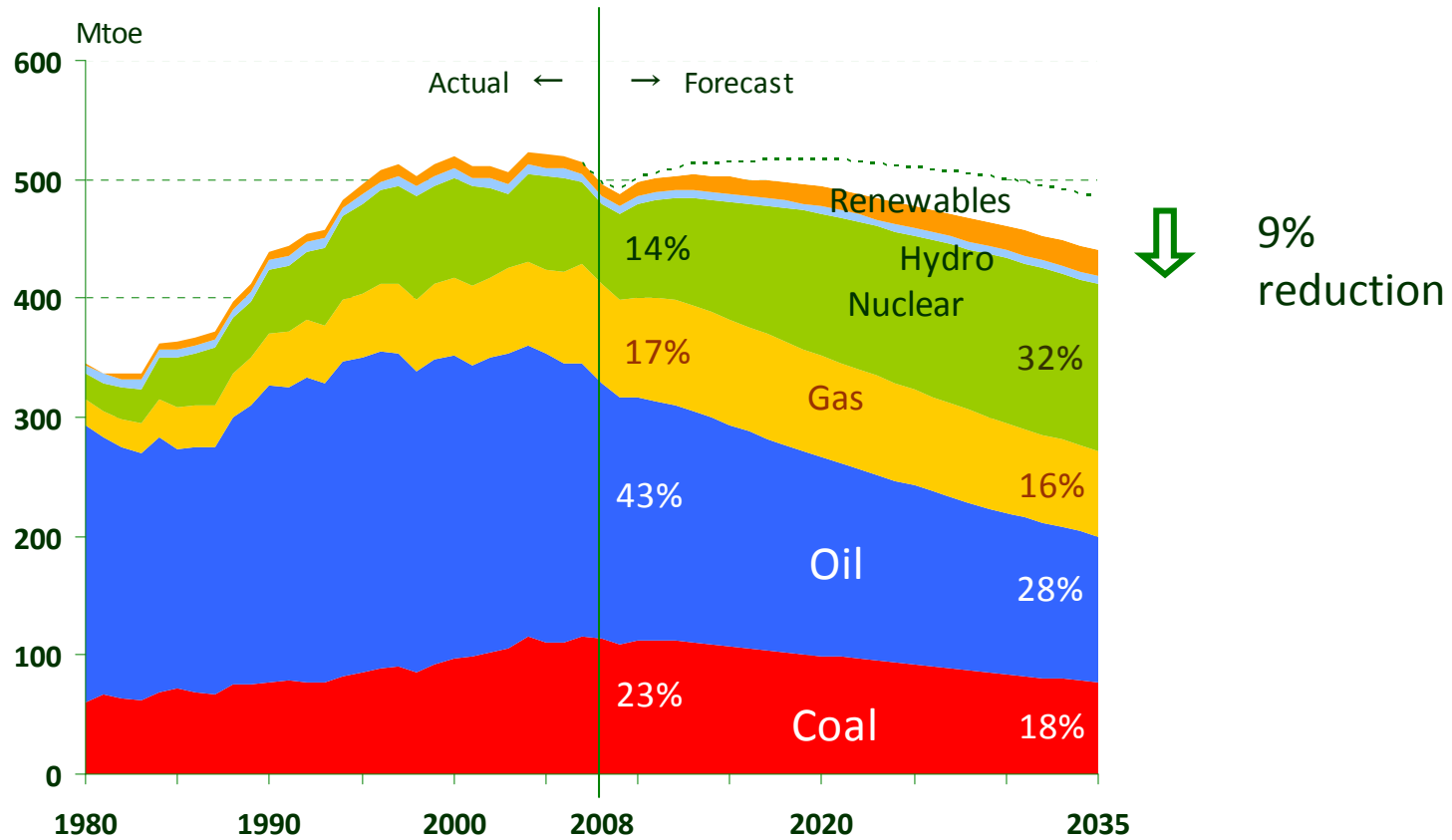
Japan



- The share of nuclear will be 47% in 2035.
- The share of renewable and hydro will be 20%, and that of fossil fuel will be 34%.

Strong Policies Scenario : Primary energy demand

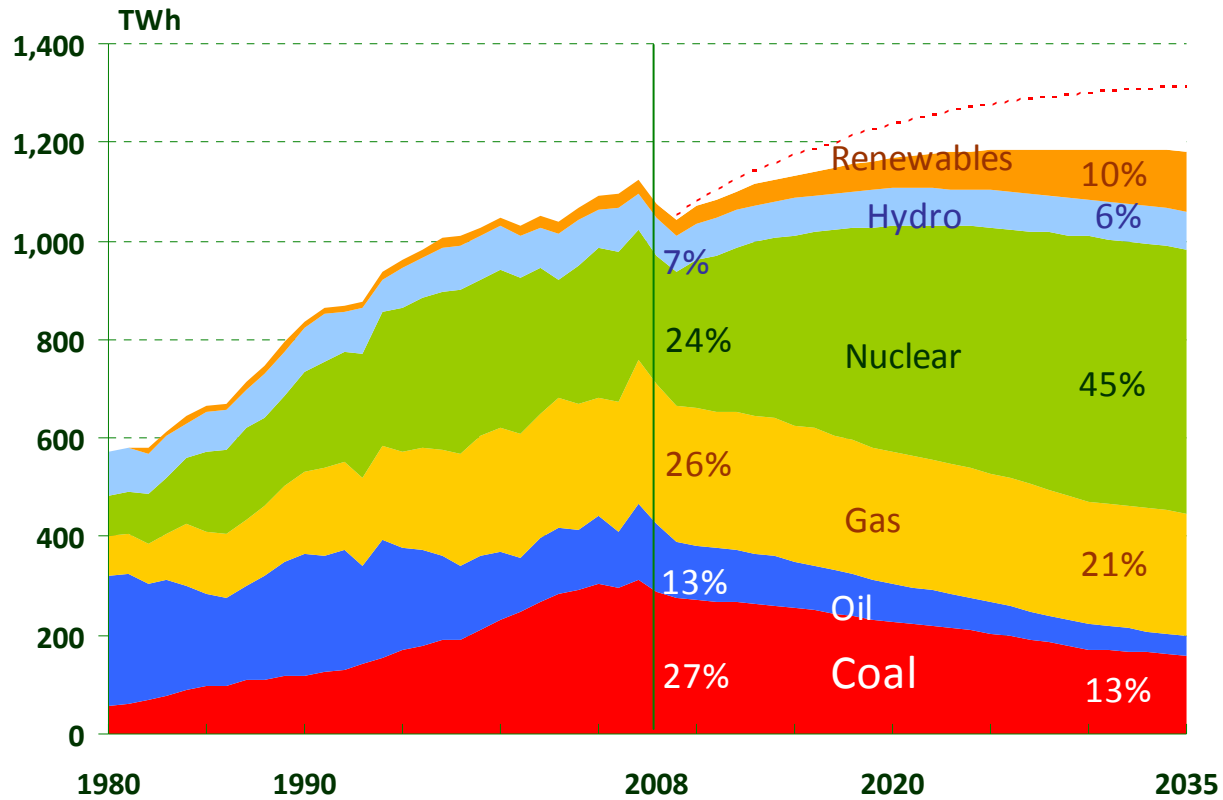
Japan



- Total primary energy demand will be reduced by 9% from the BAU scenario.
- Renewable and hydro will have 7% share in 2035. The share of fossil fuel will decrease to 62%.

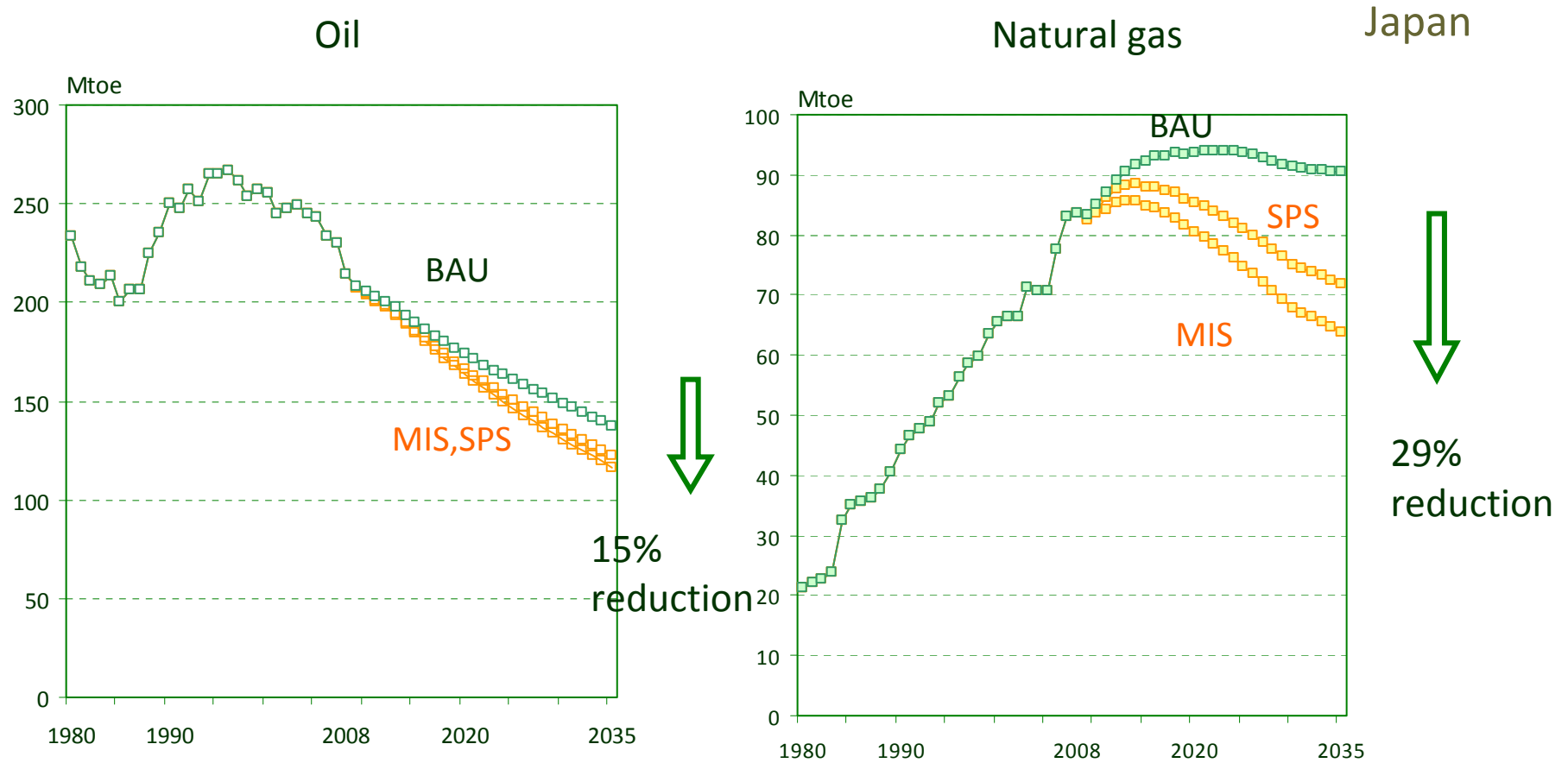
Strong Policies Scenario : Electricity generation

Japan



- The share of nuclear will be 45% in 2035.
- The share of renewable and hydro will be 16%, and that of fossil fuel will be 38%.

Oil and natural gas consumption



- In MIS, oil consumption will be reduced by 15% from BAU in 2035. It will be a 36% decrease from the current level.
- Reduction in natural gas demand will be 29% from BAU.