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Co-Control of Air Pollutants and GHGs: Review, methodology and case studies

Dr. HU Tao

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生态环境部内设机构及主要职责:

（一）办公厅

（二）中央生态环境保护督察办公室

（三）综合司

（四）法规与标准司

（五）行政体制与人事司

（六）科技与财务司

（七）自然生态保护司（生物多样性保护办公室、国家生物安全管理办公室）

（八）水生态环境司

（九）海洋生态环境司

（十）大气环境司（京津冀及周边地区大气环境管理局）

（十一）应对气候变化司。

（十二）土壤生态环境司

（十三）固体废物与化学品司

（十四）核设施安全监管司

（十五）核电安全监管司

（十六）辐射源安全监管司

（十七）环境影响评价与排放管理司

（十八）生态环境监测司

（十九）生态环境执法局

（二十）国际合作司

（二十一）宣传教育司

Low Carbon Vs Low Sulphur, Low Nitrogen, Low PM

- Low carbon
  - Low carbon cities
  - Low carbon economy
  - Low carbon cities
  - CCS (carbon capture and storage) in China Resources, Tianjin Demo Project
    - Air pollution increasing
  - PV Panel production in Baoding – a low carbon demo city supported by Yingli Corp.
    - Low carbon and clean in the process of using
    - Energy intensive production process with air pollution emissions

Low Carbon Vs Low Sulphur, Low Nitrogen, Low PM

- Low air pollutants
  - FGD (flue-gas desulfurization)
  - SCR (selective catalytic removal)
    - Coal-fired power plants
    - Vehicles
  - Electrical Vehicles (EVs)
    - Lower air pollutants: Yes and No
    - Lower carbon emissions: No and Yes

Outline

1. Review of International Experiences and Lessons
2. Methodology of Co-control
3. Discussion

Review of co-benefit development

- **Stage 1 Ancillary/Secondary Benefits Period**

  (After 1997 when Kyoto Protocol singed)
  - **Awareness of Air pollution reductions, as ancillary benefits or secondary benefits of GHGs reduction**
    - **China and US reluctant**
  - **But**
    - **Two-way impacts, rather one-way**

Review of co-benefit development

- **Stage 2 Co-benefits Period (IPCC 3)**
  - **Realization of two way impact—local pollution and GHGs are mutually linked to each other and efforts are made to measure co-benefits**
    - **Both China and US accept this concept**
    - **US EPA-SEPA-Tsinghua IES cooperation**
  - **But,**
    - **Counter-benefits**
    - **Maximization of co-benefits**

Is Co-control of air pollutants and GHGs possible?

NOx PM BC Hg

SO_2

CO_2

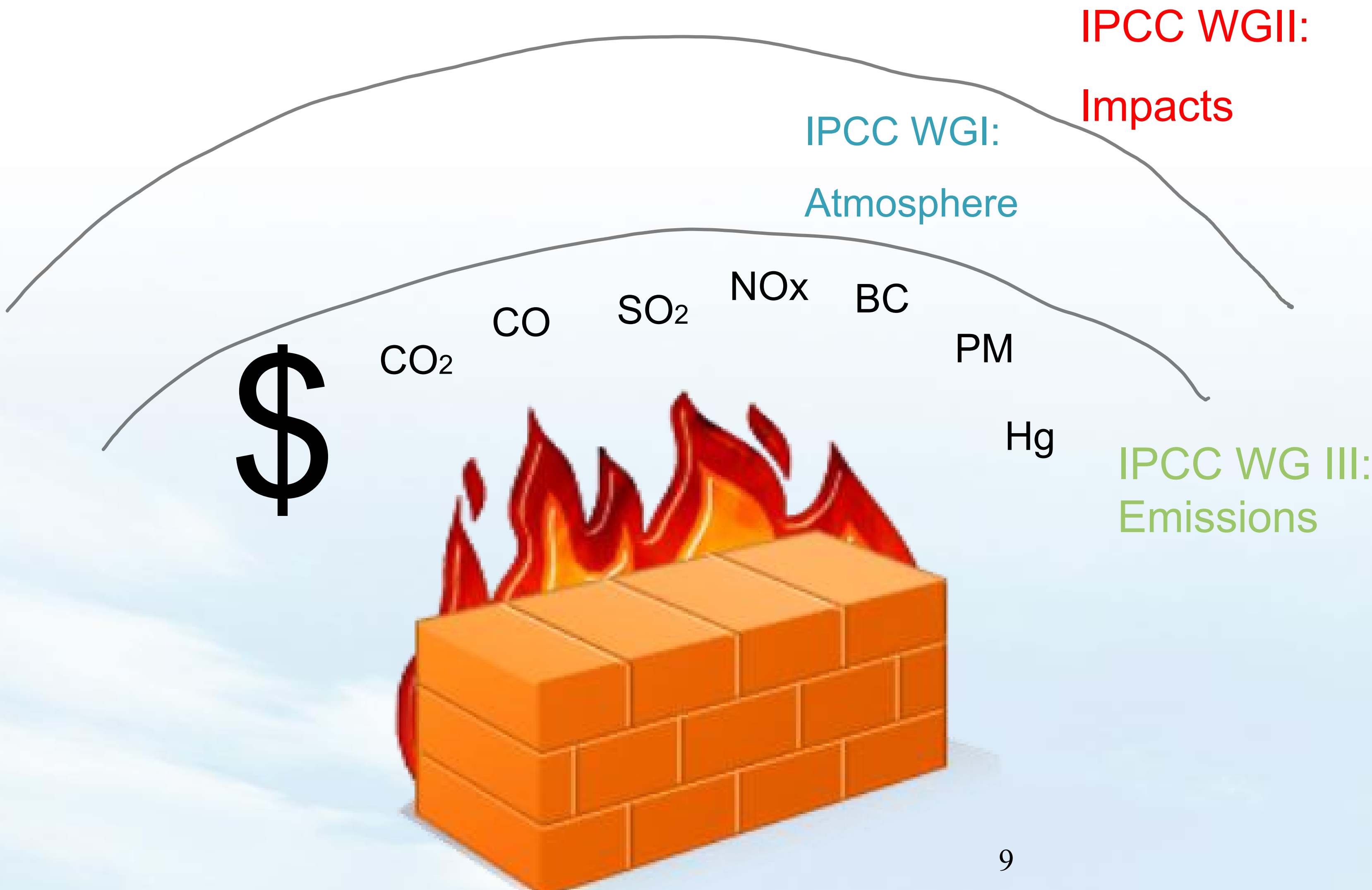
CO

One stone kills two birds!

一石二鸟、一举两得

Western Vs Oriental medicines

Theoretical question: what are the relationships among emissions?



Review of co-benefit development

- **Co-control**
  - **Recognition of co-benefits is not enough. Co-benefits should be maximized by selected and designed co-control measures**
  - **Control measure and policies for low carbon and low sulfur, low nitrogen, low PM2.5 should be combined together, to be lowed down together to gain co-benefits**

Review of co-benefit development

- **Stage 3 Co-control Period (since 2006)**
  - **Co-control measures and policies (programs/projects) are designed and proposed in order to maximize co-benefits**
    - **11th FYP set SO_2 and CO_2 targets together**
    - **12th FYP add NOx**
    - **13th FYP ambient air quality index (AQI) standards and new pollutants**
      - Pm2.5
      - VOC
      - Ground Ozone
    - **14th FYP?**

What is Co-control?

- **The control measure/policy that could maximize co-benefits**
- **Why China?**
  - **OECD:**
    - **Lower air pollutants and high carbon emissions**
  - **LDCs**
    - **Low air pollutants and low carbon emissions**
  - **China**
    - **Very high air pollution and higher and higher carbon emissions**
    - **Clause II, Air Pollution Prevention and Protection Law (New Air Act)**
    - **No guidelines to enforce the Clause II of New Air Act!**

2. Methodology of co-control

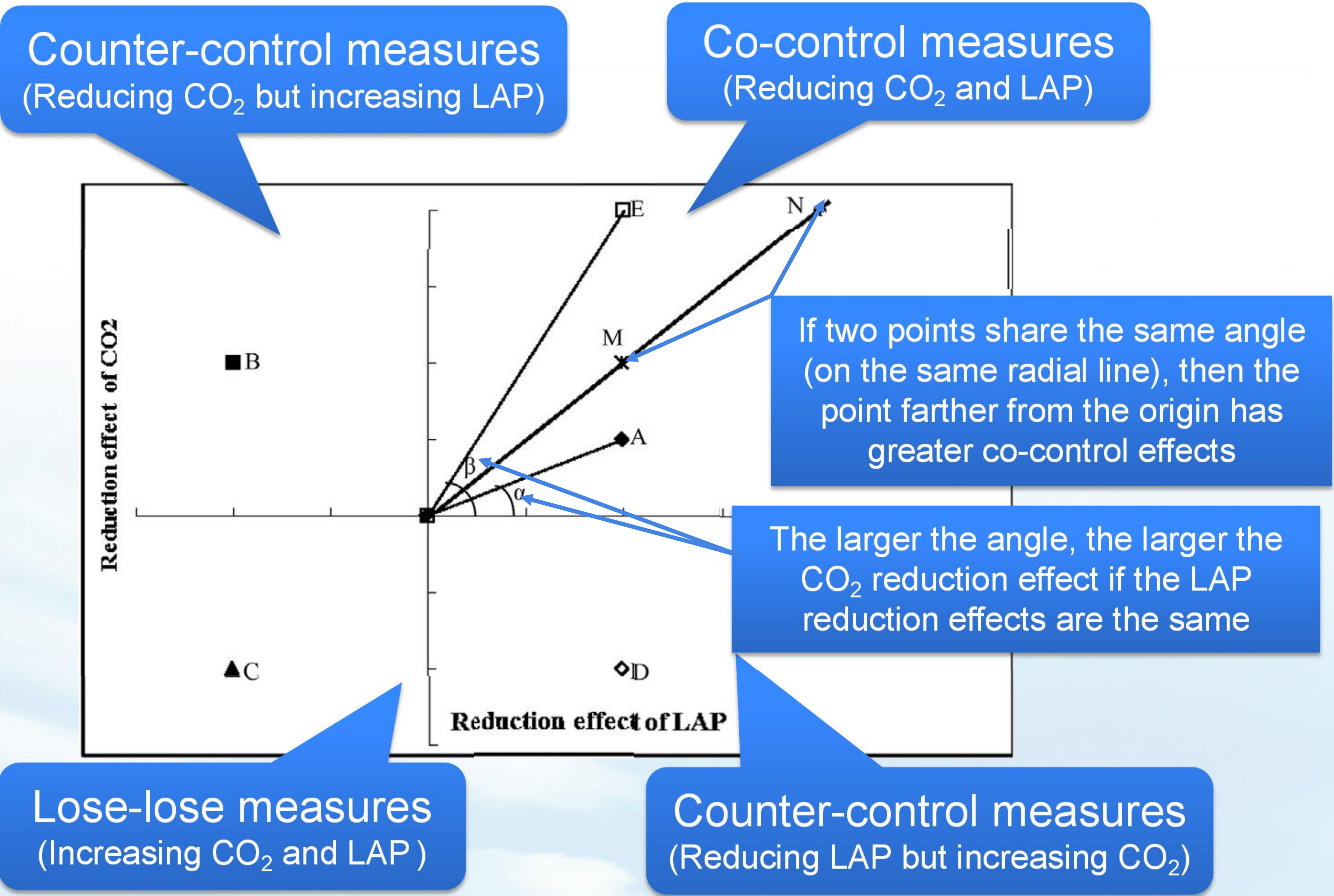
Physical co-control effects

1. Co-control measures effects coordinate system
2. Cross-elastic analysis of pollutant emission reductions
3. Pollutant Equivalence (Peq)

Economic co-control effects

4. Unit cost of pollutant reduction (UCPR)
5. Abatement cost curve
6. Cost-benefit analysis
7. Macro Energy-Economy-Environment (3E) Models
8. Micro LCA (Life-Cycle-Assessment)

☐ Co-control measures effects coordinate system



□ Cross-elastic analysis of pollutant emission reductions

$$Els_{s/c}=\frac{\Delta s/S}{\Delta c/C},\quad Els_{c/s}=\frac{\Delta c/C}{\Delta s/S}$$

$$Els_{n/c}=\frac{\Delta n/N}{\Delta c/C},\quad Els_{c/n}=\frac{\Delta c/C}{\Delta n/N}$$

$$Els_{n/s}=\frac{\Delta n/N}{\Delta s/S},\quad Els_{s/n}=\frac{\Delta s/S}{\Delta n/N}$$

- 从 交叉弹性的 正负号 判断某措施是否具有协同性（分子分母均为负值，即均增排时，属“不具协同性”）

- 对两项或两项以上措施，可以进行“协同程度”的排序：
  - 对于“减碳措施”，可考察“*ELSs/c*”
  - 对于“减污措施”，可考察“*ELSc/s*”

☐ Unit cost of pollutant reduction (UCPR)

UCPR (in Yuan/kg pollutant) measures the cost (in Yuan) needed to reduce one mass unit (kilogram, kg) of a specific pollutant.

$$\mathrm{UCPR}_{i,k} = \frac{C_i}{Q_{i,k}}$$

where the C_i is the annual cost of technology i,

$Q_{i,k}$ is the reduction effect of technology i for pollutant k.

The annualized reduction costs = investment cost + operational cost – energy saving benefit

$$C_i = ACC_i + OM_i - B_i$$

□Pollutant Equivalence (P_{eq})

We evaluated the co-control effectiveness of multi-pollutant reduction by formulating the Peq indicator to combine all of the pollutants (i.e., SO_2, NOx, $PM_{2.5}$, and CO_2) into one "integrated" pollutant.

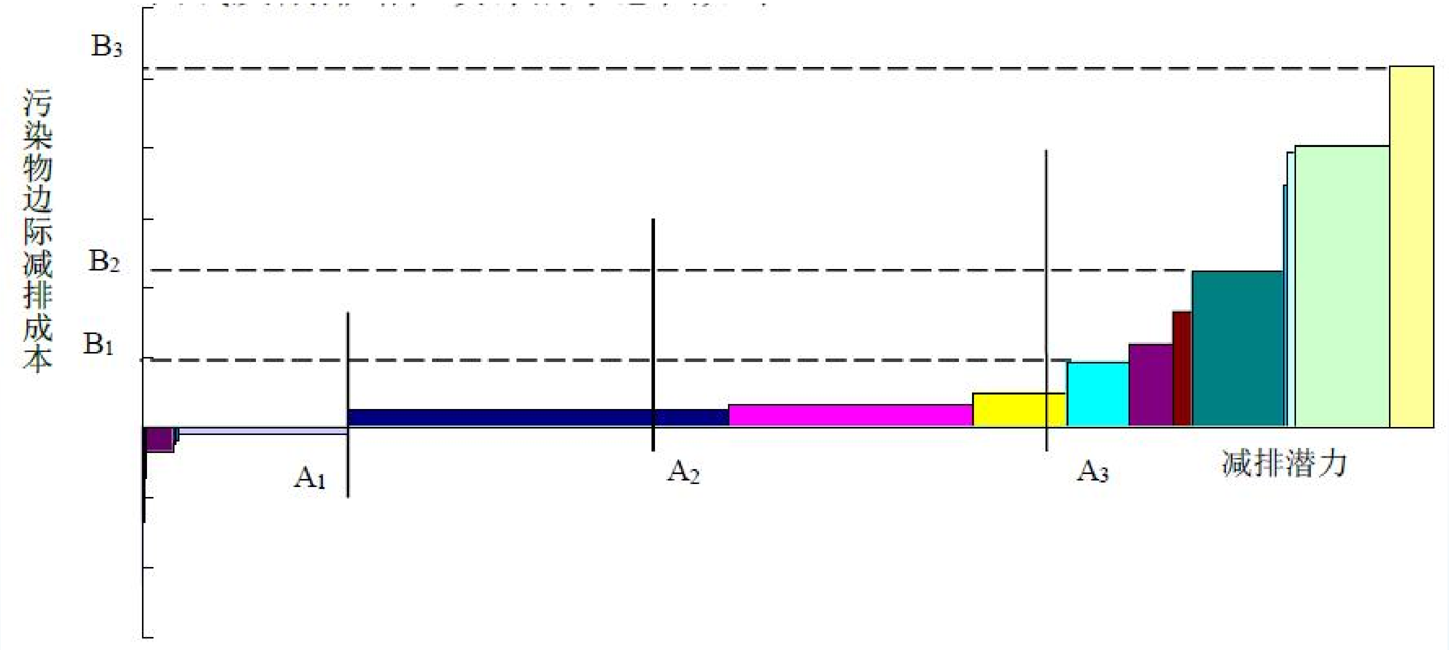
$$P_{eq} = \propto SO_2 + \beta NOx + \gamma PM_{2.5} + \delta CO_2 + \cdots$$

where $\alpha + \beta + \gamma + \delta + \ldots = 1$.

The relative weight factors α, β, γ, and δ are intended to reveal the relative importance of the pollutants in terms of the real externalities of the different pollutants, including **price, environmental standards, eco-environment and health hazards.**

三类 取值方法：价格（税、费、交易价格）、标准（排放标准）、测算的单位污染物的生态环境及健康损害值.

◻Marginal Abatement Cost Curve (MAC)



Using the abatement potential as the abscissa and the UCPR value as the ordinate, a marginal abatement cost (MAC) curve is created.

This curve shows that an incremental application of a technology or measure results in incremental pollutant reductions and consequently incremental costs.

In pollution control planning, the planner can choose the appropriate route according to the targeted total abatement quantity or total abatement cost constraint.

□Cost-benefit analysis

Cost-benefit analysis (CBA) in the current study examines the environmental-economic feasibility of the co-control plan implementation.

First, the environmental impact should be identified and later quantified via an emission-reduction calculation, air quality simulation modelling and the environmental health dose-reaction relationship.

The costs and benefits of the co-control plan are then monetized. The benefit analysis includes the global benefits of CO_2 mitigation and the human health benefits of air quality improvement.

Finally, all costs and benefits are converted to present value and aggregated, and the environmental-economic feasibility of the plan can be assessed with the indicators of net present value (NPV) and internal rate return (IRR).

◘LCA (Life-Cycle-Assessment)

life cycle assessment , LCA. Compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle.

There are four phases in an LCA study:
a) the goal and scope definition phase,
b) the inventory analysis phase,
c) the impact assessment phase, and
d) the interpretation phase.

LCA can assist in
— identifying opportunities to improve the environmental performance of products at various points in their life cycle,
— informing decision-makers in industry, government or non-government organizations ,
— the selection of relevant indicators of environmental performance, including measurement techniques, and
— marketing

Source: ISO 14040:2006 Environmental management -- Life cycle assessment -- Principles and framework

5. Discussion

- Co-Control dimension
  - measure
  - Policy
  - Institution

Thanks!