Energy Options and Health Benefits for China National Study

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Background

Background of the Project

- Pursue to a Statement of Intent (SOI) signed by Administrator Xie Zhenhua of SEPA and Administrator Carol Browner of EPA, in 1999
- One of ten projects initiated at that time in conjunction with the China-US Forum on Environment and Development
- Three Components
  - Shanghai Case Study, 1999-2001
  - Beijing Case Study, 2002-2003
  - National Assessment, 2003-2004

Coordinators

- State Environmental Protection Administration of China (SEPA)
- Environmental Protection Agency, U.S.A. (USEPA)
- National Renewable Energy Laboratory (NREL)

The Purposes

The Purpose: in Policy

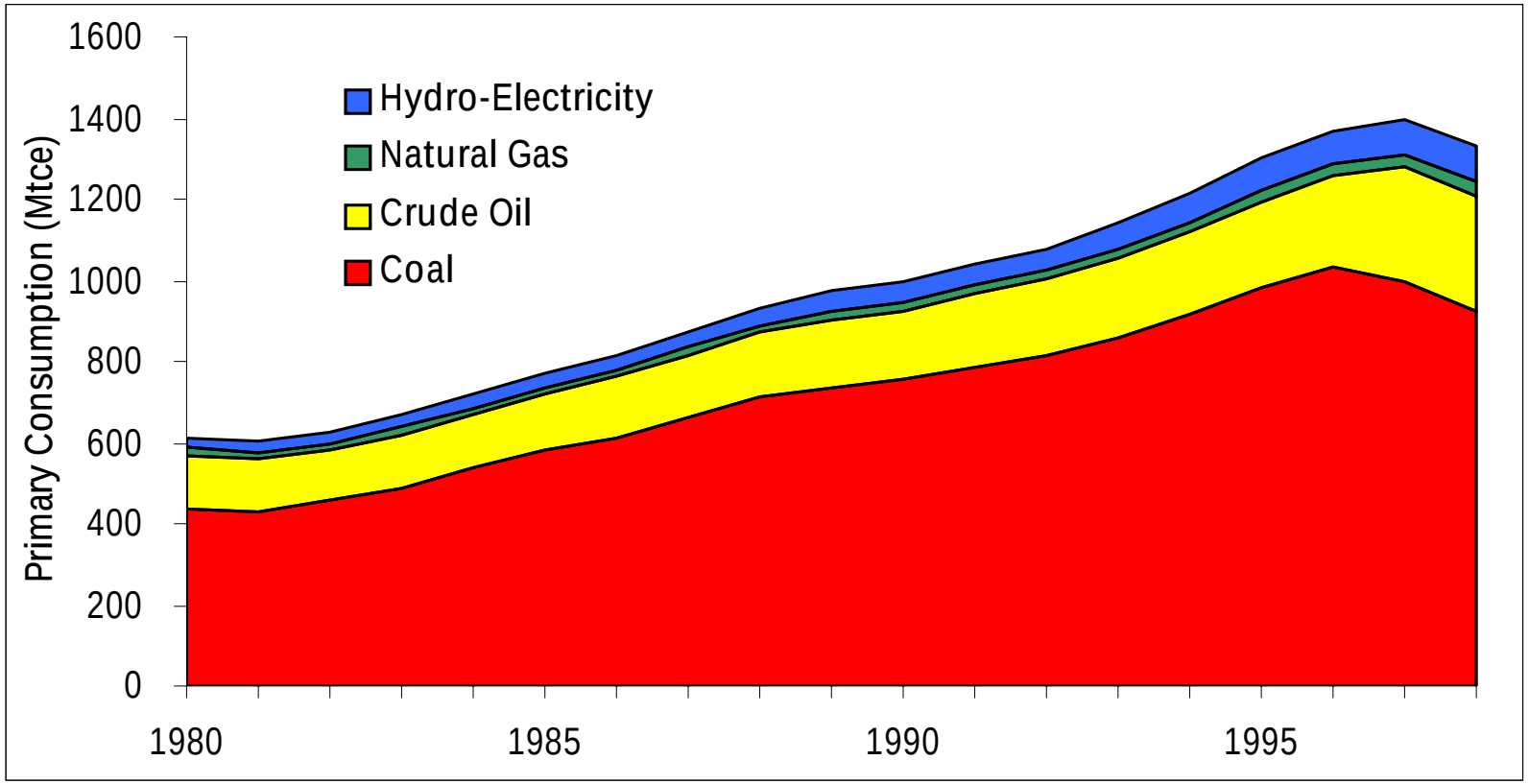
- **Develop a range of integrated strategies which take into account both air quality and GHG concerns**
- **Quantify the co-benefits of energy policies in China**
- **Provide scientific support for a comprehensive air pollution control policy making:**
  - **Useful input to the development of the 11th 5-year plan**
  - **New expert modeling framework for integrated assessment to support the implementation of the new environmental impact assessment law**

The Purpose: in Science

- Establish a new co-benefits analysis framework
- Validate & Run Models-3/CMAQ system in China
- Develop a national air pollution health benefits assessment model for China
- Capacity Building for Chinese Scientists

Why Conduct Co-benefit Analysis for Energy Policies?

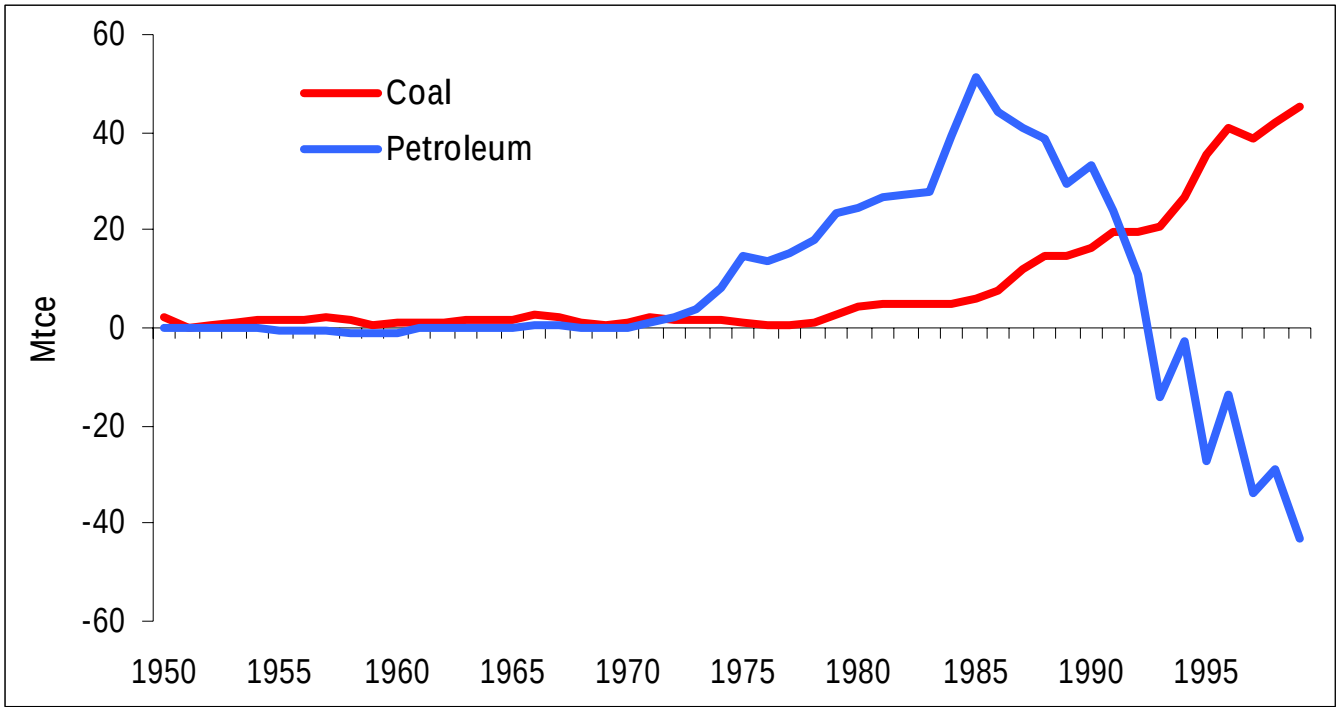
Primary Energy Consumption in China, 1980-1999



Energy Policies Can Impact

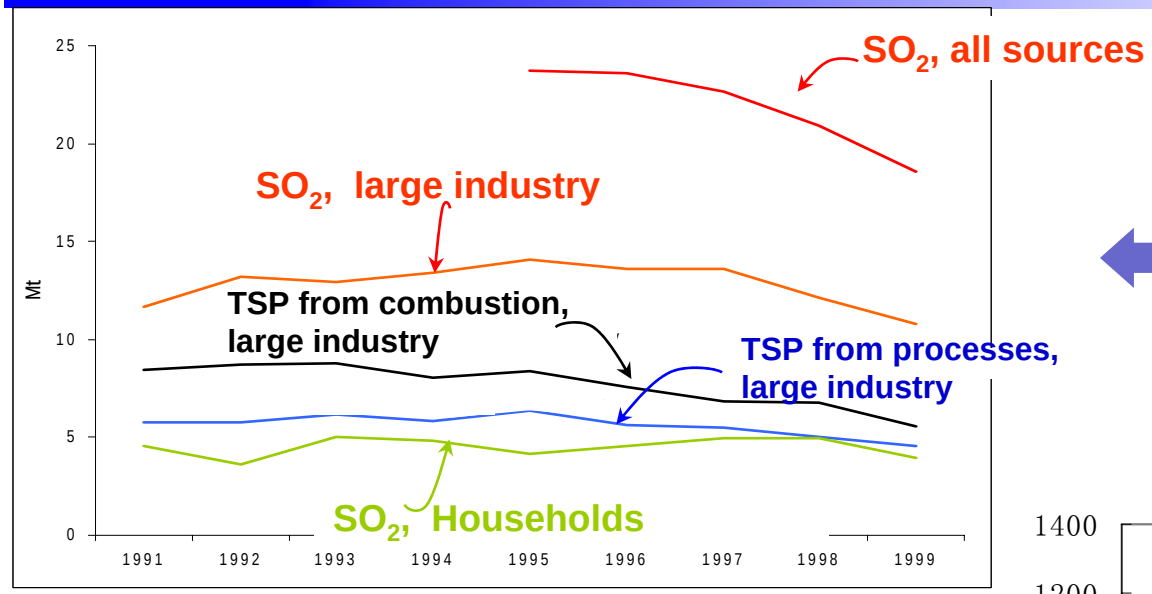
- Energy Security
- Local Air Pollution Emissions
- Exposure Level of Air Pollutants
- Global Change Potential
- Public Health
- Economy

Increasing risk from Expanded Oil Import



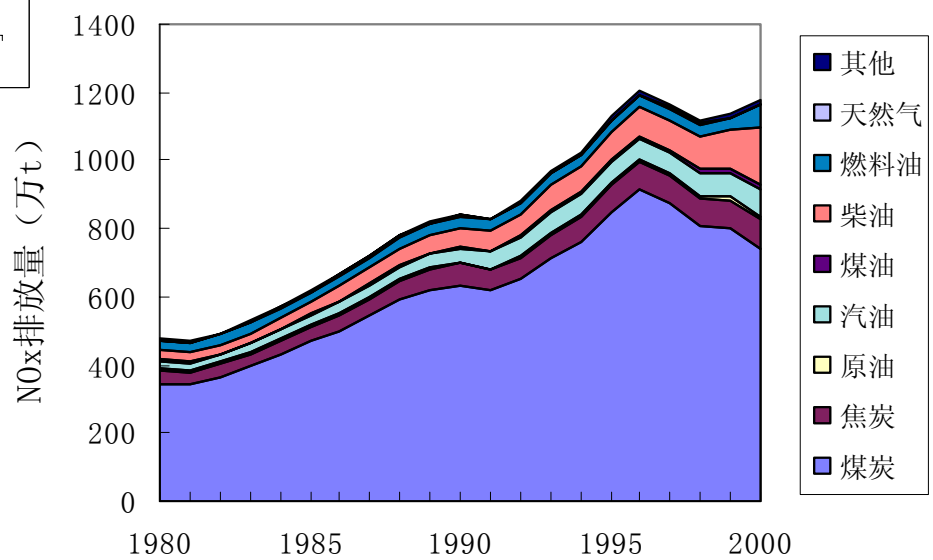
Net Energy Exports in China, 1950-1999

Local Air Pollution Emission Trends

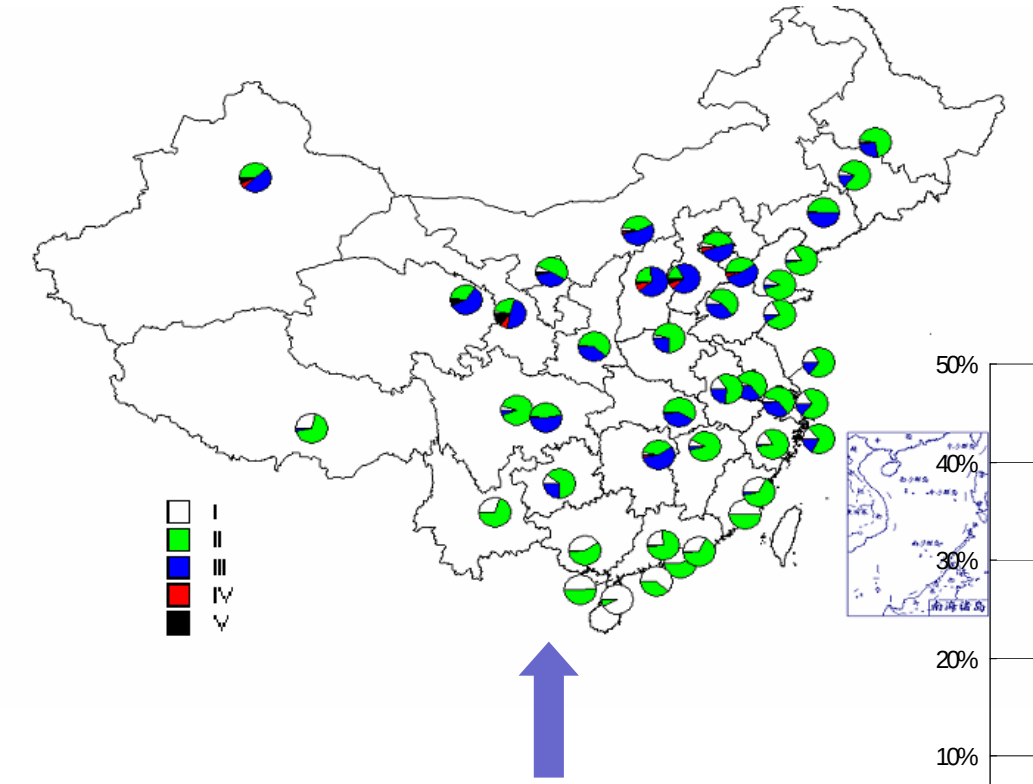


SO2 and Particulate Emissions in China, 1991-1999

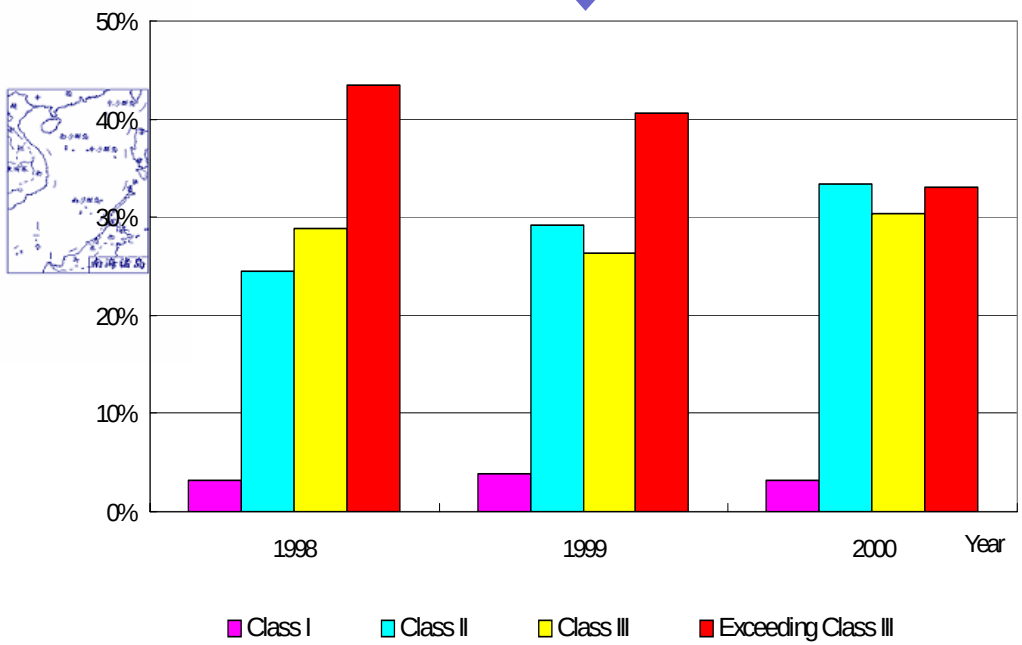
NOx Emisisons in China, 1980-2000 (Tian, et al.)



Exposure Level of Air Pollutants in Urban Areas

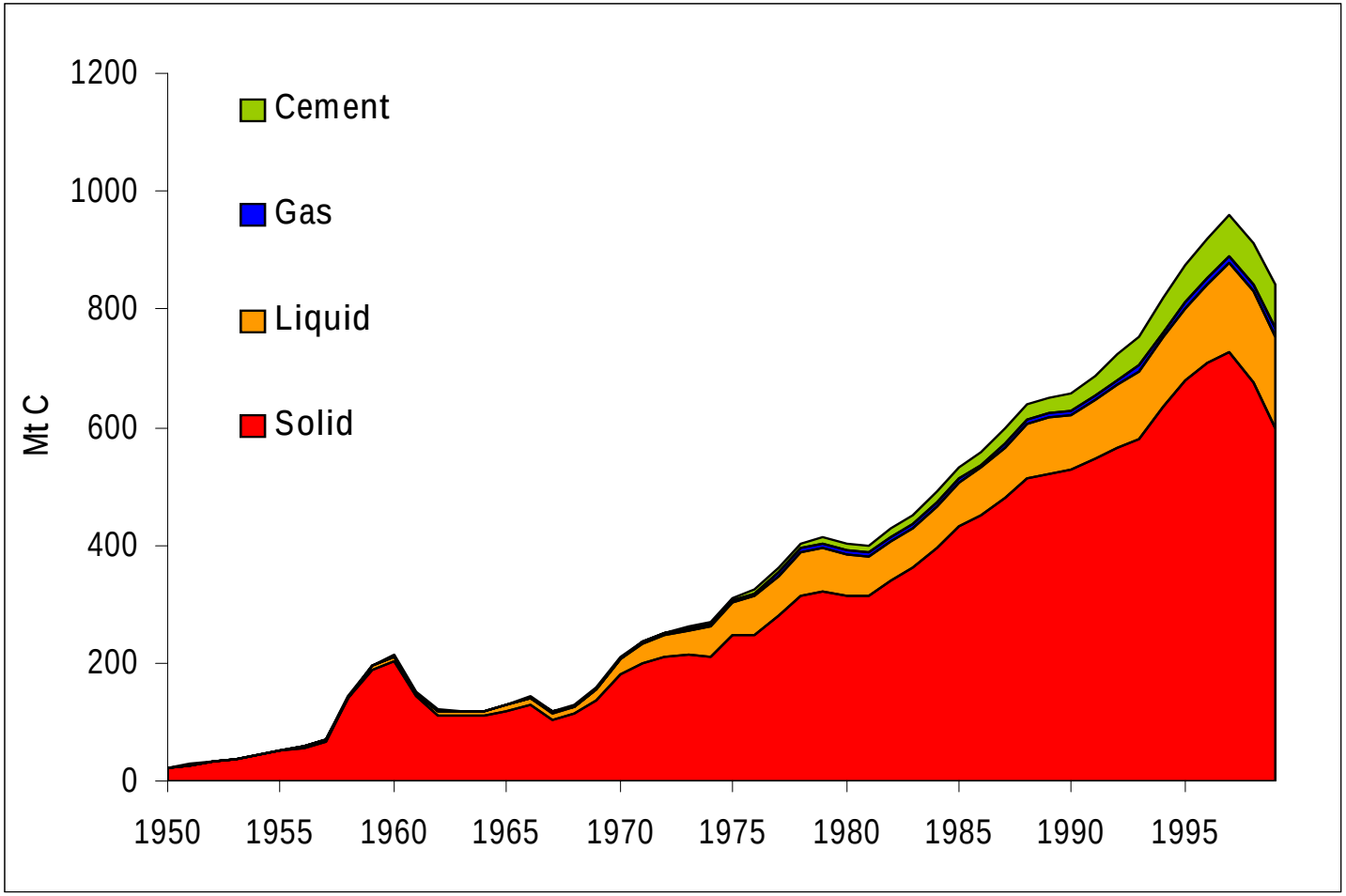


Air Quality in each of 42 key cities from July 2000 - June 2001



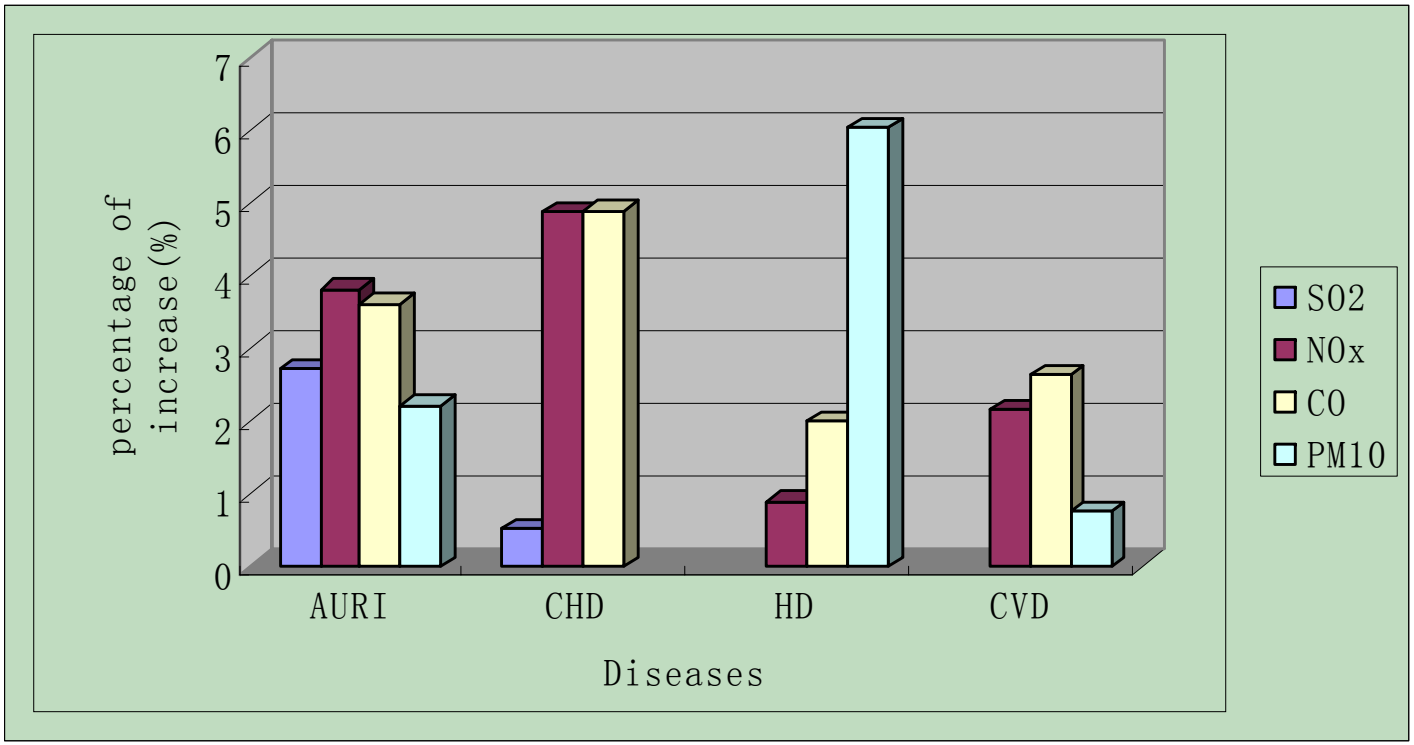
Overview of Current Urban Air Quality in China, 1998-2000

Carbon Dioxide Emissions Major Sources, 1950-1999



Health Impact

- **The percentage of increase in the hospital outpatient visits (per 100mcg/m³ increase) from air pollution by 2000, Beijing**



AURI: acute upper respiratory infections, 急性呼吸系统疾病 **CHD: coronary heart disease,** 冠心病

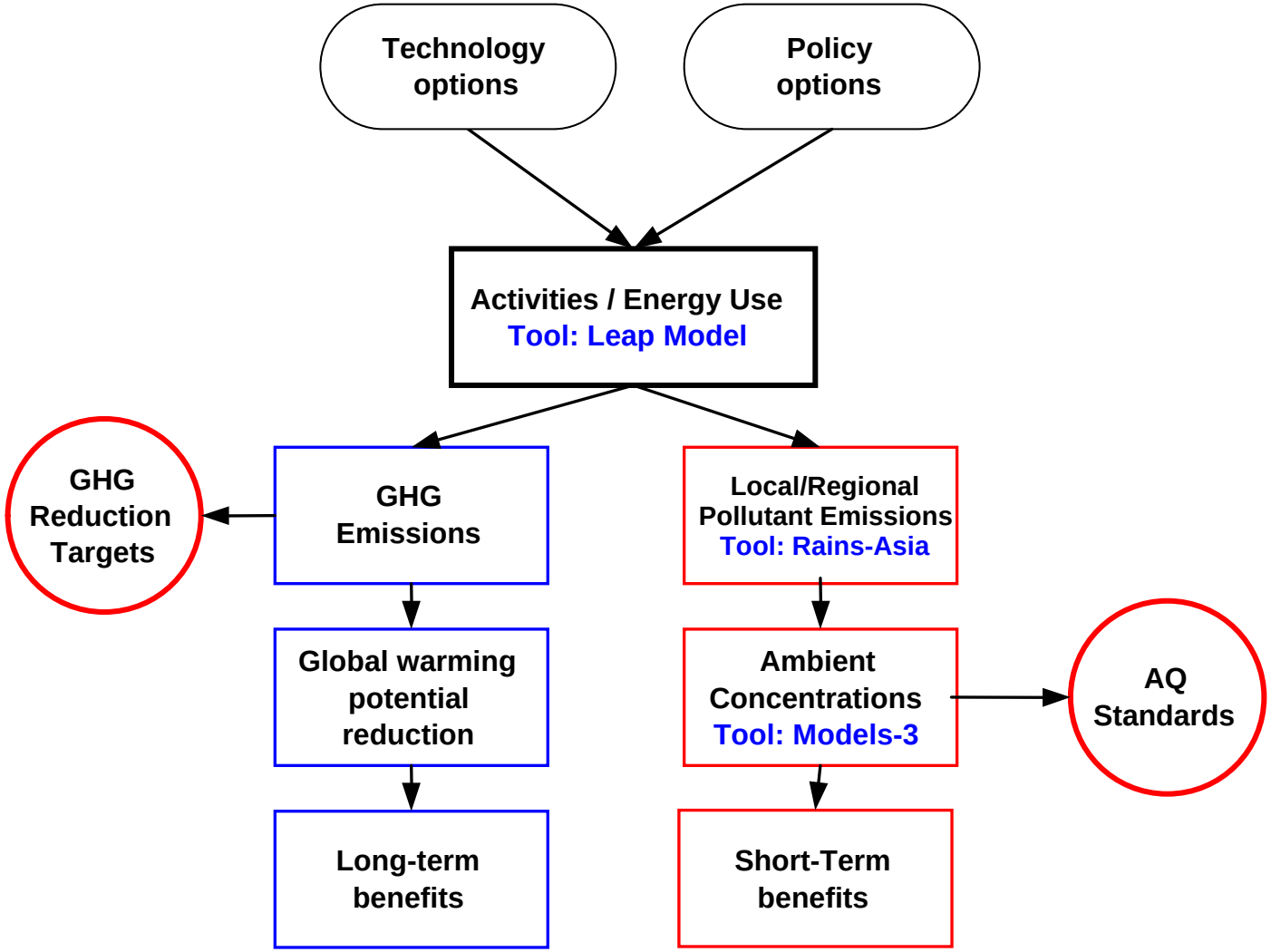
HD: hypertension diseases, 高血压 **CVD: cardiovascular disease,** 心血管疾病

Economic Losses Caused by Air Pollution

Studies	Base year	Economy losses (billion RMB)	Research categories	GNP (%)
Guo & Zhang (64)	1983	12.4		2.2
Xia (65)	1992	57.9	Health, crops, animals, and materials	2.4
Sun (66)	1992	60.5		2.5
Zheng et al. (67)	1995	30	Health damage due to TSP pollution; crop, forest, and materials damage due to acid rain	0.5
Xu (68)	1993	39.1	Health, agriculture, acid rain, household upkeep (cleaning)	1.1
Smil (69)	1990	15.1 ± 4.1		0.86 ± 0.16
World Bank (70)	1995	44.88 (billion US$)	Health effects from urban air pollution; damage from indoor rural air pollution; crop, forest, materials, and ecosystem damage from acid rain; lead exposure for children	7.1

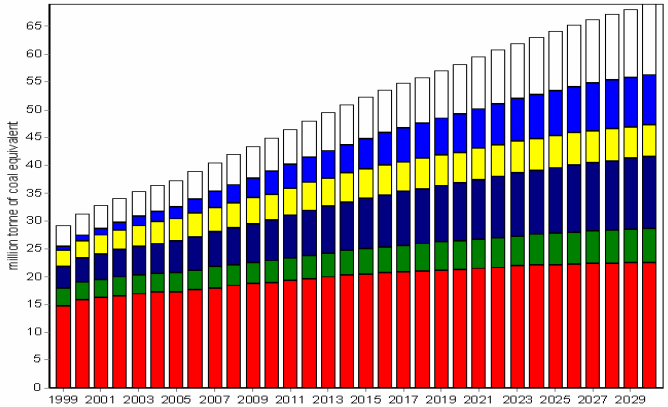
Approaches

Framework of the Project

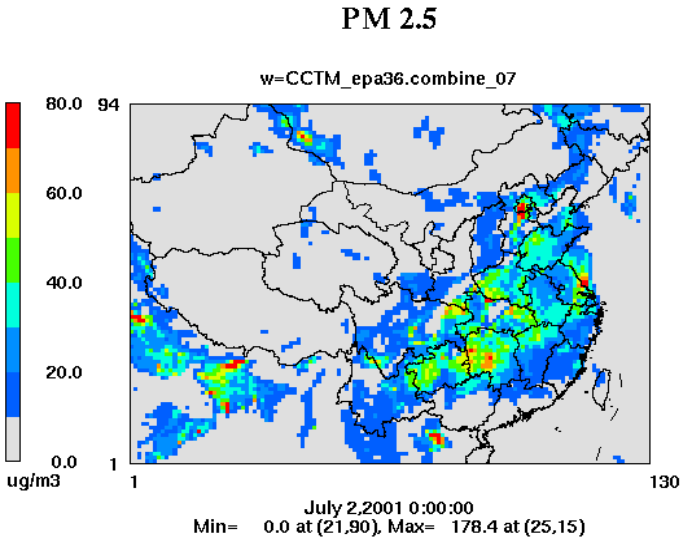


Modeling Tools

- **Leap**
  - Generate energy scenarios



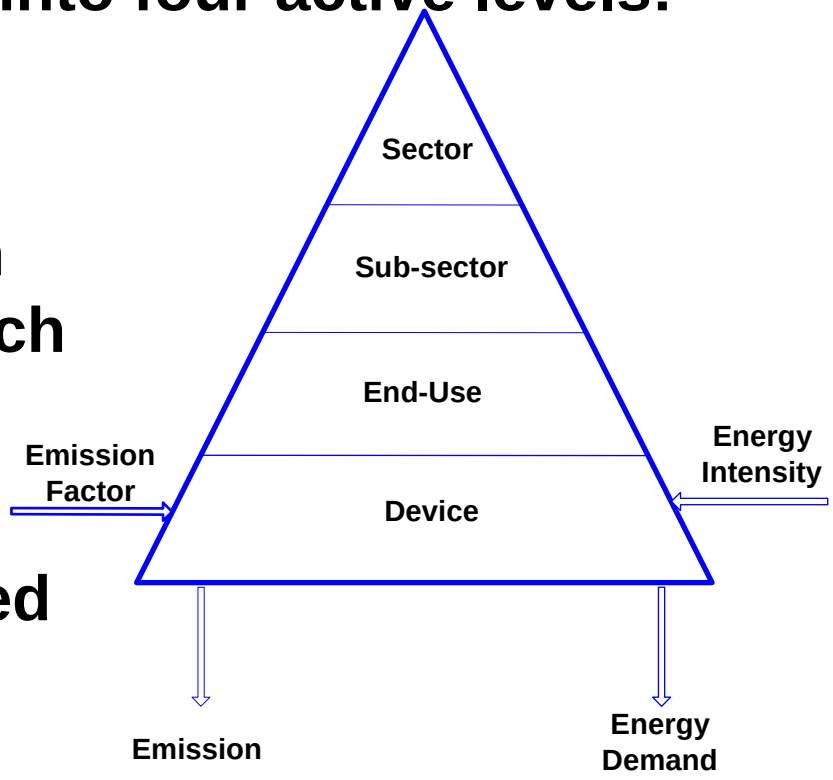
- **Models-3**
  - Estimate air quality under different scenarios



- **BenMAP and APHBA**
  - Evaluate the health impact

Methodological framework of LEAP

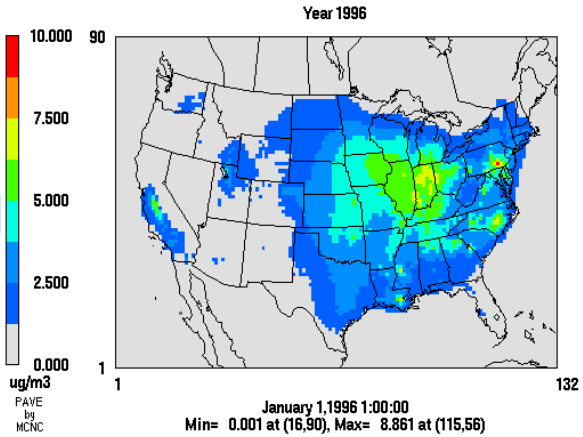
- The problem is disaggregated into four active levels:
  1.Sector 2. Sub-sector
  3.End-use 4. Device
- Energy intensity and emission factors are associated with each device at the level 4
- Total energy demand and emission amount are calculated



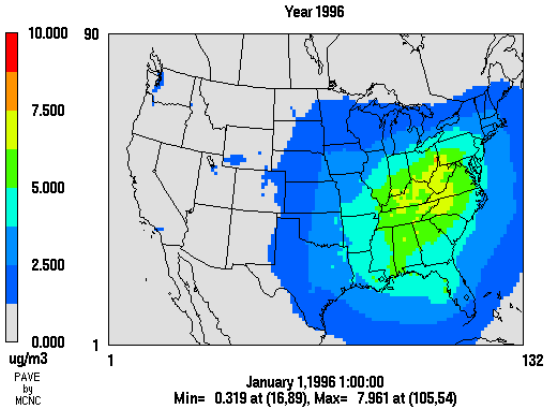
Models-3/CMAQ System

- 3rd generation air quality model
- Basic concept: ”One Atmosphere”
- Integrated atmospheric physics and chemical process
- Advanced computer/GIS technology
- Pay more attention to fine PM

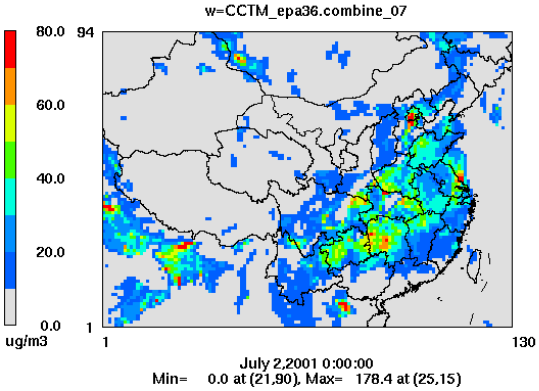
Nitrate PM



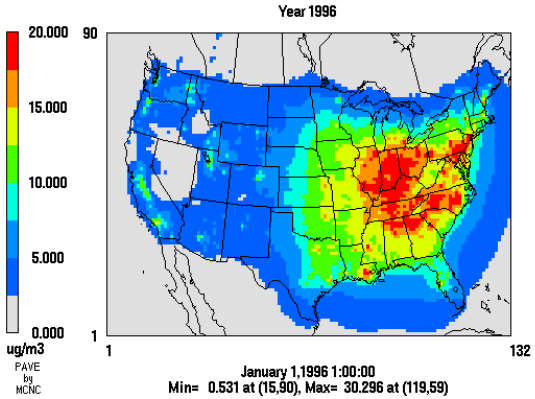
Sulfate PM



PM 2.5

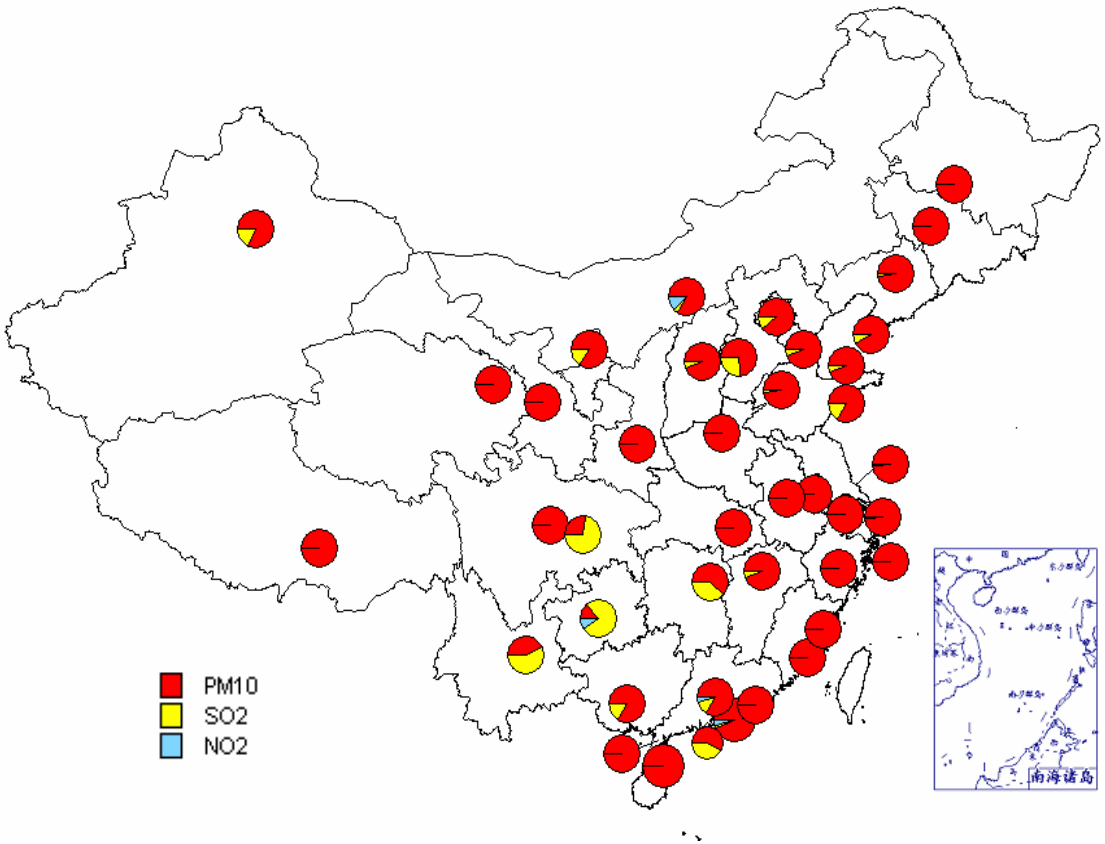


PM 2.5 (Annual Average)



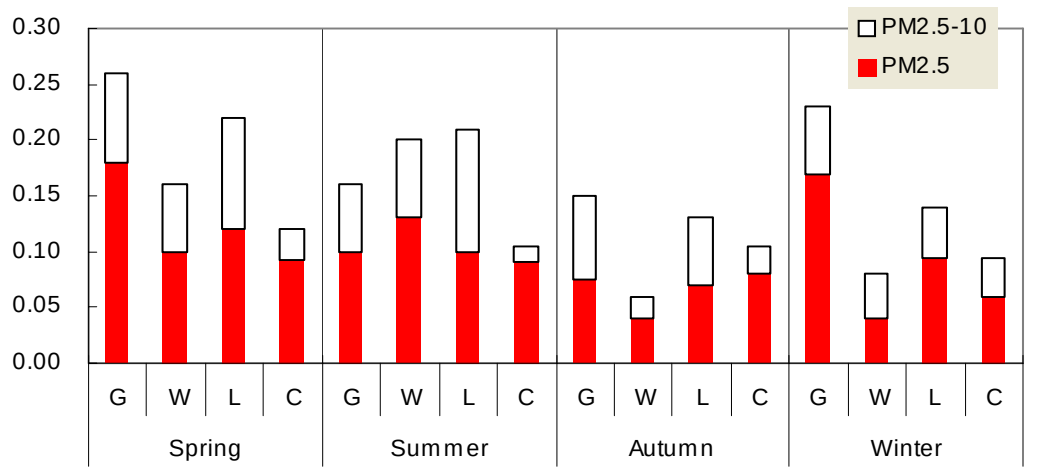
Why focus on fine PM

- Key issue in major cities
- Multi- emission sources & Multi- damage
- Especially health damage
- Difficult to control



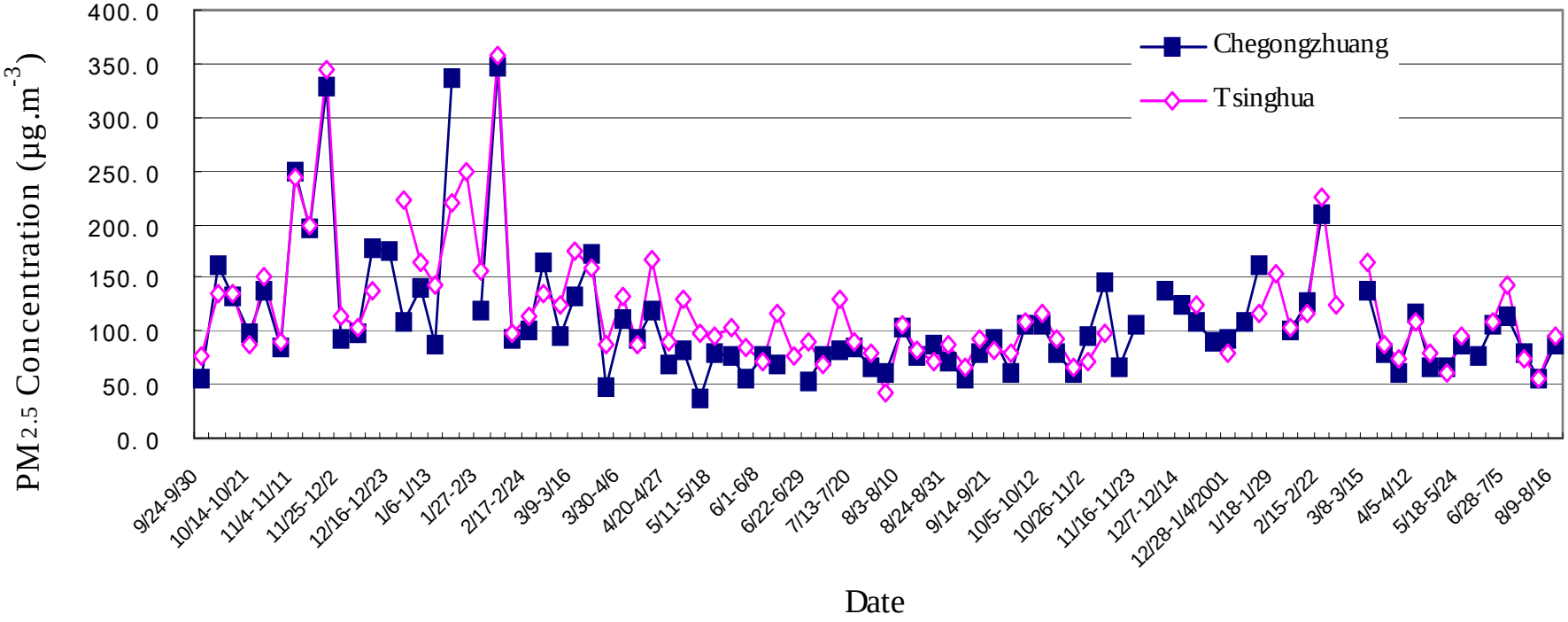
Occurrence Frequency of Each Pollutant as Major Pollutant of 42 Key Cities in China
July 2000-Jun 2001

$PM_{10}/PM_{2.5}$ Concentration in Some Cities, 1995-1996



G: Guangzhou W: Wuhan L: Lanzhou C: Chongqing

$PM_{2.5}$ Concentration in Beijing



1999.9~2001.8

Regulatory Benefits Model: BenMAP

- A population based geographic information system
- Accepts air quality information as inputs
- Uses predefined concentration-response functions and valuation estimates to estimate changes in health endpoints and the value of those changes
- Can produce estimates at the population grid scale, county, state, or national level

Main Activities

Main Activities

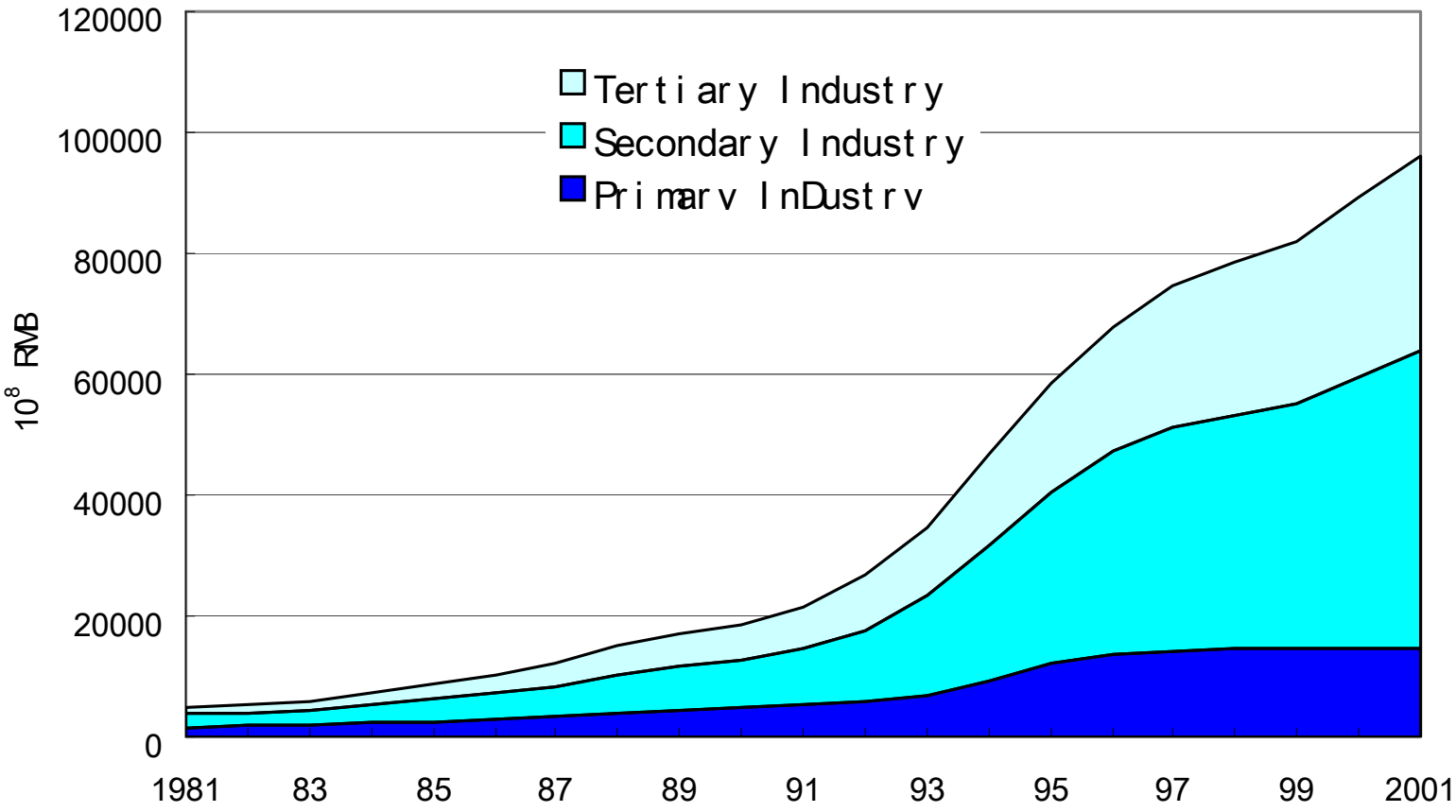
- Work Scope and Basic Information
- Scenario Definition and Development
- Development and Improvement of National Emission Inventory
- Air Quality Estimates
- Determination and Evaluation of anticipated health effects
- Economic valuation of health impacts of air pollution
- Co-benefit Analysis for Alternative Scenarios

Work Scope and Basic Information

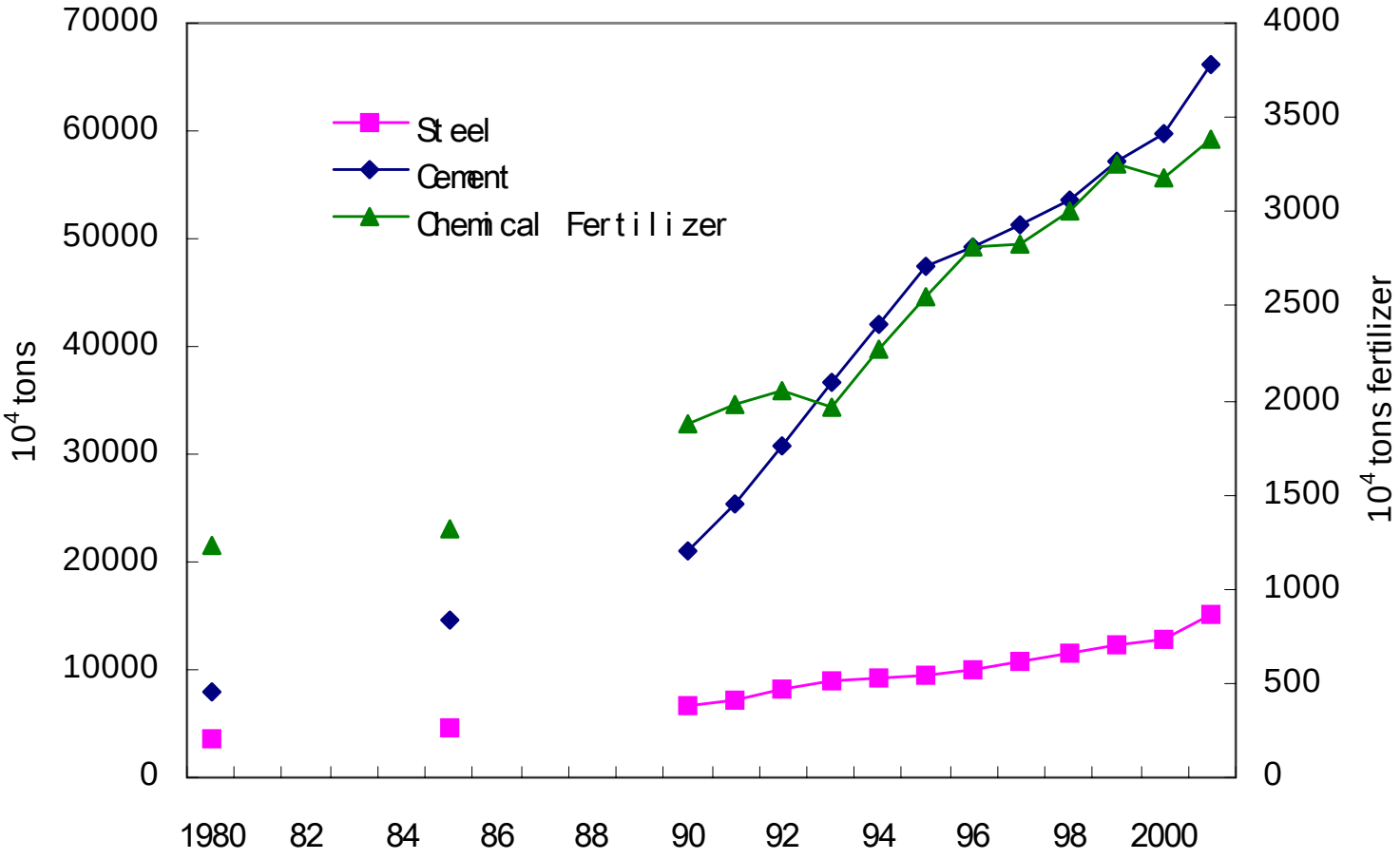
- **Spatial Scope:** China National Level
- **Time Step:** 2000 (Base Year), 2005, 2010, 2020 and 2030
- **Sectoral scope:** agriculture, industry, power plant, construction, and transportation, commercial and household
- **Environmental indicators:** SO_2, NO_x, CO, PM_{10}, $PM_{2.5}$ and CO_2
- **Basic Information:** Activity data for 3- E

Mitigation Scenarios

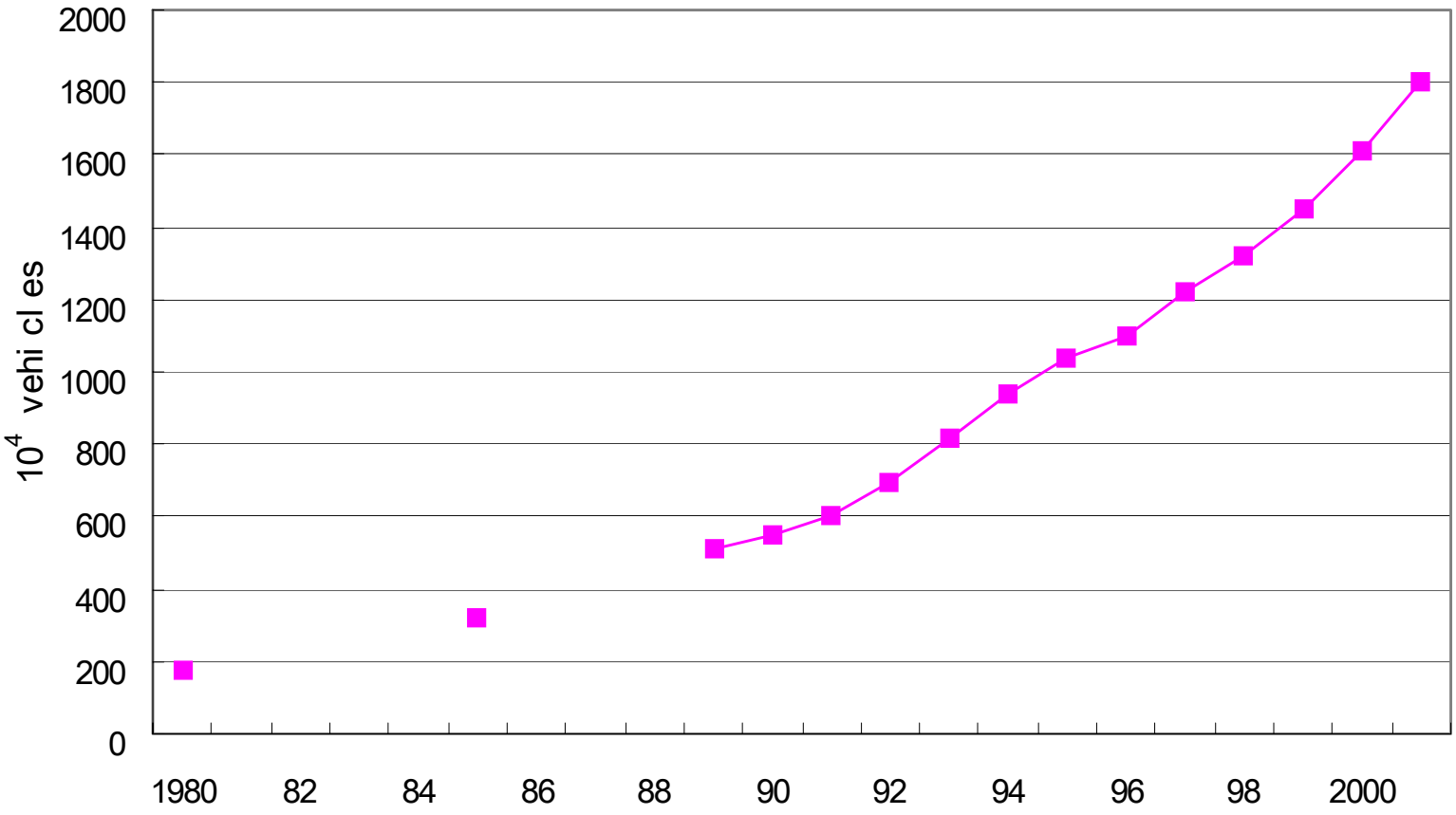
Base Year-GDP Growth



Output of Industrial Products



Vehicle Population



Mitigation Scenario Definition

- **Standard Scenario (STA)**
- **Pessimistic Scenario (PES)**
- **Optimistic Scenario (OPT)**

Sector Structure

- Residential
- Industry
- Public Building
- Transportation
- Agriculture
- Construction

Standard Scenario

- Relatively optimistic hypothetic scenario
- Based on the “10th 5-year plan” and other long range develop program mapped out by government
- 1.525 billion of population in 2030
- Technologies and energy efficiency in most sectors meet the average level in the world
- Policies and regulations to ensure sustainable development can be well implemented

Pessimistic Scenario

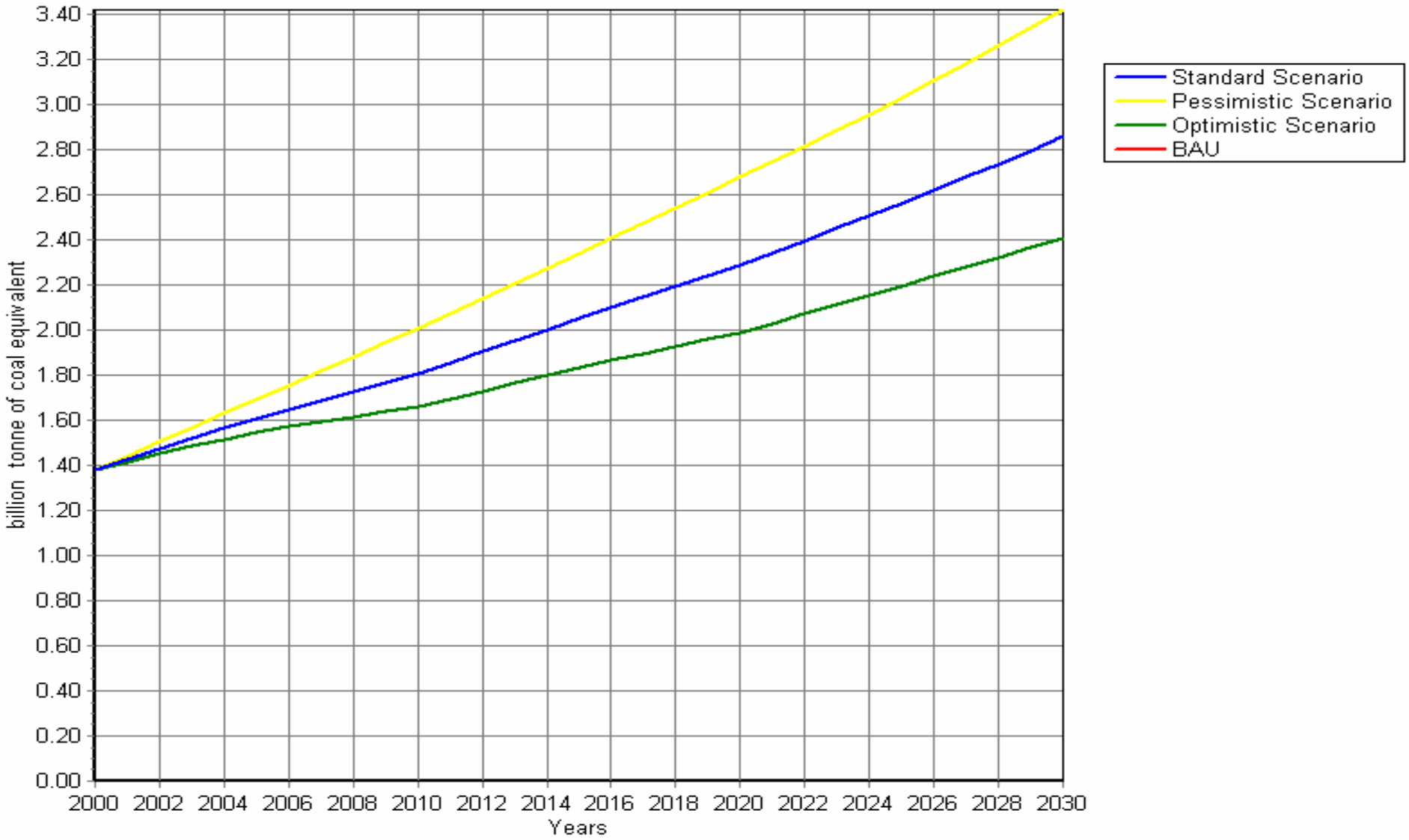
- Measures to regulate energy structure and increase energy efficiency can not meet the goal of government
- 1.55 billion of population in 2030
- Clean fuel is not widely spread and applied
- Advanced technologies is not widely used because the pressure of market competition

Optimistic Scenario

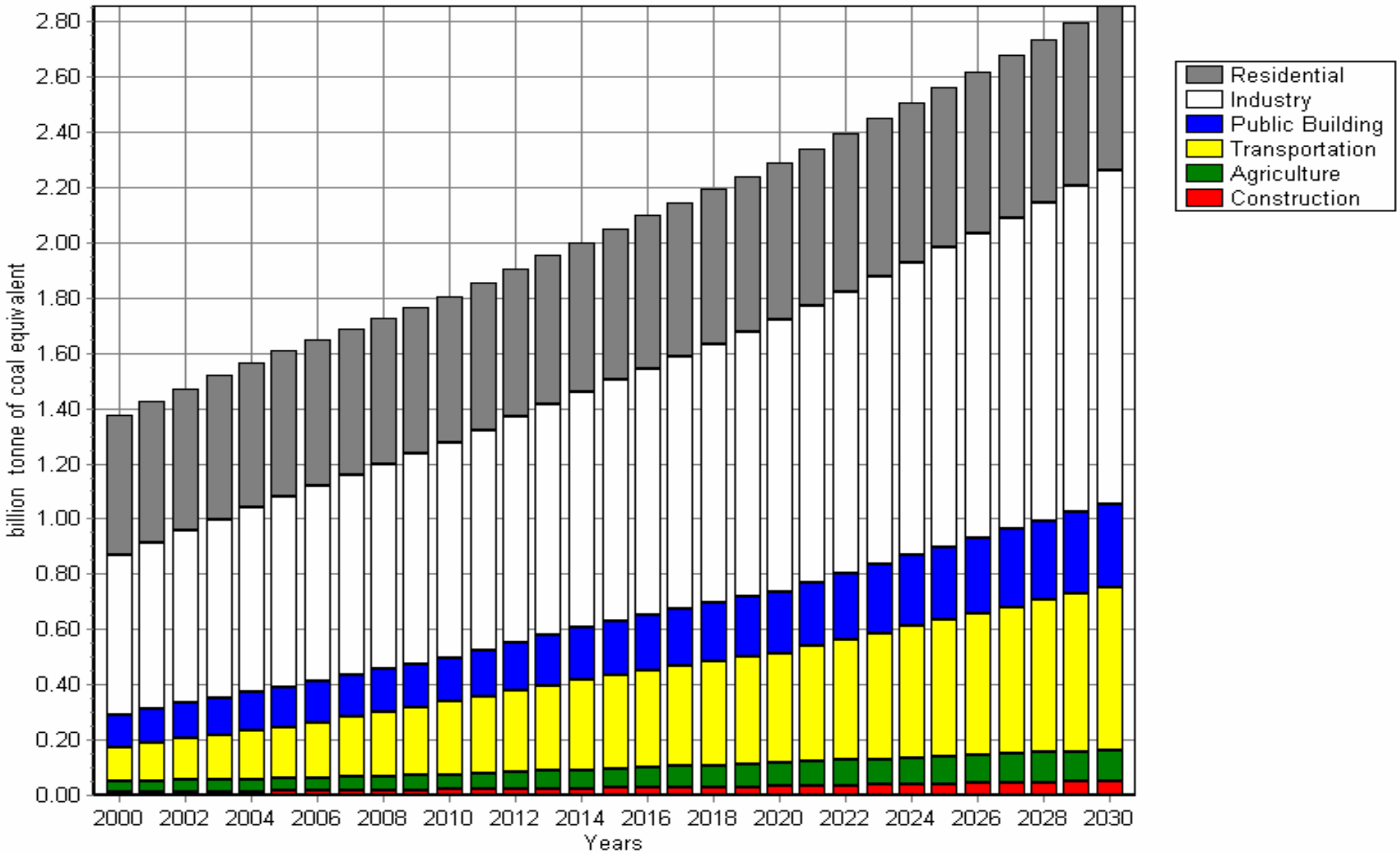
- A rather optimistic scenario
- 1.49 billion of population in 2030
- Policies related to sustainable development are strengthened and implemented successfully
- International energy resource is sufficiently used
- Advanced technologies and equipments are successfully imported

Scenario Analysis Results

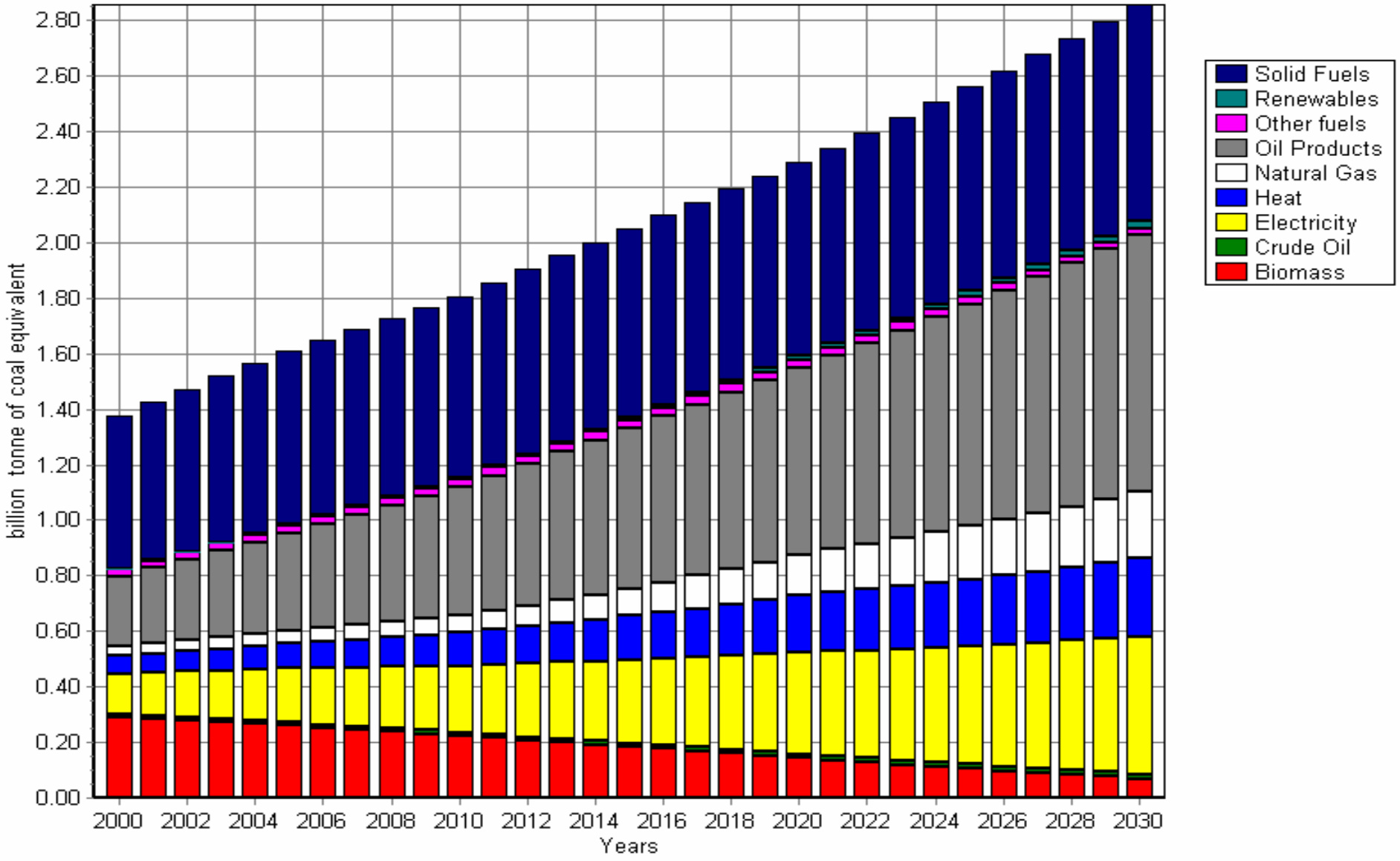
Energy demand, by scenario



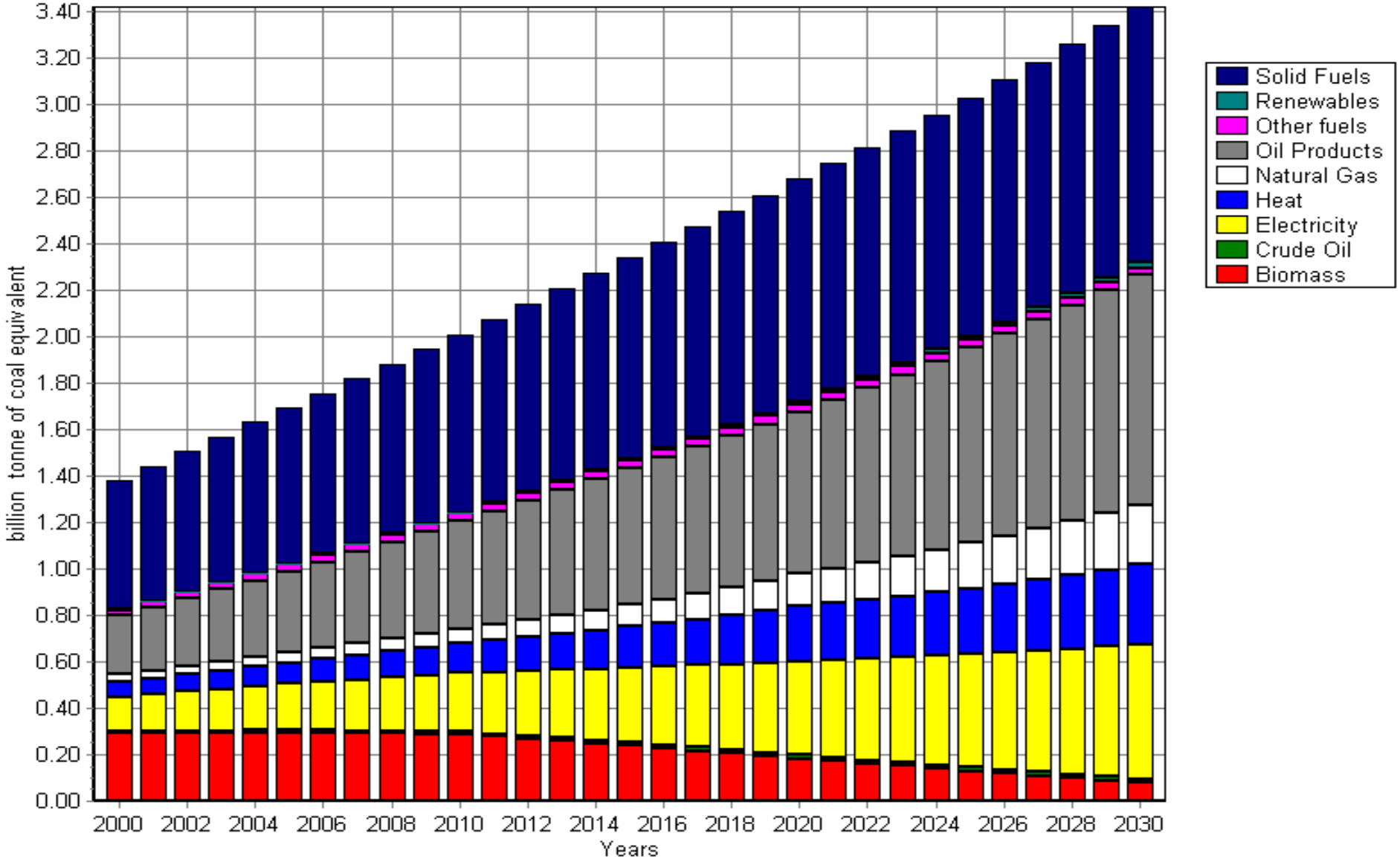
Energy demand, STA, by sector



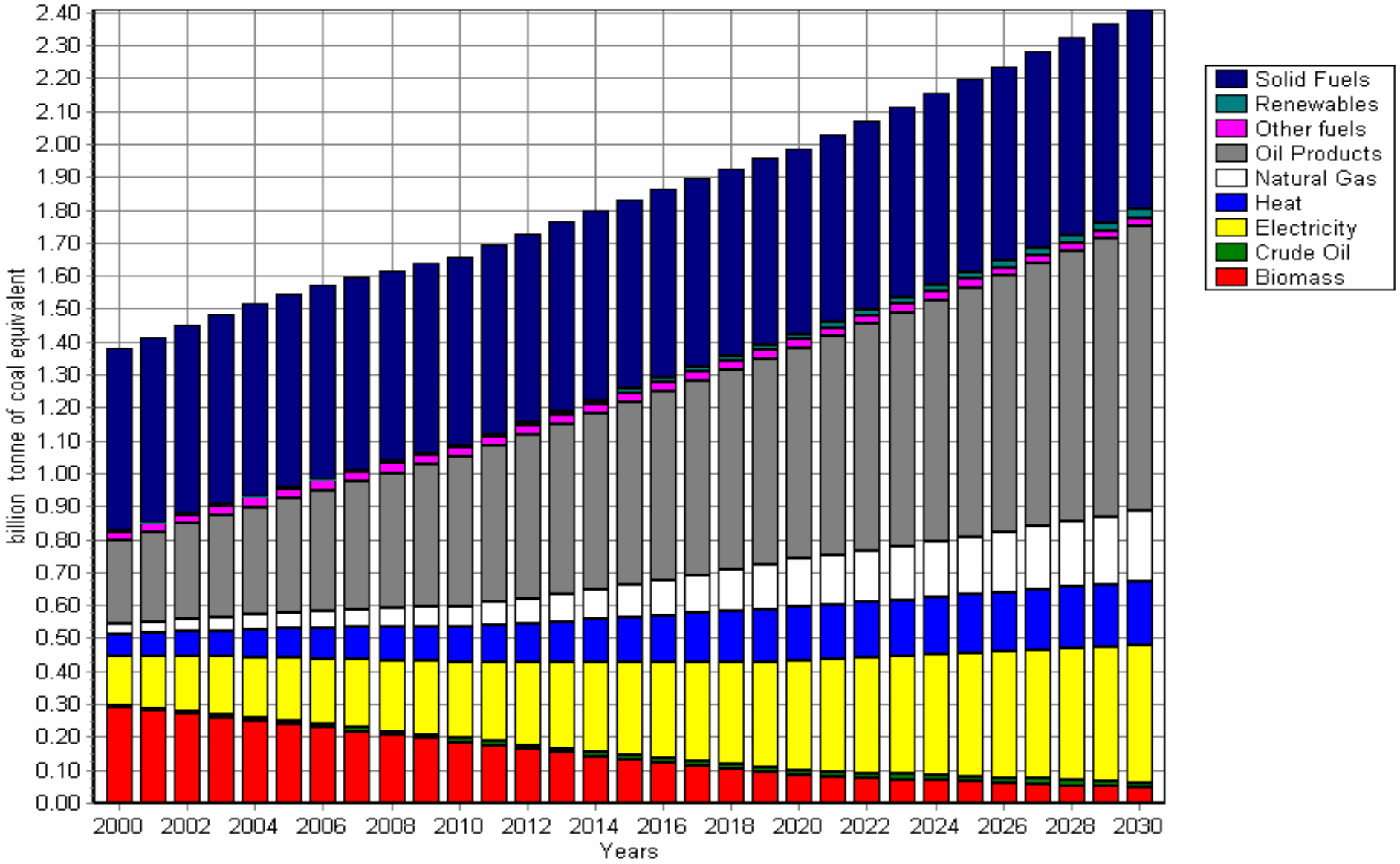
Energy demand, STA, by fuel



Energy demand, PES, by fuel



Energy demand, OPT, by fuel



Thanks!