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Maniwa, Okayama

Improving the Energy-Water-Material Nexus toward sustainable future in East Asia -Modelling Part 1-

Soocheol Lee
Meijo University

Low-carbon, Sustainable Future in East Asia: Improving energy systems, taxation and policy cooperation

Research Questions and Answers of the previous Study

How should East Asia choose its energy and power sources?

The implementation of a sustainable mix of energy and power sources based on restriction of nuclear power and fossil fuels, with a range of support measures for renewables and energy efficiency.

How could East Asian countries design energy/carbon taxes or other carbon-pricing instruments

Our analysis with the E3ME-Asia model showed that, across the East Asian region, carbon taxes offer a favorable way of raising these revenues, typically costing less in terms of GDP and employment than the alternative options.

How should East Asia choose and coordinate low-carbon policies in the tide of free trade?

The development of a low-carbon partnership in East Asia that will enable policy coordination in climate and energy issues.

Contents and Study Periods

PART 1

Improving power sectors toward sustainable low carbon economy across East Asia（study period:2016 April~2017March ）

PART2

Industry transition, transportation system and sustainable low carbon economy across East Asia（study period:2016 April~2017March ）

PART3

Transition of water, resource and land use for environmental sustainability(study period:2017 April~2018 March)

PART4

Building a policy framework to ensure future environmental sustainability(study period: 2017 April~2018 August)

Study schedule of 2016: chapters in Part 1 & 2

○August 3~5 : Maniwa workshop(one day biomass tour, 1.5 day workshop, half day cultural tour)

⇒Overseas co-authors present the ideas on the papers in which they have interest.

⇒S Lee presents how to model Part 1 (the power sector)

⇒Unnada presents how to model Part 2

○September 30 :

⇒Co-authors in Parts 1 and 2 submit 1~2 pages ideas and some references on the chapters to the first authors.

○September 30~October 30 :

⇒First authors make outlines of the chapters and discuss this with co-authors and share ideas on modelling of the chapters with Cambridge Econometrics

○October 31~November 3 : Intensive modelling workshop at Cambridge Econometrics

⇒exercise to model the chapters in Part 1 and Part 2 with the staff of CE and leading authors

○December 31 : Finish the first draft of papers in Part 1

○March 31, 2017 : Finish the final draft of papers in Part 1

⇒First authors determine co-authors and order of co-authors, discussing with editors.

⇒Contribute peer reviewed English language journals if authors want to. In this case, authors contribute the summary or reshuffled paper to the book chapter of this study

⇒Post papers on the REEPS website as working papers

⇒Recommend to present working papers to domestic and international conferences

Background and aims of this study

As global populations and incomes increase throughout the world, pressure on environmental resources is also increasing. Although the problem is global, East Asia, which includes the world's second and third largest global economies and the world's largest source of greenhouse gas emissions, will play a key role in shaping the world that we live in.

With the Paris COP, policy makers across the world are turning their attention to measures to reduce greenhouse gas emissions. However, while substantial reductions in greenhouse gas emissions are necessary to mitigate climate change, the problem is in reality far more complex.

Issues of energy consumption are intertwined with those of land use, water and the consumption of other materials – this has been described as the energy-water-material-food 'nexus'. Researchers are only now beginning to grapple with this problem and policy makers across the world do not yet have the necessary tools with which to understand the issue.

In this study we apply new advanced modelling techniques to help develop an understanding of the key issues and interactions, including socio-economic impacts. Using these models, we will make forecasts to 2050 based on a business-as-usual scenario for East Asia, covering power sector, industrial production and the use of energy, water, key mineral resources, and land as well as agricultural production.

Further, we will calculate emissions of environmental pollutants such as CO_2 and particulate matter accompanying the use, production, and consumption of the above resources, and we will assess the impacts of health damage and declining land use on agriculture.

Assuming increased energy and resource productivity, we will examine the impact of introducing various policy packages aimed at limiting pollution accompanying the use of these resources (e.g., carbon pricing and taxes on non-renewable resources, water resources, virtual water transfers, and unsustainable land use). And we use CGE models on some important issues, also comparing results to E3ME-Asia analyses.

The final section shows that cooperation across the East Asian region will be essential to meeting the challenges posed by the nexus. The research will measure, evaluate, and compare the impacts of introducing policies at the individual country level as well as simultaneous adoption of policies throughout East Asia⇒

⇒on the efficient use of energy, water and other resources, and land and agricultural productivity and on the suppression of emissions of various pollutants. It is aimed at policy makers who will ultimately be responsible for meeting these challenges while ensuring economic and social prosperity for people across the region.
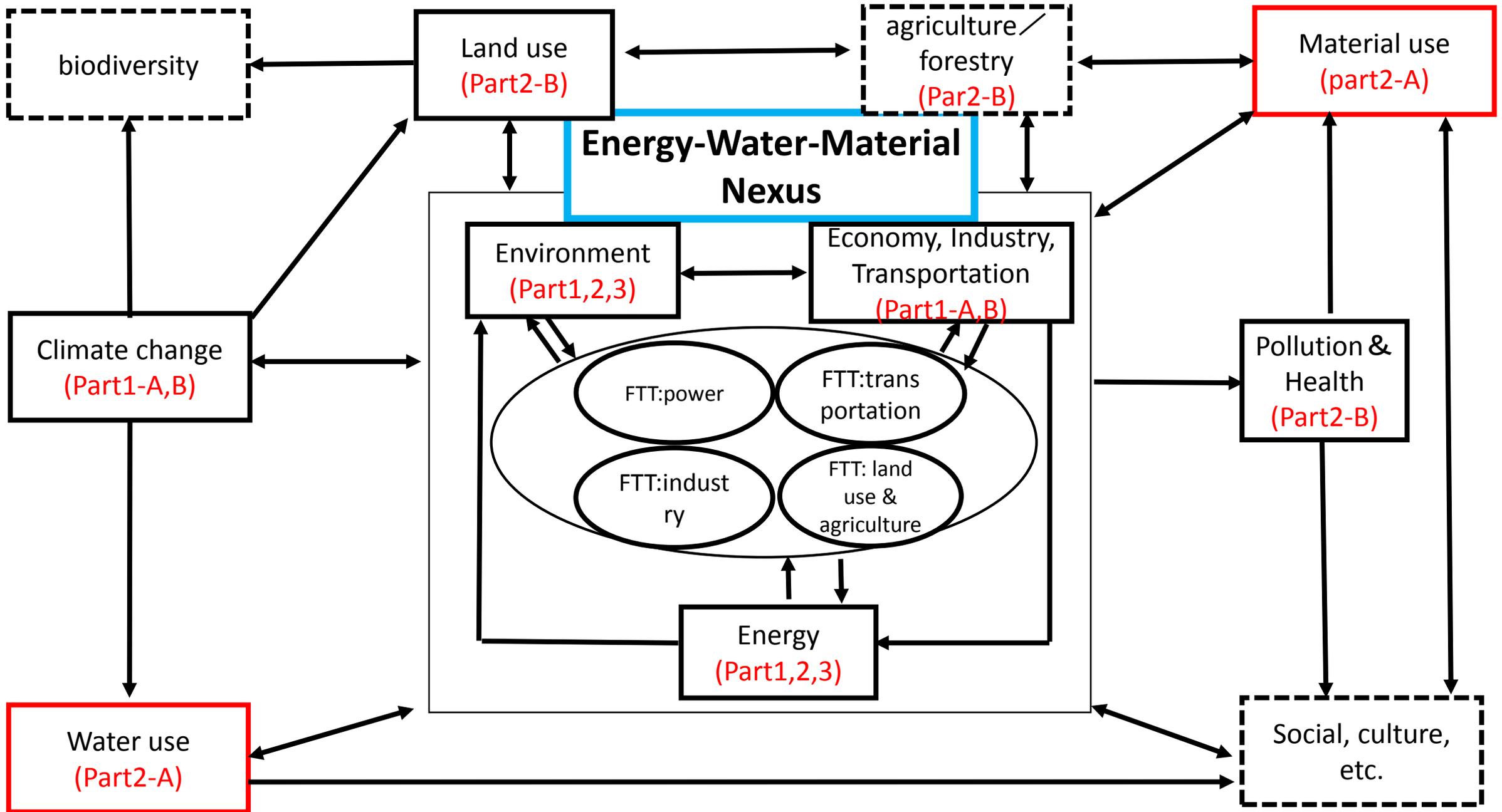
Study Target	Energy System, Industry and Resource Use Transition toward Sustainable Future in East Asia

Publicity

- Symposium(4~6 in 4 years)
- Presentation in international academic associations
- Working papers, papers for journals (more than 20 papers)
- Book publishing (20 chapters)

Teams and Study Subjects

Secretariat and Modeling team

Team 1（Energy and industry transition）	Designing sustainable electricity systems in East Asia, Reappraisal of renewable energy,Economic impact and transition of industry under decarbonisation
Team 2(Decarbonising transportation,building	Decarbonising transport systems, Reducing the environmental impact of buildings Financing the energy system and industry transition
Team 3(water, resource use transition)	Interaction between energy and material consumption, Sustainable use of water resources. Managing the use of mineral and biomass resources
Team 4(agriculture, land use transition,etc.)	Land use requirements and the agricultural sector, Local pollution and related health effects, The economics of the nexus, in East Asia and beyond
Team 5(policy frame work, policy cooperation)	Policy lessons from Europe and other global regions, Lessons from East Ssia Building cooperation between East Asian regions, Case study: East Asian supergrid

Study methods

Hearing and research(governments, Institutes, business circles, companies), Workshop, Modeling running, Policy analyses

Study Tool

Mainly E3ME-Asia＋FTT：Power,Industry,Transportation,agriculture

Study team

Secretariat and modeling team ↔ Team 1 ↔ Team 2 ↔ Team 3 ↔ Team 4 ↔ Team 5
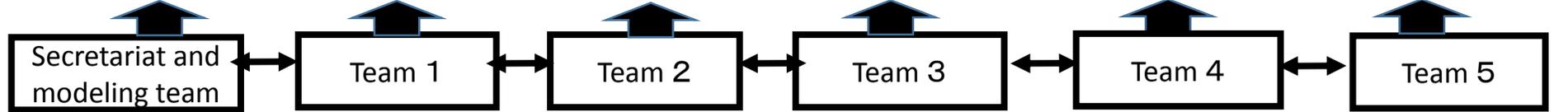
Study network

32 academics：Japan（15+3）、Overseas（UK(4), East Asia（10））

Modelling PART 1
Improving power sectors toward sustainable low carbon economy across East Asia

Japanese GHG targets

1,397 million ton
(2005=100

②
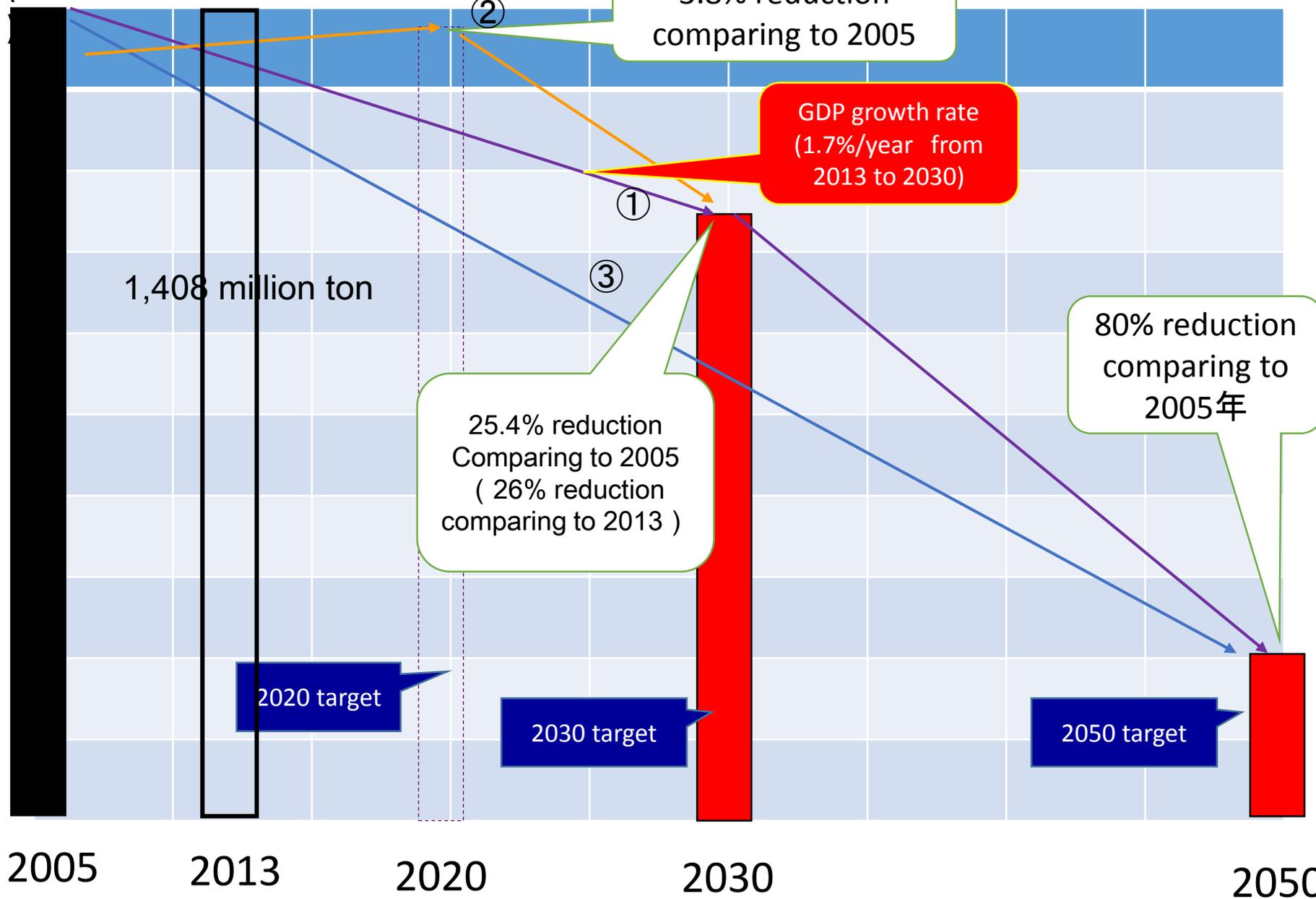
3.8% reduction comparing to 2005

GDP growth rate (1.7%/year from 2013 to 2030)

①

1,408 million ton

③

80% reduction comparing to 2005年

25.4% reduction Comparing to 2005 (26% reduction comparing to 2013)

2020 target

2030 target

2050 target

2005   2013   2020   2030   2050

Japan`s Energy and Power mix plan in 2030

GDP growth rate (1.7%/year from 2013 to 2030)

Energy Conservation (50.3 million KL)

2030 power mix plan

Geothemal(1~1.1%)

Electricity About 25% (966.6 bil. kWh)

Heat, Gasoline, City gas, etc. 75%

Energy Demand

Electricity About 28% (980.8 bil. kWh)

Heat, Gasoline, City gas, etc. 72%

Renewables (22~24)

Nuclear (20~22)

LNG (27)

Coal (26)

Petro (3%)

Biomass (3.7~7.6%)

Wind(1.7)

PV(7.0%)

Hydro (8.8~9.2%)

Renewables (13~14%)

Nuclear (10~11%)

LNG (18%)

Coal (25%)

LPG(3%)

Petroleum (30%)

Nuclear and Fossil Fuel Reliance 85%

Total electricity output (1,065 billion kWh)

361 million KL
2013

326 million KL
2030

2030

2030

Modelling this part

- ●Using FTT(Future Technology Transition) power sub model connected by E3ME, we can estimate the changes of power sectors by 2050 of East Asia by the policy scenarios of regulating the coal power, nuclear each and coal power and nuclear power simultaneously.

- ●We introduce power sector policies such as feed in tariffs or subsidies to increase renewables share and show how much these policies promote renewables.

- ●We could put carbon tax on power sector to estimate how this change the power mixes in East Asia. We could put a cap on nuclear so that it doesn't come up as substitution for fossil fuels technologies

- ●For linking grids, we effectively join the regions in FTT, removing some of the resource constraints on variable / peak load sources. It would have impacts on harmonising electricity prices between regions. The whole diffusion dynamic could also change as well, we would need to discuss with J-F, developer of FTT, but potentially very interesting.

Base line for modelling this Part

●Set base lines of Electricity mixes, CO2 emissions and GDPs of China, Japan, Korea and Taiwan by 2050 using reference scenarios of 「Asia/World Energy Outlook」 by EEIJ

⇒This report disclose detailed and reliable reference data on energy and economy of CJKT by 2040

⇒We calibrate the energy and economy data from 2040 to 2050 using the trends of 2030~2040 in 「Asia World/ Energy Outlook」

●Population data by 2050
⇒UN World Population Perspective

Pathway to get the 2050 GHG target

(2010=100)
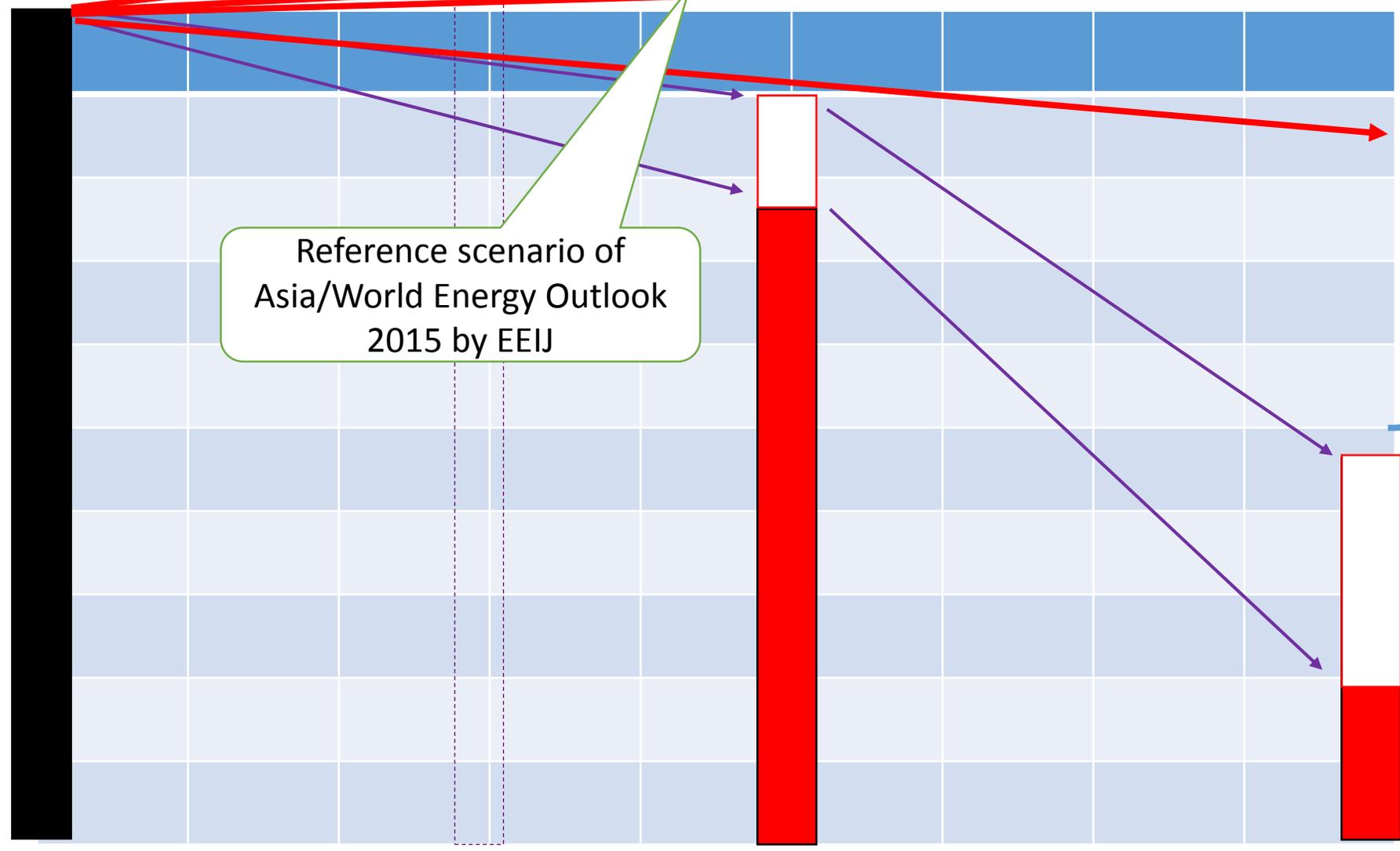
China(23.2%)

Taiwan(6.6%)

Korea(4.1%)

Japan(-16.2%)

Carbon cost

Reference scenario of Asia/World Energy Outlook 2015 by EEIJ

Japan`s 2050 target 80% reduction

2013

2020

2030 INDC

2050

Chapter 3. Modelling the power sectors in East Asia : the choice of power sources by nuclear and coal power regulations

●In this chapter we explore possible scenarios of power sector development for four East Asian regions (China, Japan, Korea, and Taiwan), all of which have specific targets for changing the composition of their technology mix in order to generate power(by chapter 3 of Routledge 2015).

●We use a method that is based on technology diffusion(E3ME+FTT), in which pathways of technology result from energy policy choices like 5 policy scenarios below. We explore the feasibility of current aspirations and targets by evaluating the effectiveness of putative electricity policies in chosen 5 scenarios below.

We simulate impacts on electricity mixes of CJKT using E3ME+FTT by the 5 scenarios below

- Scenario 1 : Nuclear ⇒ fade out by 2050

- Scenario 2 : Coal ⇒ regulate by 2050

- Scenario 3 : Scenario 1 + Scenario 2

- Scenario 4 : Scenario 3 +Policy scenario on renewable

  Electricity subsidies of CJKT

- Scenario 5 : all scenarios + East Asia Super Grid impacts

On the expected results of the scenarios in general on the electricity mixes of CJKT:

- Sc 1 will show a shift from nuclear to coal
- Sc 2 will show a shift from coal to gas
- Sc 3 will be a shift from coal and nuclear to gas
- Sc 4 will be a shift from nuclear and fossil fuels to renewables
- Sc 5, one of the important features of a super-grid would be that intermittent renewables could be combined better without needing so much storage – but with only an annual resolution this is difficult to judge with E3ME.

Chapter 4. Modelling the power sectors in East Asia : the choice of power sources by feed-in-tariffs and carbon taxes to meet the 2030 INDCs and 2050 targets

● In this chapter we focus on the power sector and we will see how power mixes of CJKT will be influenced by feed-in-tariff and carbon tax on power sector by 2050 below.

● Estimate carbon tax to meet the 2030 INDCs of CJKT and simultaneously to meet the 80% reduction by 2050(comparing 2010) in Japan, Korea and Taiwan and 50% reduction by 2050(comparing 2010) in China(no restriction on energy mix target of CJKT).

Policy Scenarios

- Scenario 1 :
  Nuclear ⇒fade out by 2050 plus feed-in tariff and carbon
                    tax
- Scenario 2 :
  Coal ⇒regulate by 2050 plus feed-in-tariff and carbon tax
- Scenario 3 :
  ⇒Scenario 1 + Scenario 2 plus feed-in-tariff and carbon tax
- Scenario 4 :
  ⇒Scenario 3 +Policy scenario on renewable Electricity
          subsidies plus   Carbon Tax
- Scenario 5 : Carbon tax alone(no recycling)

Chapter 5. Modelling the power sectors in East Asia : economic and environmental impact by the choice of power sources of nuclear and coal power regulations

●In chapter 3 above, we will analyse scenarios, i.e. limiting the share of nuclear power, limiting the share of coal-fired power, limiting the share of both nuclear and coal-fired power, and subsidizing renewables. Economic impacts of these scenarios in East-Asia are not immediately or intuitively obvious to predict.

●This is due to many interacting factors: phasing out inexpensive energy systems, such as nuclear and coal-fired plants, drives up the total costs of supplying electricity in the power sector. This, in turn, may decrease welfare for consumers and may also reduce international trade competitiveness through higher export prices(Chapter 4 of Routledge 2015).

●Meanwhile, investment in low-carbon technology often has beneficial impacts on employment (see, for instance, Wei et al. 2010, and Cambridge Econometrics et al. 2013), since new technologies often involve higher levels of technological complexity and sophistication, research and development activities, and increased demand in interrelated sectors across the economy.

We will provide the economic impacts from E3ME-Asia for each scenario of electricity policy and technology, as defined in the chapter 3 above.

Scenario 1 : Nuclear ⇒ fade out by 2050

Scenario 2 : Coal ⇒ regulate by 2050

Scenario 3 : Scenario 1 + Scenario 2

Scenario 4 : Scenario 3 +Policy scenario on renewable

Electricity subsidies of CJKT

Scenario 5 : all scenarios + East Asia Super Grid(??)

Chapter 6. Modelling power sectors in East Asia: the choice of power sources by CGE

　-This chapter is CGE version of chapter 3,4

　-Basically same scenario and same logic of chapter 3,4

Chapter 7. Modelling power sectors in East Asia: economic and environmental impact by the choice of power sources by CGE(CGE version of chapter 5)

　-This chapter is CGE version of chapter 5

　-Basically same scenario and same logic of chapter 5