APPLICATION OF LEAP IN JAPAN: THE "POWER SWITCH" ENERGY PATH

East Asia Energy Futures (EAEF)/Asia Energy Security Project

Energy Paths Analysis/Methods Training Workshop

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OUTLINE OF PRESENTATION:

- Background of Study
  - Funding and rationale of study
  - Data set and approach used
- The Japanese Power Sector
- The “Business-As-Usual” Path
- The “Power Switch” Path
- Cost and Emissions Comparison between Paths
- Benefits of and Barriers to a Power Switch Path in Japan

BACKGROUND OF STUDY

- WWF-Japan “Power Switch” Study commissioned in early 2003, completed this month (and to be released shortly)
  - Funded by WWF-Japan as part of a broader International WWF Power Switch campaign
  - Researchers involved: Masami Nakata, David Von Hippel, Junichiro Oda, Charlie Heaps
  - Reviewed by WWF staff in Japan and elsewhere, as well as by Prof. Tatsujiro Suzuki
- The “Power Switch” Study builds on results of earlier EAEF work by the Japan EAEF team, as well as on work done for the PARES study

BACKGROUND OF STUDY

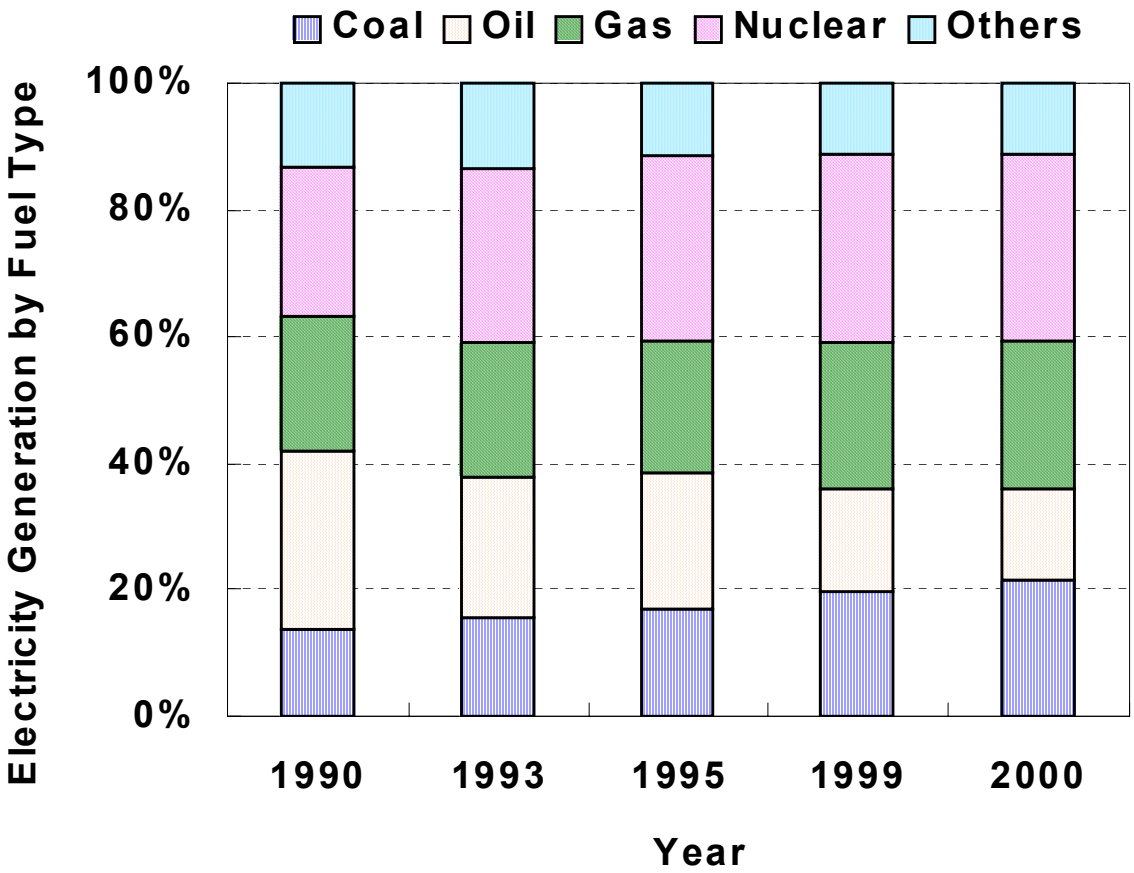
- **Approach**: Use LEAP to study the potential reductions in emissions from a Power Switch path that includes a shift toward energy-efficiency and low/no-carbon fuels
  - The Japan EAEF team's LEAP data set was used as a starting point
- **Intent**: Show the possible impact of an aggressive, but concievable, set of measures on Japan's greenhouse gas emissions, evaluate--quantitatively and qualitatively--relative costs and benefits of a "Power Switch" path
  - Meet Japan's Kyoto Protocol obligations

THE JAPANESE POWER SECTOR

- **Fuels used: coal, oil, gas, nuclear, and some hydro, MSW, others**
  - In recent years, share of output from coal has increased, as output from oil has decreased
- Power generation sector accounts for about **30%** of Japan's CO_2 emissions
- Recent increases in electricity production
  - 27.8 percent between 1990 and 2000
- Increases in carbon dioxide emissions from electricity generation
  - 16.5 percent between 1990 and 2000

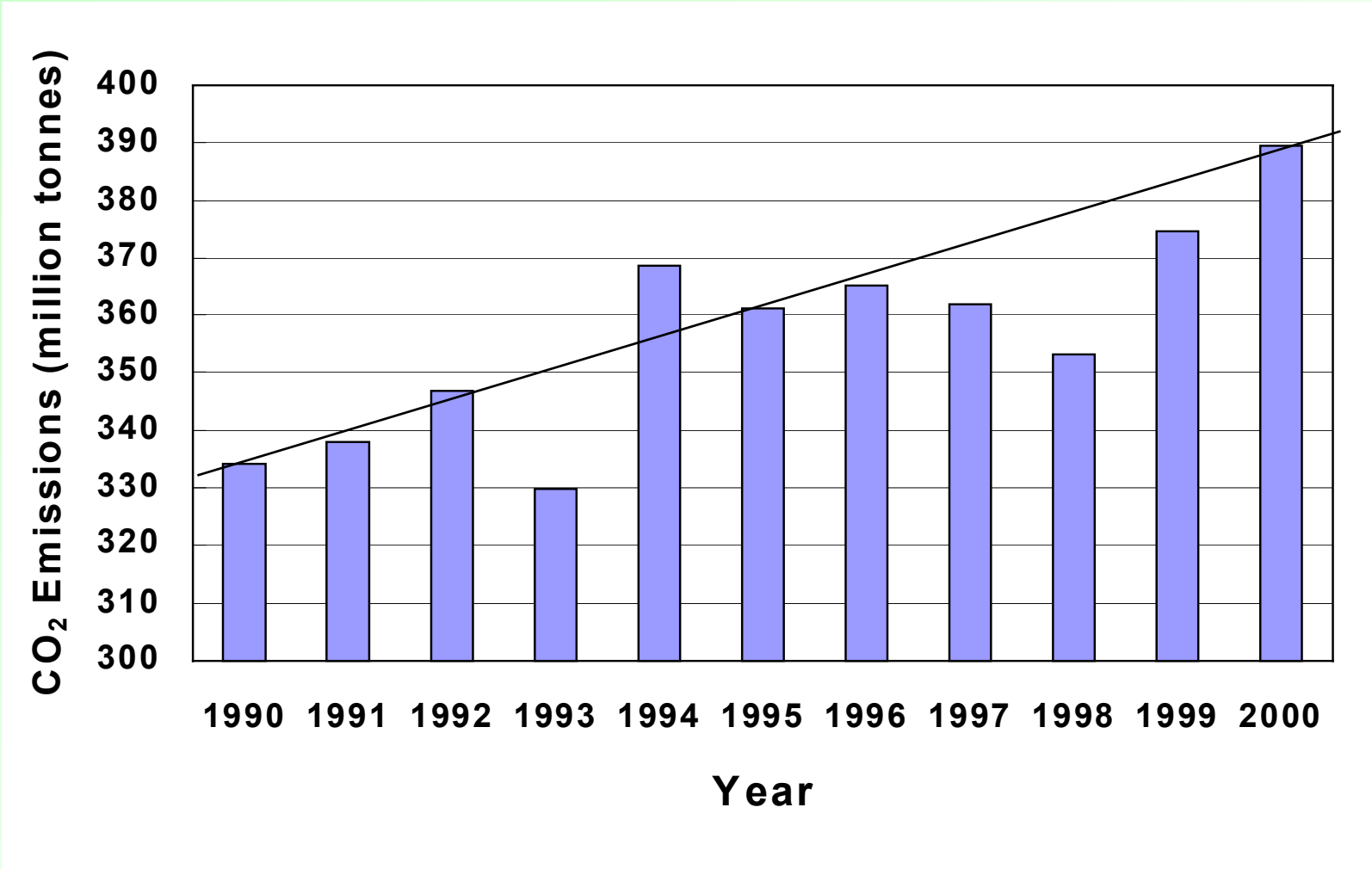
THE JAPANESE POWER SECTOR

- Fraction of Generation by Fuel Type, 1990 - 2000



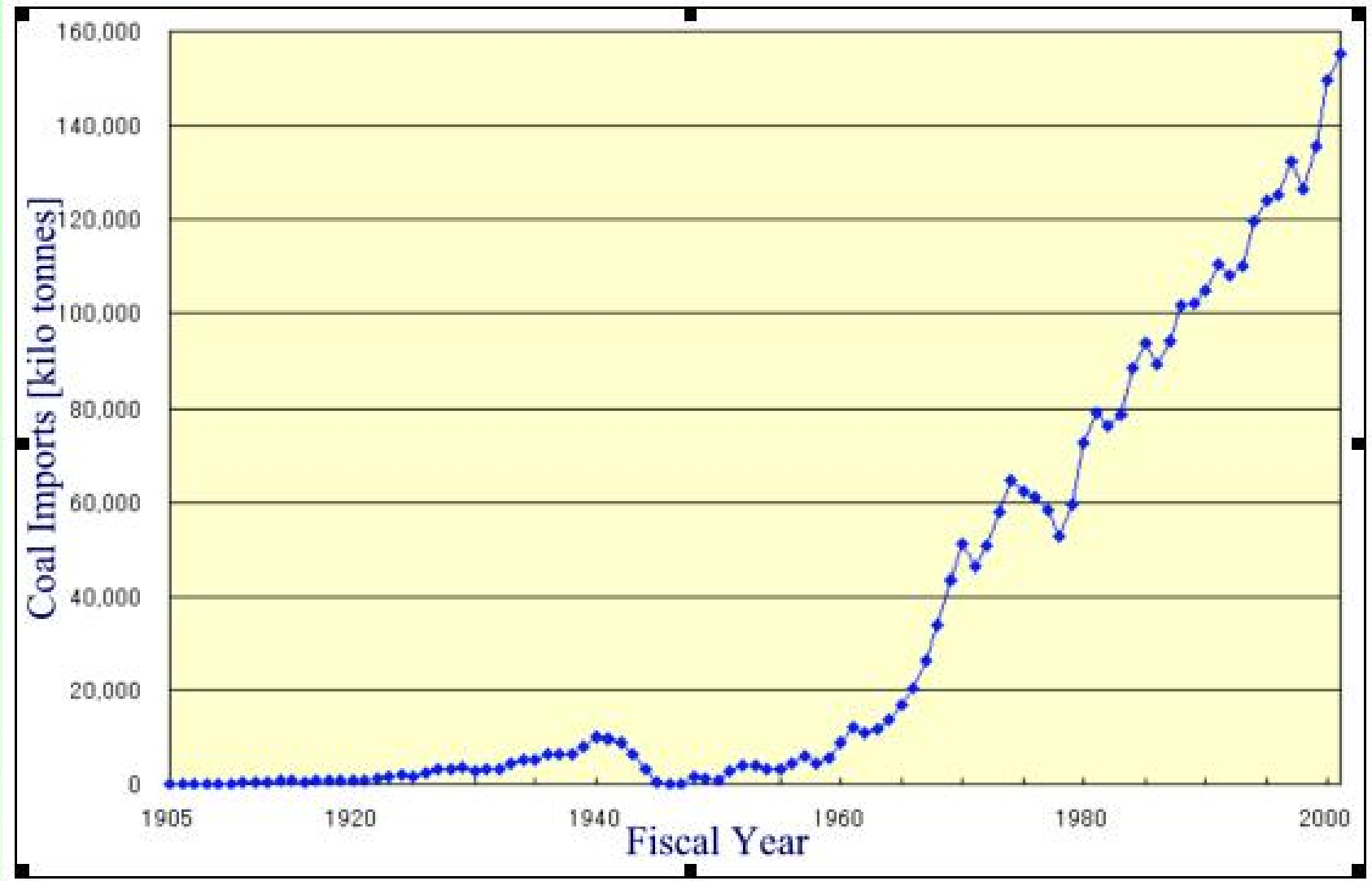
THE JAPANESE POWER SECTOR

- Power Sector CO_2 Emissions, 1990 - 2000



THE JAPANESE POWER SECTOR

- Coal Imports, ~1990 to 2002 (mostly for power)



THE "BUSINESS-AS-USUAL" PATH

- Key data sources for base-year supply and demand data: EDMC Energy Handbook and Japan Energy Statistics, published by IEEJ
- BAU Path assumptions largely derived from BAU "scenarios" outlined by the Ministry of Economy, Trade and Industry (METI) and the Institute of Energy Economics, Japan (IEEJ)
  - GDP growth assumed 0.5 percent annually until 2005, 1.5 percent/yr after 2005

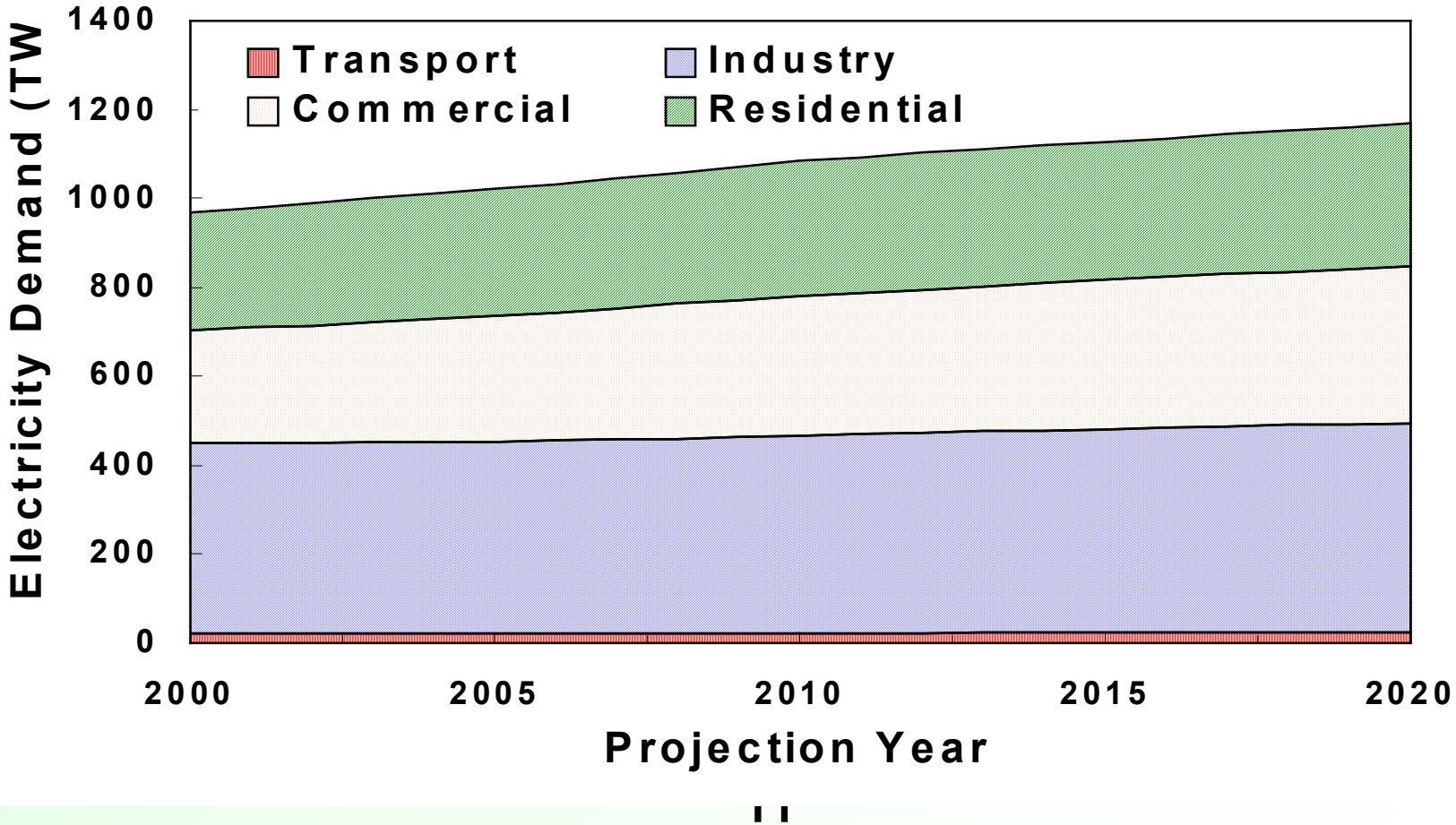
THE "BUSINESS-AS-USUAL" PATH

Overall assumptions:

- **Current trends in electricity consumption continue**
  - Trend of increasing consumption since ~1986
- **No extensive additional energy conservation measures are imposed**
- **No drastic policy changes are implemented**

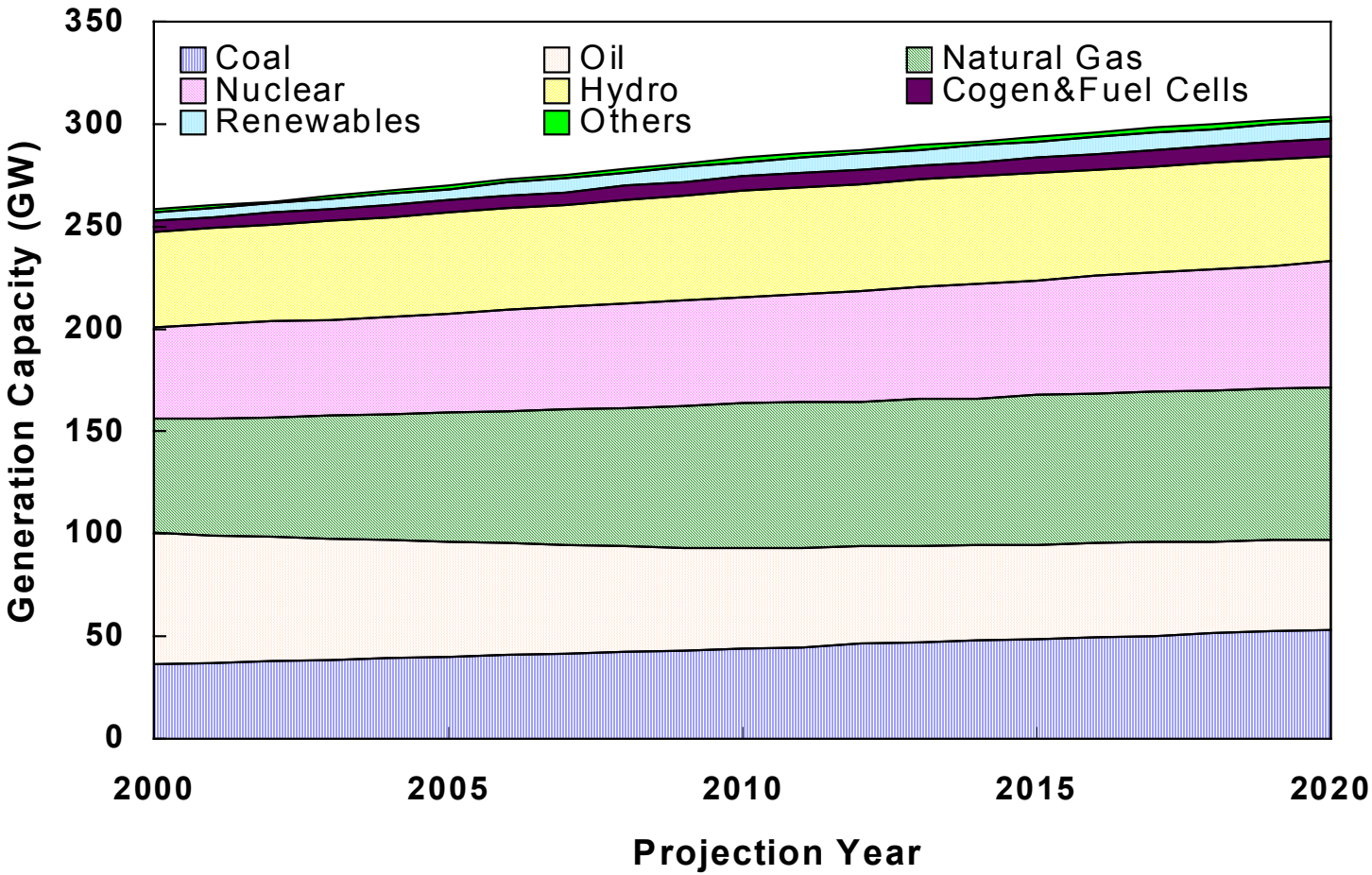
THE "BUSINESS-AS-USUAL" PATH

- Electricity demand in the BAU Path (average growth, 0.9%/yr)



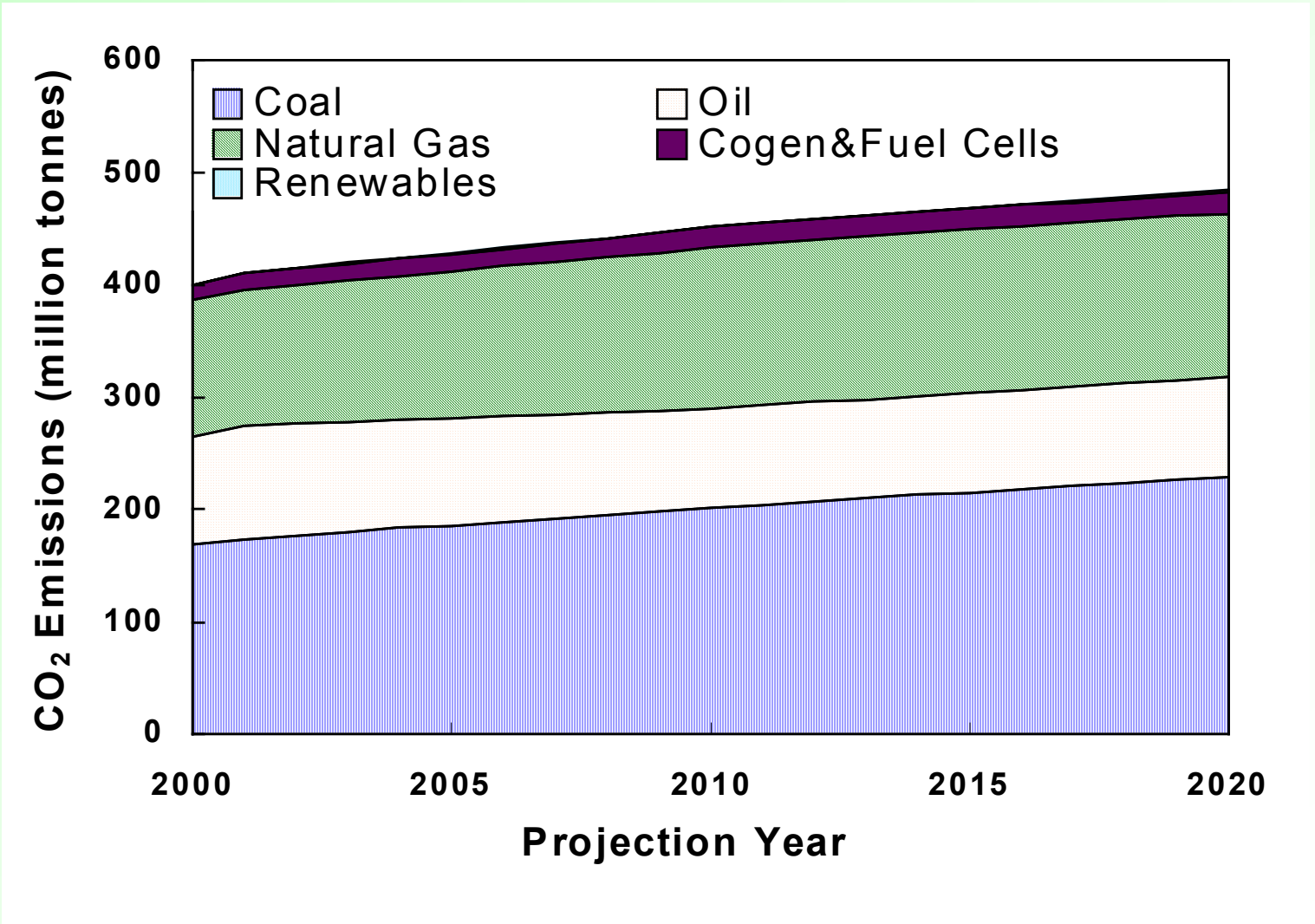
THE "BUSINESS-AS-USUAL" PATH

- Electricity generation capacity in the BAU Path



THE "BUSINESS-AS-USUAL" PATH

- GHG Emissions from the electricity sector



THE “POWER SWITCH” PATH

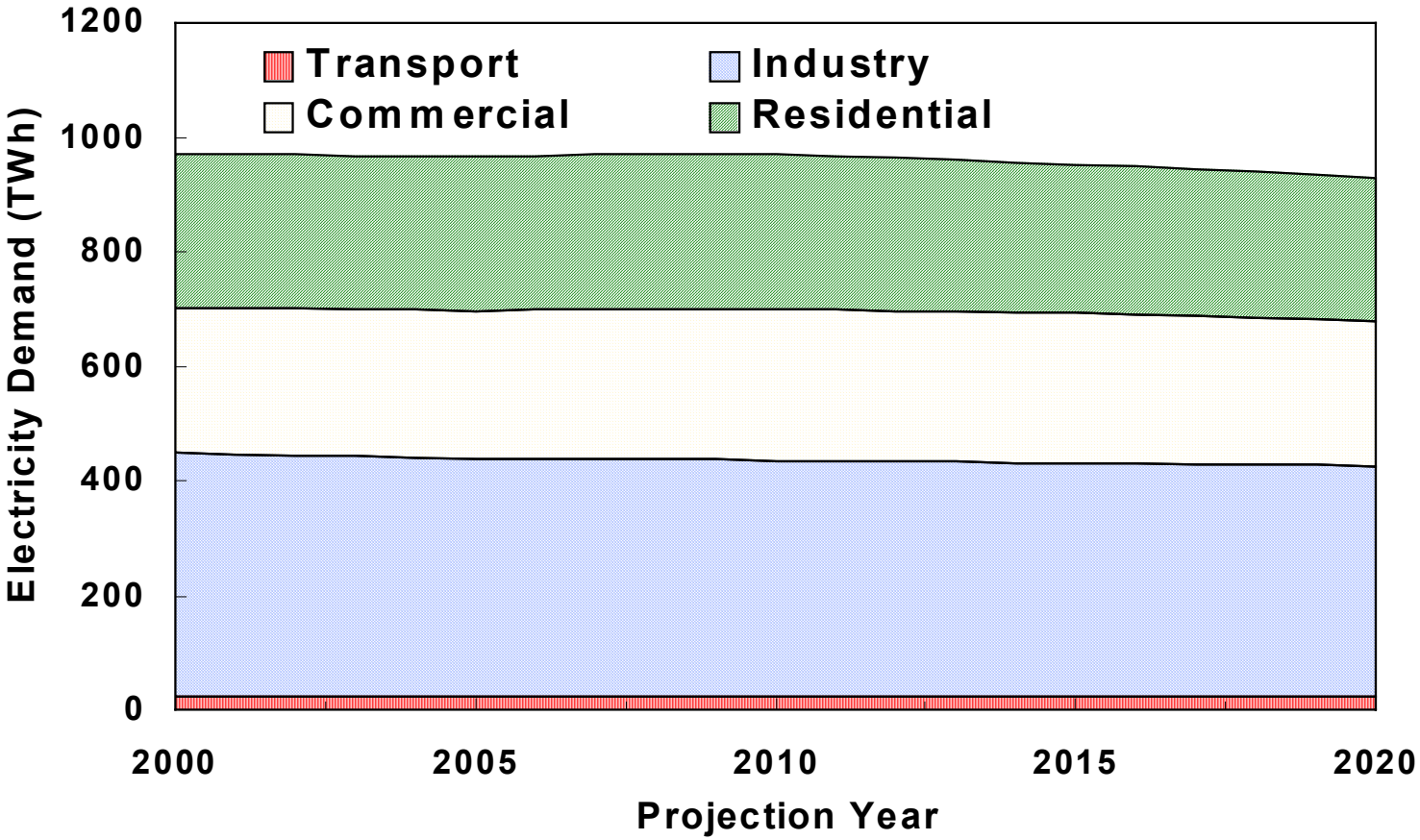
- Demonstrates savings in GHG emissions that Japan could achieve through a program of switching power generation technologies or fuels to low- or no-carbon resources, coupled with a timely, aggressive program of increasing energy-efficiency/demand-side generation
- Incorporate WWF Japan studies:
  - Energy efficiency study by Dr. Haruki Tuchiya of the Institute of System Technology
  - Renewable energy study by the Institute of Sustainable Energy Policies (ISEP)

THE “POWER SWITCH” PATH

- Stronger emphasis on substitution of natural gas for coal
- A gradual (partial) nuclear phase-out
- Explicit emphasis on renewable energy implementation (supply- and demand-side), natural gas-fired cogeneration (central and distributed) and highly efficient natural gas-fired combined cycle generation
- Implementation of energy efficiency and energy conservation measures

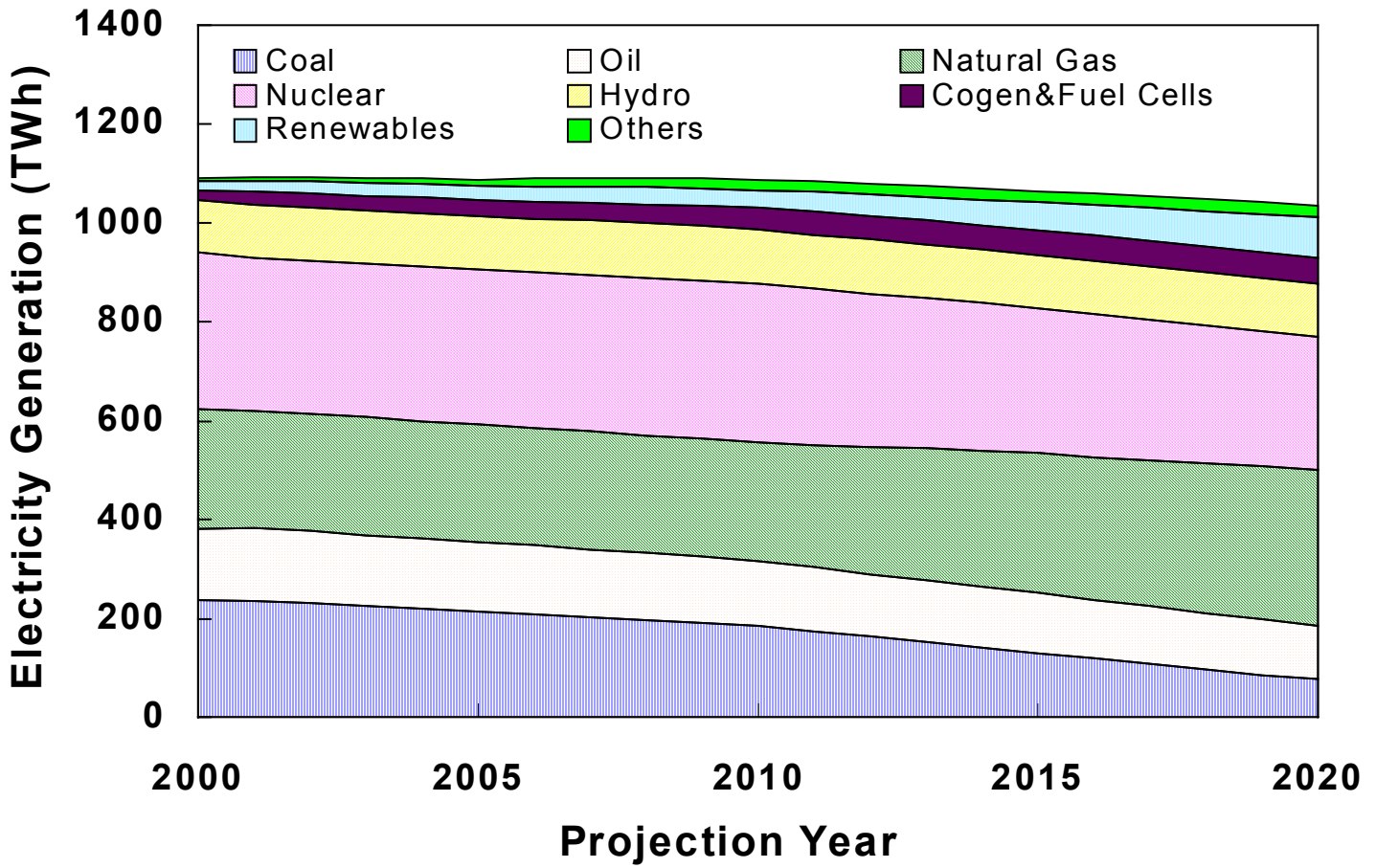
THE “POWER SWITCH” PATH

- Net electricity demand in PS Path -incorporating Tsuchiya study results



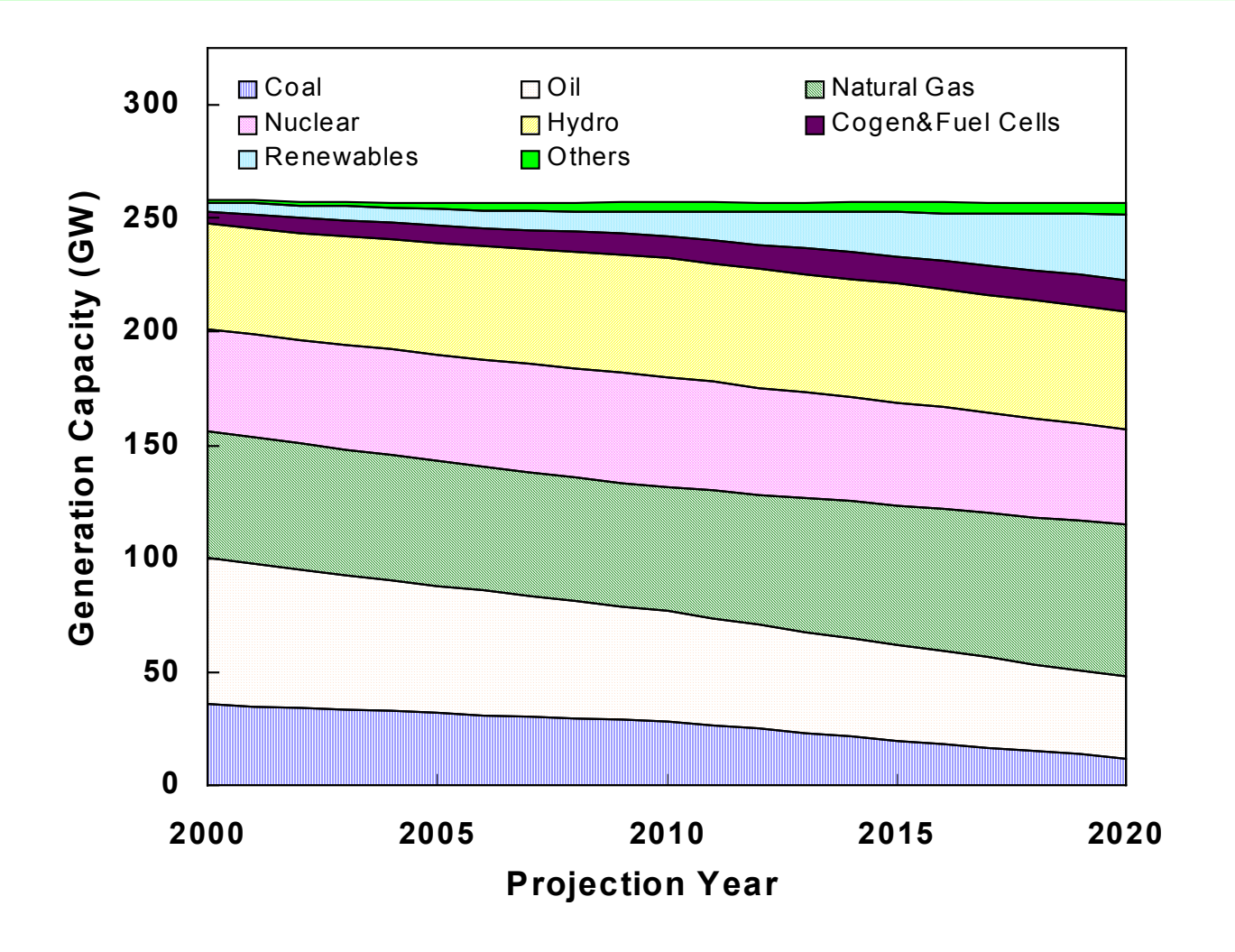
THE “POWER SWITCH” PATH

- Generation (TWh) by type in PS Path



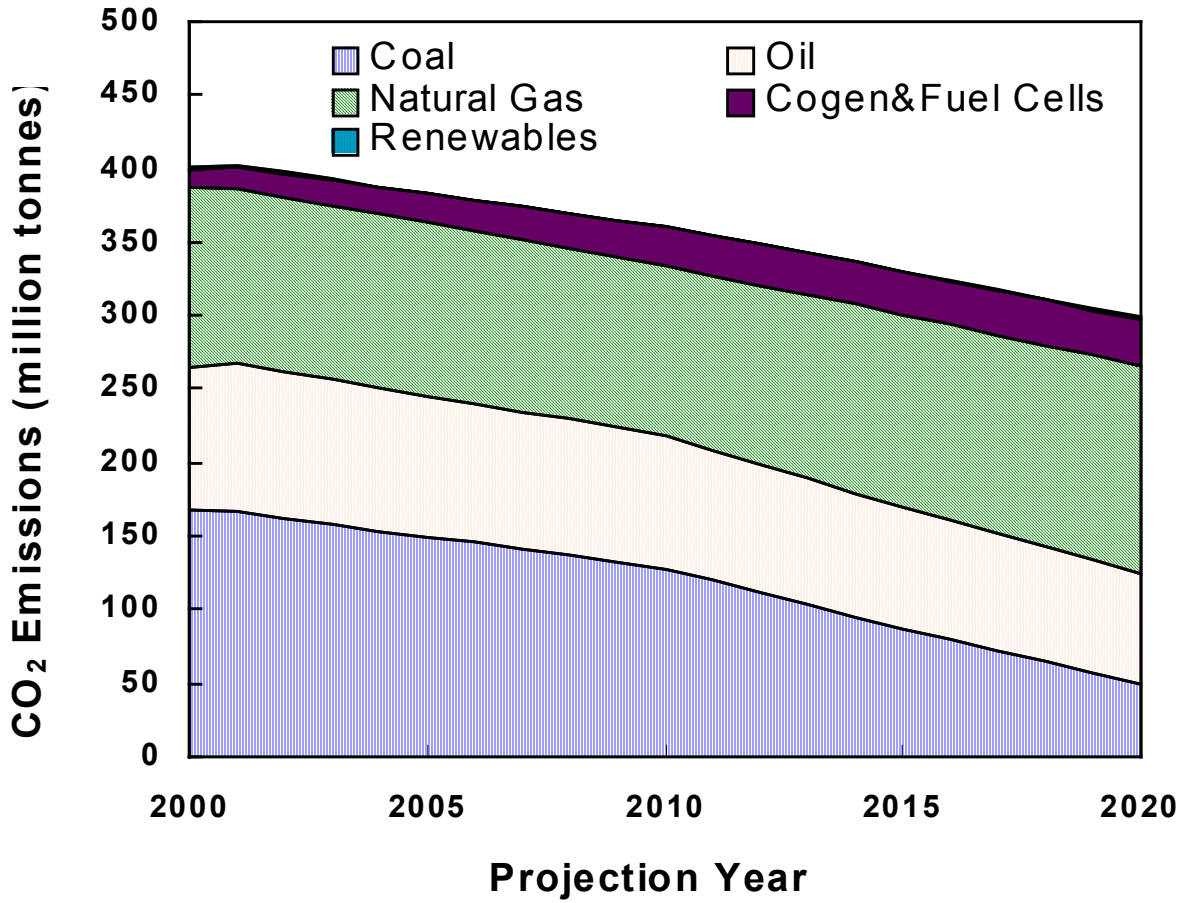
THE “POWER SWITCH” PATH

- Generation capacity (GW) by type in PS Path



THE "POWER SWITCH" PATH

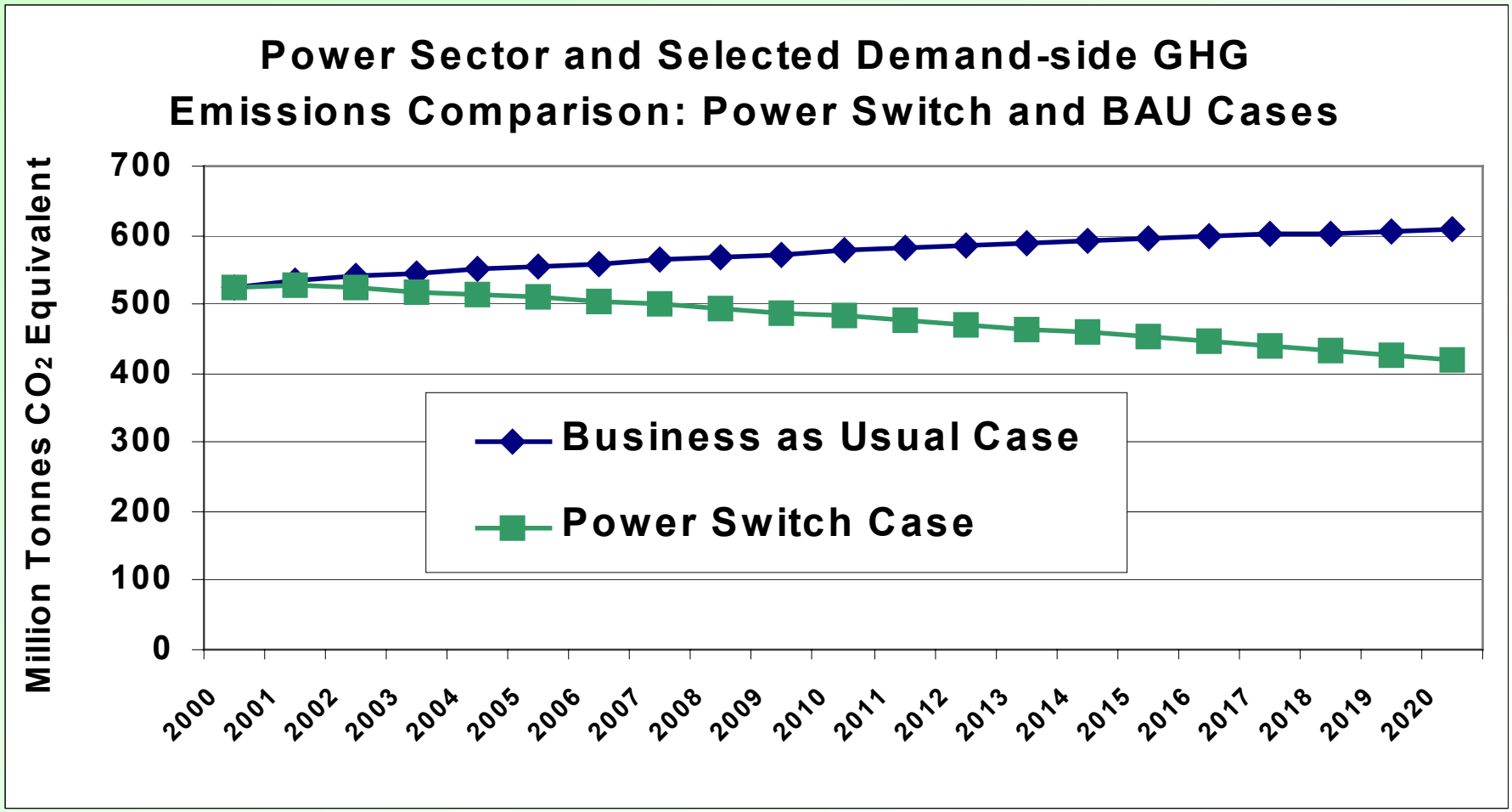
- GHG Emissions from the electricity sector



EMISSIONS, SECURITY, AND COST COMPARISON BETWEEN PATHS

- Overall (power sector and some demand-side) emissions markedly lower in PS Path, **declining** by 20 percent vs. emissions in 2000
- Emissions in 2020 PS case are 31 percent **lower** than they are in the BAU case
- Major emissions differences between scenarios: reduced emissions from coal-fired, oil-fired power in the PS case, slightly reduced emissions (1%) from gas-fired power

EMISSIONS, SECURITY, AND COST COMPARISON BETWEEN PATHS



EMISSIONS, SECURITY, AND COST COMPARISON BETWEEN PATHS

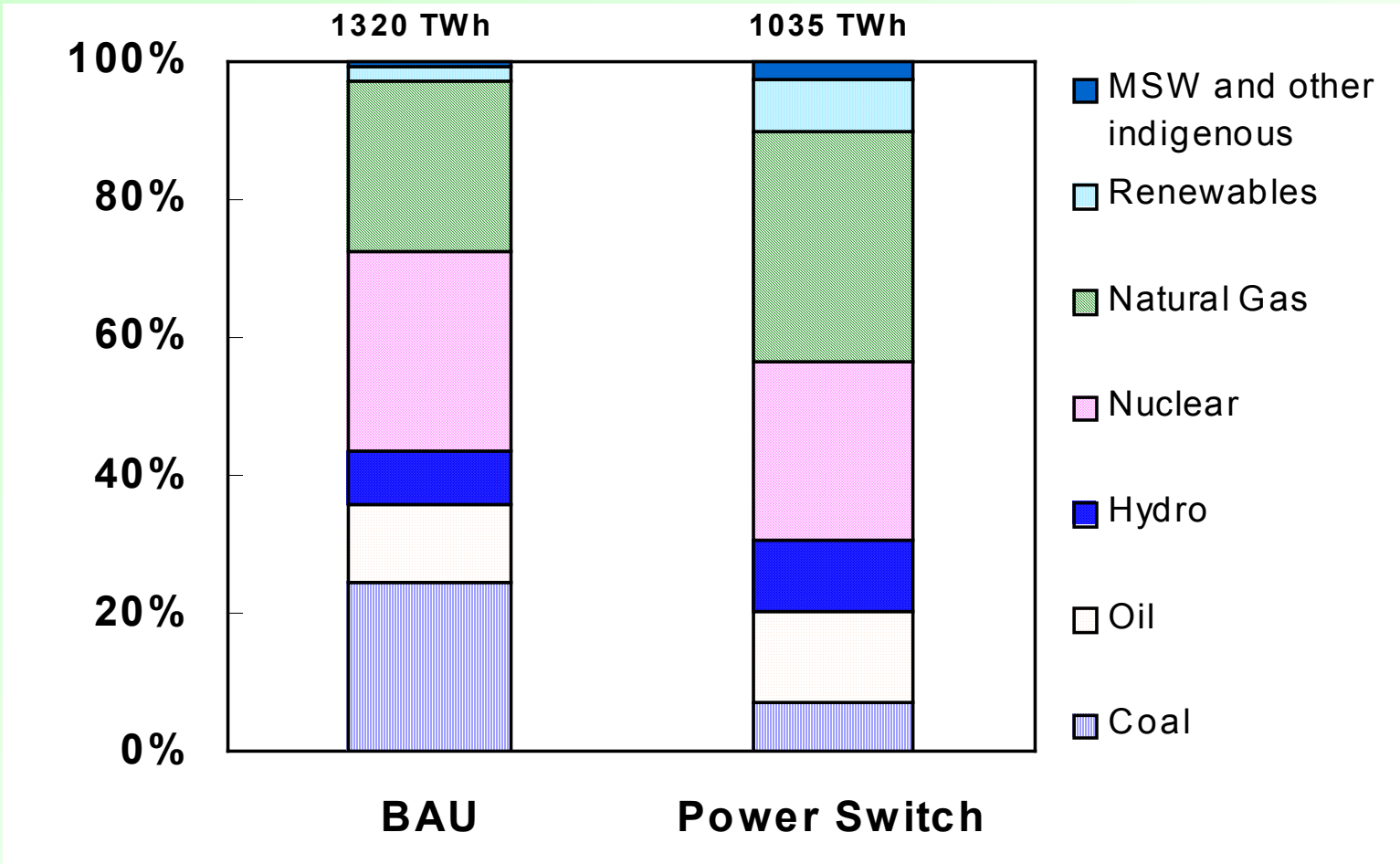
- Relative to the BAU path, the PS path reduces Japan's GHG emissions by
  - 94 million tonnes of CO_2 equivalent per year by 2010
  - 190 million tonnes per year by 2020
  - Overall GHG reductions from the PS scenario, relative to the BAU scenario, total nearly 2.0 billion tonnes of CO_2 equivalent between 2000 and 2020

EMISSIONS, SECURITY, AND COST COMPARISON BETWEEN PATHS

- PS Path changes **overall gas use** for electricity generation **very little**, but increased use of power generation from renewable, domestic sources relative to BAU yields improved fuel supply diversity.
  - Reduction in coal imports (70 %), crude oil (3 %), nuclear fuel (20 %)
  - LNG imports increase, but only modestly (less than 2 percent)
- Lowered **vulnerability to supply disruptions**, less reliance of Japan on imports, more reliance on domestic energy

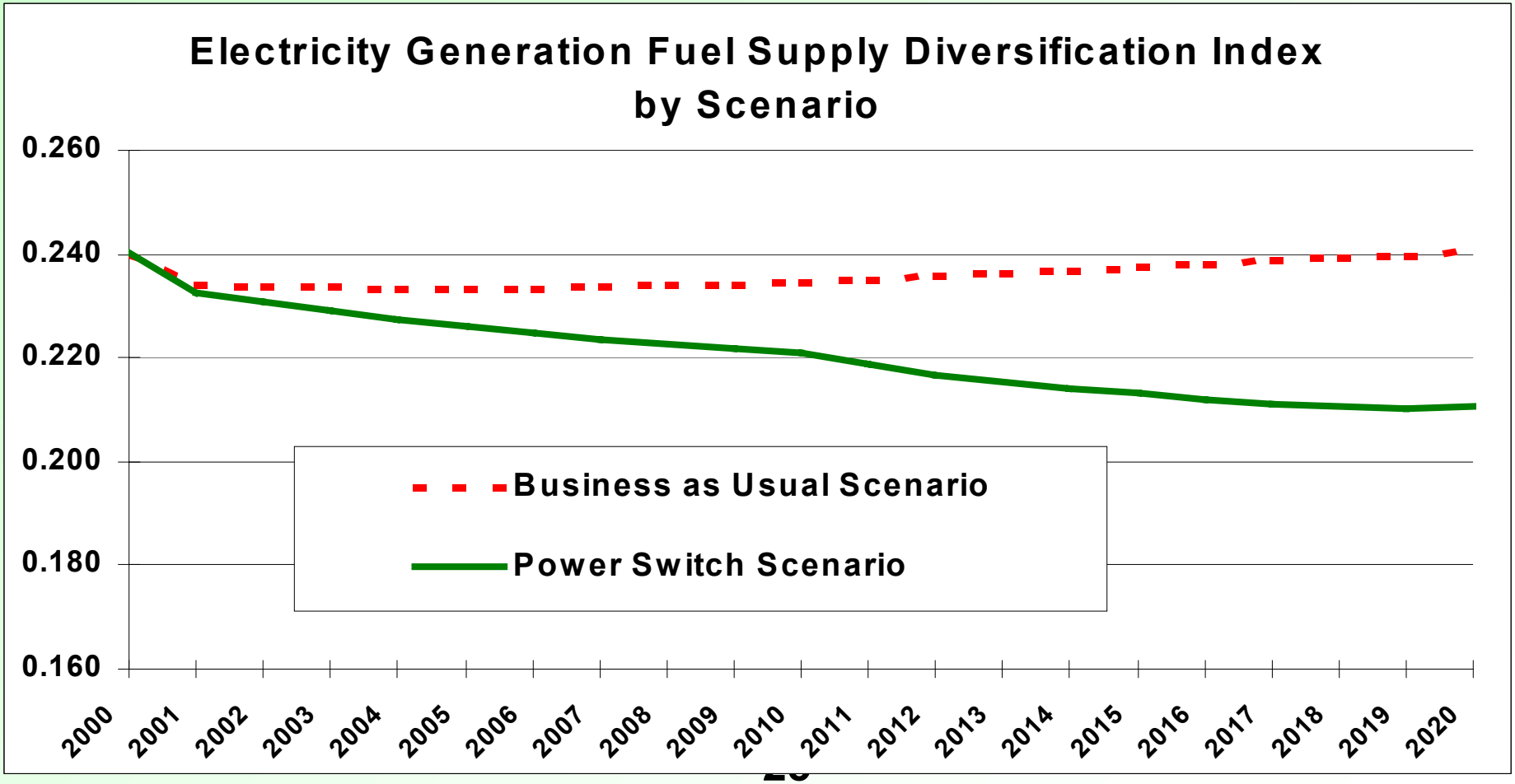
EMISSIONS, SECURITY, AND COST COMPARISON BETWEEN PATHS

- Fraction of Generation by Path



EMISSIONS, SECURITY, AND COST COMPARISON BETWEEN PATHS

- Electricity Fuel Supply Diversification Index



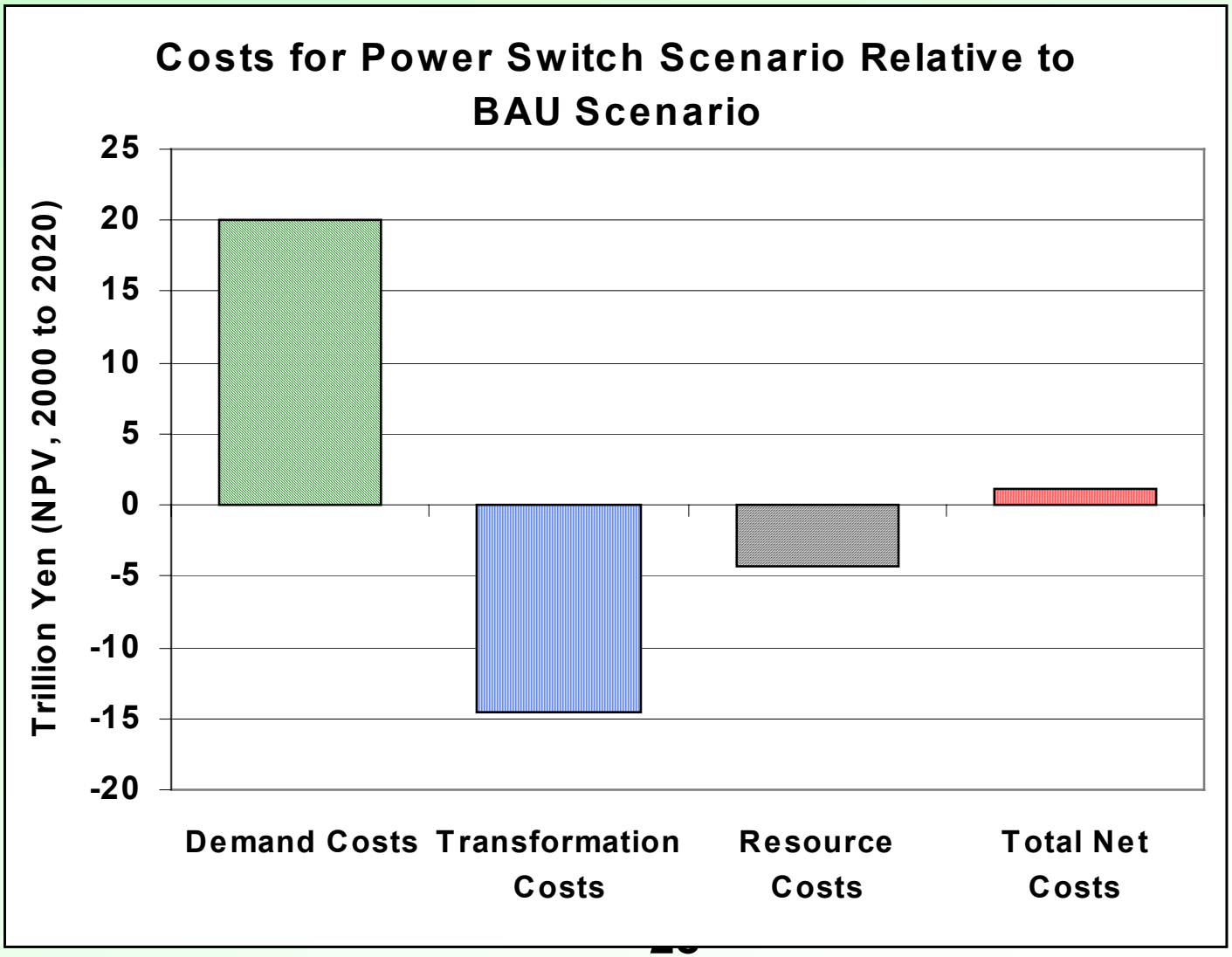
EMISSIONS, SECURITY, AND COST COMPARISON BETWEEN PATHS

- **Cost Assumptions**
  - Demand-side changes range widely in cost, but generally assumed **1.5 times US-based costs**
  - Costs for renewable generation, cogeneration **fall over time**
  - Costs for other power supplies remain constant
  - Costs for **fuels change relatively little** over study period (coal costs, oil/gas costs rise after 2015

EMISSIONS, SECURITY, AND COST COMPARISON BETWEEN PATHS

- **Cost Results**
  - PS Transformation costs over 2000 to 2020 14.5 trillion Yen **less** than costs in BAU
  - Additional costs for demand-side energy-efficiency measures, on-site generation: ~20 trillion Yen, of which more than 50% for distributed PV, cogen
  - Import fuel costs avoided: 4.4 trillion yen
- 31% reduction in annual GHG emissions relative to BAU by 2020, at net cost 1.1 trillion yen over study period, or 57 billion yen/yr
- Net 850 JPY/ tonne of CO_2, **equivalent to 0.3 % tax on electricity use--350 Yen/HH-yr**

EMISSIONS, SECURITY, AND COST COMPARISON BETWEEN PATHS



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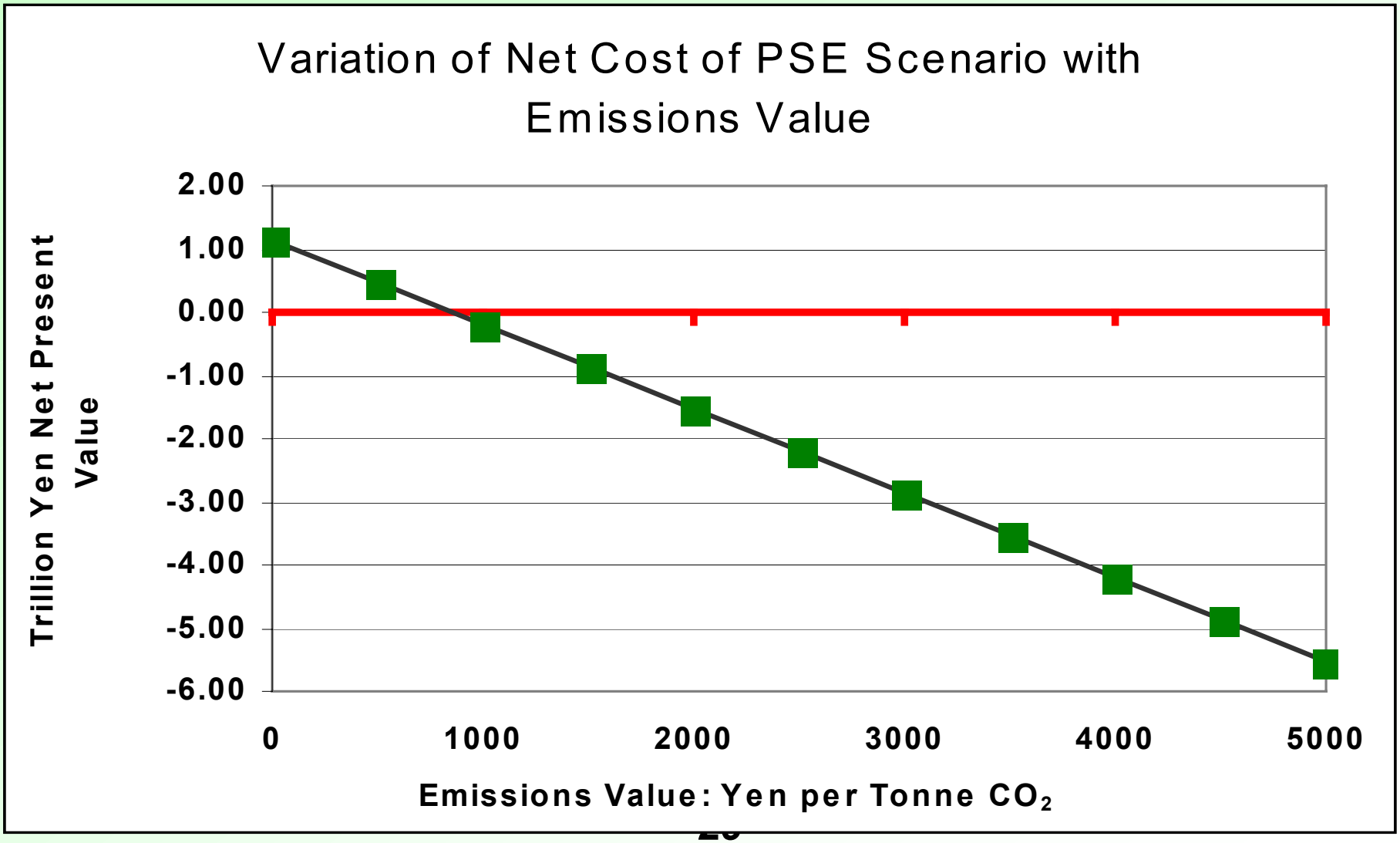

BENEFITS OF AND BARRIERS TO A POWER SWITCH PATH IN JAPAN

- Additional Benefits
  - Improvements in domestic investment through reduction of money spent on imported fuel
  - Boost to Japan's renewable energy industry.
  - Overall increase in domestic employment
  - A reduction in coal ash, nuclear waste to be disposed of
  - Reduction in emissions of nitrogen oxides and other air pollutants

BENEFITS OF AND BARRIERS TO A POWER SWITCH PATH IN JAPAN

- Barriers to Power Switch Path
  - Existing institutional structure of the electric and gas utilities sectors
  - Lack of information about demand-side measures among electricity consumers.
  - Lack of information about the climate change problem/opportunities for solutions among consumers.
  - Lack of funding for demand-side measures and for renewable power development
  - Entrenched interests, expertise within government and utilities, favoring "BAU" approach to energy sector development