Computation and Analysis on Taiwan Index of Energy Security Risk

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Outline

• Introduction
• Exposure of Energy Import
• Prediction for the Future Years
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Introduction

• The International Index of Energy Security Risk - by U.S. Chamber of Commerce (USCC).
• 29 indexes belong to eight categories
• Localization for these energy security risk analysis
• Taiwan's domestic data were prepared to complete energy security risk analysis
Structure of international index of energy security risk of USCC
Analysis for the past years

Comparison of Taiwan’s energy security risk index results

The financial crisis in 2008

fossil fuel price dropped since 2011
Risk Exposure of Energy Import

• Taking Diversity of Supply into account on gas, coal, and oil
• Taiwan has been over-concentrated in a particular country in the past,
  – induced high risk of exposure of energy import for a specific period of time.
• The issue has been adequately mitigated by increasing the importing countries to enhance diversity and to reduce the risk exposure.
Gas Import Exposure results analyzed by INER

- Gas import focused on a specific country during 1991 – 1995, which induce high gas import exposure.
- Taiwan started to import gas in 1991.
- Gas demand has been increased since 2011. Gas import focused on a specific new country, gas import exposure increased slightly.
- Followed by increasing the import countries, the import exposure risk gradually decreased.
Energy Security Risk Analysis

Coal import focused on a specific country during 2001 - 2005

Coal import exposure results analyzed by INER
Comparison of average of petroleum, gas, and coal import exposure and weighted total index analyzed by INER
Prediction for the Future Years

• To predict energy security risks
  – TIMES model predicts the basic data of the scenarios, and the
  – GEMEET model calculates GDP based on the electricity demand from TIMES model.
  – To analyze the energy security risks of Taiwan's domestic energy security risks
Recognizing the calculation of each index
Data collection
Calculating the risk of each index and sum of them to obtain the "total weighted risk"

Planning the scenarios for different energy portfolios
Assuming suitable energy service demand for different scenarios
Based on the concept of "balance of energy supply and demand" and minimization of the cost, the data required in the indexes for different scenarios can be obtained.

Combining the USCC energy security indexes with TIMES and GEMEET model
Prediction for the Future Years

• Scenarios:
  – Business as usual (BAU)
  – Optimistic Scenario
  – Moderate Scenario

• In compliance with Intended Nationally Determined Contribution (INDC) and Greenhouse Gas (GHG) Reduction Act

• For Optimistic Scenario and Moderate Scenario,
  – a large scale of renewable energy, gas-fired power generation, coal-fired power plants with CCS are used
  – electricity demand is suppressed to achieve carbon reduction requirement.
Power generation for BAU

Coal fired
Gas fired

fossil fuel power plants are massively used.
Power generation for Optimistic Scenario

- Maximized renewable energy
- Gas-fired power generation
- Coal-fired power plants with carbon capture and storage (CCS)
- Reduce power demand
- to achieve \( \text{CO}_2 \) emission policy

Power generation for Optimistic Scenario
• Limited renewable energy
• Gas-fired power generation
• Coal-fired power plants with carbon capture and storage (CCS)
• Reduce MORE power demand
• to achieve CO$_2$ emission policy
Comparison of BAU, Optimistic Scenario and Moderate Scenario on total power generation for future years
Comparison of BAU, Optimistic Scenario and Moderate Scenario on GDP per Capita for future years
Comparison of BAU, Optimistic Scenario and Moderate Scenario on the Risk of GDP per Capita for future years.
Comparison of BAU, Optimistic Scenario and Moderate Scenario on the Risk of Non-Carbon Generation for future years

To fulfill GHG reduction act
Comparison of BAU, Optimistic Scenario and Moderate Scenario on the Risk of CO₂ Emissions Trend for future years

To fulfill GHG reduction act
Comparison of BAU, Optimistic Scenario and Moderate Scenario on the Risk of CO₂ per Capita Trend for future years

To fulfill GHG reduction act
Comparison of BAU, Optimistic Scenario and Moderate Scenario on the risk of CO₂ GDP intensity for future years.
Imported fossil fuel price projections
Comparison of BAU, Optimistic Scenario and Moderate Scenario on the risk of Energy expenditures per capita for future years.
Comparison of BAU, Optimistic Scenario and Moderate Scenario on the risk of fossil fuel import expenditure per GDP for future years
Comparison of BAU, Optimistic Scenario and Moderate Scenario on the risk of energy expenditure intensity for future years
Comparison of BAU, Optimistic Scenario and Moderate Scenario on energy security risk analysis for future years
Conclusions

• At present, the Taiwan government has decided to perform 2025 nuclear-free homeland policy objectives,

• The power generation portfolio by 2025 will be: coal 30%, gas 50%, renewable energy 20%.

• With this power generation portfolio,
  – nuclear energy is excluded,
  – coal-fired power generation is reduced, gas-fired power generation and renewable energy are widely used.
Conclusions

• However, from the energy security point of view, heavily relying on a particular power generation will worsen the energy import risk exposure, which has been in serious condition.
• Massively using gas-fired power generation will induce short spare storage period and international natural gas price volatility issues.
• Excluding nuclear power and reducing coal-fired power generation will cause base load power shortage issues.
• Massively increasing renewable energy will cause deterioration of power quality and high electricity price issues.
Suggestion

• The energy policy with diversity consideration should be taken into account.
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