Non-CO_2 Gas Emissions Modeling
- AIM/Trend, AIM/Enduse, AIM/CGE(Asia) -

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Why do we need modeling for multi-gas analysis ?

To estimate the effect on

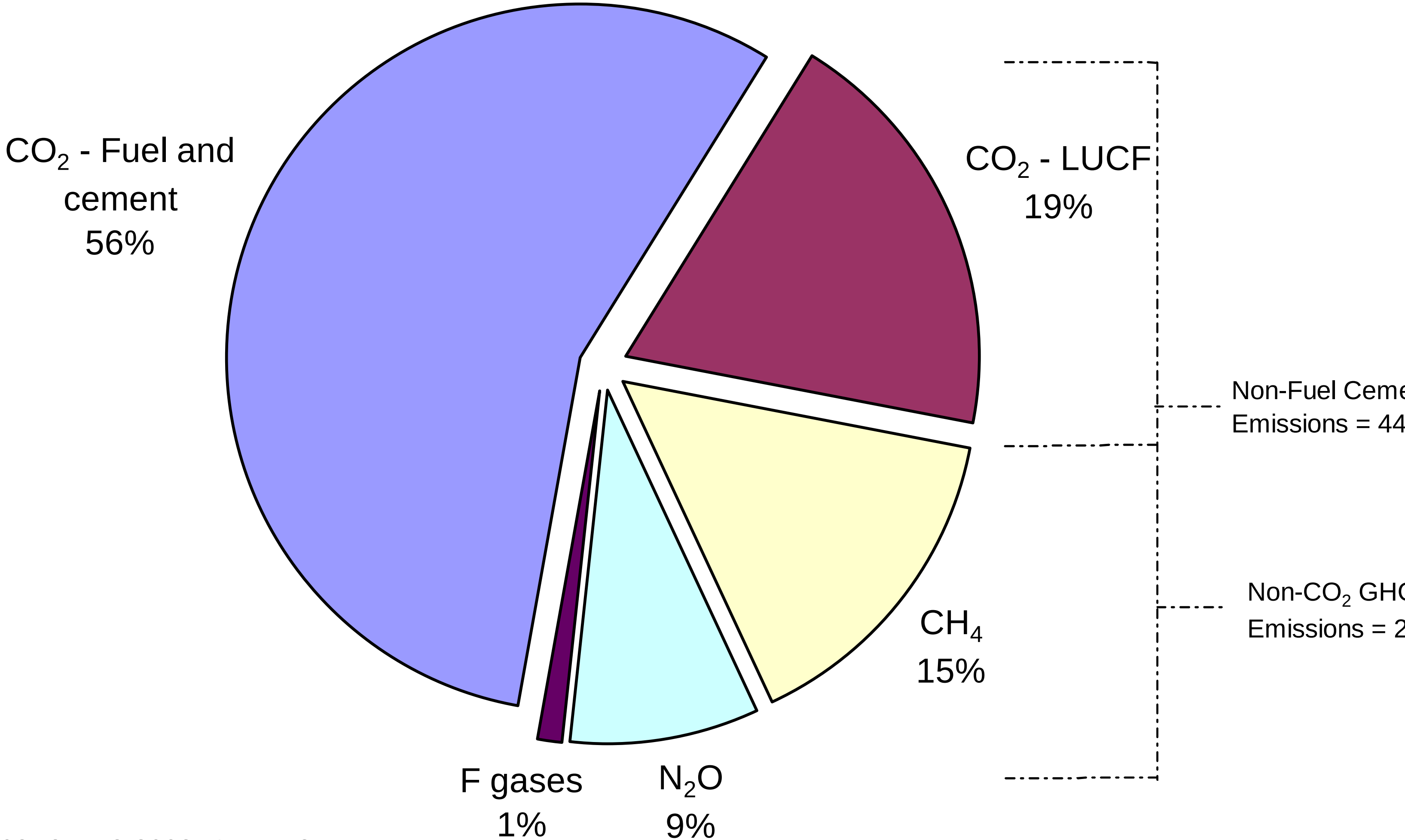
CO_2-only mitigation vs. multi-gas mitigation

quantitatively and synthetically

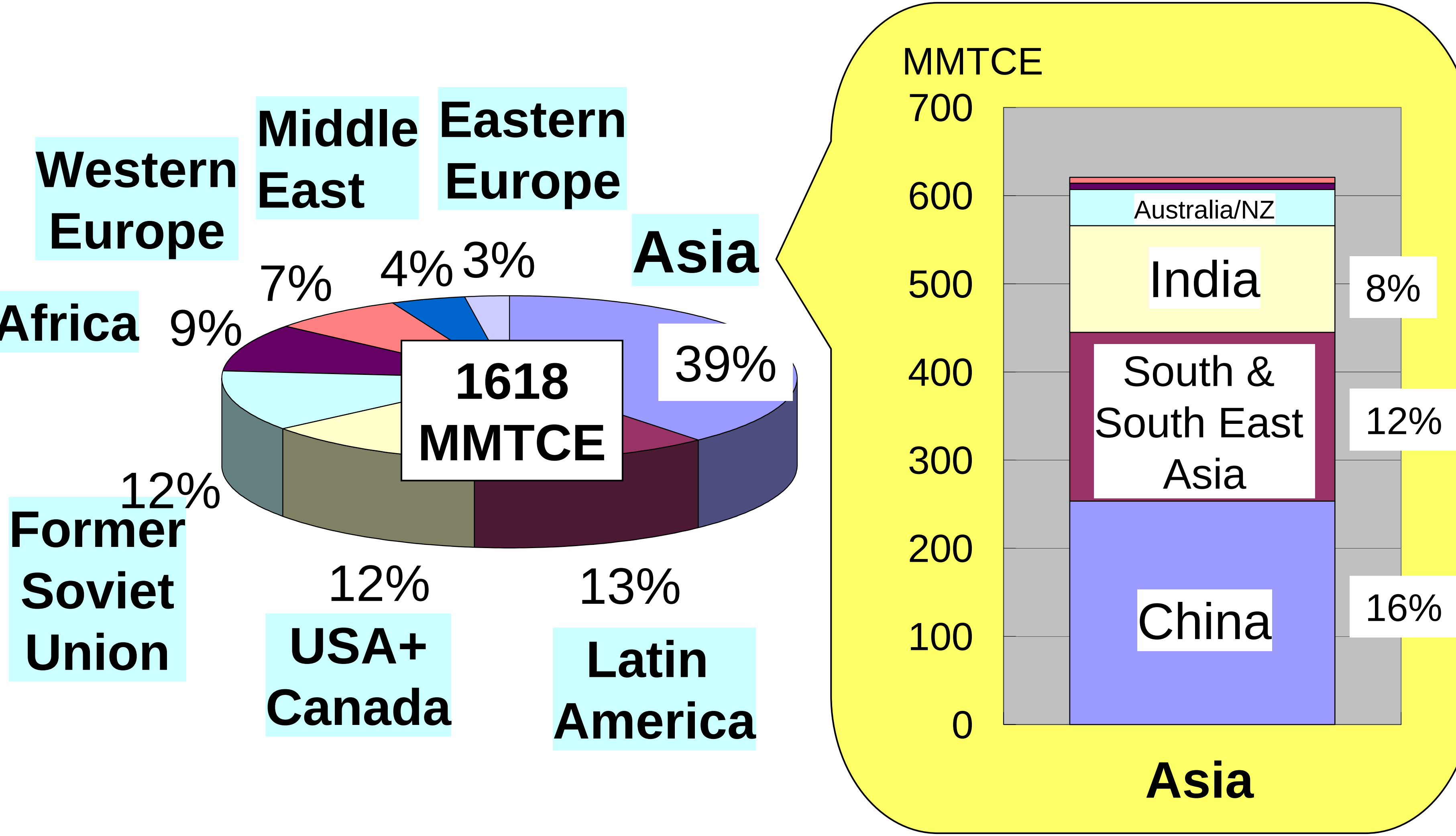
How much economic loss will be reduced ?
Which mitigation option will be adopted?
Is climate change a only target for non-CO2 mitigation options?

Why Multi-gas Mitigation?

2000 Global Net Emissions of CO_2, CH_4, N_2O, F gases, and LUCF (Total 10,863 MMTCE)

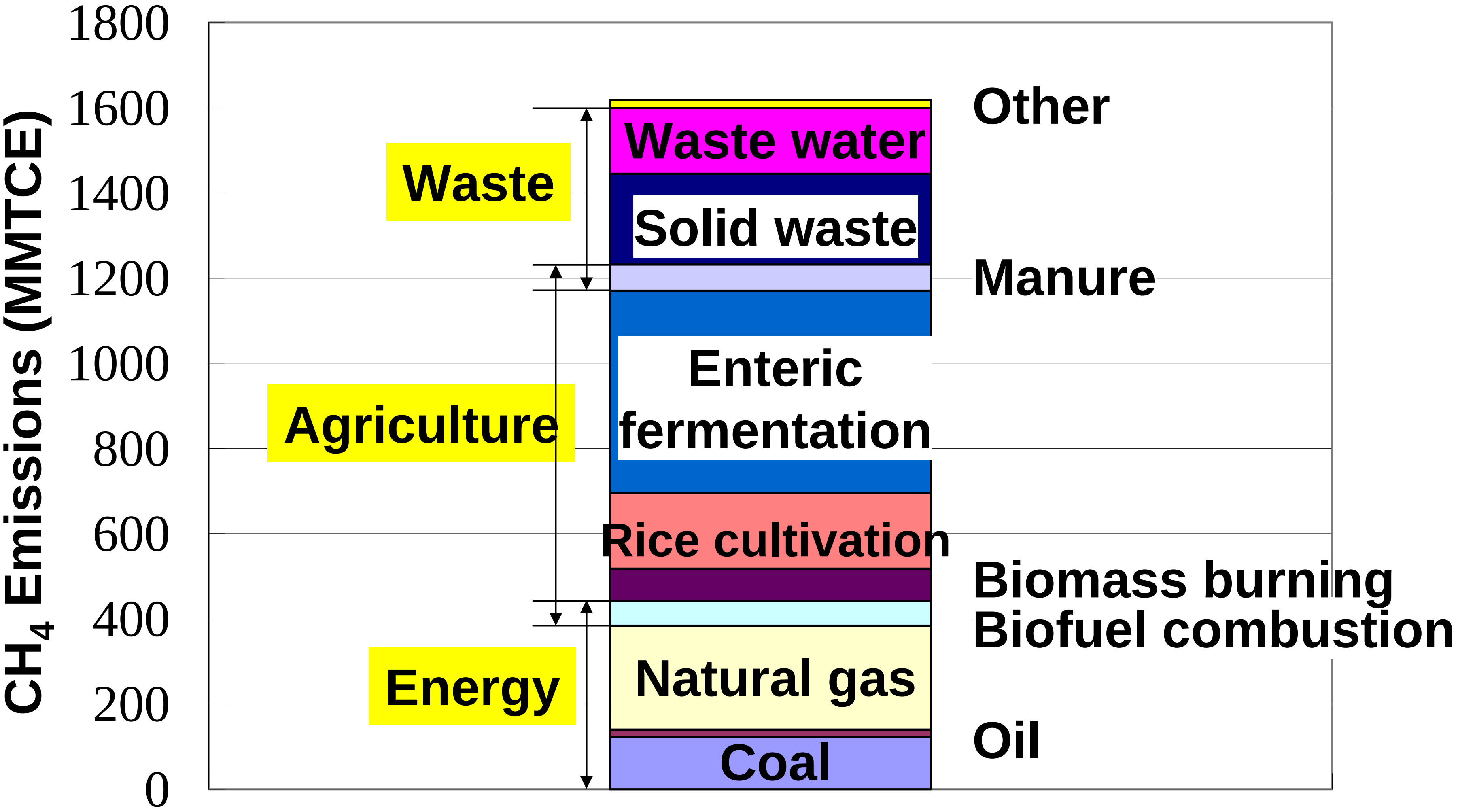


Regional CH_4 Emissions in 2000



Data source: USEPA

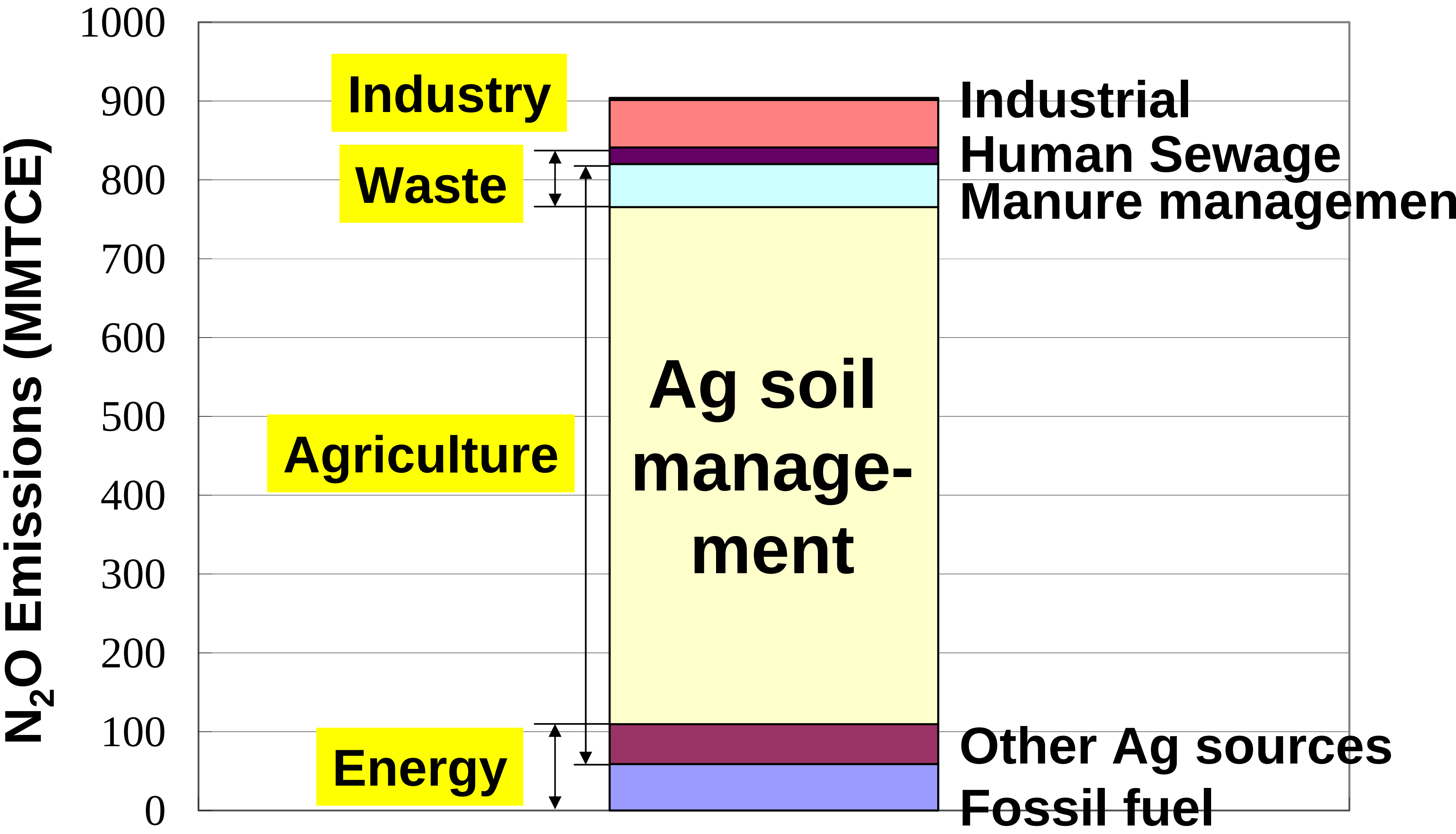
Global CH_4 Emissions in 2000



(MMTCE: Million Metric Ton Carbon Equivalent)

Data source: USEPA

Global N_2O Emissions in 2000



(MMTCE: Million Metric Ton Carbon Equivalent)

Data source: USEPA

Global non-CO_2 gas emissions (2000)

(MMTCE)		CH_4 1618	N_2O 950	F gas 122
Energy 459	Coal mining	123		
	Natural gas system	244		
	Oil industry	17		
	Stat&Mobile sources	16	59	
Agriculture 1610	Biomass burning	134	51	
	Rice cultivation	177		
	Ag soil management		656	
	Enteric fermentation	476		
	Manure management	61	55	
Waste 388	Solid waste	213		
	Waste water	154	21	
Industry 182	Adipic acid, Nitric acid		60	
	HFCs			26
	PFCs			29
	SF6			15
	ODS			52

- **Asia**: around 1/3 of global non-CO_2 gas emissions
- **Agriculture**: the largest emission source of non-CO_2 gas is agriculture sector (enteric fermentation, agriculture soil management)
- **Uncertainty**: emission factors, mitigation options, abatement policy

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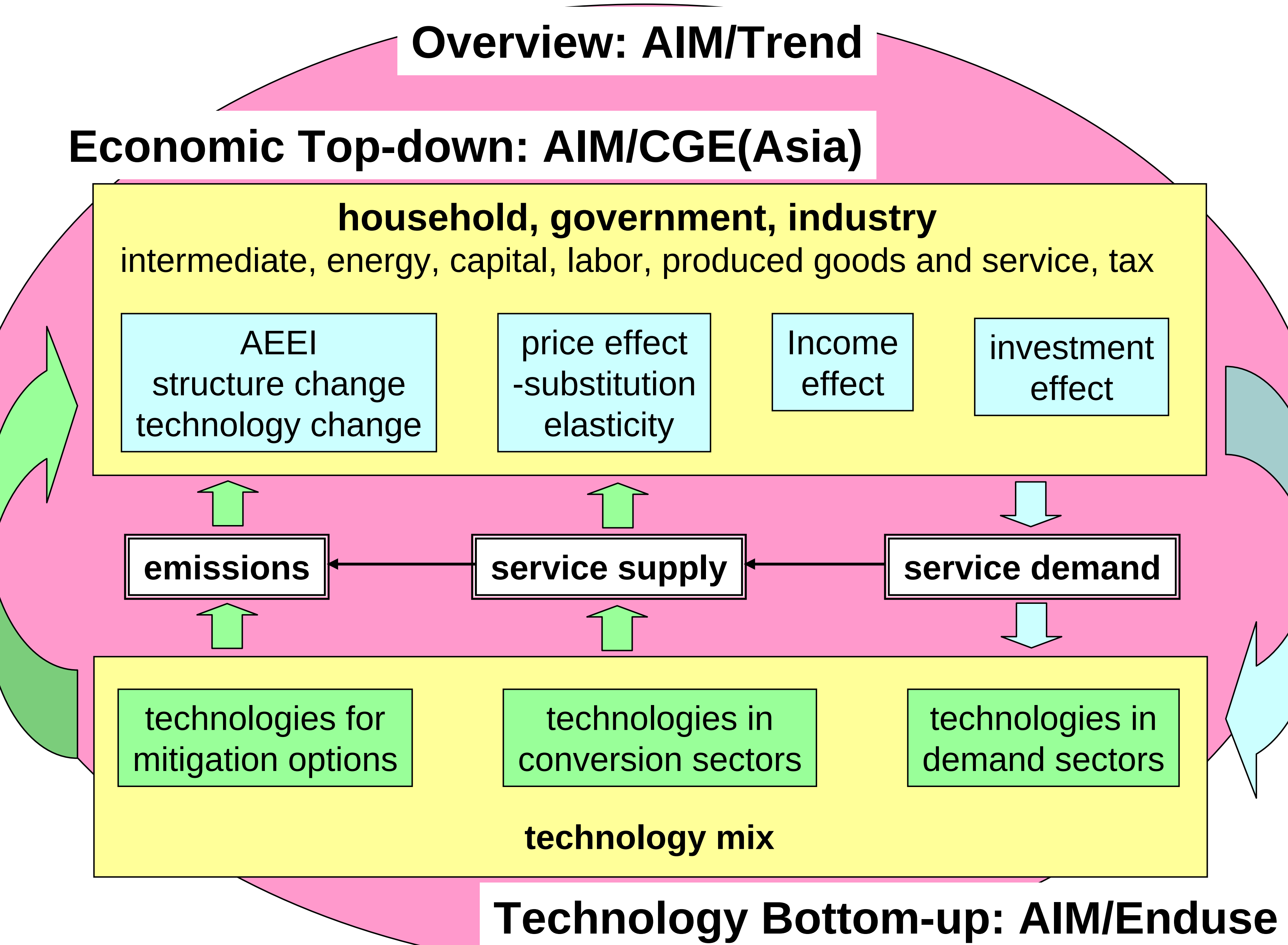
Non-CO_2 gas emissions Modeling

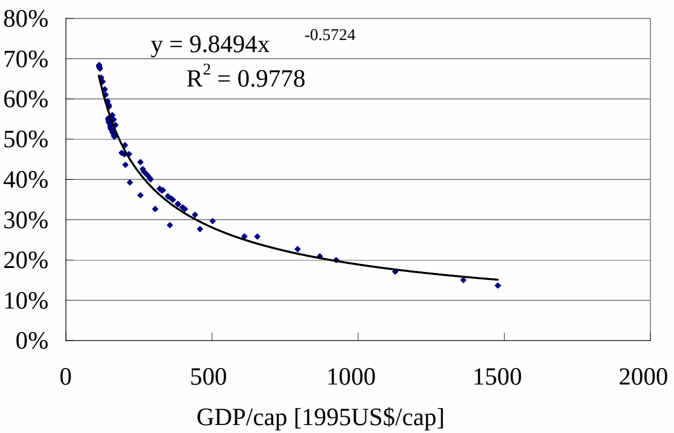

Overview: AIM/Trend
Economic Top-down: AIM/CGE(Asia)
household, government, industry
intermediate, energy, capital, labor, produced goods and service, tax
AEEI
structure change
technology change
price effect
-substitution
elasticity
Income
effect
investment
effect
emissions
service supply
service demand
technologies for
mitigation options
technologies in
conversion sectors
technologies in
demand sectors
technology mix
Technology Bottom-up: AIM/Enduse

Overview: AIM/Trend model

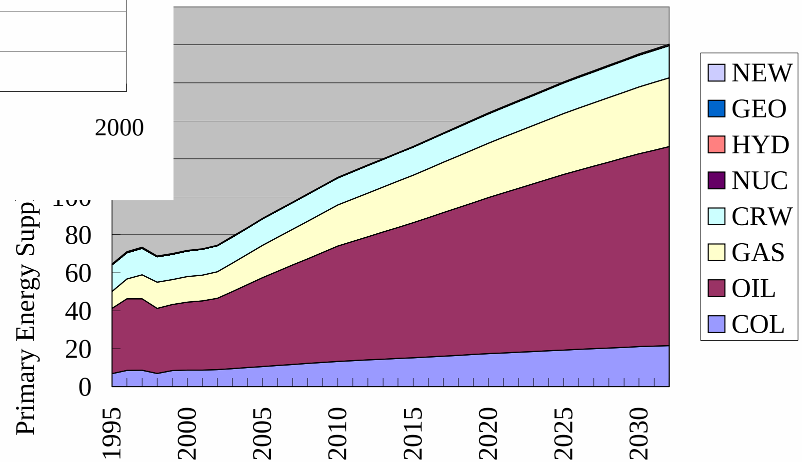
<u>Driving Forces</u>
Population
GDP
GDP share

<u>Energy</u>
final energy demand
energy conversion
primary energy supply

<u>GHG emissions</u>
Energy-related
GHG emissions
CO_2, SO_x, NO_x,
CH_4, N_2O, CO

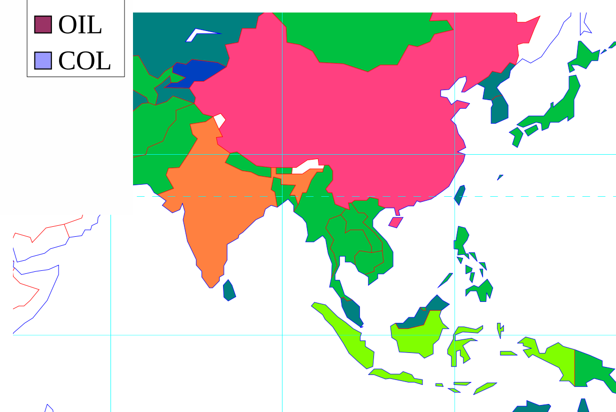


Relationship between AVA (Agriculture Value Added and GHG per capita)

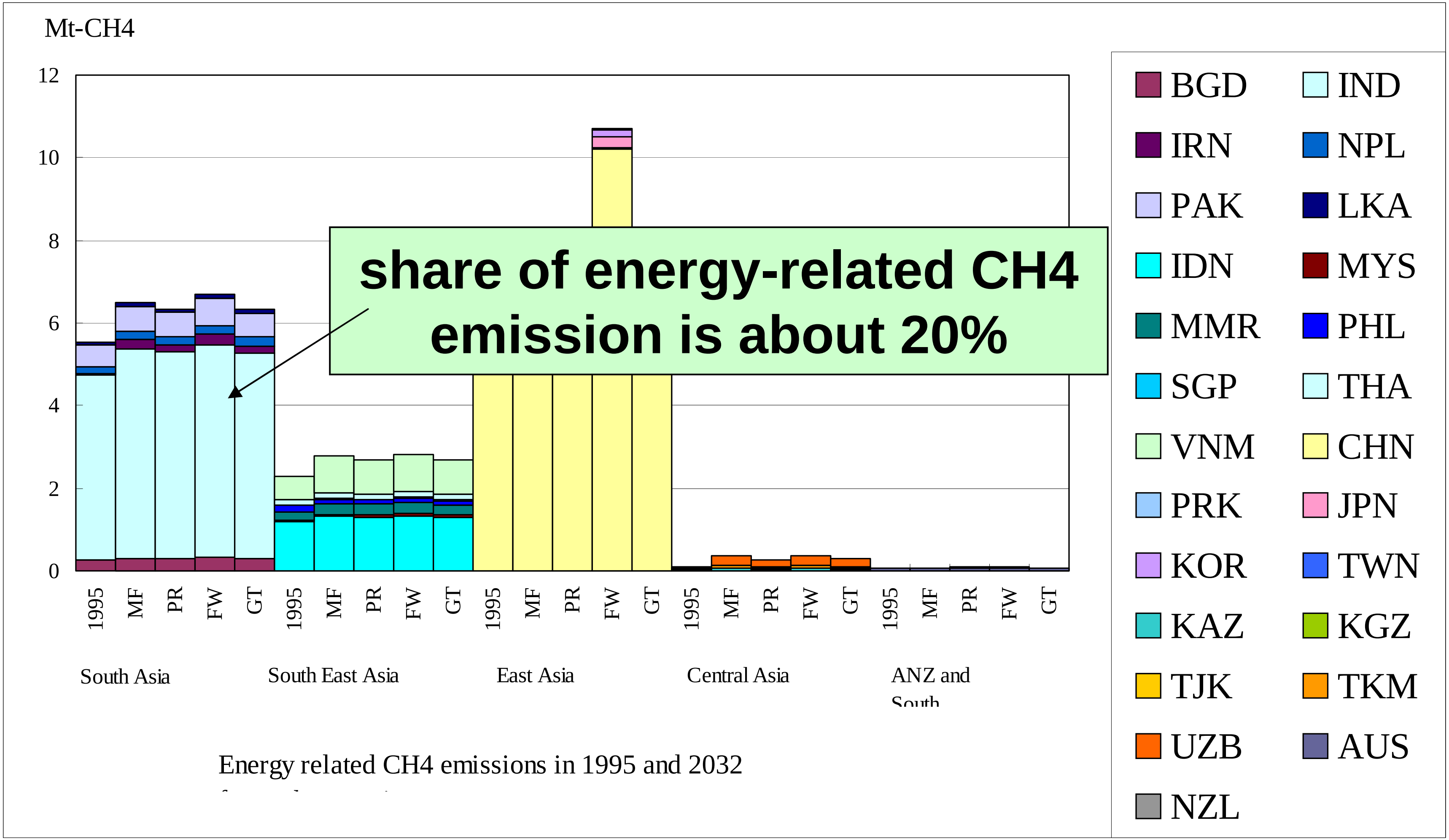


Primary energy supply Projection in Thailand

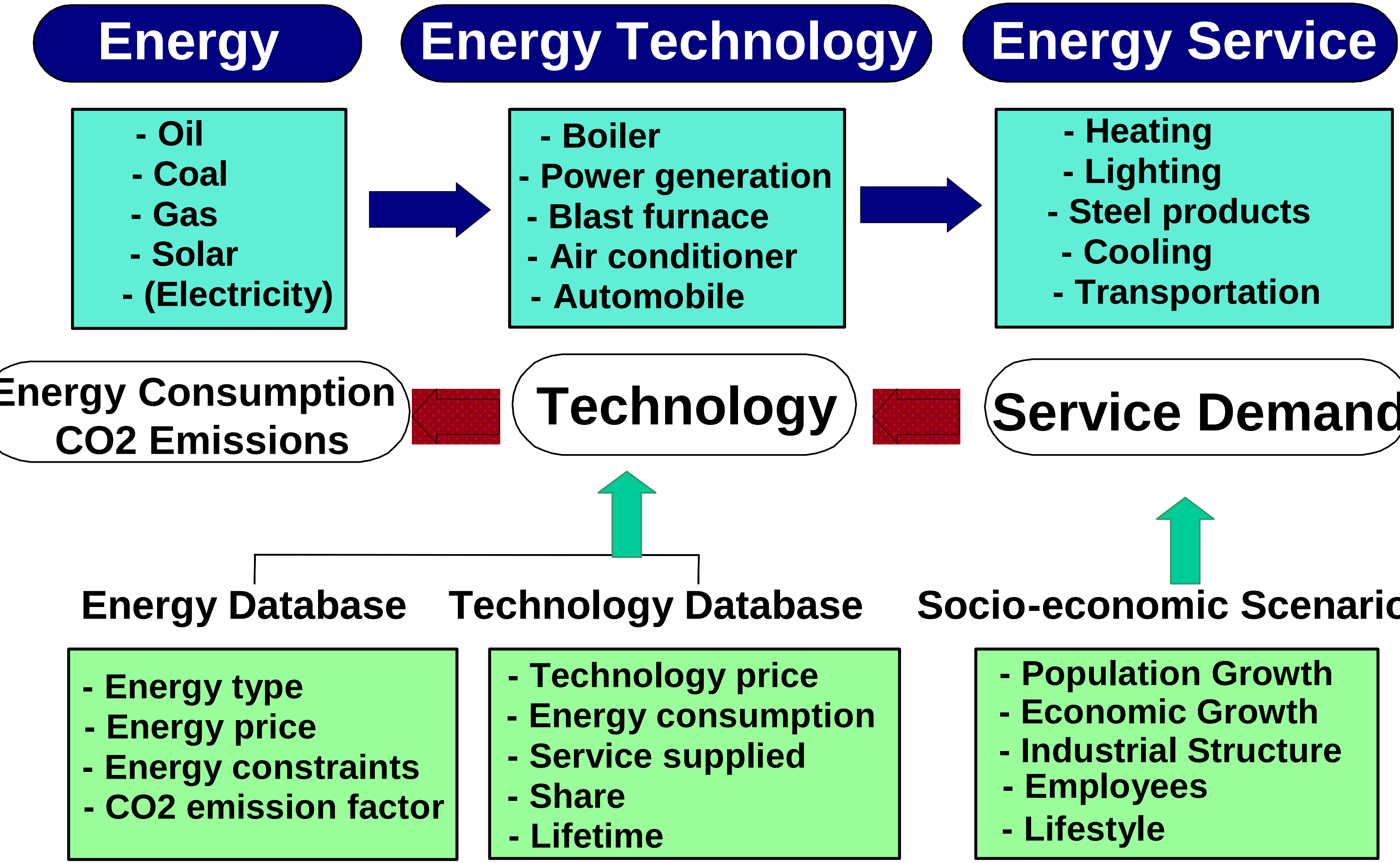
CH4 emissions in Asia-Pacific region in 2032



MF: Market Force FW: Fortress World
PR: Policy Reform GT: Great Transition



Energy related CH4 emissions in sub-regions of Asia Pacific

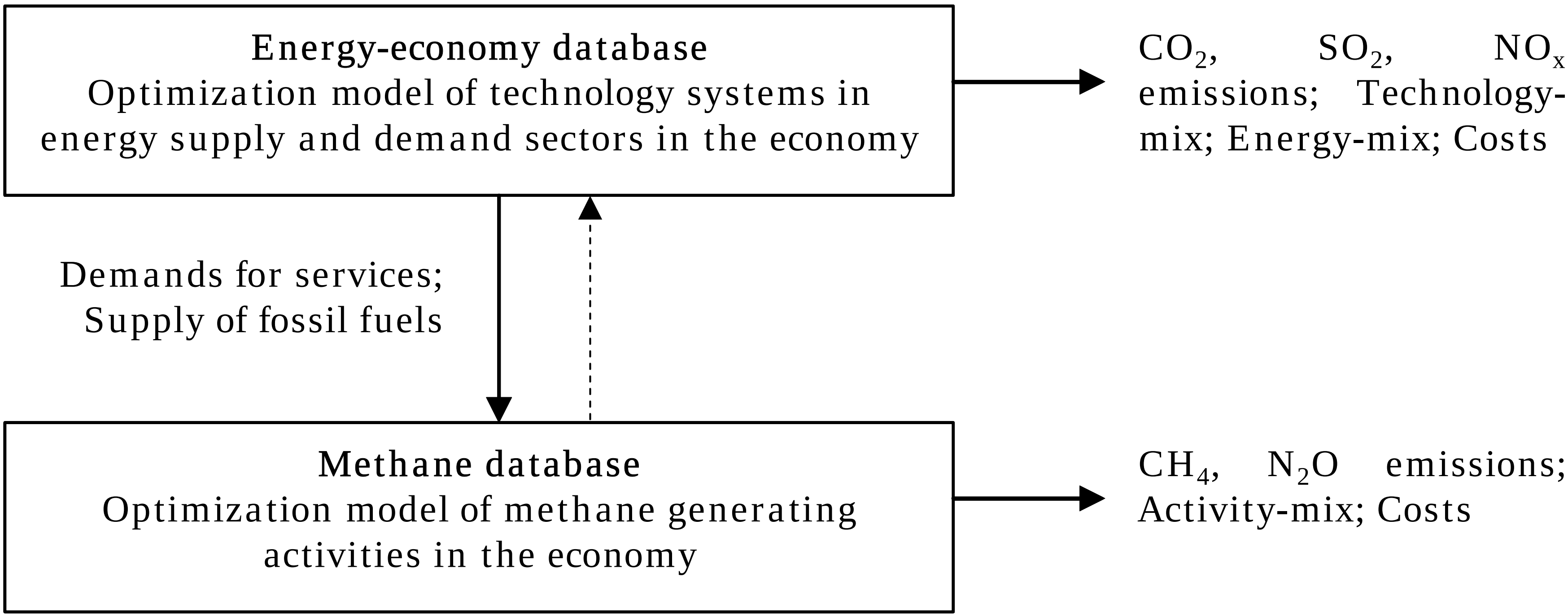


Technology Bottom-up: AIM/Enduse Model

Methane abatement options example

- Coal mining
  - Degasification and pipeline injection
  - Catalytic oxidation
- Oil and Gas production and supply
  - Flaring
  - Improved design and maintenance of compressors
  - Use of gas turbines for energy supply
- Manure management
  - Anaerobic digesters
- Solid waste management
  - Anaerobic digesters
  - Composting
  - Mechanical biological treatment

Framework of the AIM/Enduse Model for Methane

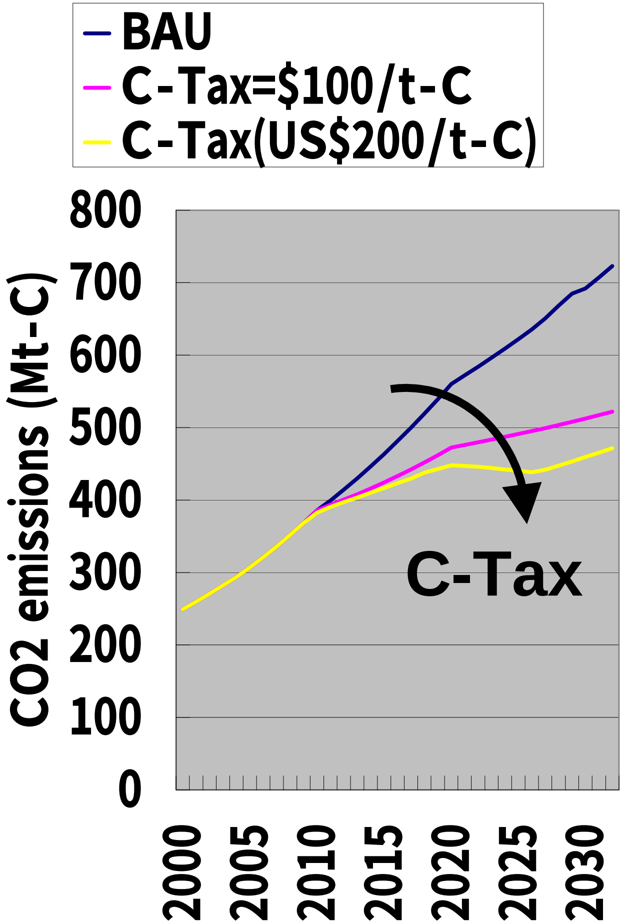


- Bottom-up type model
- Minimize total system cost for each year
- Stock for each technology is transferred to next period

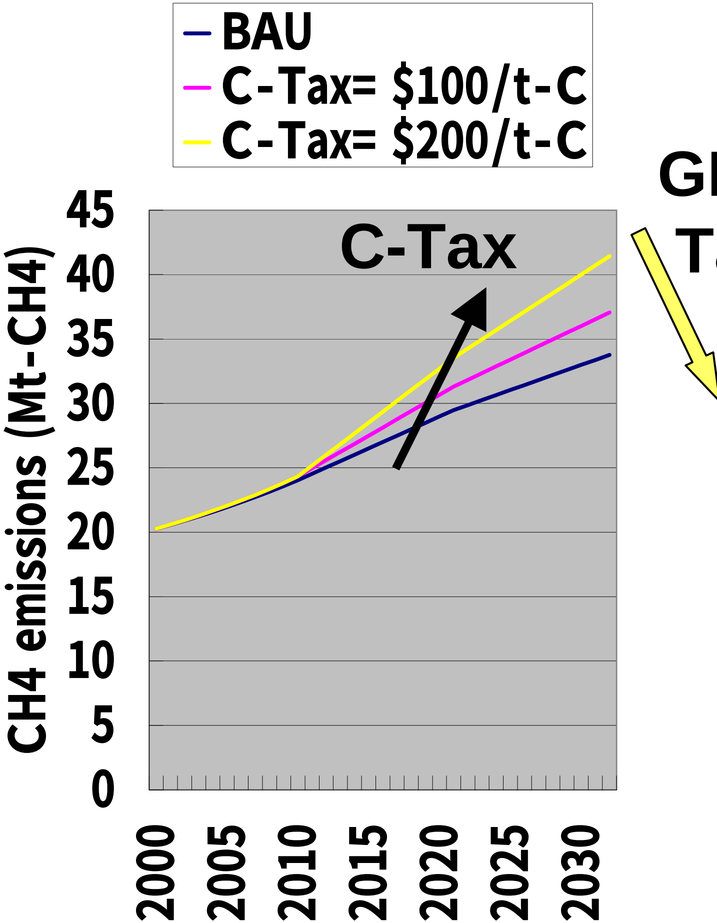
CO_2 tax scenario: CO_2 and CH_4 Emissions

Next steps

GHG tax



CO_2 emissions



CH_4 emissions

GHG
Tax

Economic Top-down: AIM/CGE(Asia)

Region

AUS,NZL,CHN,HKG,JPN,KOR,TWN,IDN,MYS,PHL,SGP,THA,VNM

BGD,IND,LKA,ASI,

CAN,USA,WEU,EEU,FSU,MEA,LAM,AFR,ROW

Sector

* Energy
OIL
COL
GAS
P_C: Oil products
ELY: Electricity

* Energy Intensive
I_S: Iron and steel
CRP: Chemical
PPP: Pulp and paper
NMM: Non-metal
OMN: Mining

* Agriculture
FPR: Food
LUM: Wood
AGR: Agricultural

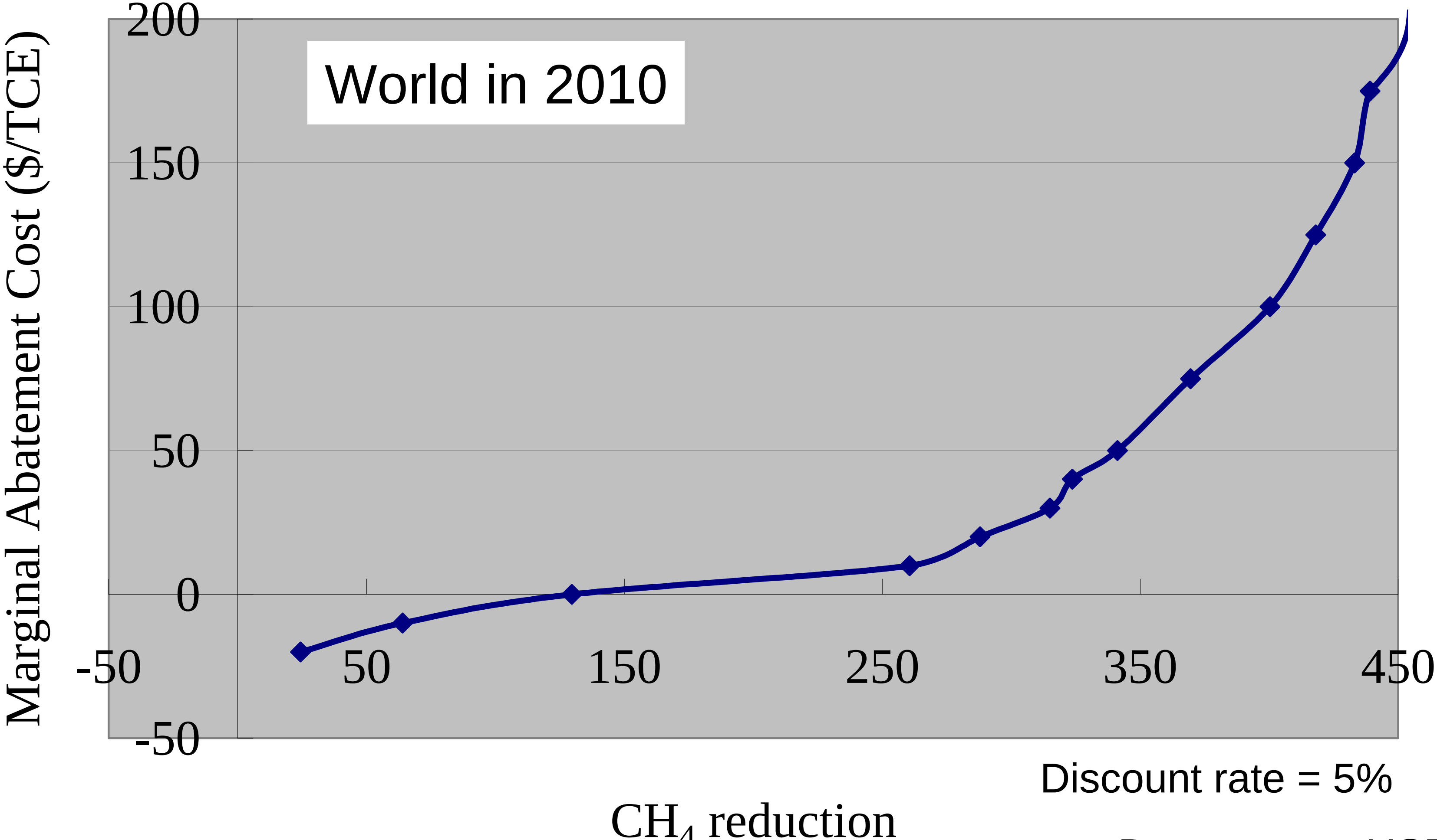
* Other industry
NFM, TRN, OME,
LUM, CNS, TWL, OMF

* Other sector
ATP, T_T
SER, DWE
CGD

Factor

Capital
Labor
Resource
Land

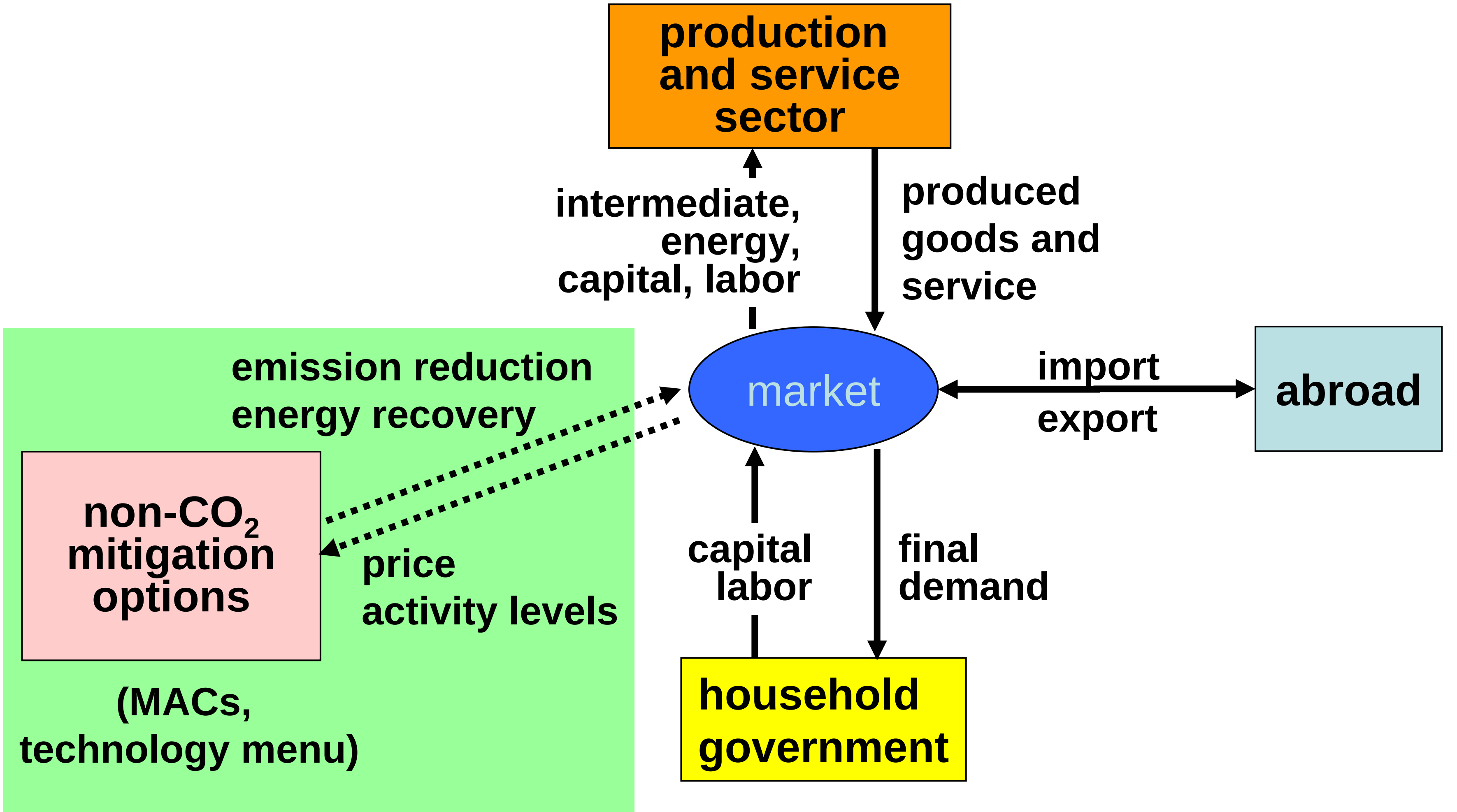
Marginal Abatement Cost Curves (MACs) for CH_4



Discount rate = 5%

Data source: USEPA

AIM/CGE (Asia) for non-CO_2 gas mitigation options



AIM model components for multi-gas analysis

- **AIM/Trend: Overview Sketch of Multi-gas**
  - 42 countries in Asia-Pacific region
  - Simple econometric model

- **AIM/Enduse: Detailed Sketch of Multi-gas**
  - 20 countries in Asia-Pacific region
  - Bottom-up model with detailed technological processes

- **AIM/CGE: Long-term scenario of Multi-gas**
  - Top-down global model (17 regions in Asia-Pacific)
  - Multi-regional Computable General Equilibrium model
  - Recursive dynamics

Remarks

- **Trade-off**: CO_2 only policy will increase non-CO_2 gas emissions by substitution coal with gas
- **Co-benefit**: Methane policy will not only reduce methane emission but may increase energy recovery
- **Leakage through trade**: non-CO_2 gas leakage problem will become serious by global trade of natural gas, livestock products…

- **Include non-energy sector (agriculture, waste…)**
- **Linkage of CO_2 model and non-CO_2 model**
- **Linkage of technology bottom-up model and economy top-down model**