



REPUBLIC of ARMENIA

An aerial night photograph of a city, likely Yerevan, Armenia. The city is illuminated with numerous lights, creating a vibrant scene. In the center, a prominent building with a large, illuminated dome is visible. The surrounding buildings and streets are also lit up, with a mix of warm and cool tones. The overall atmosphere is that of a bustling city at night.

**Innovative Nuclear Reactors Implementation in the Armenian
Energy Sector**

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25-26, JUNE, 2007

Power Sector

Installed capacity

Armenian NPP	815 (440) MW
Hrazdan TPP	1100 MW
Yerevan TPP	550 MW
Sevan-Hrazdan cascade of HPPs	550 MW
Vorotan cascade of HPPs	400 MW
Small HPPs	100 MW

Transmission system

220 kV	1323 km	14 substations
110 kV	3169 km	119 substations
Interconnections with all neighboring countries		

Distribution system

35 kV	2675 km	278 substations
6(10) kV	9740 km overhead and 4955 km cable lines	
0.4 kV	13570 km overhead and 2160 km cable lines	

Main System Interconnections

- ✓ **Armenia-Iran 220 kV** transmission line, built in 1997, 150-200 MW capacity, 360 mln. kWh/ year power exchange contract. Starting 2003, line capacity increase to 300 MW
- ✓ **Armenia-Georgia 220 kV** transmission line, 250 MW capacity,
- ✓ **Armenia-Azerbaijan 330 kV** transmission line, 420 MW capacity, currently disconnected
- ✓ **Armenia-Turkey 220 kV** transmission line, 300 MW capacity, currently disconnected

The Power System Scheme



Gas sector

Transmission system

Length	1800 km
Pressure	12-55 bar
Substations	67 units
Abovyan underground storage	220 mln. cub.m (design capacity)
	140 mln. cub. m (oper. capacity)

Distribution system

High pressure (6-12 bar)	558 km
Medium pressure (0.05-6 bar)	2656 km
Low pressure	6041 km

Evolution of the Energy Sector

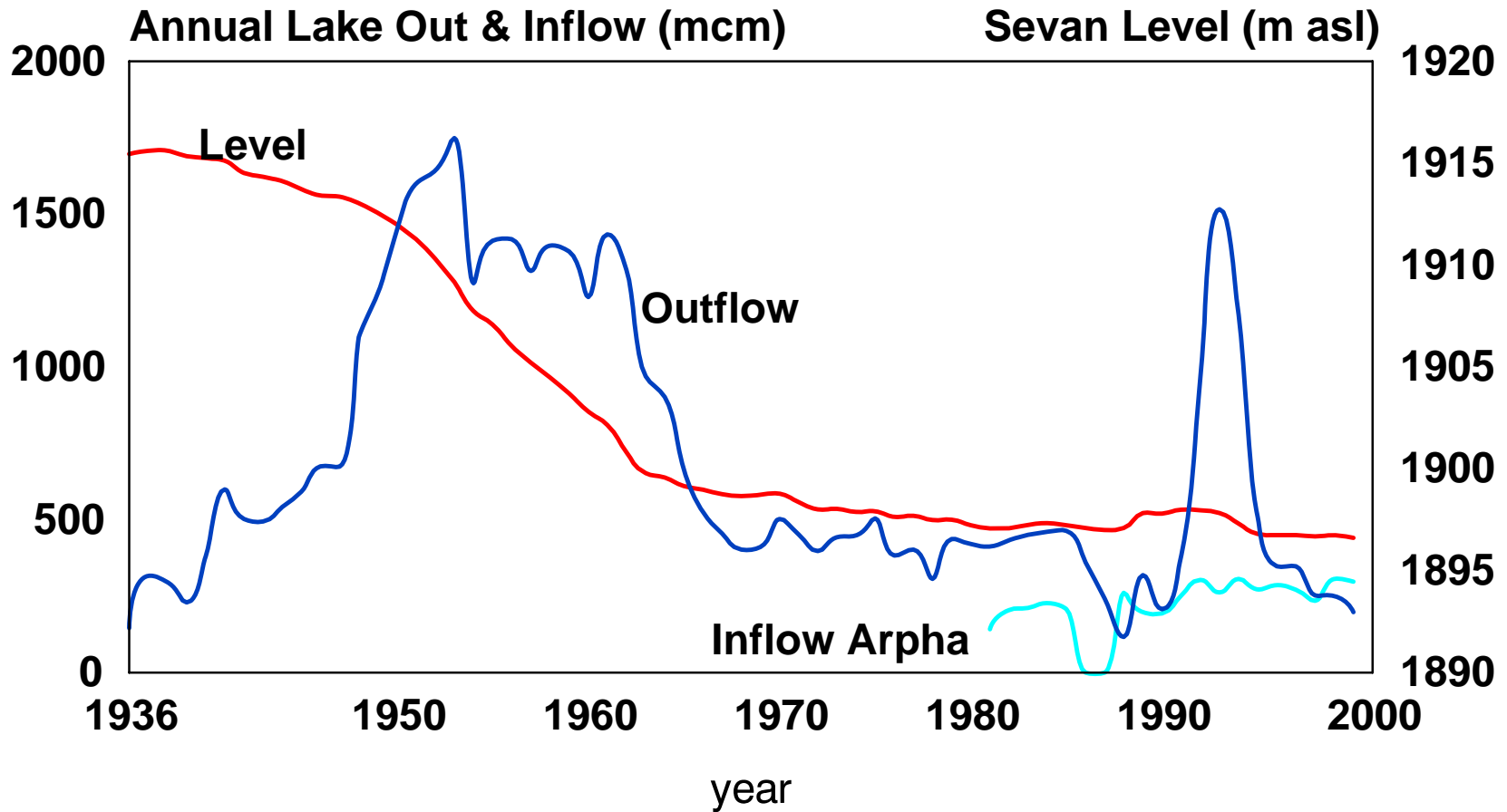
The results of asset reevaluation showed

- ✓ **38% of installed capacity is over 30 years old**
- ✓ **Most TPP units have reached their design limit of operating hours**
- ✓ **HPPs-70% of installed equipment is more than 30 years old and
-50% - more than 40 years**
- ✓ **Equipment doesn't comply with international standards for efficiency and environmental protection**

The Energy Sector is threatened with serious equipment crisis

Replacement of the equipment in Energy Sector is required

Water Balance of the Lake Sevan

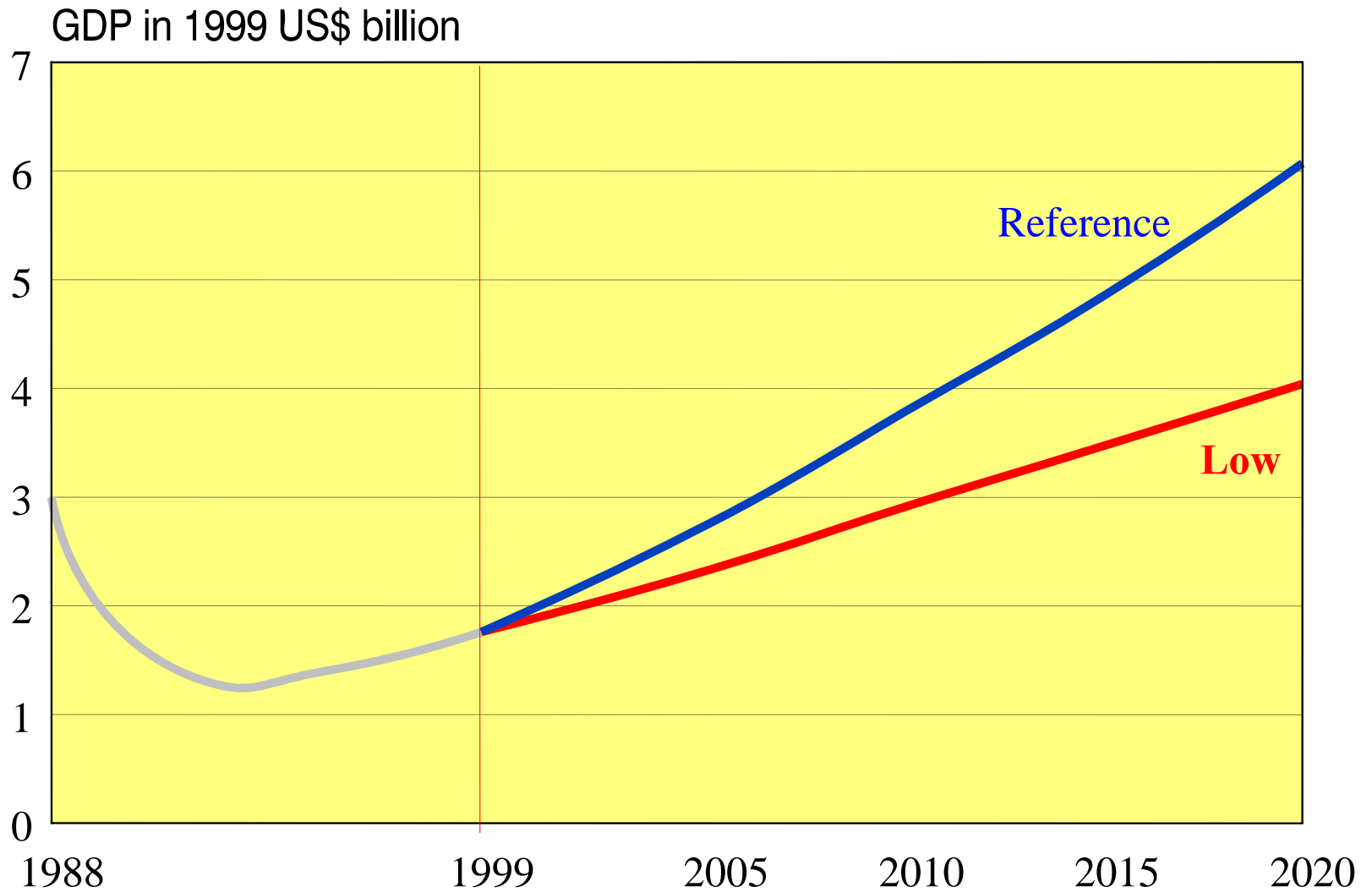




The Energy Security of Armenia

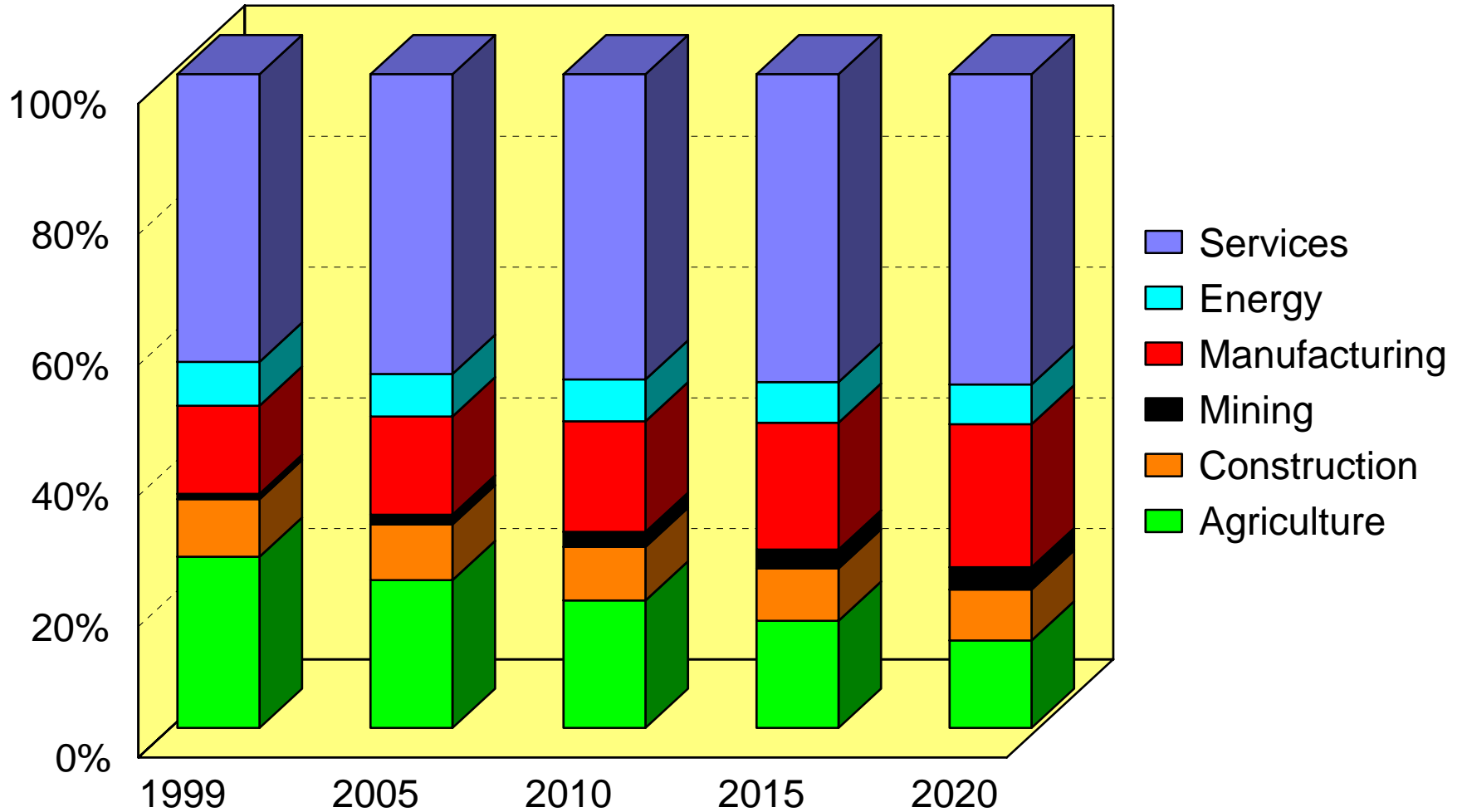
- ✓ **Energy Security - ability for the reliable energy supply for all requirements of a person, society and country under stable development as well as extreme conditions.**
- ✓ **Ensuring of Energy Security is the main task and responsibility of the State Institutions without excepting the participation of private and public organizations of Armenia.**

GDP Growth Forecast

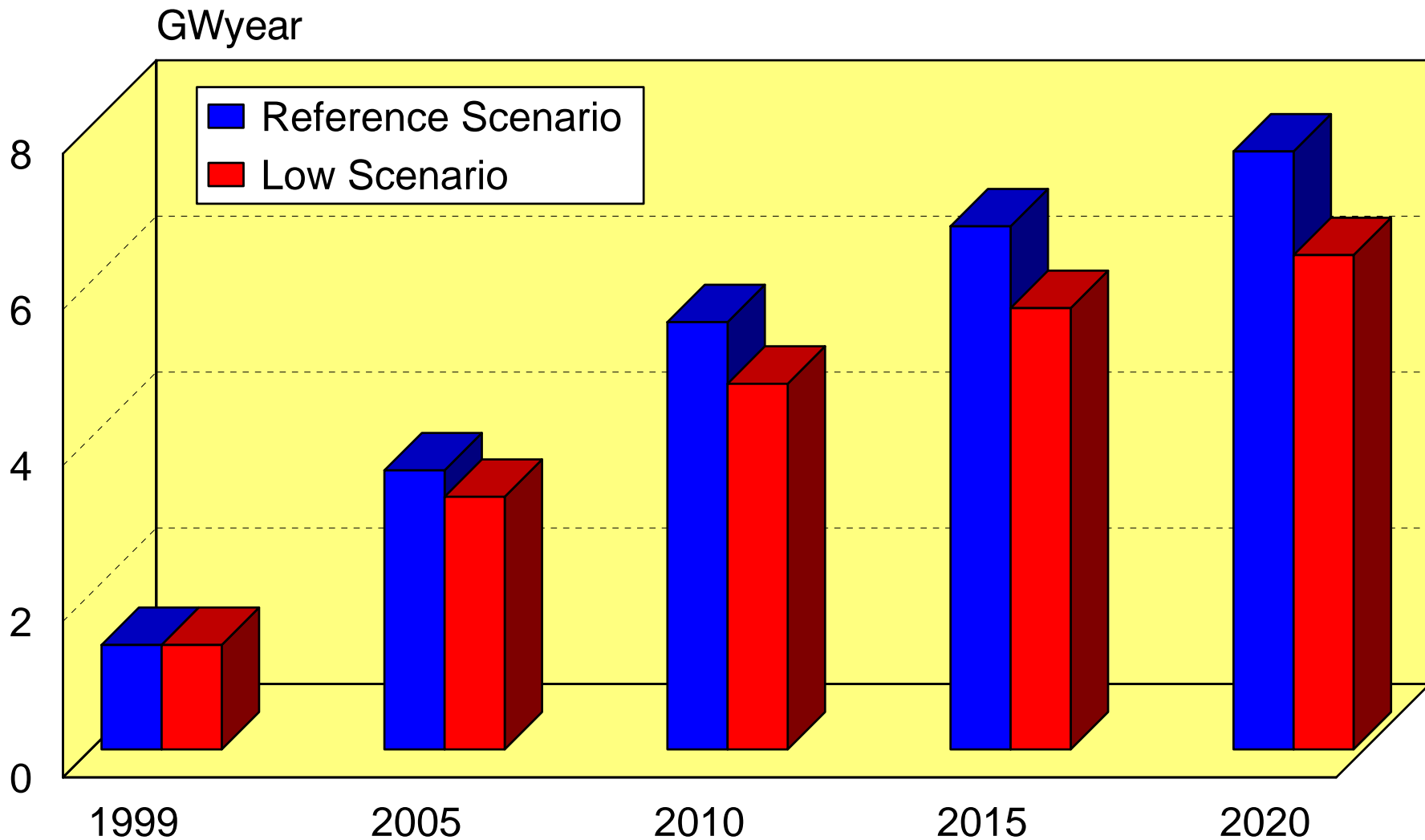


Projected Shares in GDP

Reference Scenario

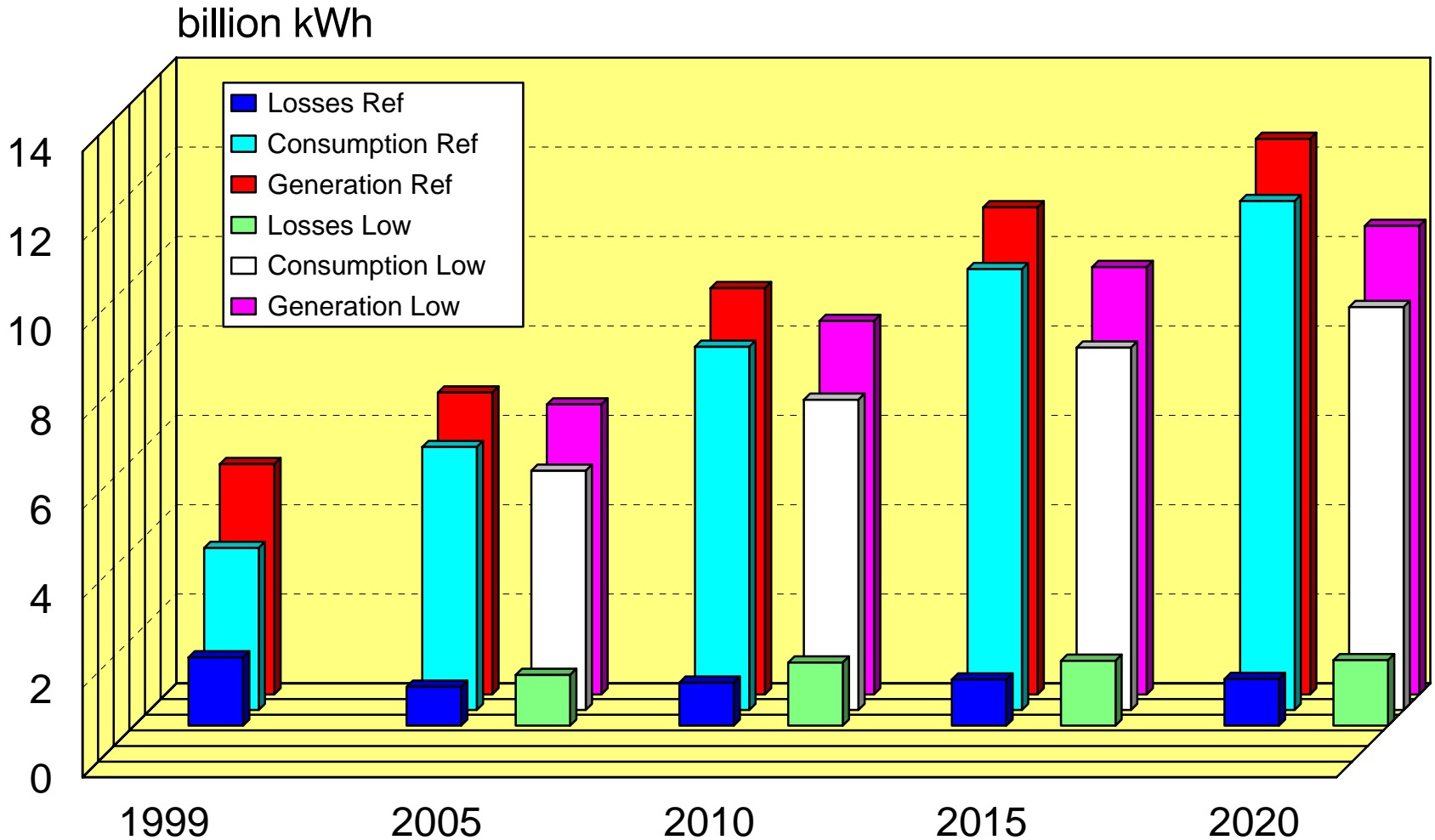


Final Energy Demand



Electricity Contribution

Reference & Low Scenarios



Supply Options

Hydropower Potential

- Untapped hydropotential is 480 MW, which would generate 1800 GWh per year
- 60% of this can be developed at less than USc 6 / kWh
 - Shnokh (75 MW)
 - Megri (80 MW, on the border with Iran)
 - Small hydro projects (75 MW)
- Some good locations for pumped storage plants exist

Supply Options

Other options

- **Geothermal**

- can be used for district heating only
- research and development urgently required

- **Windpower**

- limited potential, but some good sites exist: Pushkin Pass, Aragaz, Sevan Lake, Sisian Pass

- **Miscellaneous**

- Solar too expensive
- Waste incinerator (10 MW)

Supply Options

Thermal Plant

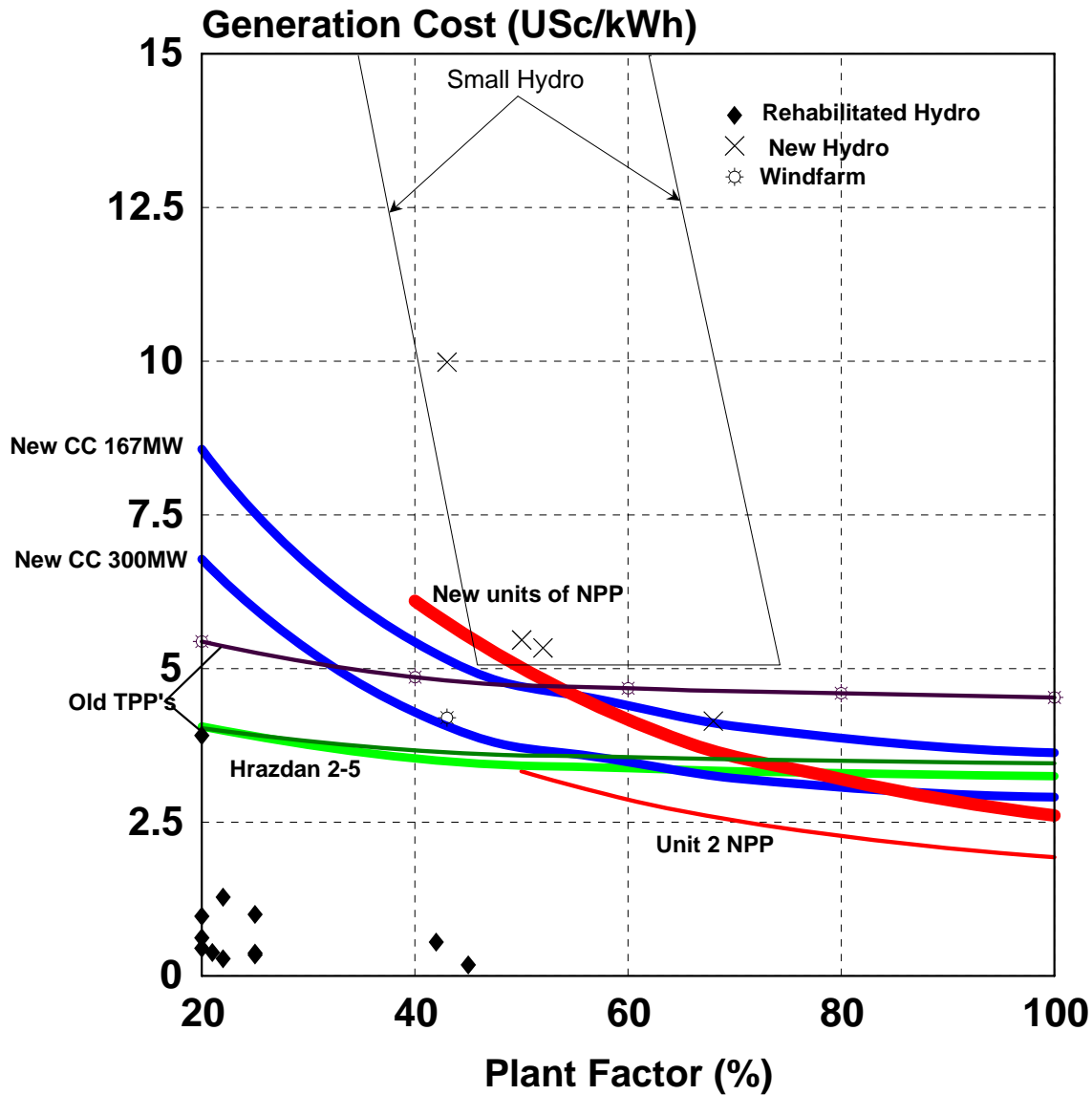
- No new thermal capacity is needed until 2007
- Conversion of existing thermal units to combined cycle plant is too expensive
- Best candidate plant for future
 - combined cycle CHP 208 MW
 - combined cycle 300 MW

Supply Options

Nuclear Plant

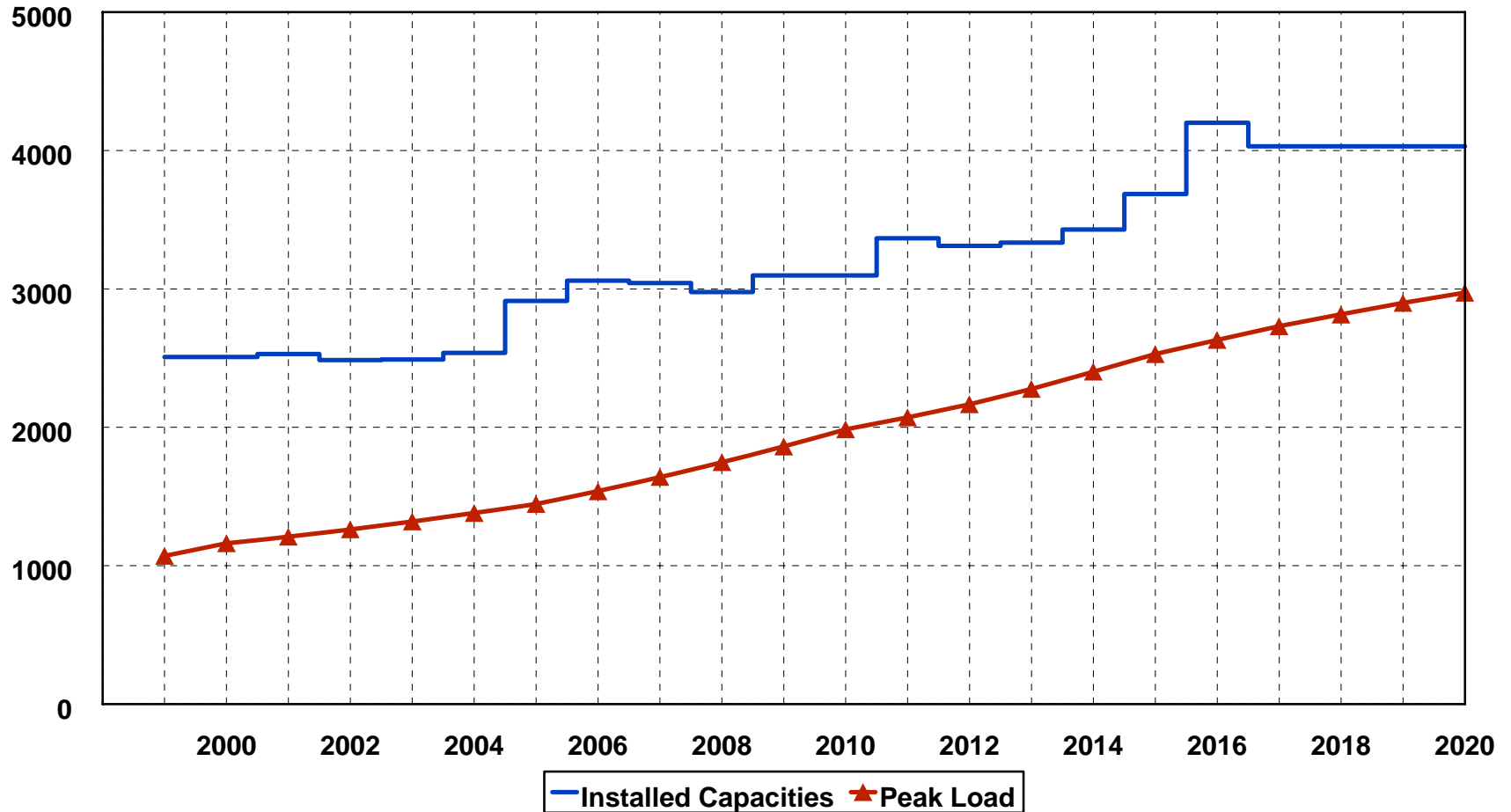
- ✓ **New 600 (#3) MW unit would replace existing unit #2 in 2015**
- ✓ **New 600 (#4) MW unit would beginning to work in 2016-2017**
- ✓ **More expensive than gas-fired CC plant, but important in the context of fuel diversification**

Specific Generation Costs



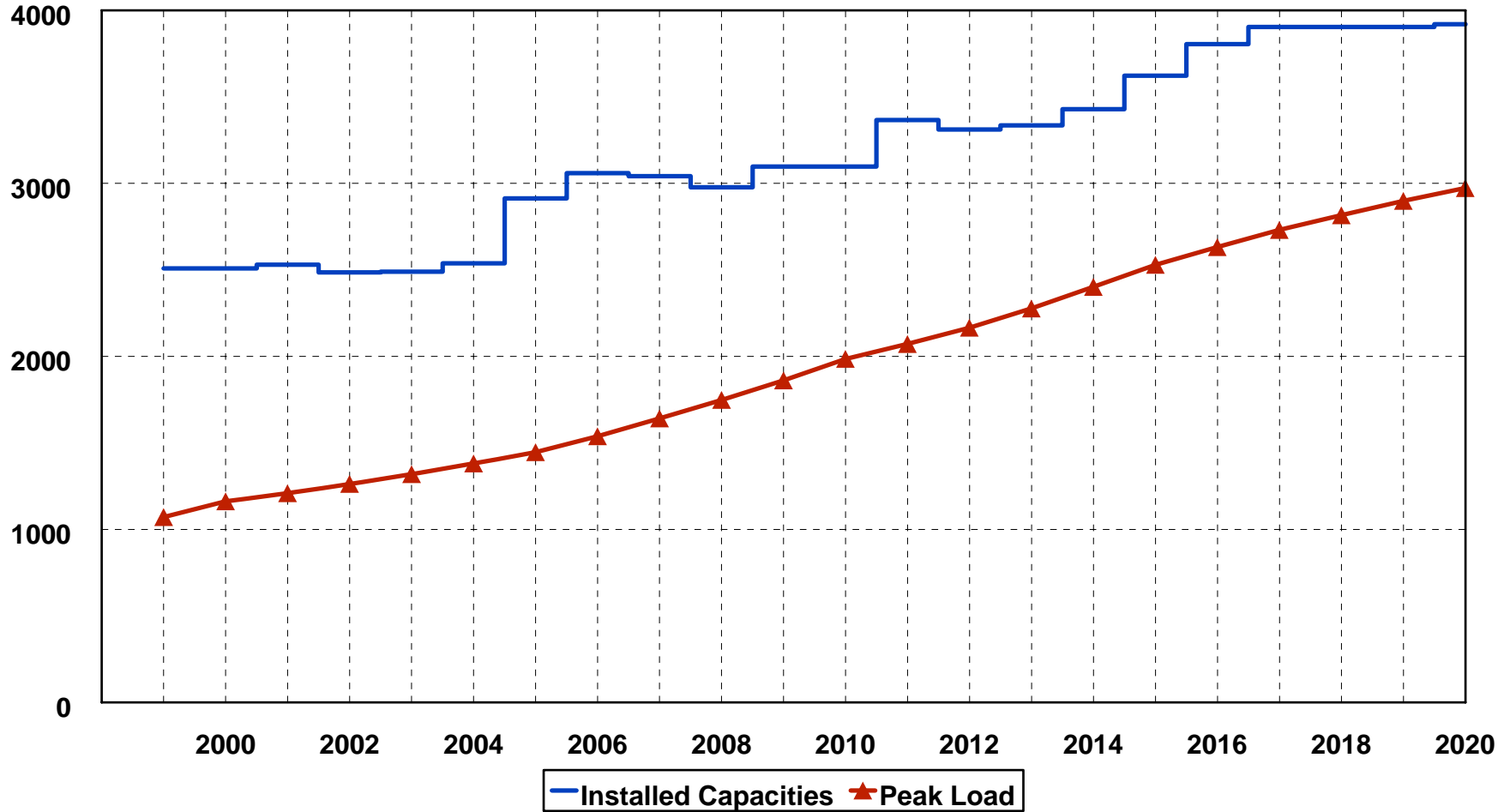
Installed Generation Capacities & Peak Load

Reference Demand - **with Nuclear**



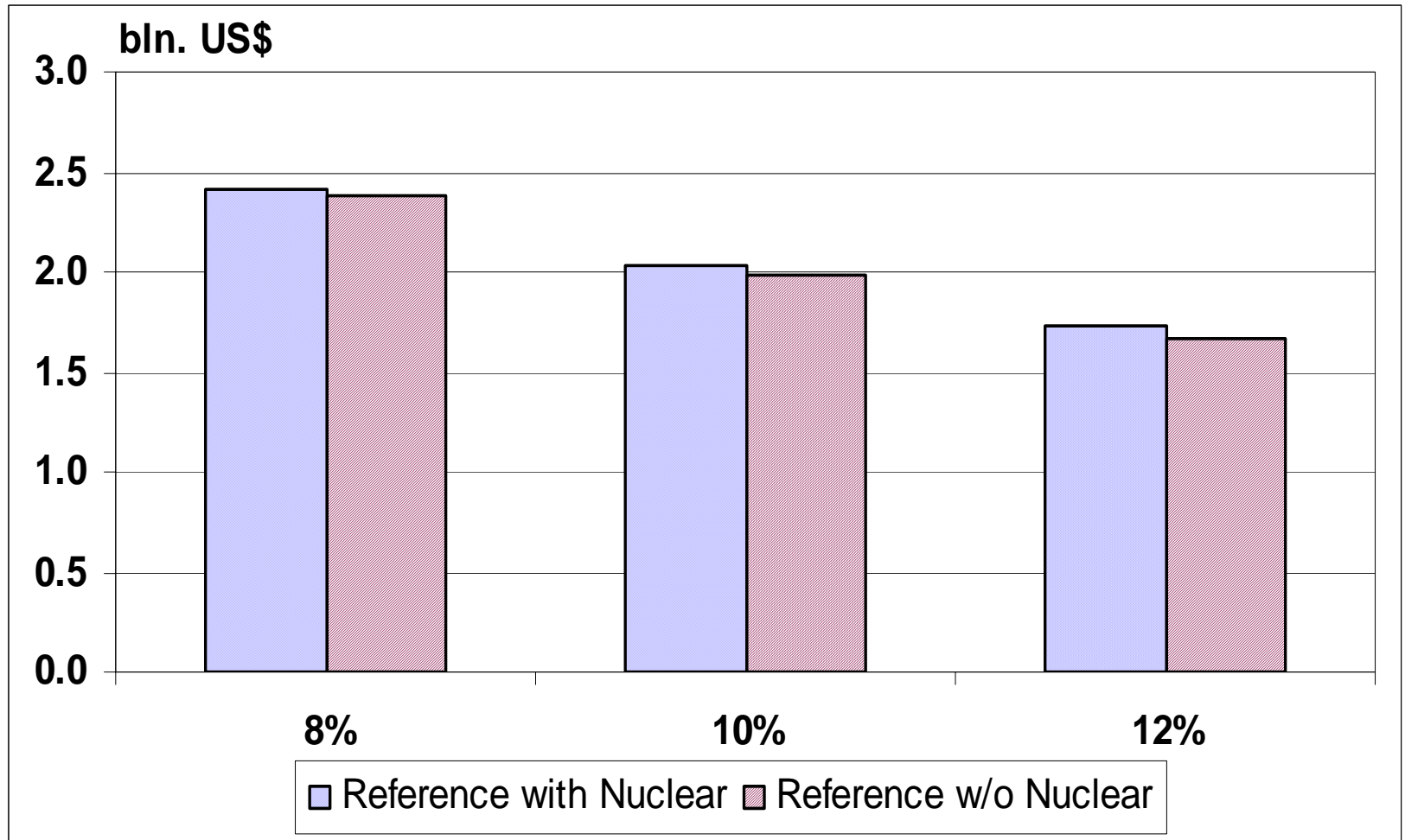
Installed Generation Capacities & Peak Load

Reference Demand - **w/o Nuclear**



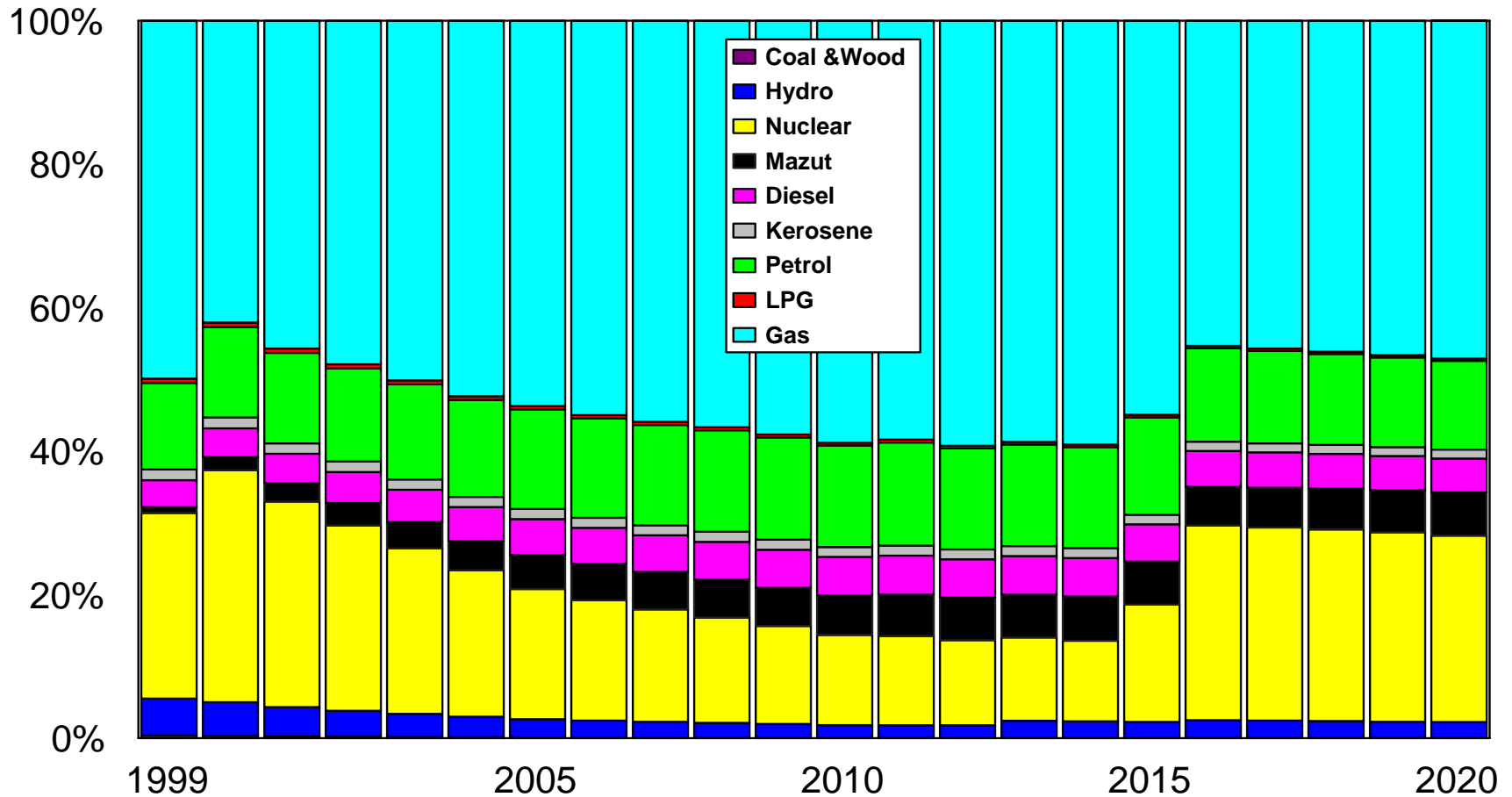
System Present Values

million 1999 US\$ - Reference scenario



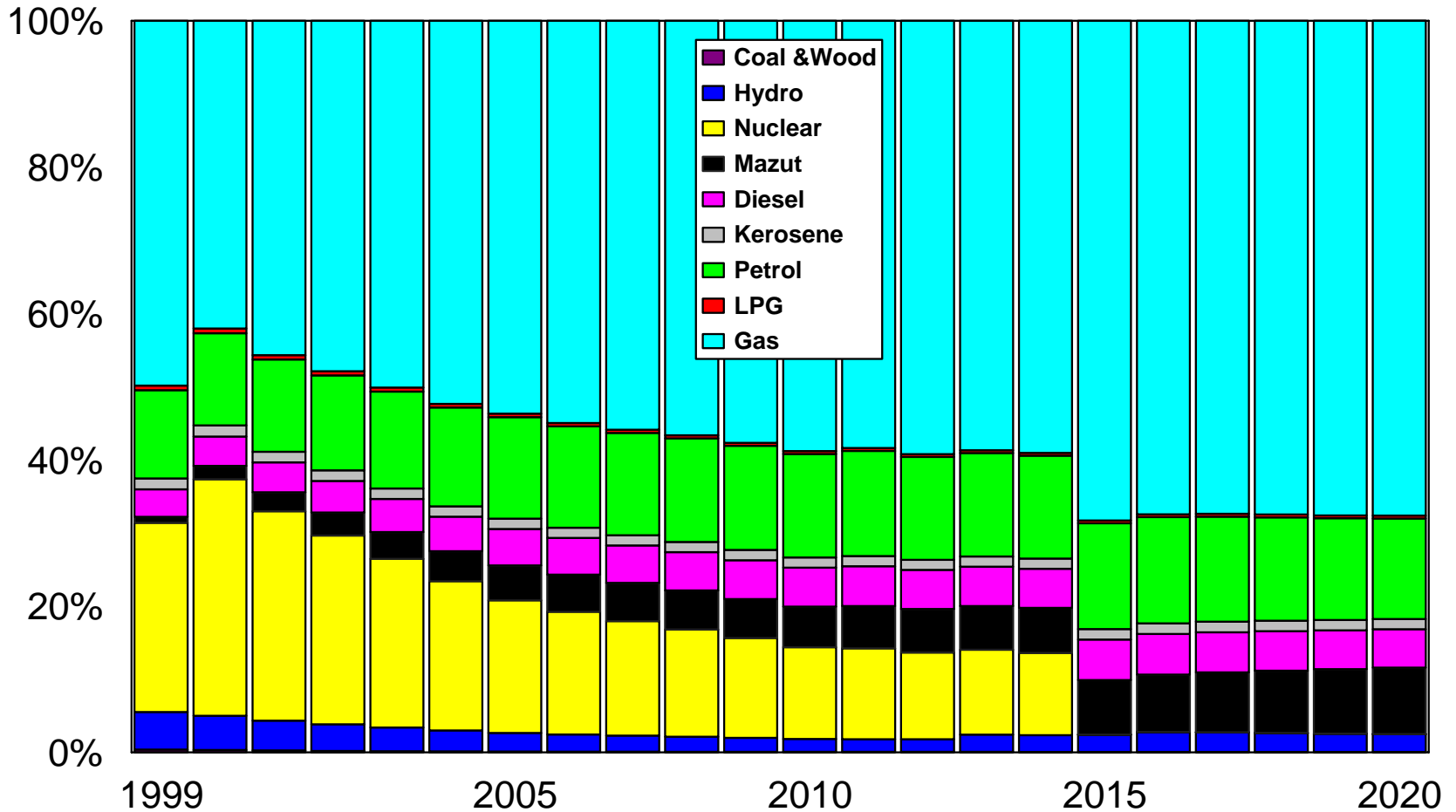
Energy Generation Shares by Fuel

Reference Demand - Nuclear Scenario



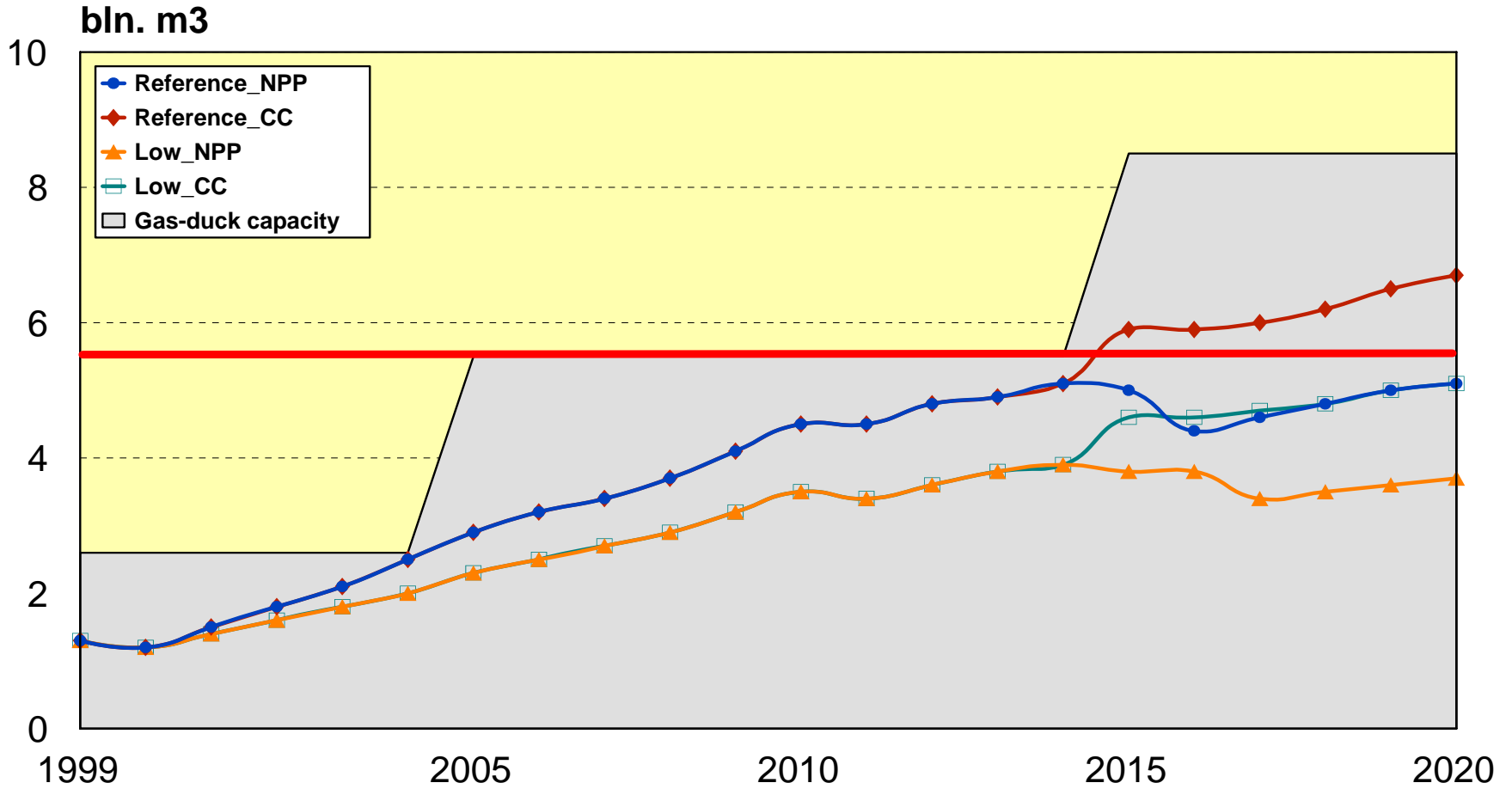
Energy Generation Shares by Fuel

Reference Demand - CC Scenario

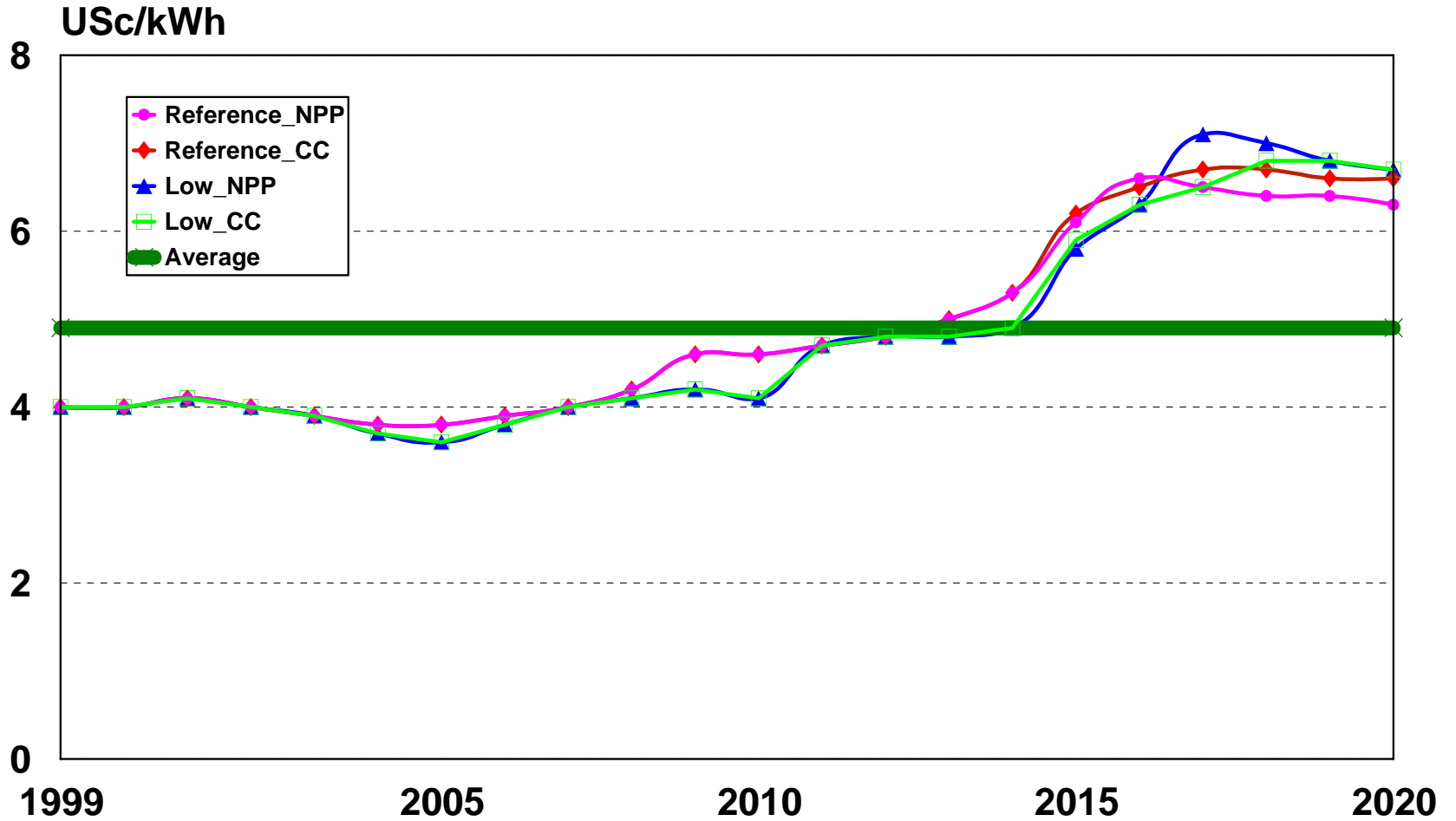


Natural Gas Consumption

All Demand Scenarios



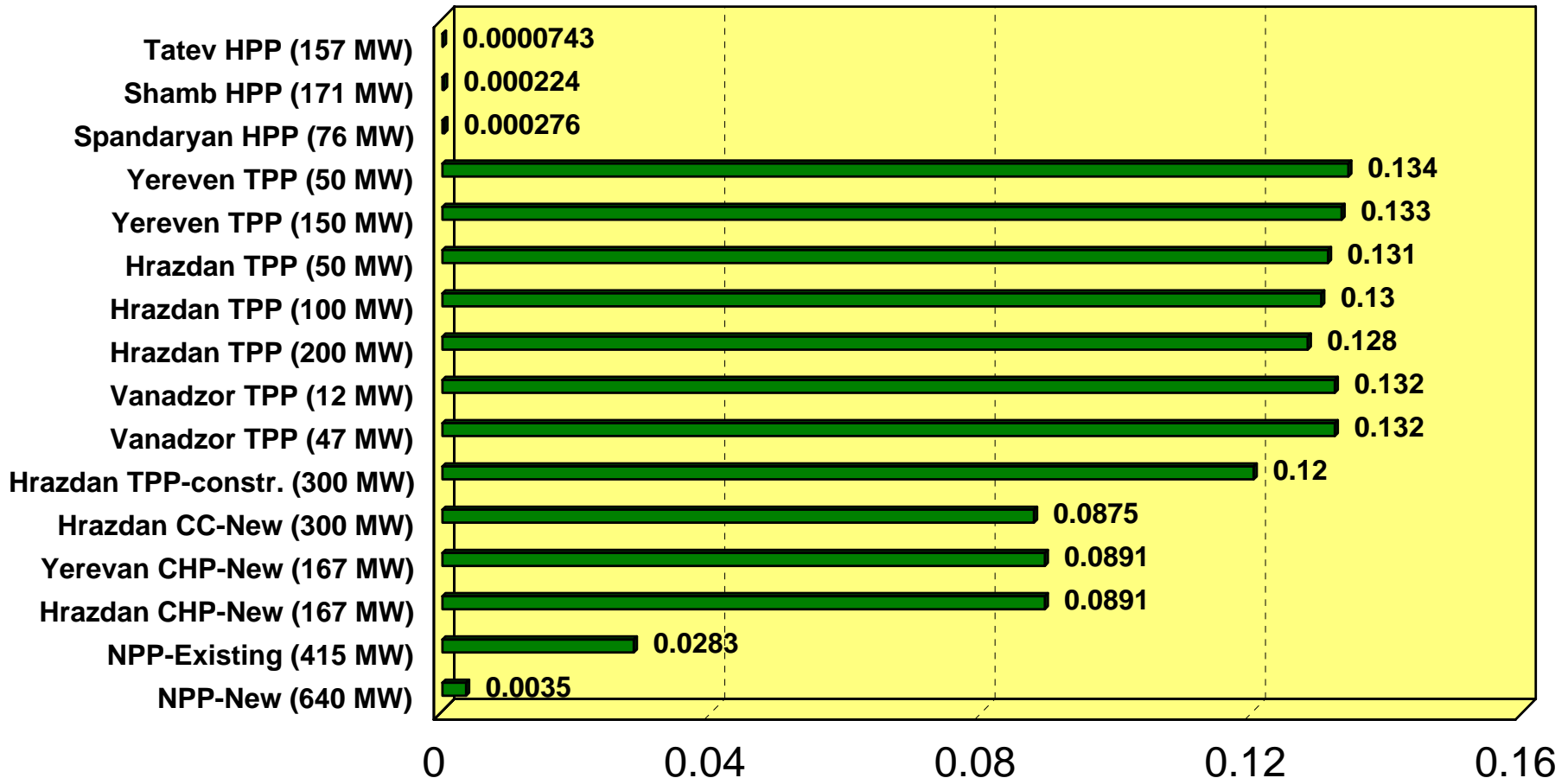
Cost of Electricity



Environmental Analysis

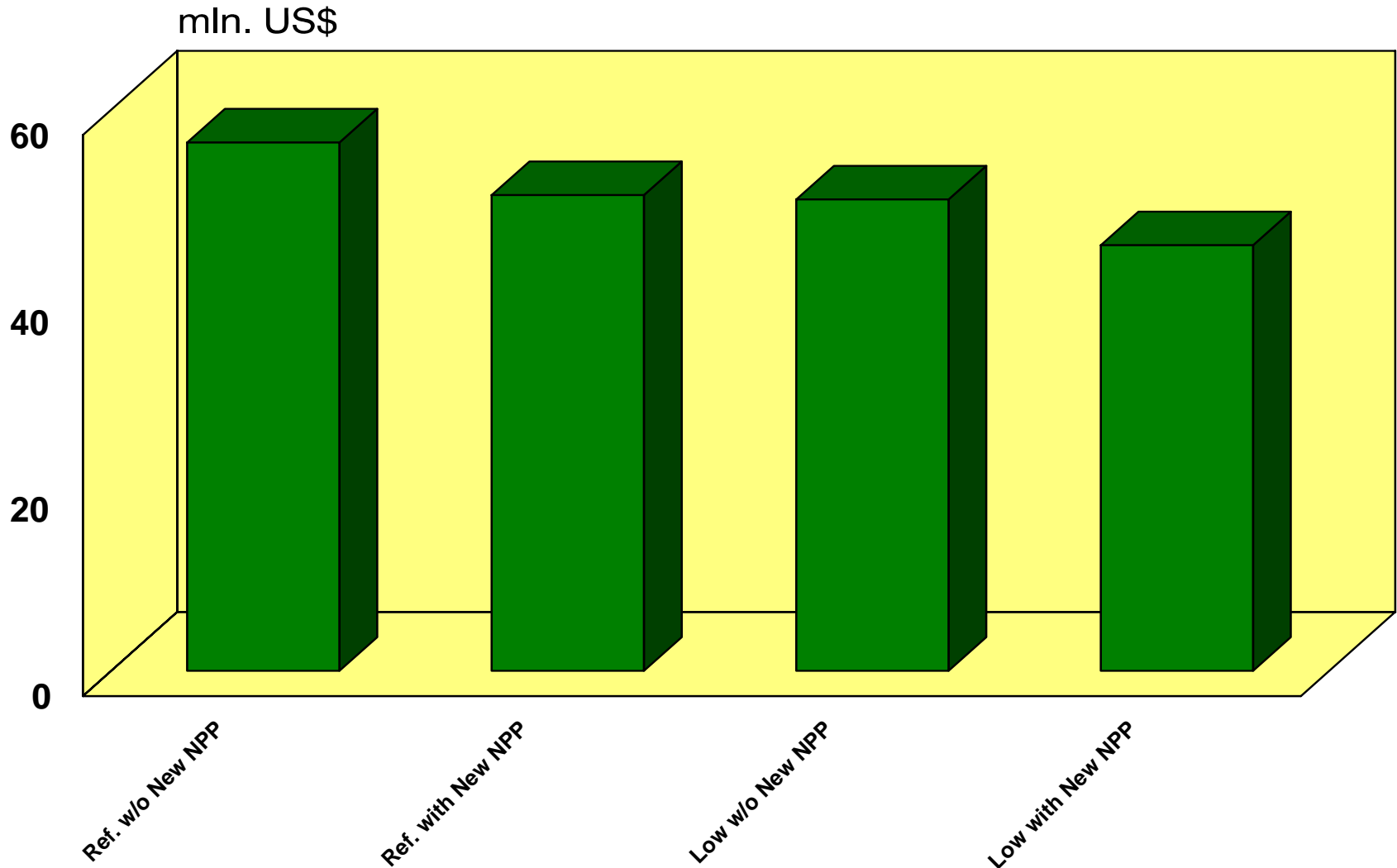
External Specific Cost of Electricity Generation

USc/kWh



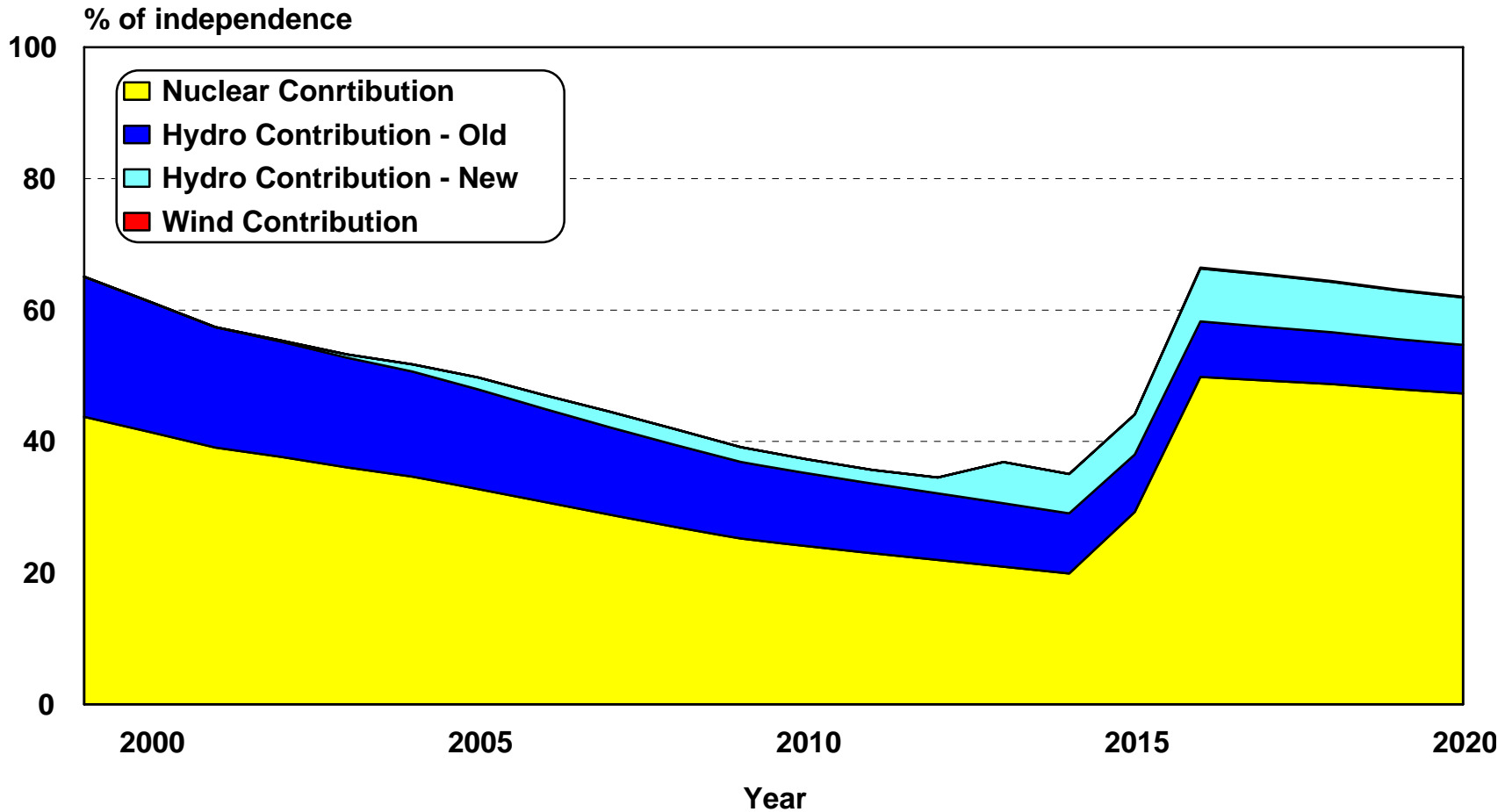
Environmental Analysis

Total External Costs (discounted, IR-10%)



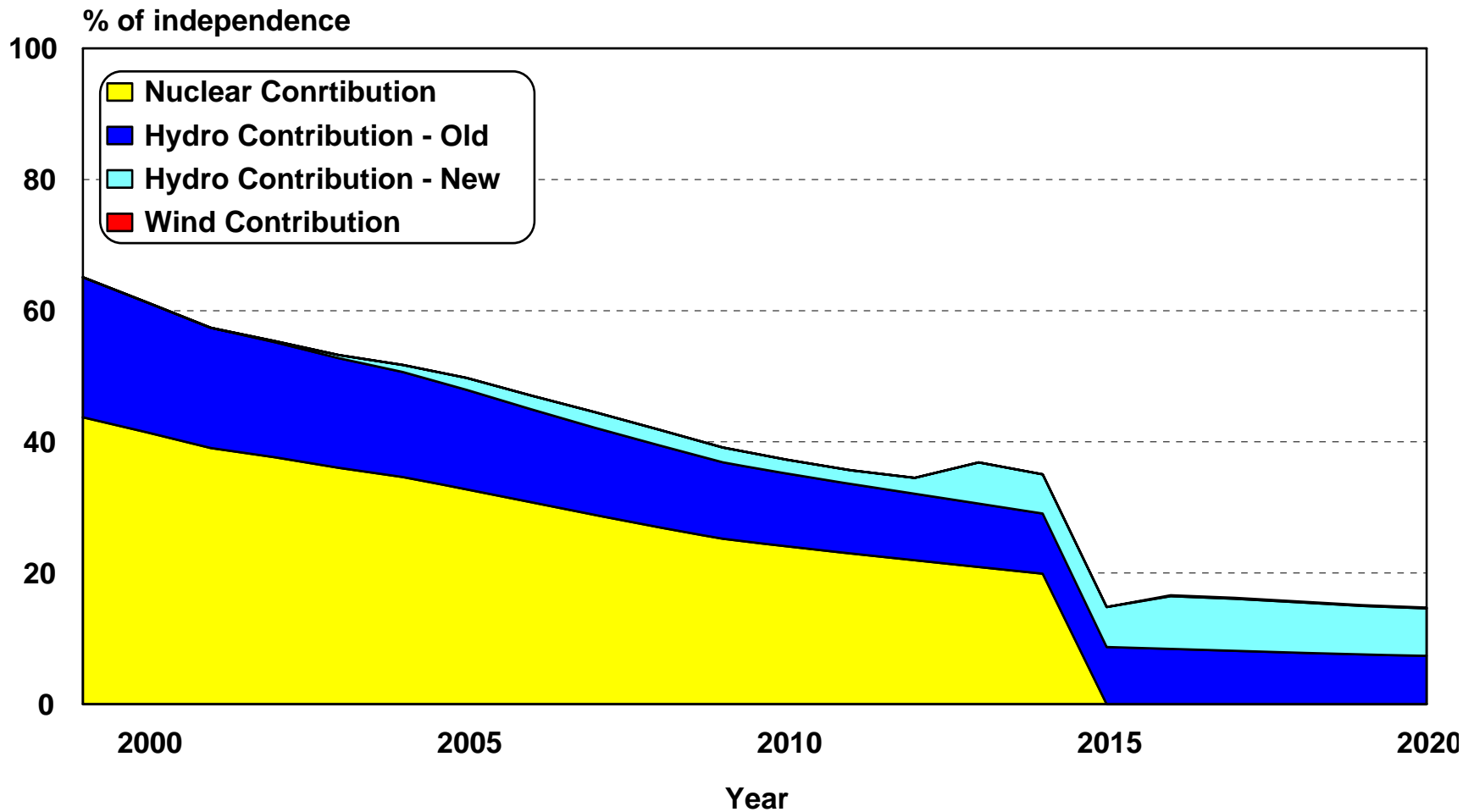
Energy security and independence

Reference demand - Nuclear scenario



Energy security and independence

Reference demand - CC scenario



- Development of Nuclear Energy on the base of Modern Technologies
- Preparation for replacement of existing NPP units by modern ones
- Enhance Nuclear Safety not only at the Plant level, but also by System measures
- Strengthen and Development Gas and Electrical Interconnections to neighbouring countries
- Develop Wind, Solar and Geothermal