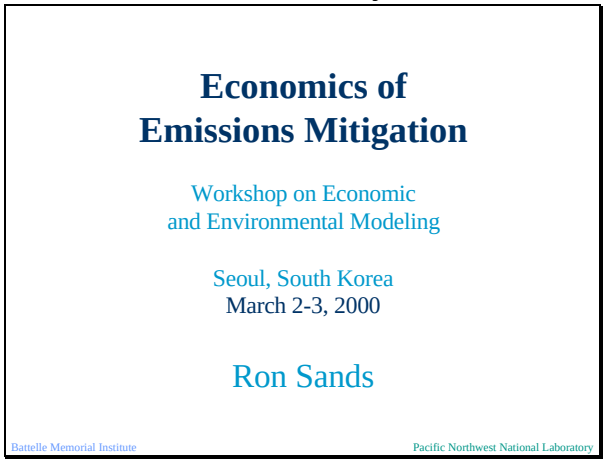
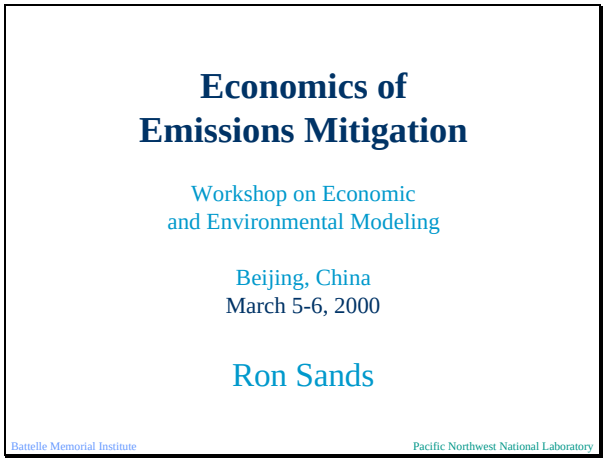
APPENDIX H - Presentation by Ron Sands, PNNL





Overview

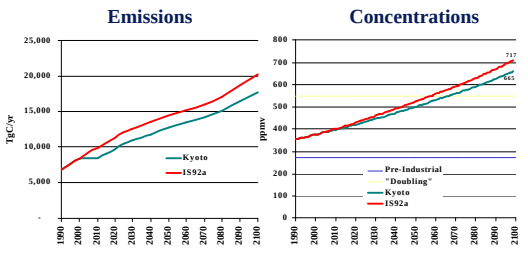
- ★Framework Convention on Climate Change
- ★Emissions vs. Concentrations
- ★Energy Modeling Forum Activities
- ★Choice of Baseline
- ★Model Development

The FCCC

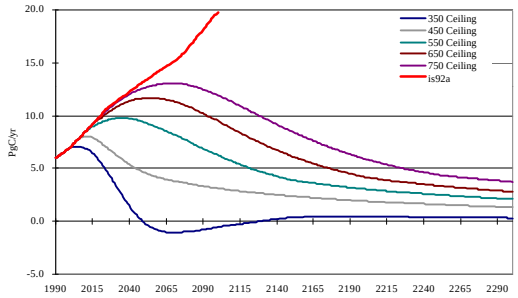
The ultimate objective of this Convention and any related legal instruments that the Conference of the Parties may adopt is to achieve, in accordance with the relevant provisions of the Convention, stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.

Article 2

KYOTO
Emissions and Concentrations



Atmospheric Stabilization Emissions Paths



Top-Down Economic Models

- ★Project baseline carbon emissions over time for a country or group of countries
- ★Find the least-cost way to meet any particular emissions constraint
- ★Provide a measure of the carbon price, in dollars per metric ton
- ★Provide some measure of the overall cost of meeting an emissions target

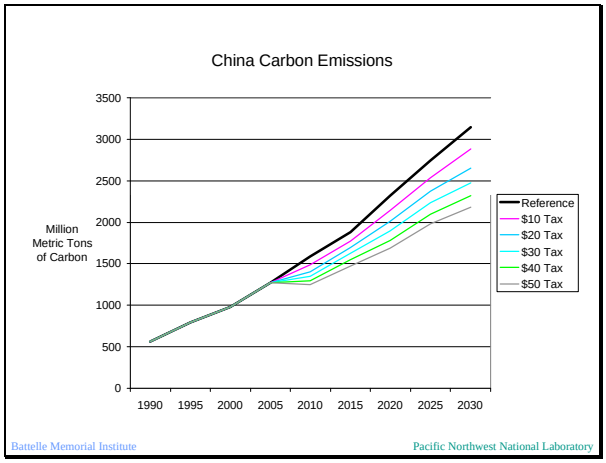
SGM Regions

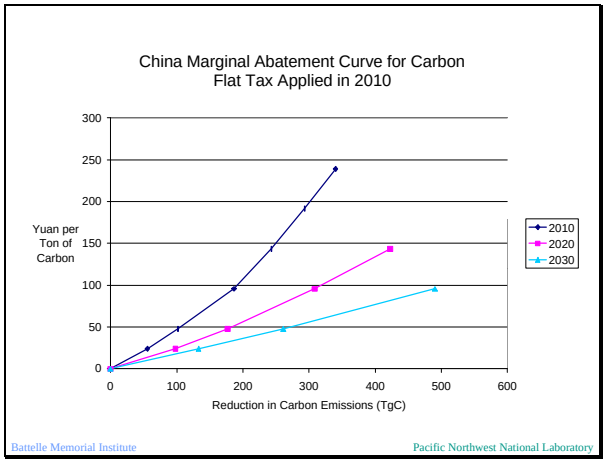
★Annex I
- United States
- Canada
- Western Europe
- Japan
- Australia
- Former Soviet Union
- Eastern Europe

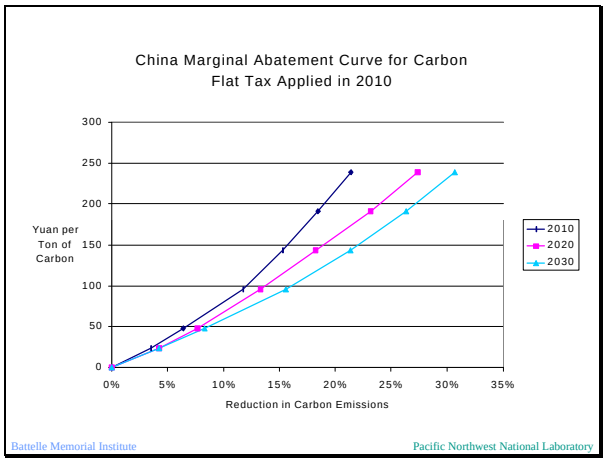
★Non Annex I
- China
- India
- Middle East
- Mexico
- South Korea
- Rest of World

SGM Data Requirements

Original Data	Derived Data for SGM
1990 Input-Output Table 1990 Energy Balances	Hybrid Input-Output Table
Annual Investment Data by Sector	Capital Stocks by Sector
Data on Fossil Fuel Resources	Resource Grades
Electricity Supply: generation, installed capacity, energy consumption, capital costs, operating costs	Input-output representation of electricity generation by fuel
National Income Accounts	tax rates, savings rates







Energy Modeling Forum

- ★EMF 16 with Kyoto Emissions Targets
  - ➢Reference case
  - ➢No trading
  - ➢Annex I trading
  - ➢Global Trading
- ★Simple CDM Assumptions
  - ➢15% of Global Trading

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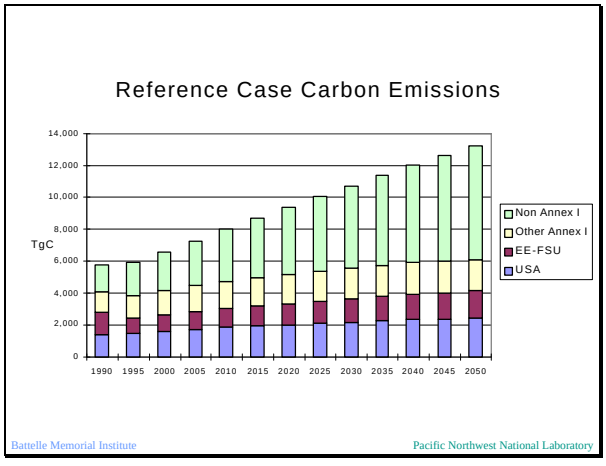

Round #2 Post-Kyoto EMF Scenarios
Second Generation Model

US Permit Prices in 2010
(1990 US$)

	No Trading	Annex I Limit on Sales	Annex I Limit on Purchases	Full Annex I Trading	CDM	Double Bubble	Annex I plus China and India	Global Trading
Kyoto Targets	**188**	181	103	**85**	73	59	27	**22**
Kyoto Targets + 5%	149							

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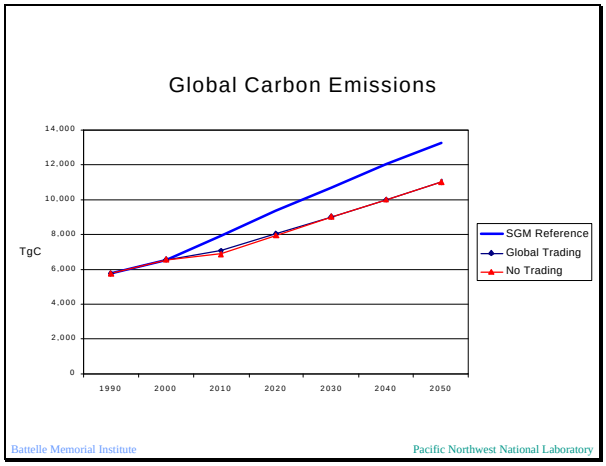

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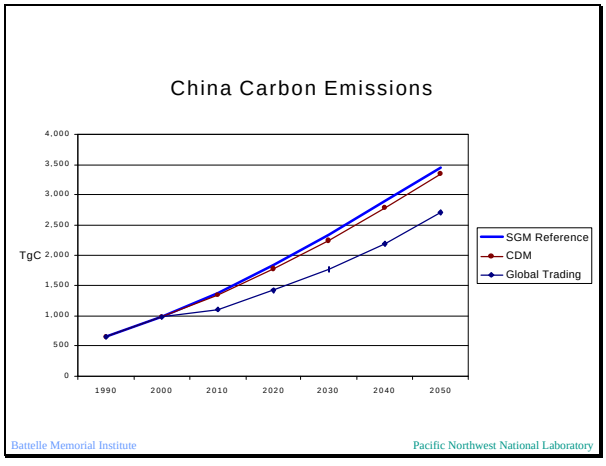

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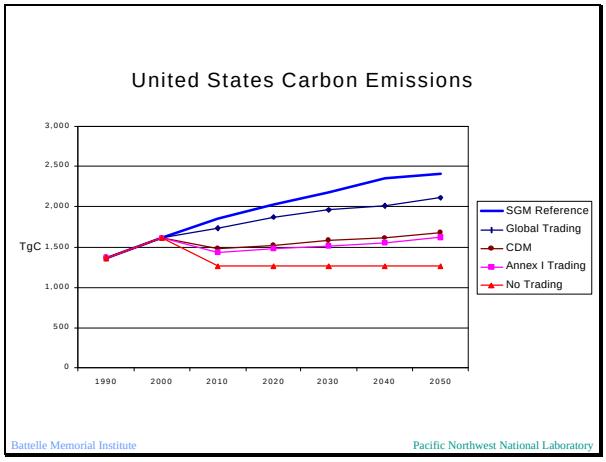
United States Carbon Emissions
TgC
3,000
2,500
2,000
1,500
1,000
500
0
1990
2000
2010
2020
2030
2040
2050
SGM Reference
Global Trading
CDM
Annex I Trading
No Trading
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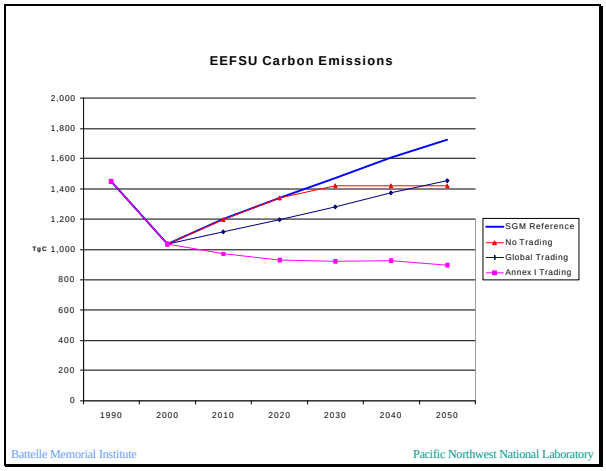
EEFSU Carbon Emissions
TgC
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
1990
2000
2010
2020
2030
2040
2050
SGM Reference
No Trading
Global Trading
Annex I Trading
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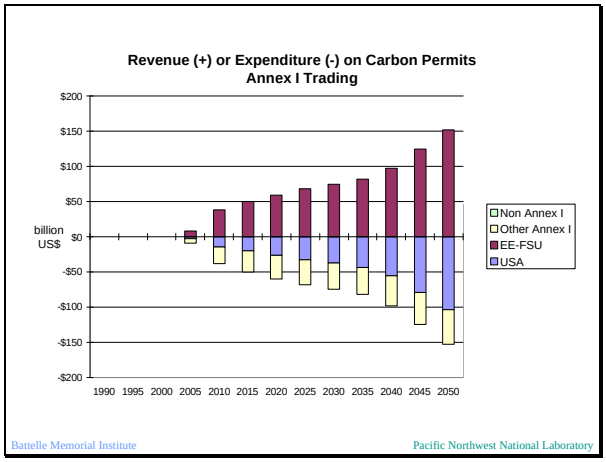
Revenue (+) or Expenditure (-) on Carbon Permits
Annex I Trading
billion US$
$200
$150
$100
$50
$0
-$50
-$100
-$150
-$200
1990
1995
2000
2005
2010
2015
2020
2025
2030
2035
2040
2045
2050
Non Annex I
Other Annex I
EE-FSU
USA
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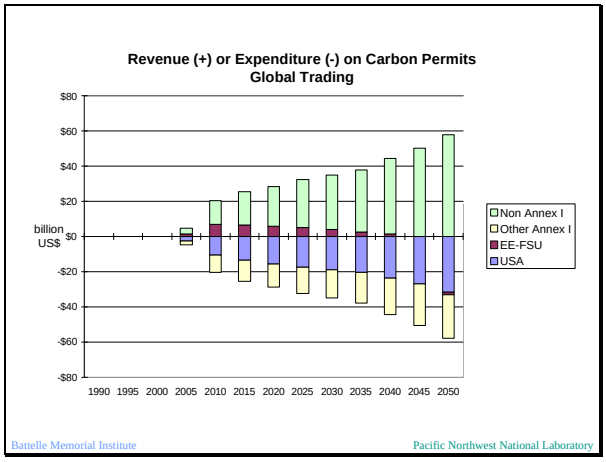
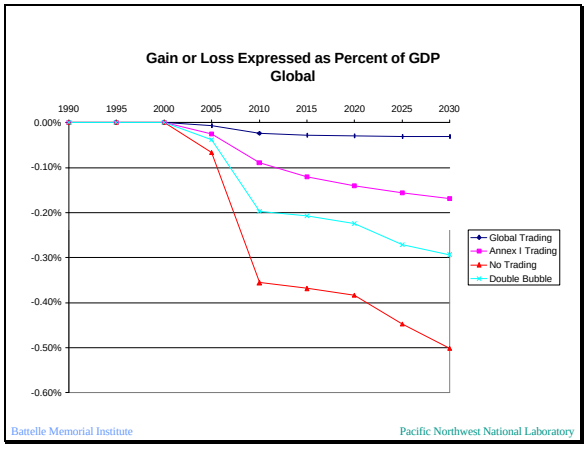

Revenue (+) or Expenditure (-) on Carbon Permits
Global Trading
billion US$
$80
$60
$40
$20
$0
-$20
-$40
-$60
-$80
1990 1995 2000 2005 2010 2015 2020 2025 2030 2035 2040 2045 2050
Non Annex I
Other Annex I
EE-FSU
USA
Battelle Memorial Institute
Pacific Northwest National Laboratory


Gain or Loss Expressed as Percent of GDP
Global
1990 1995 2000 2005 2010 2015 2020 2025 2030
0.00%
-0.10%
-0.20%
-0.30%
-0.40%
-0.50%
-0.60%
Global Trading
Annex I Trading
No Trading
Double Bubble
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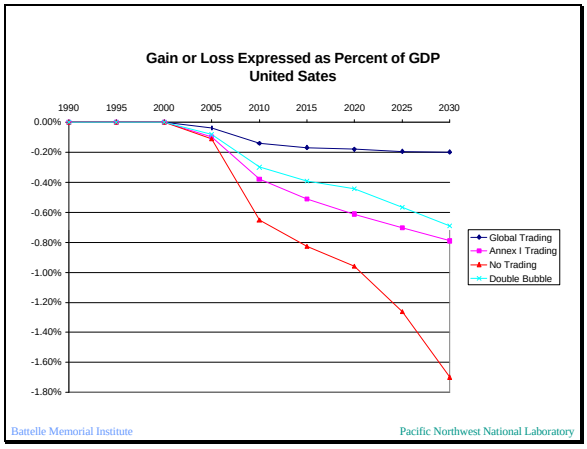
Gain or Loss Expressed as Percent of GDP
United Sates
1990 1995 2000 2005 2010 2015 2020 2025 2030
0.00%
-0.20%
-0.40%
-0.60%
-0.80%
-1.00%
-1.20%
-1.40%
-1.60%
-1.80%
Global Trading
Annex I Trading
No Trading
Double Bubble
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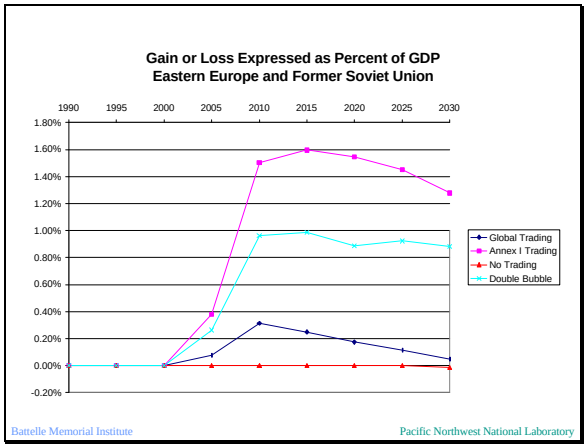

Measuring and Reporting Cost

- ★Direct Cost
  - area under marginal abatement curve
- ★International Transfer Payments
- ★Indirect Costs
  - **terms of trade (energy)**
  - **terms of trade (non-energy)**
  - **energy tax/subsidy distortions**
  - **revenue recycling**

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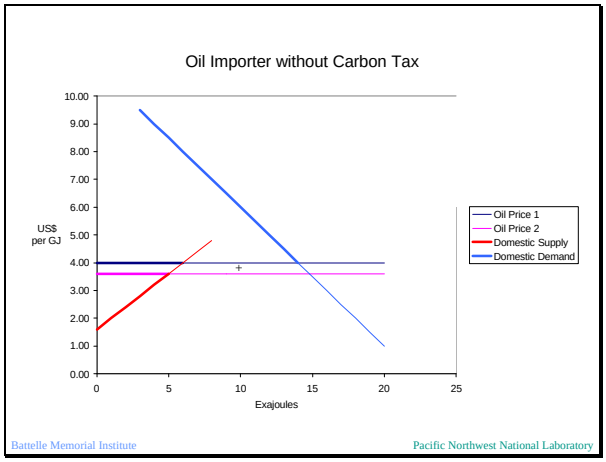

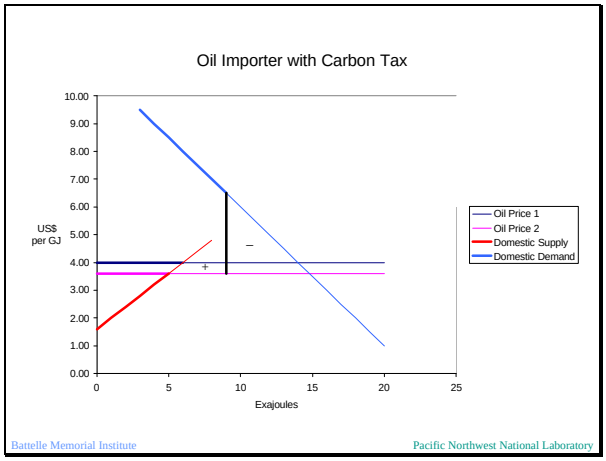
Oil Importer with Carbon Tax
US$ per GJ
Exajoules
Oil Price 1
Oil Price 2
Domestic Supply
Domestic Demand
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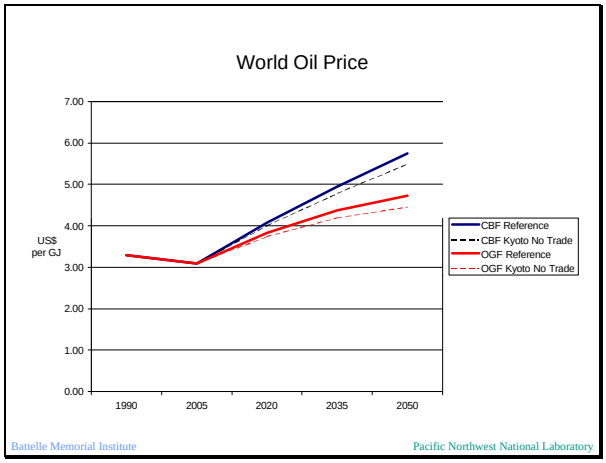
World Oil Price
US$ per GJ
CBF Reference
CBF Kyoto No Trade
OGF Reference
OGF Kyoto No Trade
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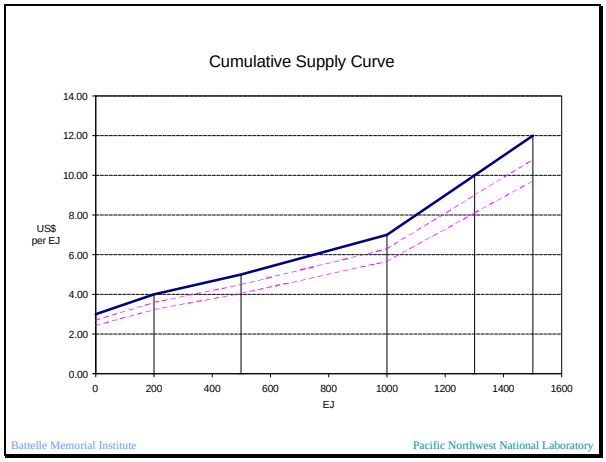
Cumulative Supply Curve
US$ per EJ
EJ
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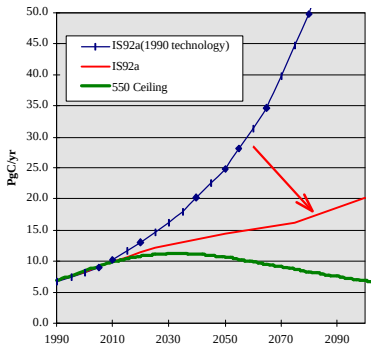
Cost Components in 2050
Annex I Trading
(Carbon Tax = $186 per metric ton)

	Oil	Gas	Coal	Total
"Direct Cost"	-32	-32	-252	-316
World Energy Markets	11	2	-1	12

Which Baseline?

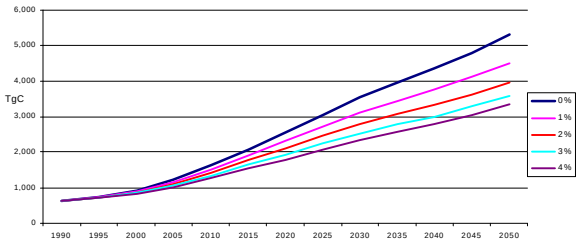


Production Functions

$$Q_t = f(K_t, L_t, E_t, M_t; a_{Kt}, a_{Lt}, a_{Et}, a_{Mt})$$

- ★Technical coefficients control change in input-output ratios over time.
- ★Energy coefficient is similar to AEEI (Autonomous Energy Efficiency Improvement).

China Carbon Emissions at Varying Rates of Energy-Efficiency Improvement



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SGM 98

1 Agriculture
2 Everything Else
3 Oil Production
4 Gas Production
5 Coal Production
6 Biomass
7 Nuclear Fuel
8 Electricity Production
Oil-Fired
Gas-Fired
Coal-Fired
Nuclear
Hydro
9 Oil Refining
10 Gas Distribution

SGM 2000

1 Other Agriculture
2 Everything Else
3 Oil Production
4 Gas Production
5 Coal Production
6 Coal Products
7 Biomass
8 Electricity Production
Oil-Fired
Gas-Fired
Coal-Fired
Nuclear
Hydro
9 Oil Refining
10 Gas Distribution
11 Paper and Pulp
12 Chemicals
13 Cement
14 Primary Iron and Steel
15 Primary Non-Ferrous Metals
16 Other Industry
17 Passenger Transport
18 Freight Transport
19 Grains and Oil Crops
20 Animal Products
21 Forestry
22 Food Processing
23
24
25

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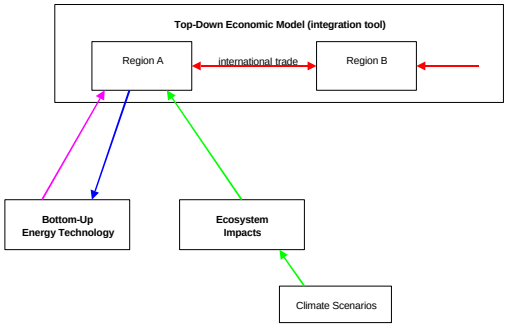
Model Integration



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