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Resource Constraints in a Dynamic Econometric Input - Output Model

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Area 2: Starting points & research questions

- New growth path ("high road strategy") or transition must be based on fundamental innovations in policy
  - Resolving post crisis problems (debt overhang, unemployment, income distribution..)
- *Is stable (and high ?) GDP growth compatible with resource constraints and paths of radical resource savings ?*
- Development of resource scenarios for Europe & interface with the macroeconomic models
  - Existing resource scenarios for materials, energy and land on global and European levels, - 2020 or - 2050
  - Creating an interface with "LowGrow 2.0" and DEIO (dynamic econometric IO) model

Modelling Framework

- 'DEIO' models for selected EU countries (Germany, France, peripheral, nordic)
- Physical interface to resource scenarios:
  - Environmental Accounts (EA) from WIOD
  - Price system (international energy prices, import prices for primary goods
- Introducing physical constraints into models:
  - Resources in limited supply in Europe (land) → modeling of "factor market" for resource in Europe (price increase, growth constraint)
  - Resource prices or constraints are determined at international markets or international policy agreements → resource price shock for Europe

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What is a DEIO model?

- More than an input-output model, long-run similar to dynamic CGE, but short-run Neo-Keynesian
- Consumption: Dynamic "buffer stock" model:
  - durables, non-durables → saving for down payment, liquidity constraints (difference to PIH)
  - energy linked to durables (energy efficiency & 'service demand') → rebound effects.
- Production: Dual model (K,L,E,M^m,M^d) of production and factor demand with crs → TFP as the main supply side driver of growth
- Factor markets (supply side): wage curve
- Budget constraint for public sector (target net lending)

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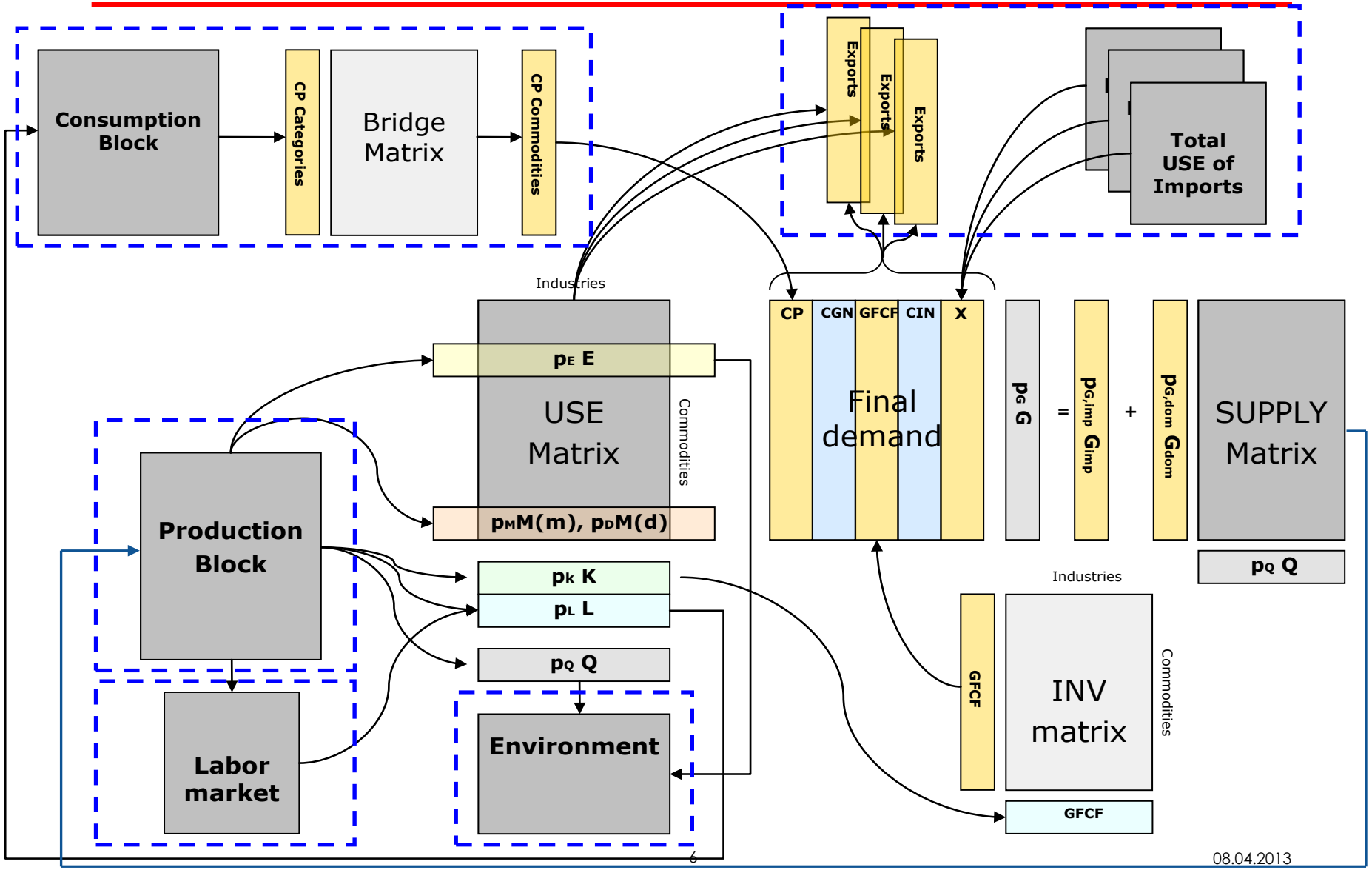
What is a DEIO model?

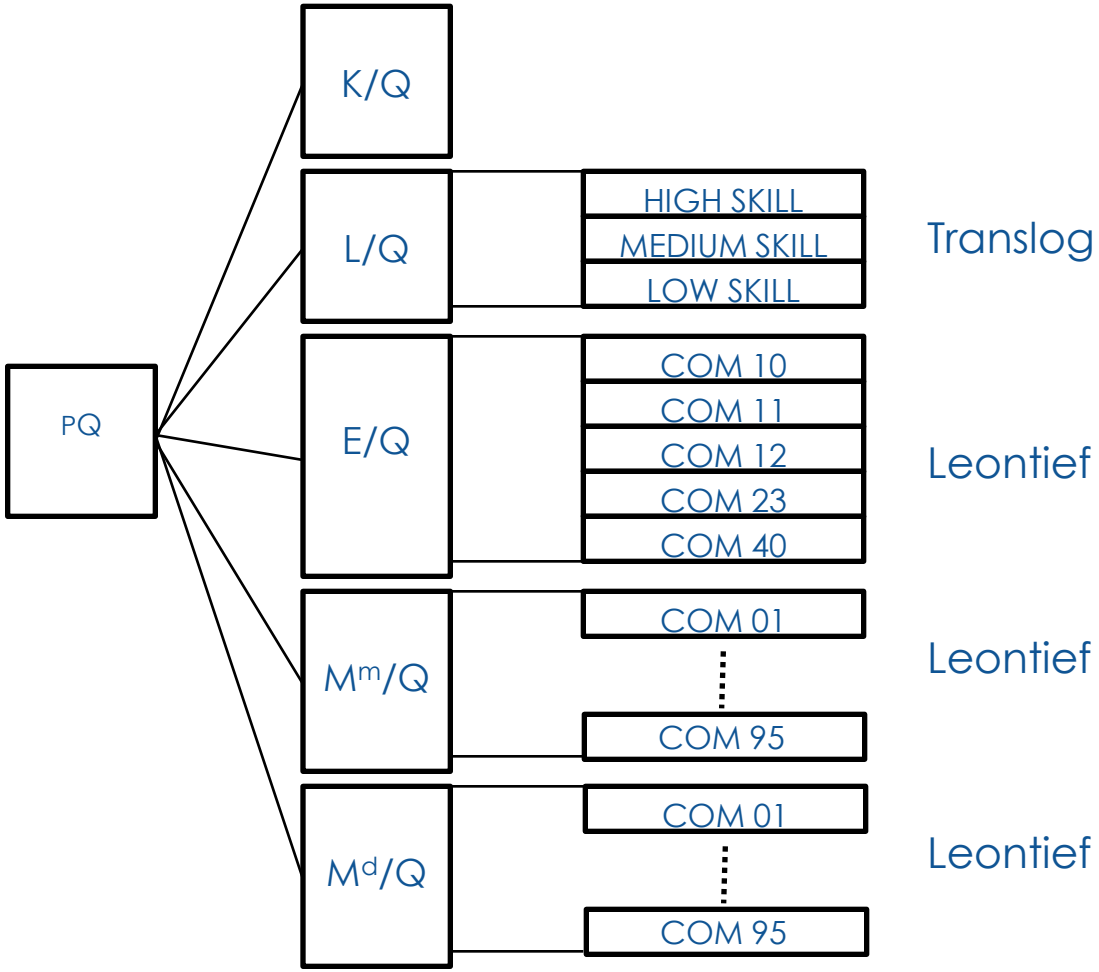
- Energy
  - energy in consumption (private transport, heating, electricity in monetary units)
  - energy in production (coal, oil, gas, electricity (CPA) in monetary units)
  - Link to EA (Environmental Accounts) of WIOD → via deflated monetary units and physical quantities (TJ)
- Resources
  - Physical data from EA (WIOD)
  - Link to output by industry (physical/monetary)
- Example of DEIO model: **FIDELIO**: **F**ull **I**nter-regional **D**ynamic **E**conometric **L**ong-term **I**nput-**O**utput Model

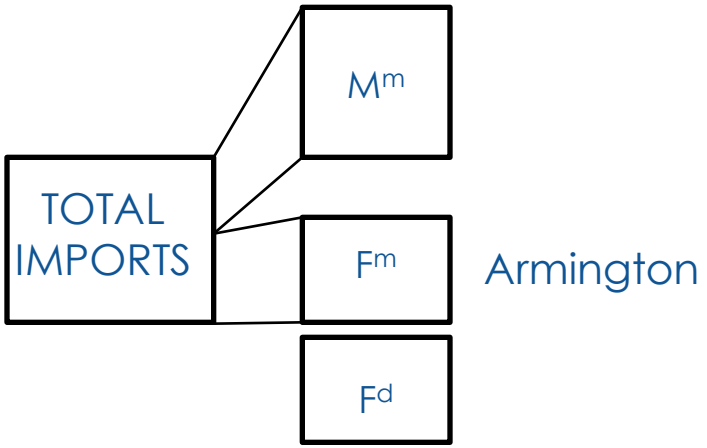
Structure of the FIDELIO model



A dual model of production

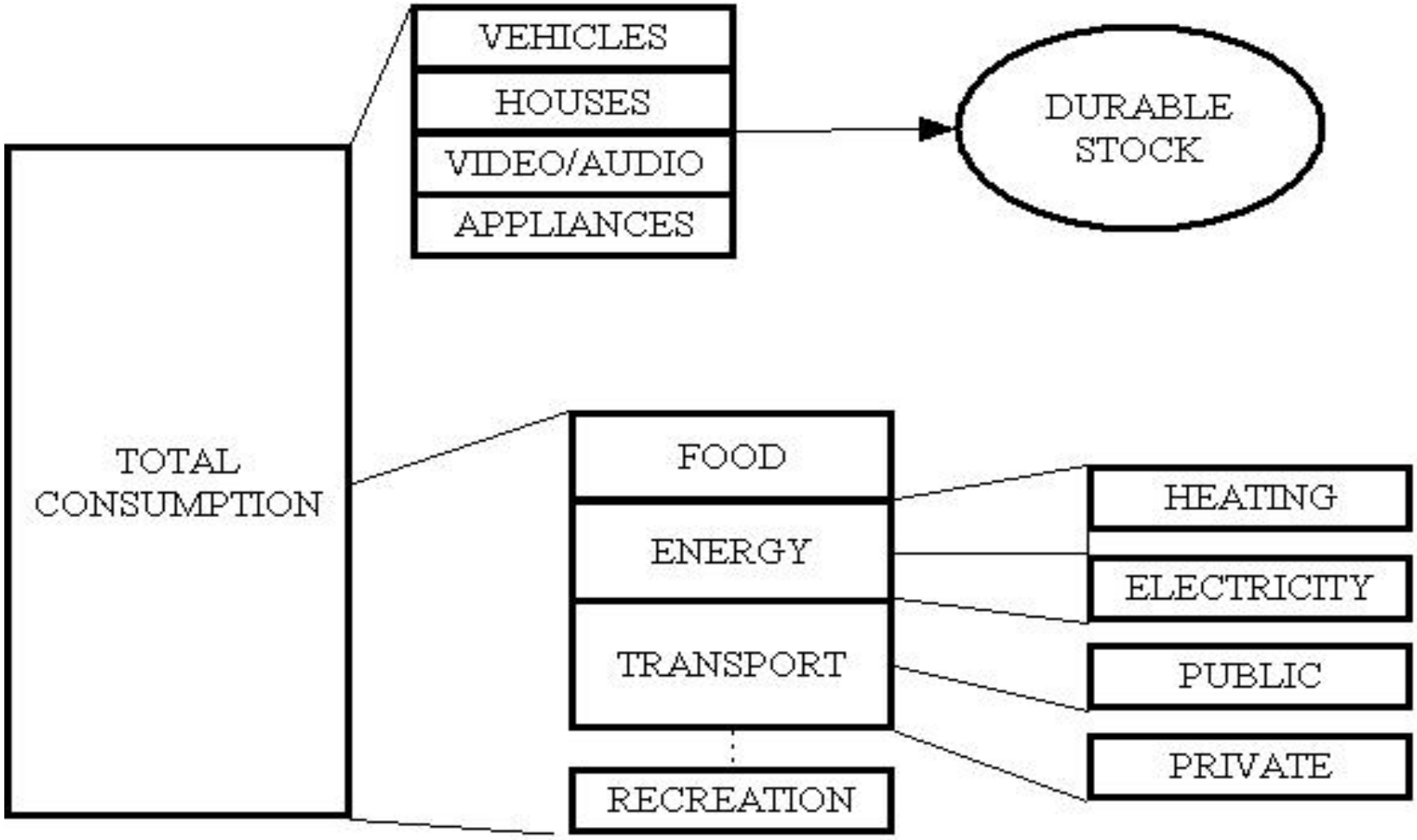
Production and Factor Demand





A ‚buffer stock' model of consumption

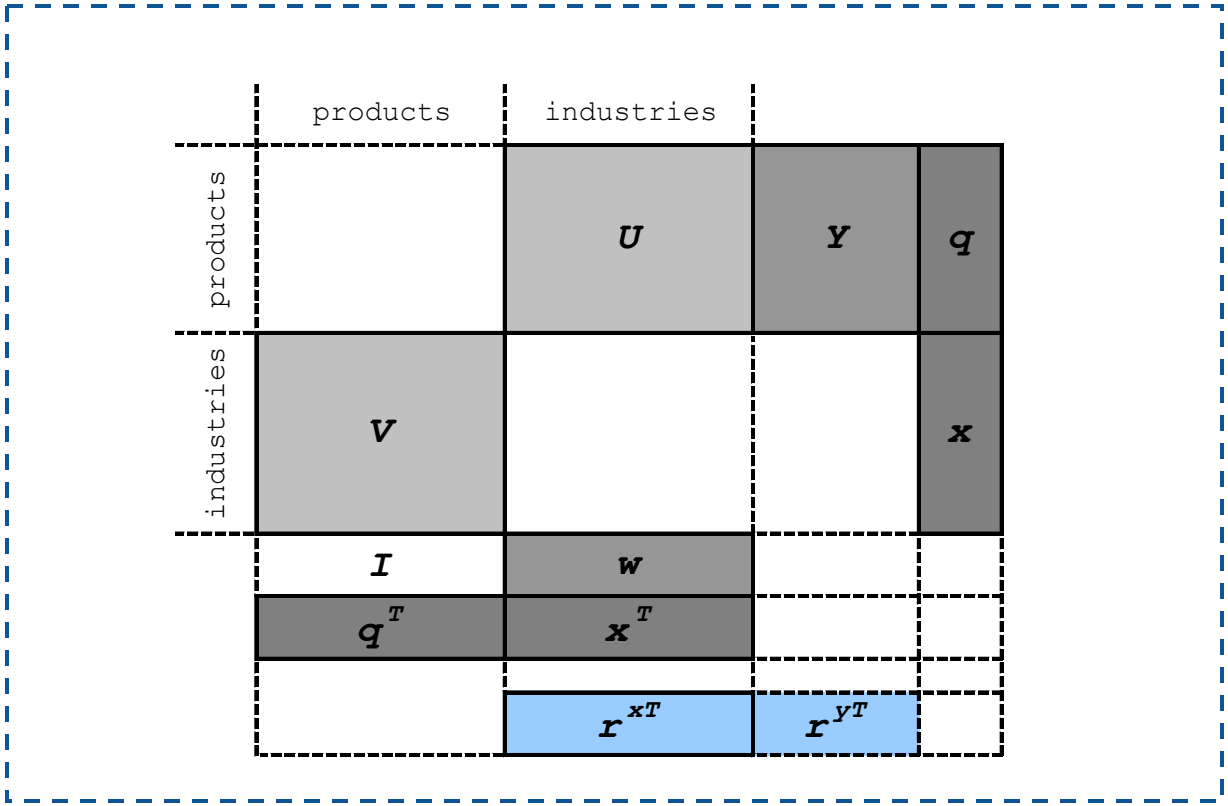
Private Consumption



Database of the DEIO model: WIOD

- World Input-Output Database
  - National supply/use and I/O tables
  - Socio-economic satellite accounts
  - Environmental satellite accounts
- Geographical coverage: full world coverage
  - EU27 countries
  - 13 major non-EU countries
  - Rest of the world (1 region)
- Time coverage: full time series 1995-2009
- Sectoral coverage of Environmental Accounts
  - 35 WIOD industries (based on NACE Rev. 1.1, 2002)
  - Final consumption (households)

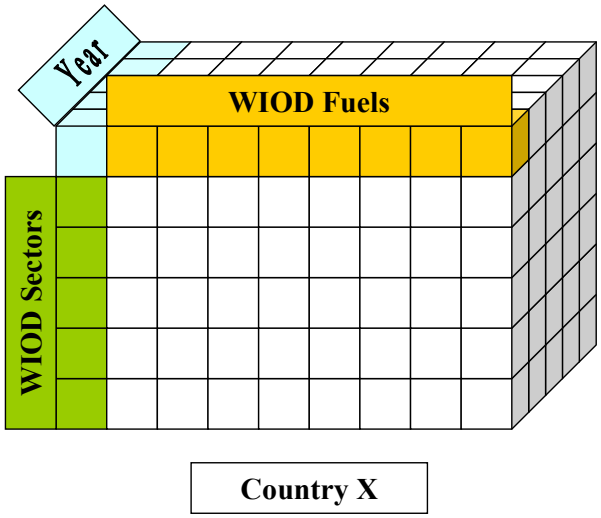
Framework of Environmental Accounts



(Moll et al., 2008)

Structure of energy accounts

1995-2009



36 sectors
- Industries
- Households

26 fuels and losses
- Coal
- Oil and gas
- Electricity and heat
- Refinery products
- Renewables
- Waste
- Losses

Overview of air emission accounts

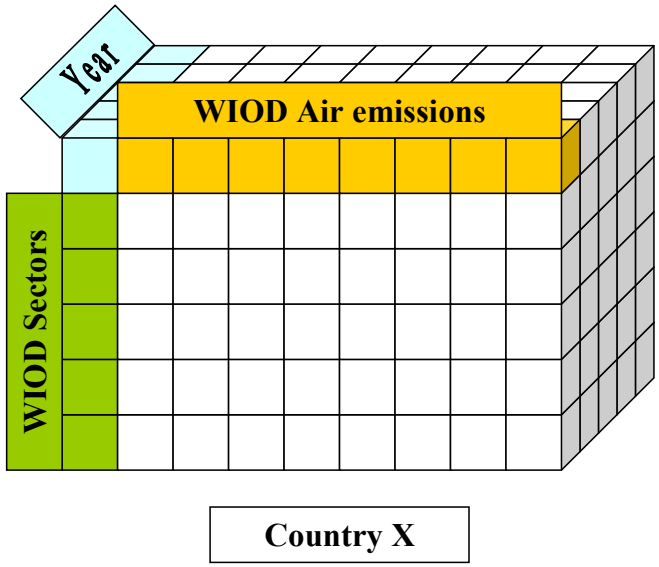
- NAMEA air: fully compliant with SNA
- Emission flows (in t or 1000 t) of 8 pollutants related to:
  - Global warming (CO2, CH4, N2O)
  - Acidification (SO2, NOX, NH3)
  - Tropospheric ozone formation (NOX, NMVOC, CO, CH4)
- CO2 emissions from 26 fuels and non-energy related emissions covering:
  - Coal and coal derivatives
  - Oil and gas
  - Electricity and heat
  - Refinery products
  - Renewables and waste
  - Non-energy related

Same as in energy accounts

Structure of air emission accounts

1995-2009

36 sectors
- Industries
- Households



8 pollutants
- CO2
- CH4
- N2O
- SO2
- NOX
- NH3
- NMVOC
- CO

Data sources for air emission accounts

- Eurostat NAMEA air (EU27)
- UNFCCC emission inventories
- EDGAR emission inventories
- IPCC emission factors
- WIOD data (SUTs, employment data)

Overview of other satellite accounts

- Other extensions fully compliant with SNA
- 12 types of materials extraction (in 1000 t) covering:
  - Biomass
  - Fossil fuels
  - Metals and other minerals
- 4 types of land use (in 1000 ha) covering:
  - Agriculture areas
  - Forestry areas
- 3 types of water use (in 1000 m^3)
  - Blue water
  - Green water
  - Grey water

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Resource constraints in the DEIO model

- Modeling domestic resource constraints: mainly on land, as "Natura 2000" and other protected areas (biodiversity):
  - Derived demand for land from all economic activities → price of land → adjustment of demand
  - Additionally restricting footprint of imports
- Modeling resource price shocks from international markets:
  - Impact on all domestic prices → adjustment of demand
  - Additional policy measures for resource saving technical change (innovation, technology diffusion)

Resource constraints in the DEIO model

- Different explicit technologies in several industries
  - Backstop technologies
  - Recycling of primary resources ("urban mining")
- Choice of technique exogenous to the DEIO model and determined in a submodel
- Example: A submodel for shifting resource constraints by new technologies (e.g. recycling)
  - Input Technology *A* in industry 1 with primary extraction: (a_{11}, a_{21}, ...a_{n1})
  - Input Technology *B* in industry 1 with recycling: (b_{11}, b_{21}, ...b_{n1})
  - → Aggregate IO model as a linear combination of A and B, depending on input prices p_n.