

CO₂ in the iron and steel
industry: An analysis of Japanese
emission reduction potentials

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QUESTIONS

- 1 What is the CO₂ emission reduction potential ?
- 2 How serious is carbon leakage on the long term, given technological change?
- 3 How can leakage be minimised?

BACKGROUND

- 1995-2000 Initial analysis for Europe - MATTER model: single-region multi-material analysis (http://www.ecn.nl/unit_bs/etsap/markal/matter)
- 2000-2002 National Institute for Environmental Studies, Japan: multi-region single-material analysis (<http://www.resourcemodels.org>) [This presentation](#)
- 2002-present IEA, Energy Technology Policy Division: multi-region multi-material analysis (planned)

Carbon leakage

- Emissions reduction in a country/sector is balanced by emissions increase elsewhere because of relocation of production capacity and/or fuel price effects

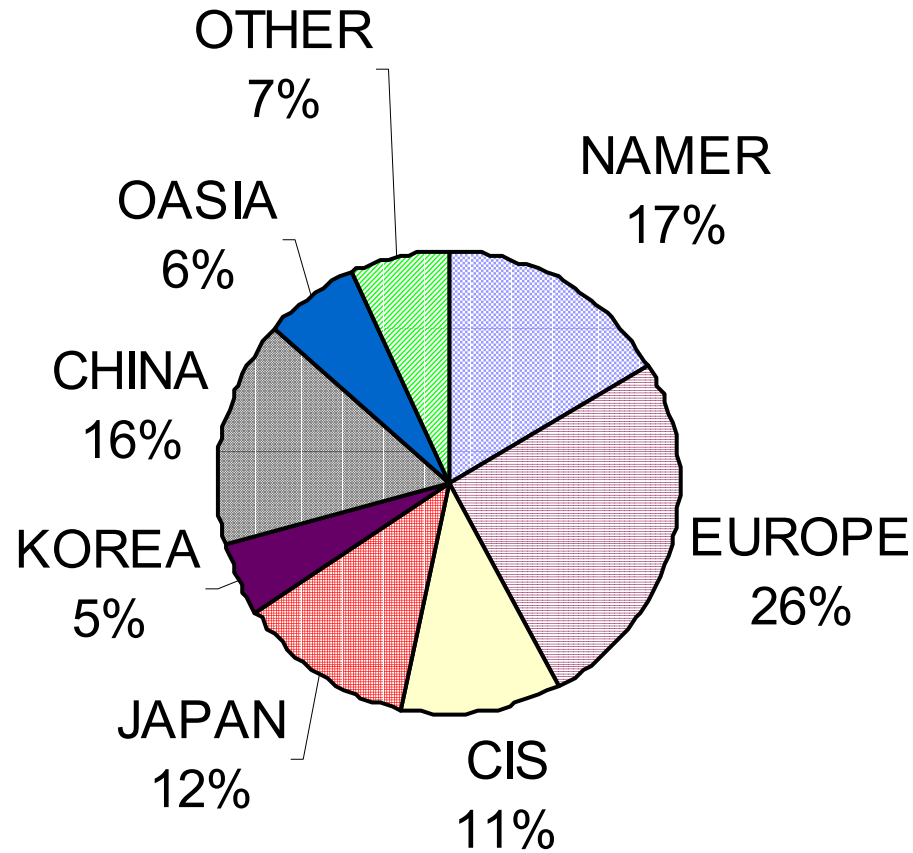
1 WHAT IS THE CO₂ EMISSION REDUCTION POTENTIAL?

- The Japanese I&S industry
- Systems approach and technology potentials
- Modelling issues

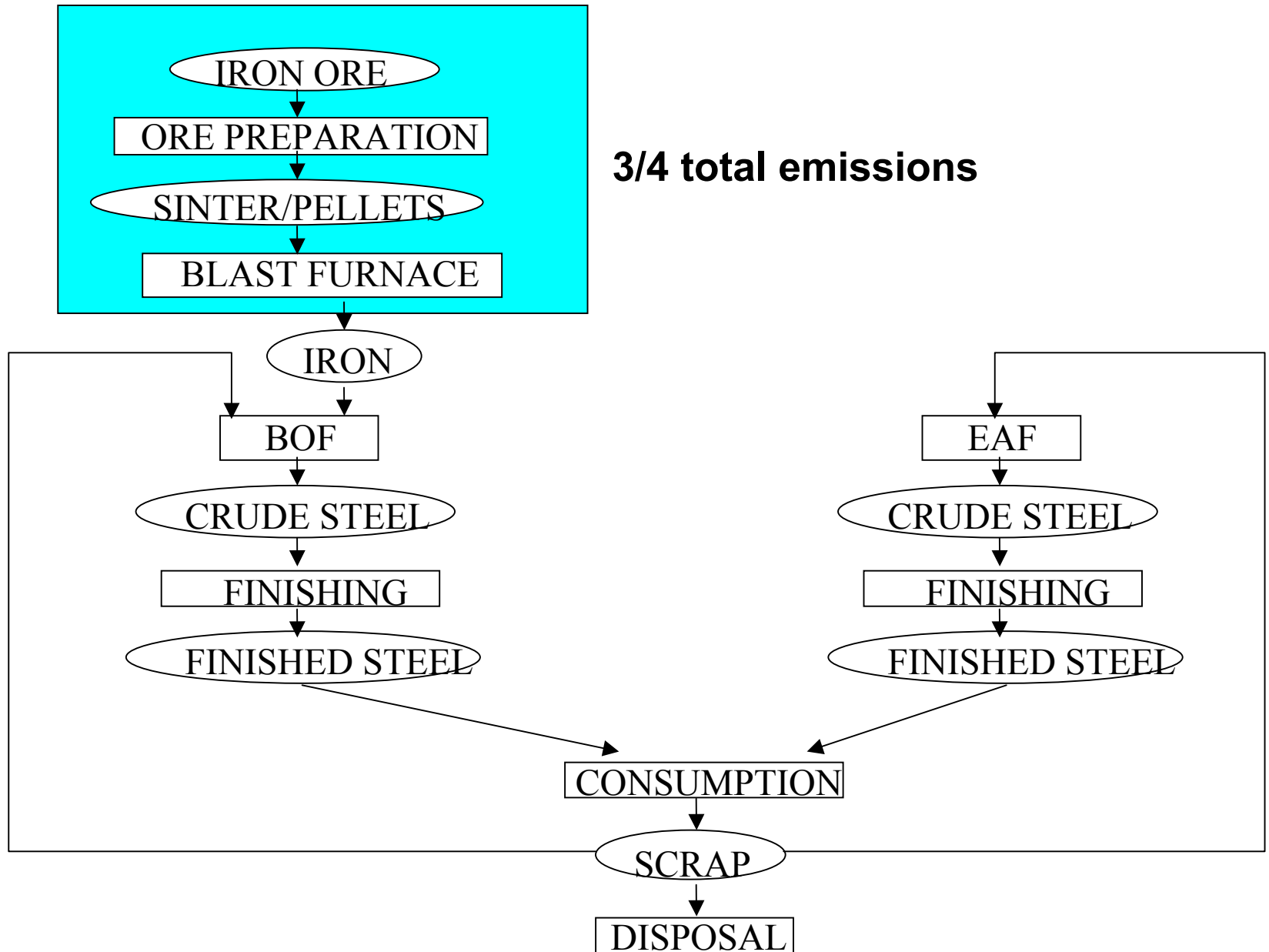
The Japanese Iron&Steel Industry

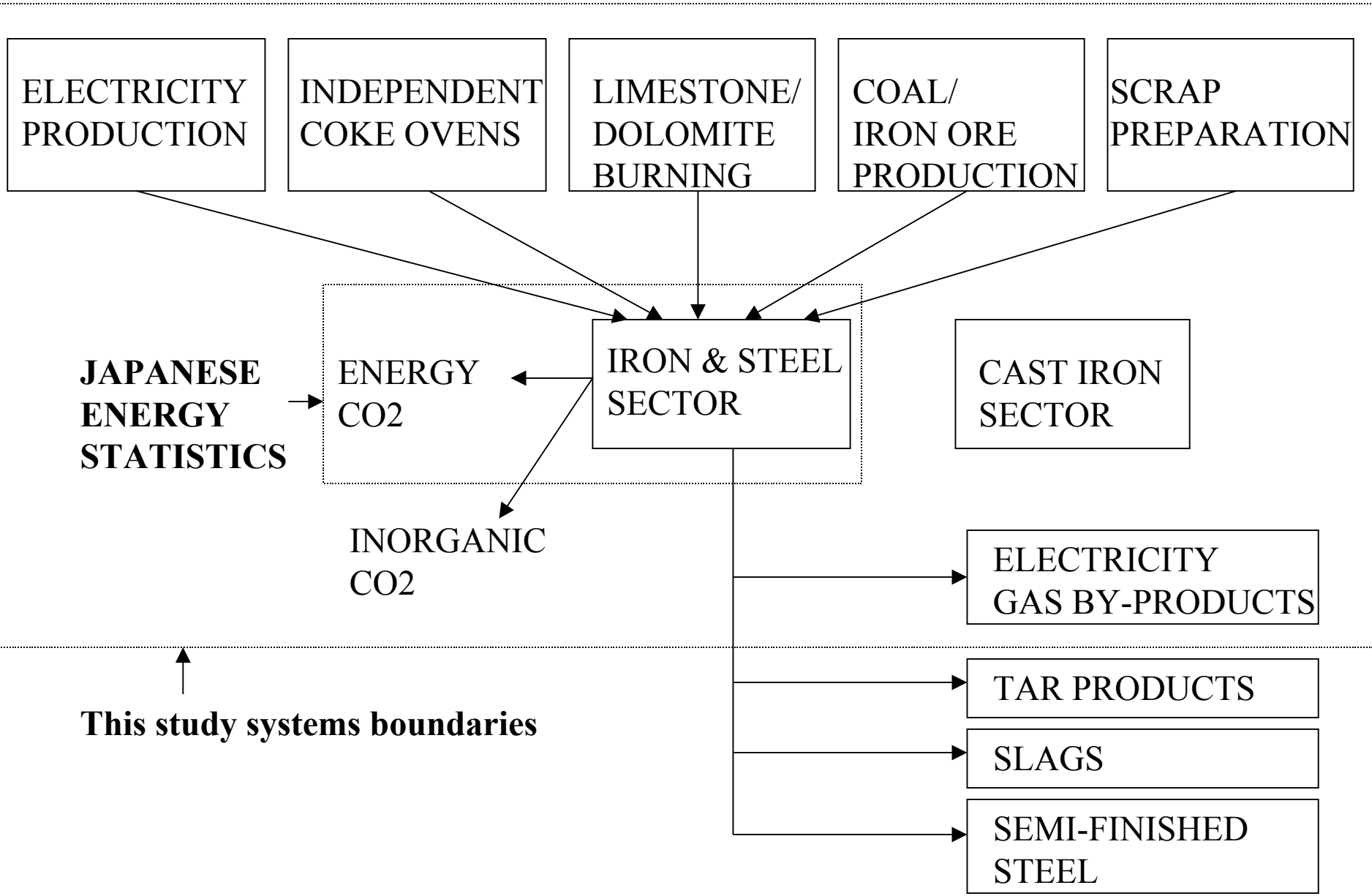
- Iron & steel sector represents 15% of Japanese GHG emissions
- Japan represents 12% of global steel production
- Low share recycling (31%)
- Competition from China and Korea

REGIONAL STEEL PRODUCTION



STEEL INDUSTRY





ELECTRICITY
PRODUCTION

INDEPENDENT
COKE OVENS

LIMESTONE/
DOLOMITE
BURNING

COAL/
IRON ORE
PRODUCTION

SCRAP
PREPARATION

**JAPANESE
ENERGY
STATISTICS**

ENERGY
CO2

IRON & STEEL
SECTOR

CAST IRON
SECTOR

INORGANIC
CO2

ELECTRICITY
GAS BY-PRODUCTS

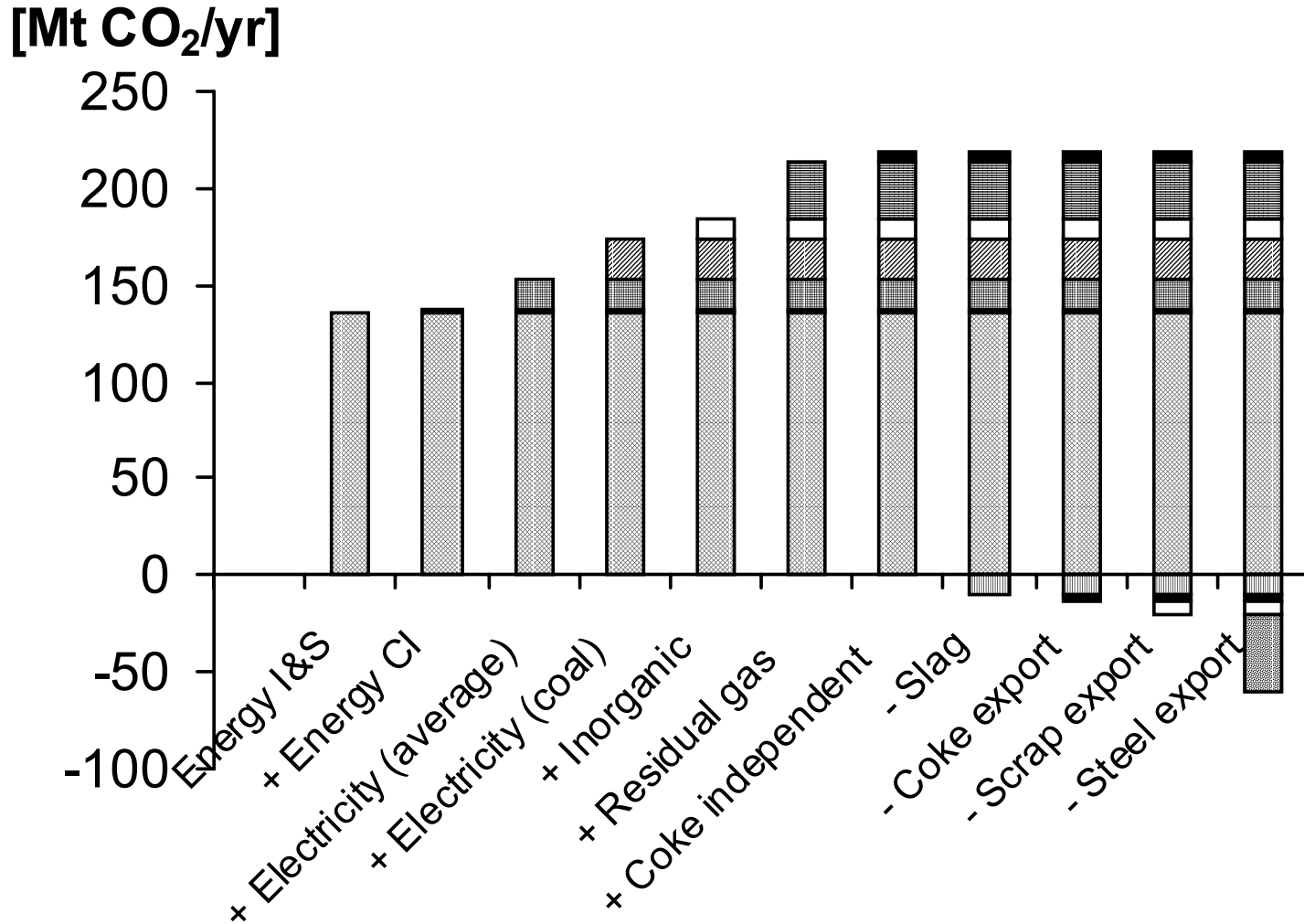
This study systems boundaries

TAR PRODUCTS

SLAGS

SEMI-FINISHED
STEEL

System boundaries have policy relevance

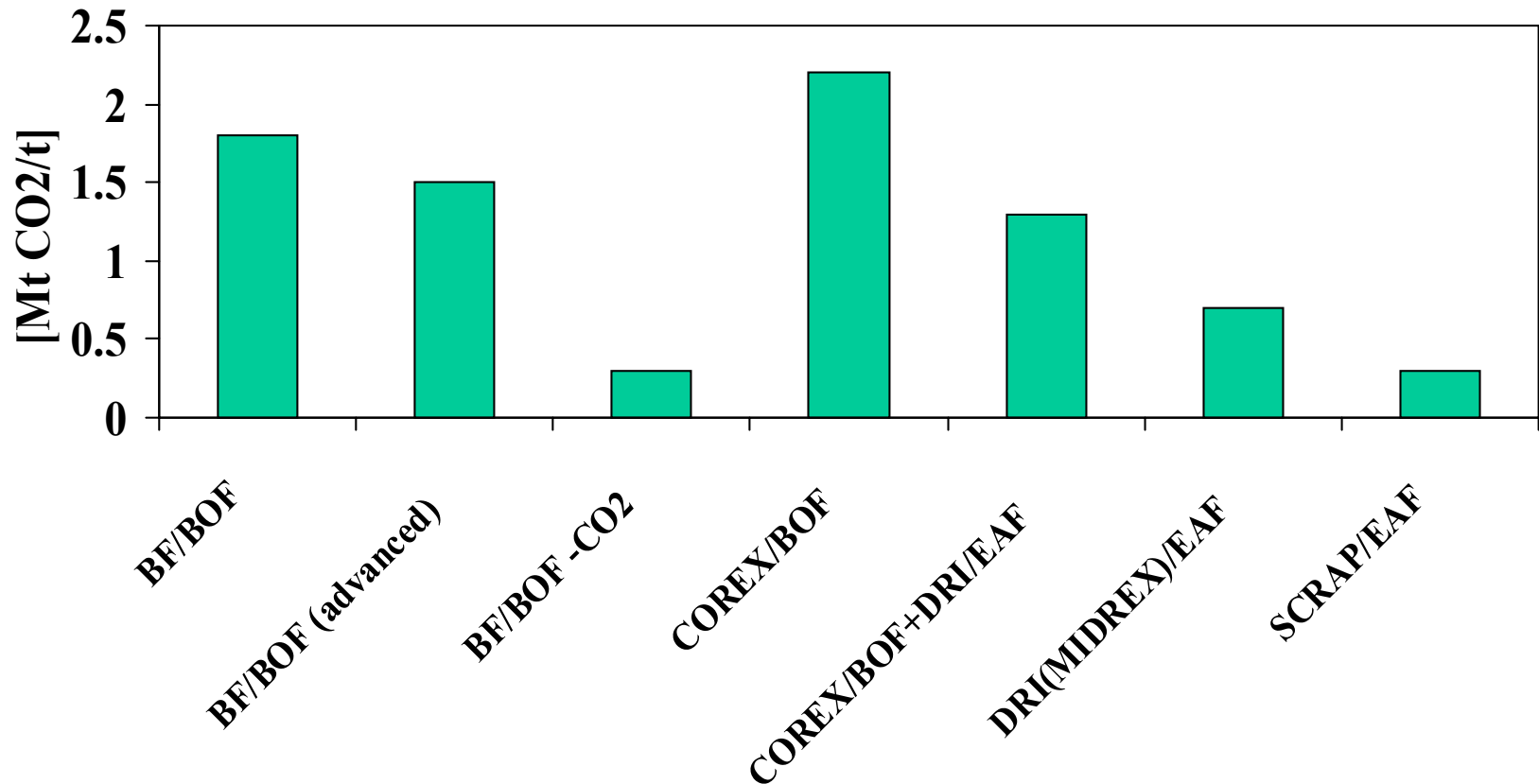


Technological potentials

Strategy	Potential 2020 [Mt CO ₂]
Energy efficiency	30-60
Fuel switch	15-70
CO ₂ capture	50-100
Increased recycling	5-10
Materials efficiency	10-20
Upstream	10-20

CO₂ BALANCE OF CRUDE STEEL PRODUCTION

(reference electricity 0.1 t CO₂/GJ)



INNOVATIVE APPROACHES CO₂ CAPTURE ?

Component	Shell gasifier	Coal fired	Conventional	Corex
[mol %]		power plant	blast furnace	
CO ₂	1	13	20	24
CO	64	0	21	44
Other	35	87	59	32

MODELLING ISSUES

- Econometric (top-down) or engineering approaches (bottom-up)

In this case it is important to:

- Account for capital equipment vintaging
- Account for technological change potentials
- Account for scrap availability
- Consider upstream and downstream linkages
- Consider globalisation

THE STEAP MODEL

- STeel Environmental strategy Assessment Program
- Market simulation
- Linear/Mixed Integer Programming
- Partial equilibrium model
- Life cycle costing/environmental impacts
- Explicit technology learning
- Steel product trade
- Global, 11 regions
- 9 I&S products, 7 demand categories
- Long-term perspective until 2040

IRON & STEEL PRODUCTS

- Cast iron
- Reinforcement bars
- Hot rolled sheet
- Steel wire
- Alloyed steel
- Heavy plate
- Cold rolled coil
- Cold rolled coil, annealed and tempered
- Galvanised sheet

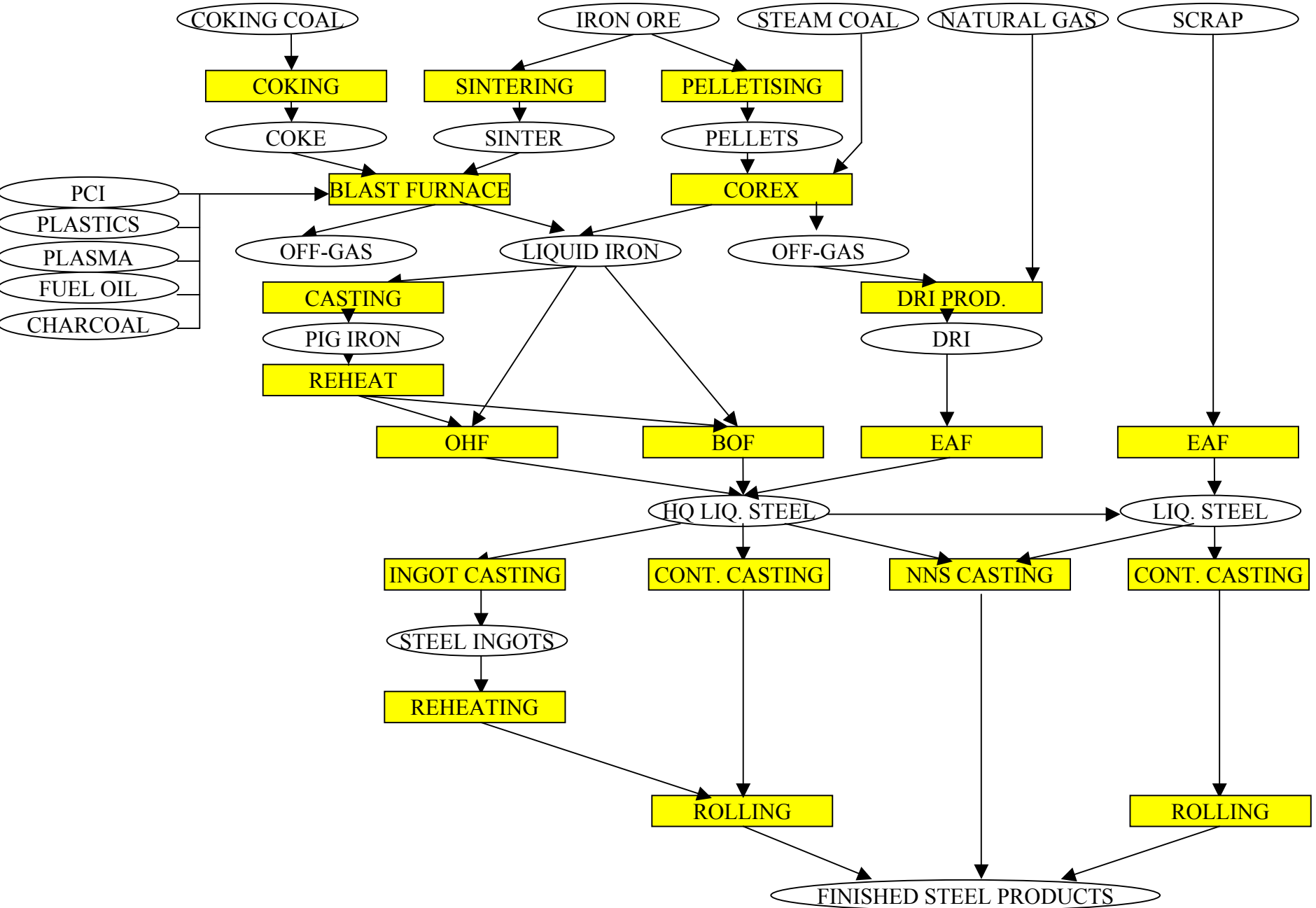
DEMAND SECTORS

- Packaging
- Transportation equipment
- Machinery
- Building & Construction
- Fabricated metal products
- Electric machinery
- Other manufacturing

TRADE MODELLING

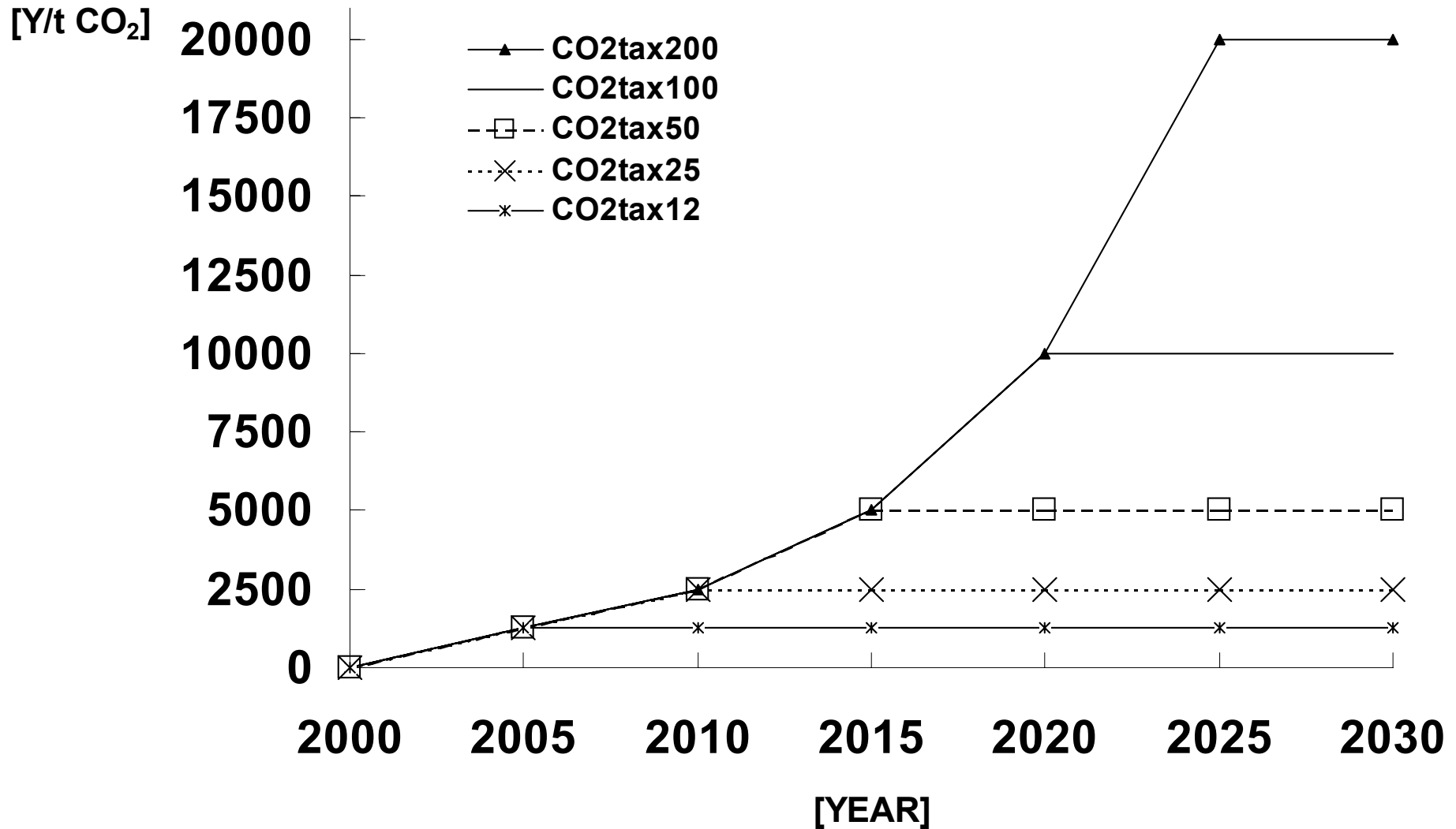
- Transportation costs + barriers
- At this moment substantial tariff and non-tariff barriers
- However inter-regional trade has increased substantially (37% of production traded internationally in 2000)
- Unclear what will happen to trade barriers (WTO-DOHA)
- Assumption tariffs decline by 50%, non-tariff barriers disappear

STEAP PRODUCTION STRUCTURE

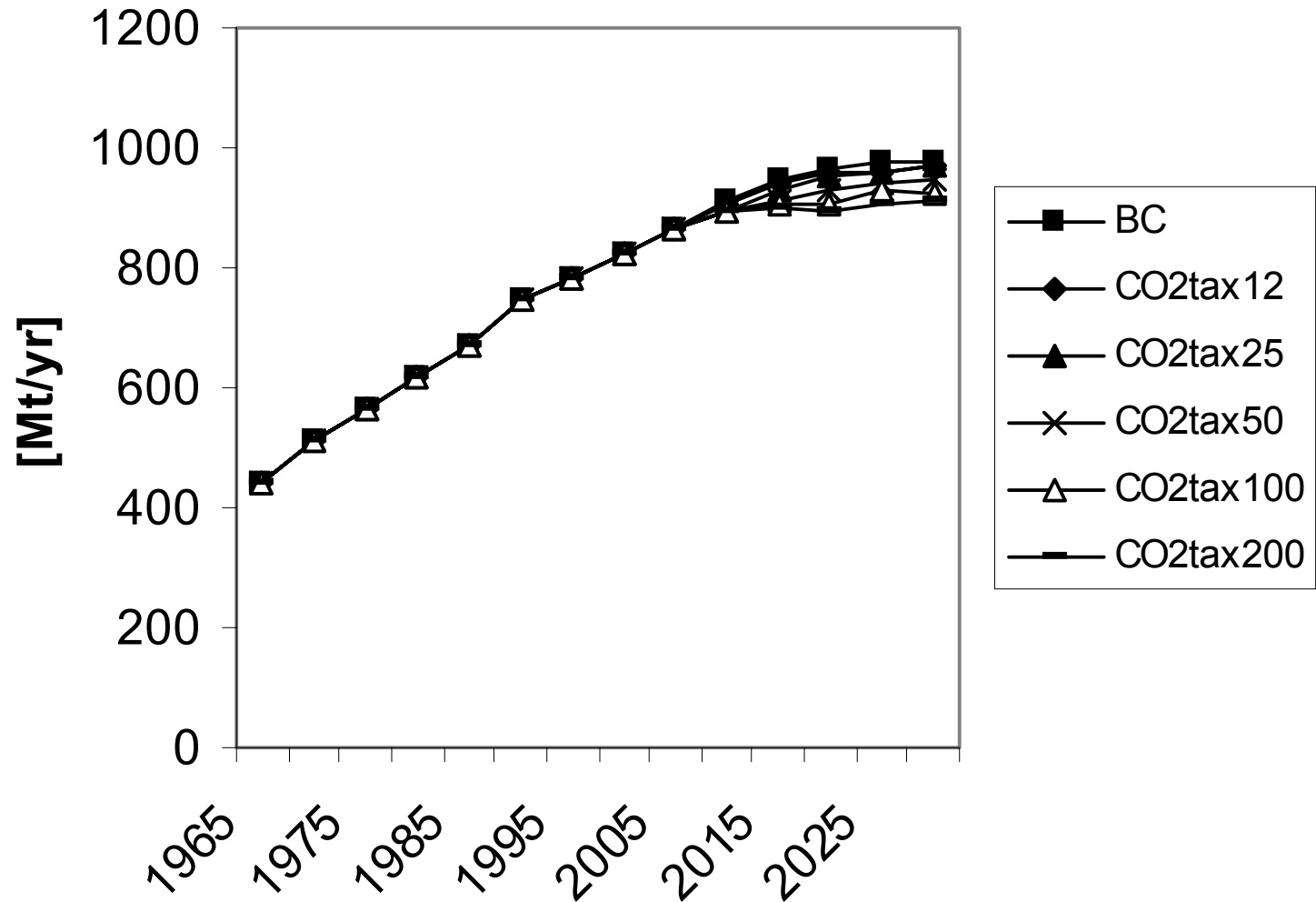


2 How serious is leakage?

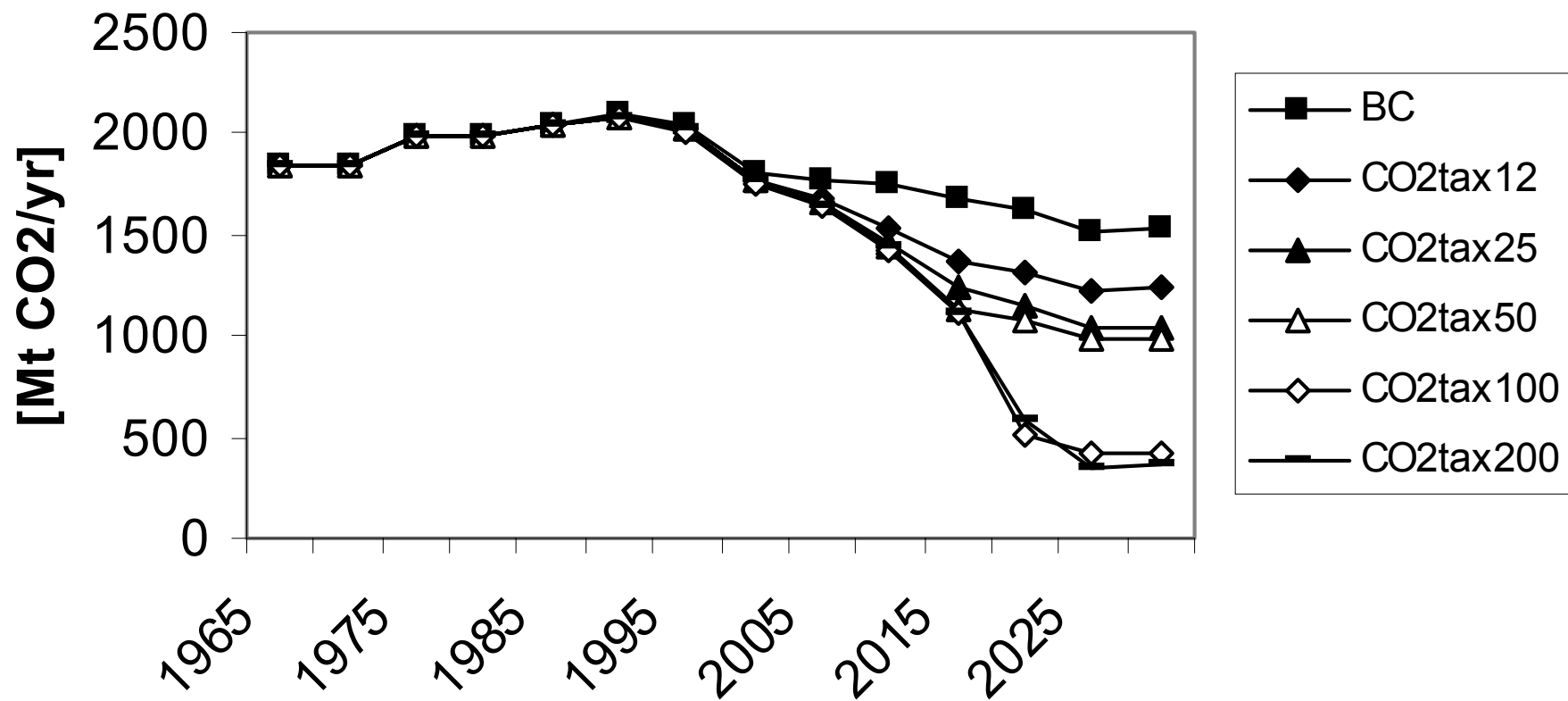
POLICIES CONSIDERED



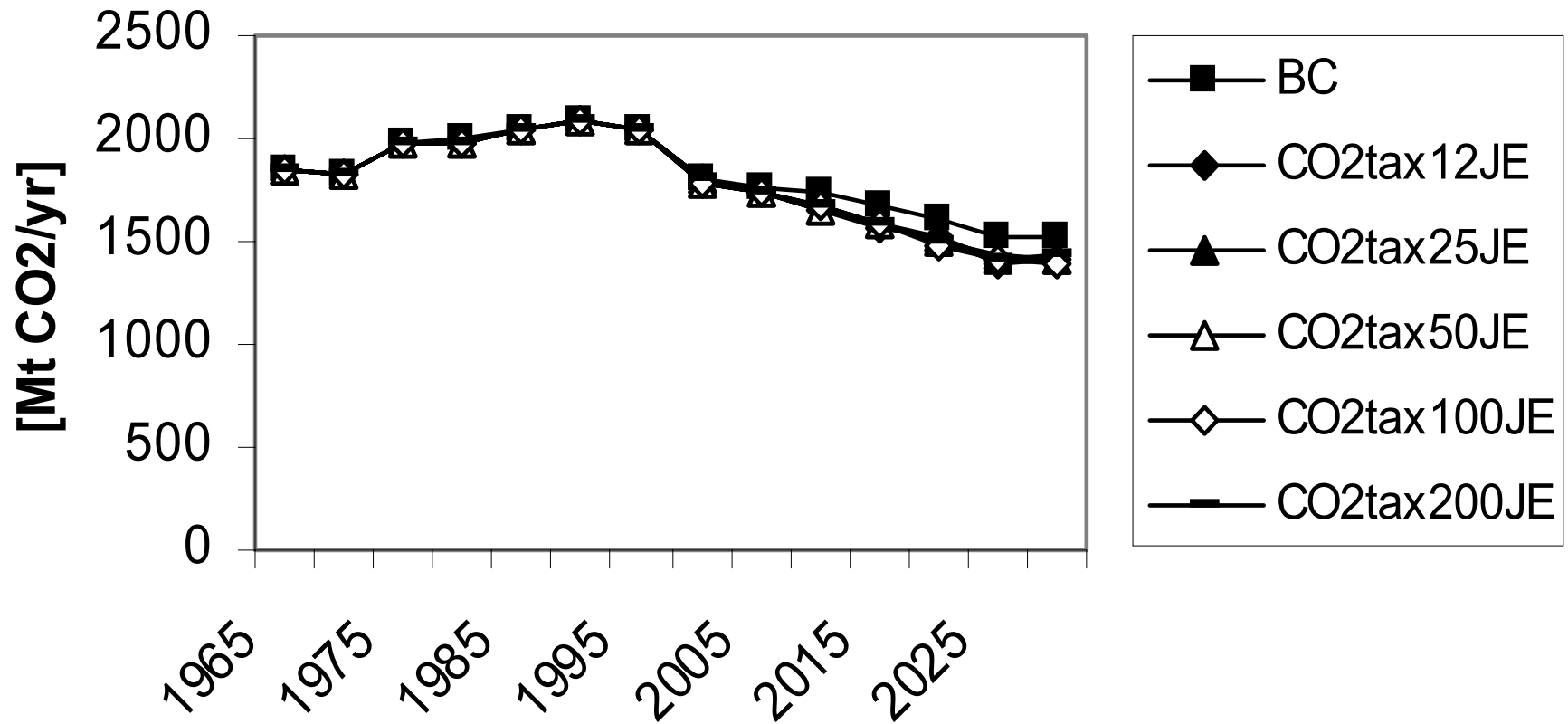
EFFECT ON PRODUCTION



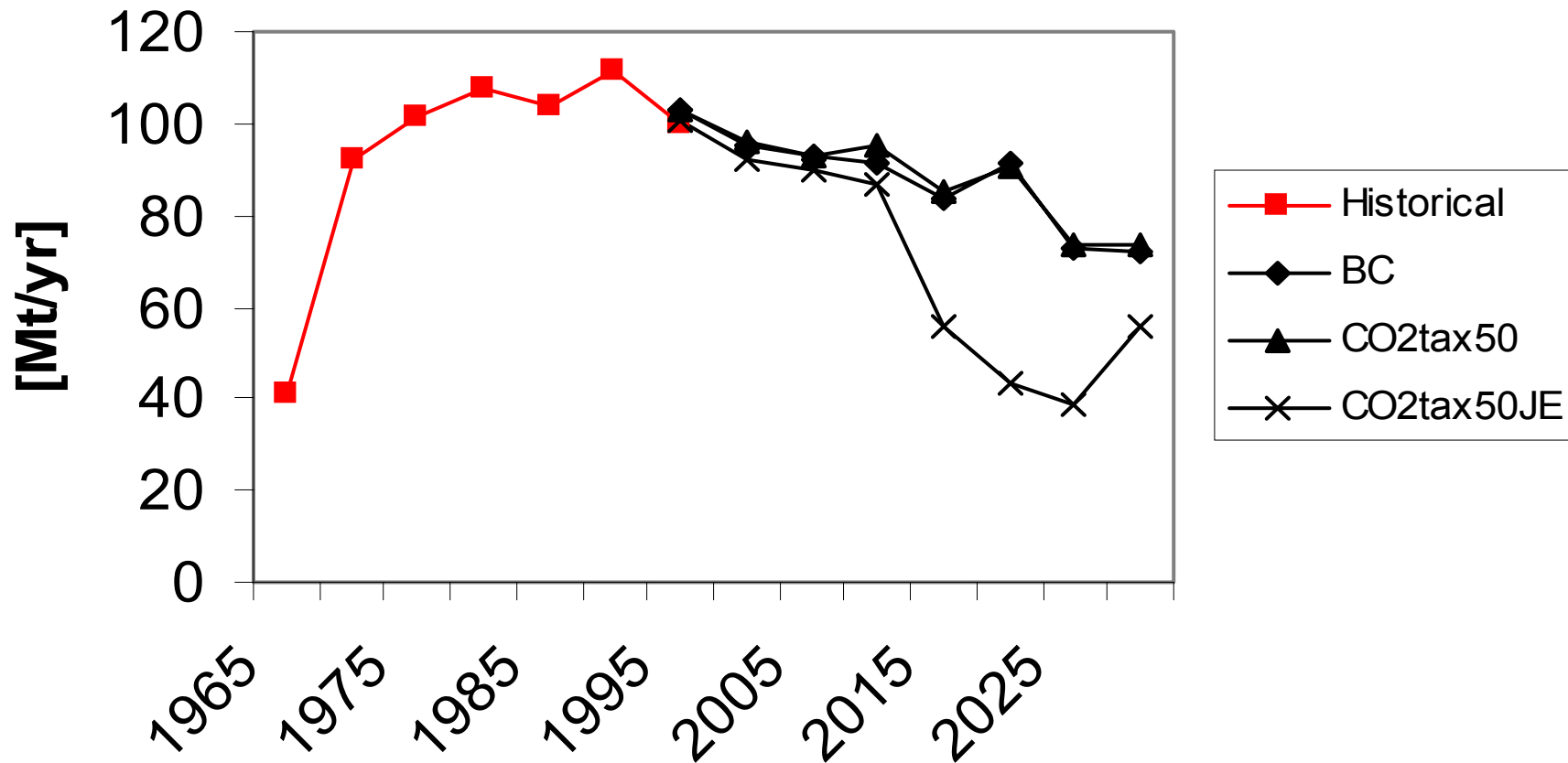
CO₂ EMISSIONS GLOBAL POLICY CASE



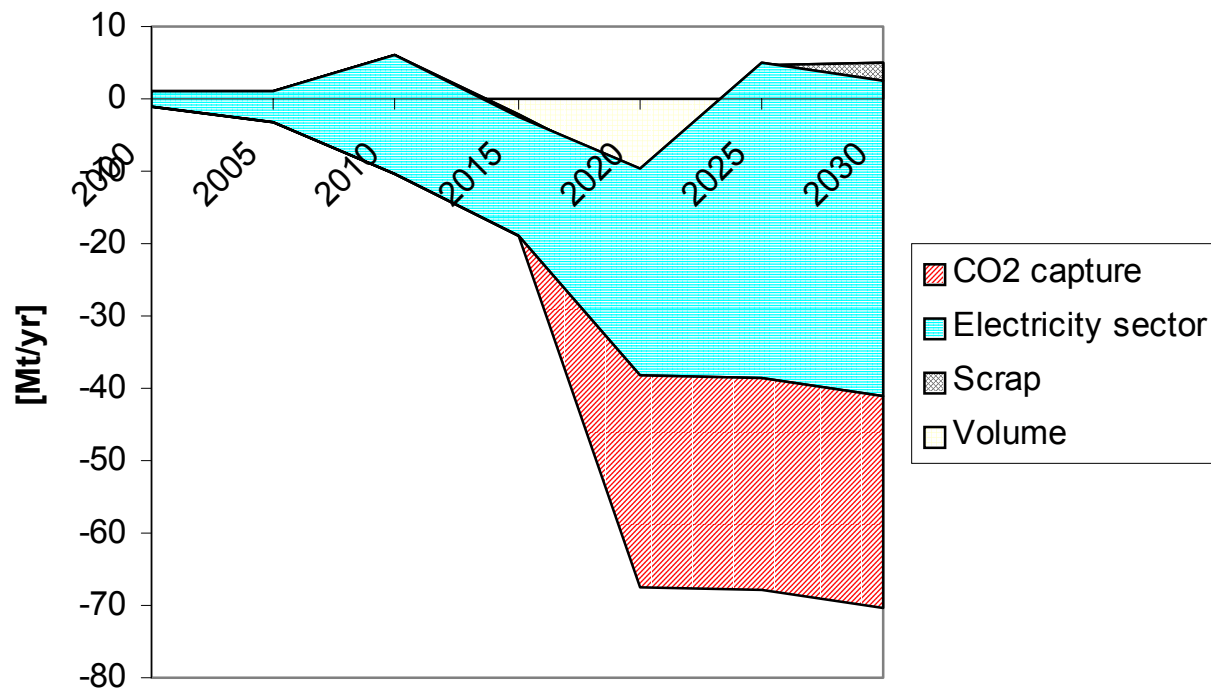
CO₂ EMISSIONS JAPAN/EUROPE POLICY CASE



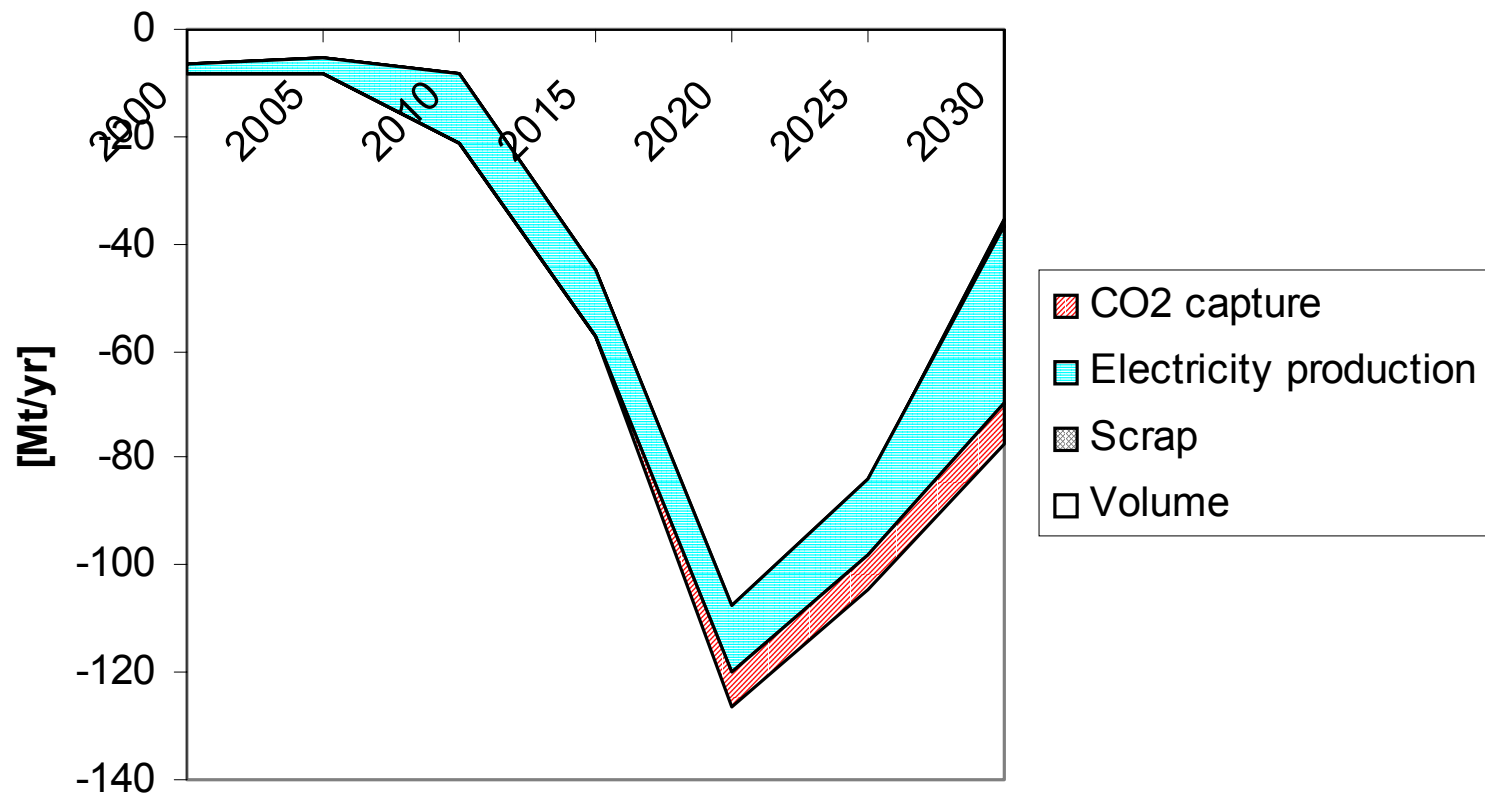
JAPANESE STEEL PRODUCTION



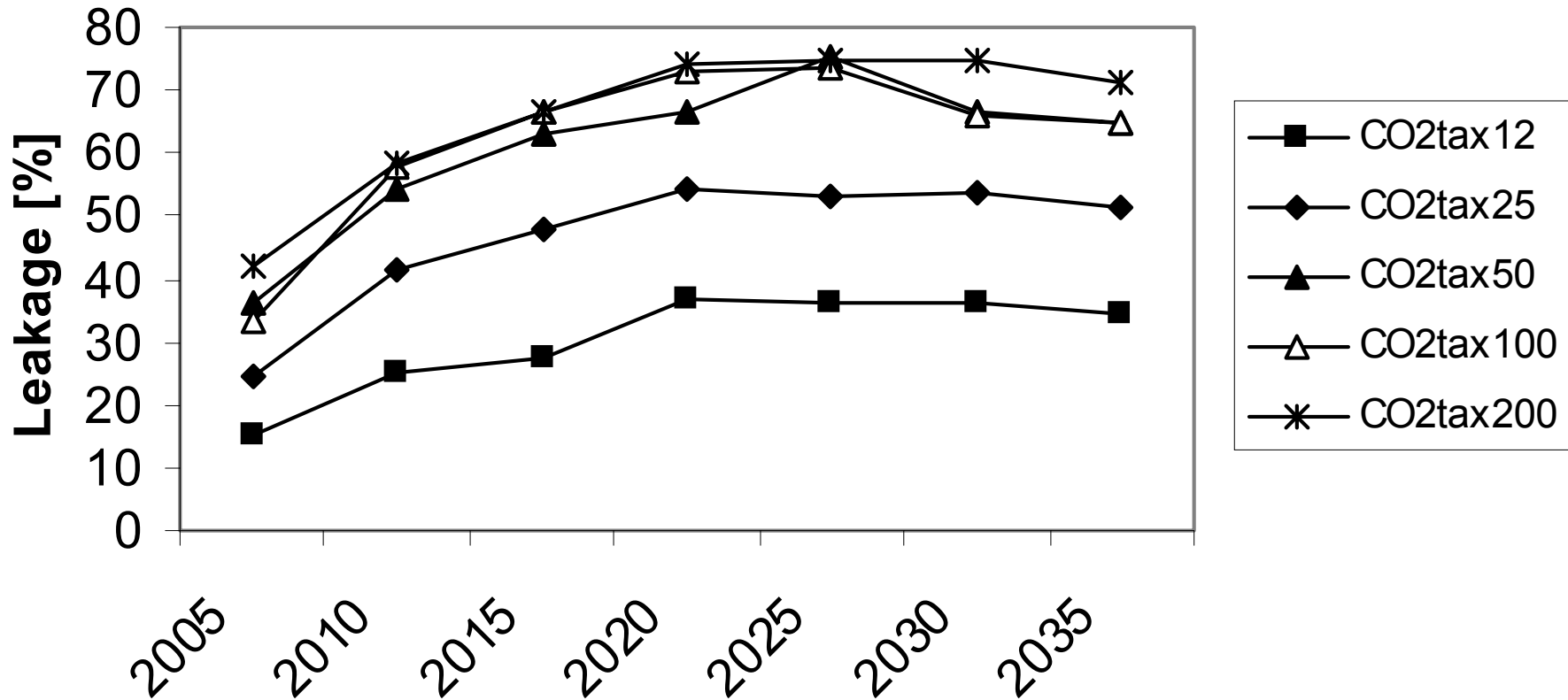
JAPANESE EMISSION REDUCTION GLOBAL POLICY CASE CO₂ TAX 100



JAPANESE EMISSION REDUCTION JAP/EUR POLICY CASE CO₂ TAX 100



CARBON LEAKAGE



CL = INCREASE OUTSIDE REGION / REDUCTION INSIDE REGION x 100%

3 How can leakage be
minimised?

CO2 tax + Import tariffs

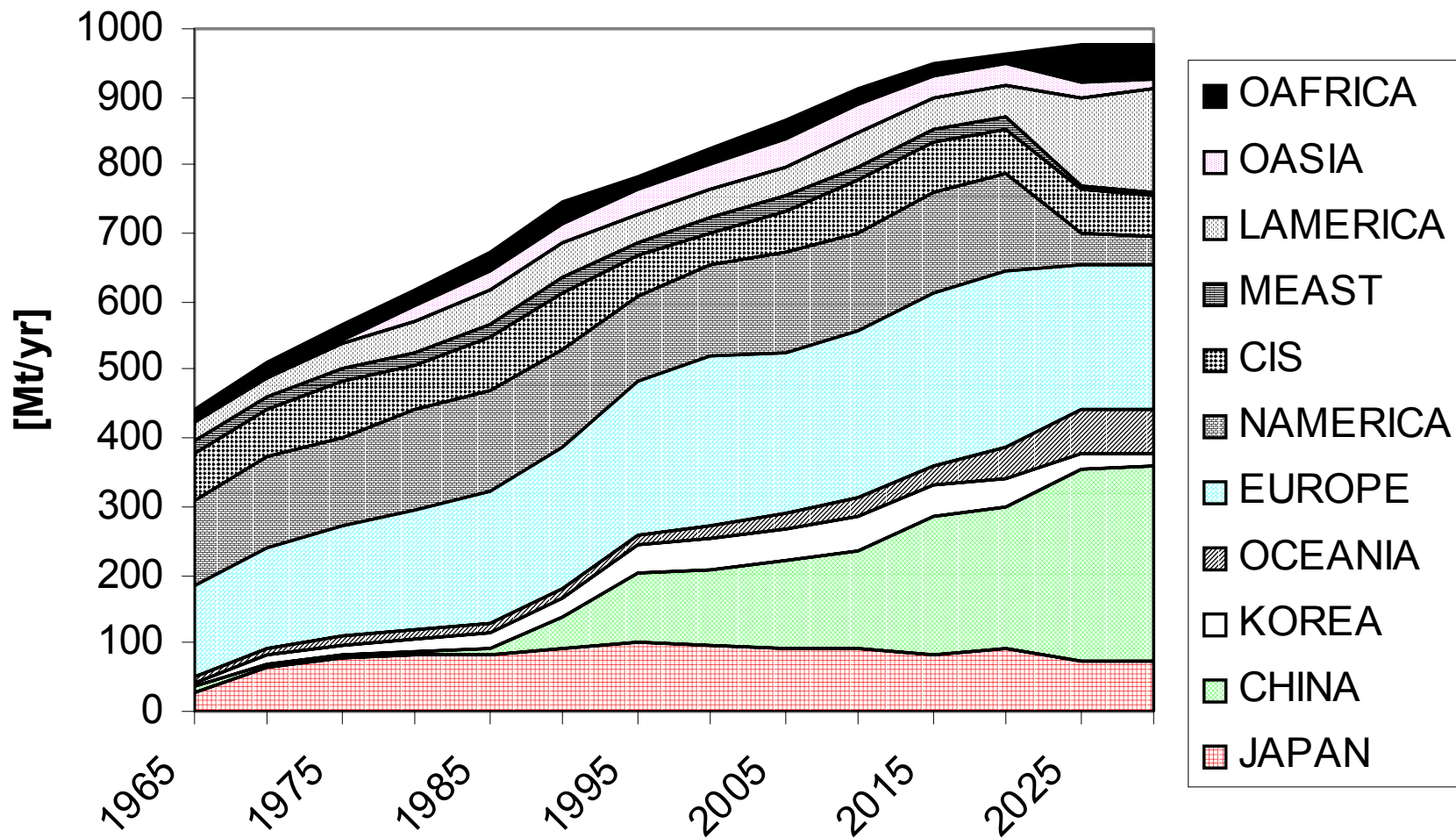
	CARBON LEAKAGE [%]
No import tariff	50
2500 Y/t steel	7
5000 Y/t steel	-11

CONCLUSIONS

- Currently 9-10% global emissions (incl. upstream and downstream)
- The choice of system boundaries will affect the emission mitigation
- Autonomous trend CO₂ –25% (efficiency gains, increased recycling)
- Technical potential CO₂ –75% (gas, CO₂ capture, upstream electricity)
- Leakage can be a serious problem, *not only in case of taxes, but also in case of permit trading*
- Strong link trade negotiations & CO₂ policies
- Trade barriers can prevent leakage

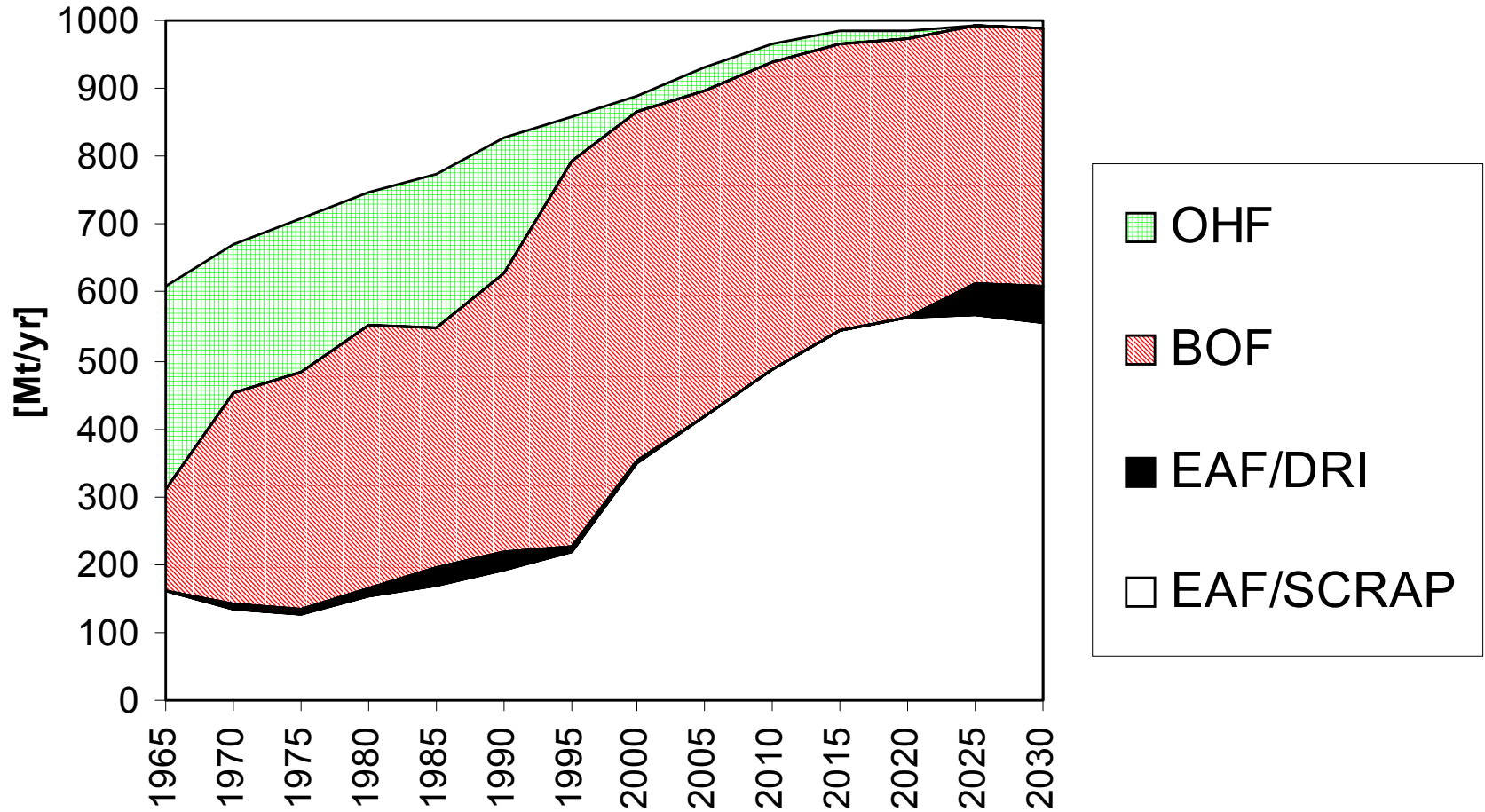
RESULTS II

BC



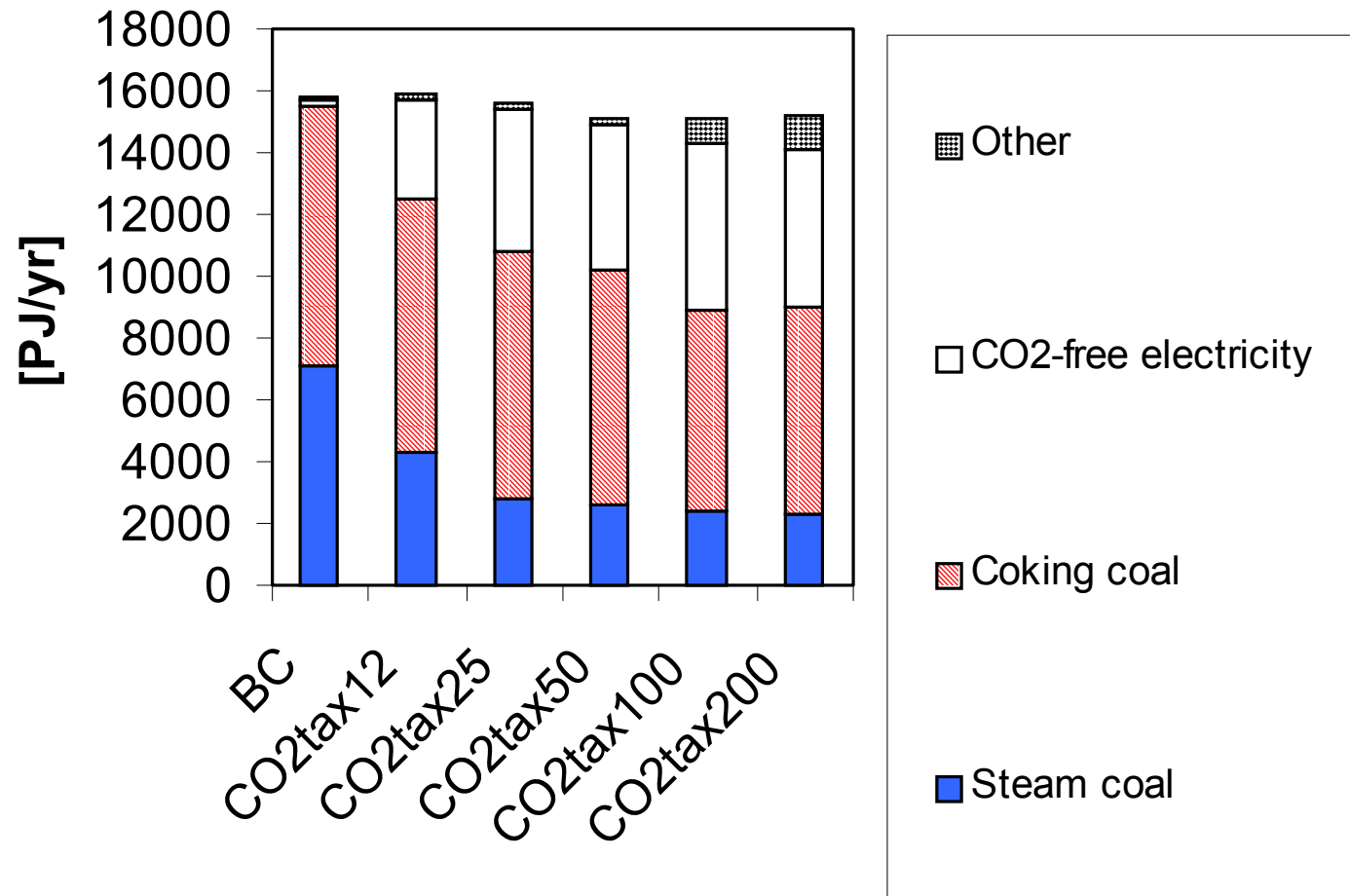
RESULTS III

BC



RESULTS V

GLOBAL POLICY



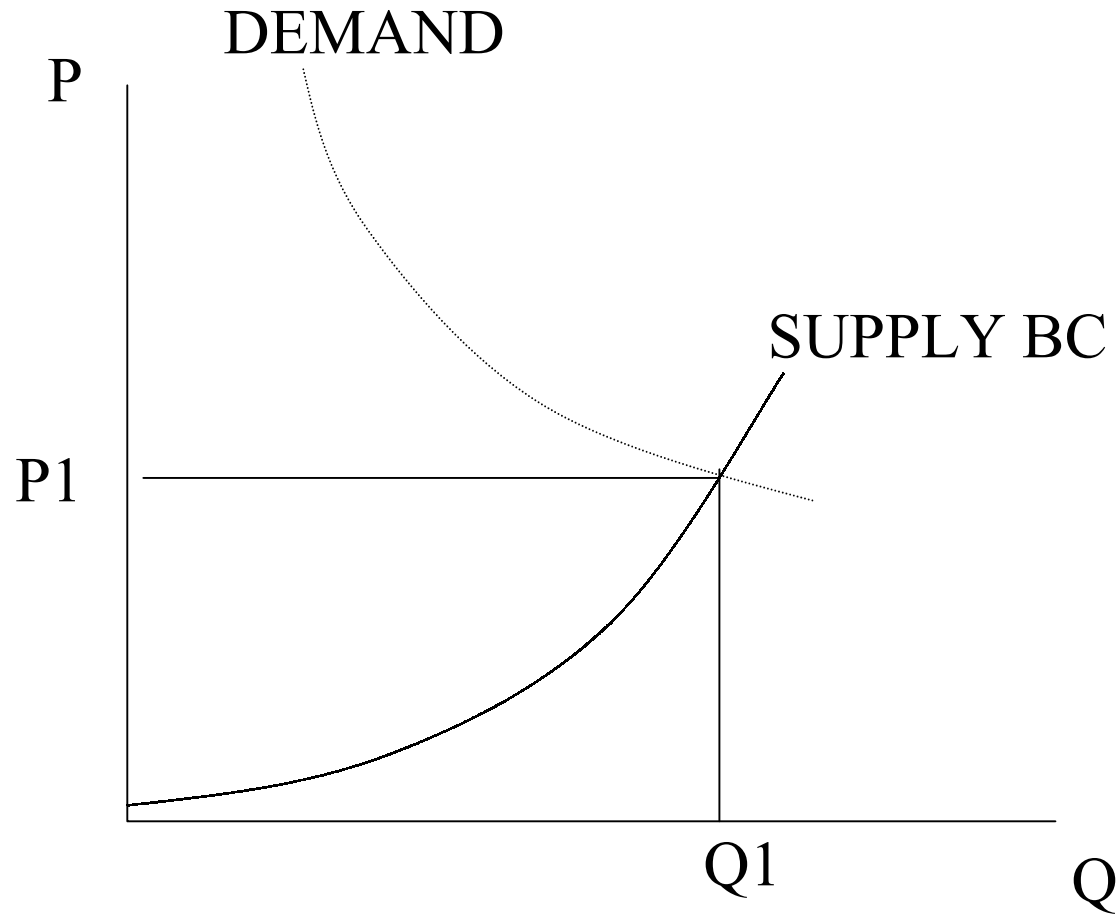
DEMAND PROJECTIONS (STEAP)

- GDP growth projections (region specific)
- Demand income elasticities
- -0.2 - -0.5%/yr autonomous decoupling
- Own price elasticity demand -0.2

EXAMPLE PROCESS CHARACTERISATION

INPUT		
ELECTRICITY	[GJ/t]	1.4
STEEL SCRAP	[t]	1.05
OUTPUT		
LIQUID STEEL	[t]	1.0
INVESTMENT	[EUR/t.yr]	500
VARIABLE COST	[EUR/t]	20
UPPER BOUND CAPACITY	[Mt/yr]	Year and region specific
LIFE	[years]	20

DEMAND/SUPPLY EQUILIBRIUM



DEMAND REDUCTION IN CASE OF PRICE INCREASE

