USAID
FROM THE AMERICAN PEOPLE

Cost-Benefit Analysis of Global Climate Change Mitigation

Welcome Remarks

Jay Knott, Esq.
Executive Vice President
Abt Associates

March 4, 2013

The Importance of AILEG to USAID and Abt

- Abt Associates is honored to be supporting USAID in this exciting course on the application of Cost-Benefit Analysis (CBA) to climate change mitigation

- The AILEG project is a global opportunity to build capacity in USAID countries on an area of critical importance – how to help countries transition to low emission development strategies to meet climate change challenges while also achieving their development goals

- As a leader in environmental and economic analytics for over 40 years, Abt Associates is privileged to continue assisting people throughout the world to improve the quality of life and economic well-being as well as environmental stewardship through this training

USAID
FROM THE AMERICAN PEOPLE

Cost-Benefit Analysis of Global Climate Change Mitigation

Overview of CBA & Mitigation Economics Training

Marcia Gowen Trump, Ph.D.

Abt Associates

March 4, 2013

AILEG Analysis and Investment for Low-Emission Growth

WELCOME: 4-DAY Agenda

Day 1
- Introducing CBA/CEA basics for evaluating mitigation options

Day 2
- Including ecosystem and health co-benefits into CBA/CEA

Day 3
- Comparing mitigation options with Marginal Abatement Cost Curves

Day 4
- Selecting options using decision criteria and scenario analysis

Training Team

Moderators:

- Eric Hyman, Juan Belt, Bill Ward (USAID)

Presenters:

- Tulika Narayan (Abt/IEG), Brian Murray (Duke University), Bill Ward (USAID/Clemson), Elena Besedin (Abt/ERD), Anna Belova (Abt/ERD), Michael Westphal (Abt/IEG)

Break-out sessions/logistics:

- Lindsay Kohlhoff, Dianna Gillespie (Abt/IEG)

Facilitators:

- Dana Kenney, Marcy Trump (Abt/IEG)
- Group leaders

Logistics


MEN
WOMEN


Help


2 ABC
3 DEF
4 GHI
5 JKL
6 MNO
7 PQRS
8 TUV
9 WXYZ
0 +
#


HOTEL

Session Outline

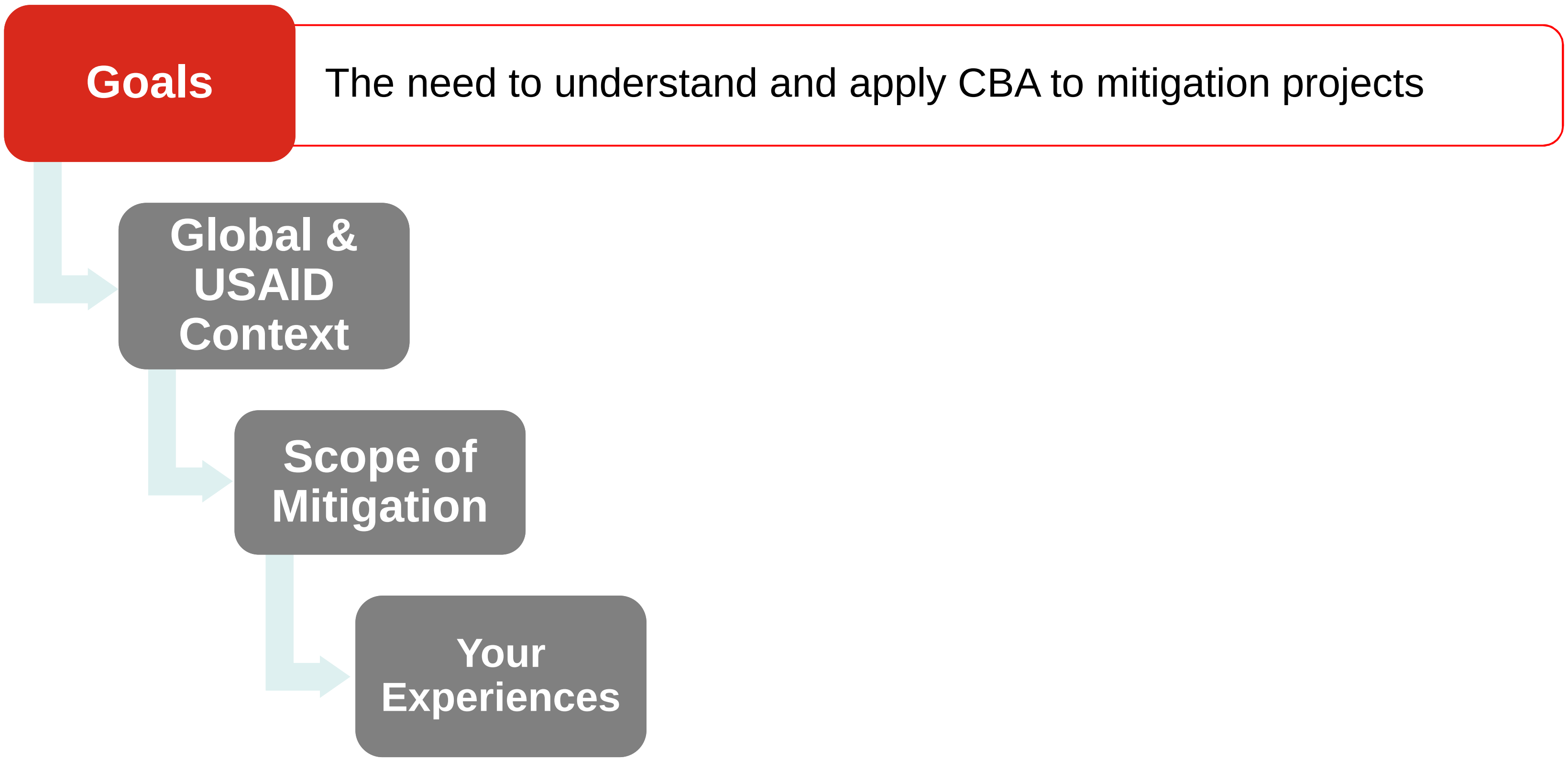
- **Goals**: The need to understand and apply CBA to mitigation projects
- **Global & USAID Context**: Agreements and initiatives on climate change and mitigation
- **Scope of Mitigation**: Types of mitigation projects and how they reduce emissions or enhance sink absorption
- **Your Experiences**: USAID and your mitigation projects and plans

Learning Objectives

Upon completion, you will be able to:

1. Integrate assessments of climate change mitigation projects into development
2. Evaluate rigor/credibility of economic assessments of mitigation projects using best practices
3. Guidance on how to select and prioritize mitigation project & program funding

Goals


Goals
The need to understand and apply CBA to mitigation projects
Global & USAID Context
Scope of Mitigation
Your Experiences

Goals

- Focus on the project level decisions: how to choose the "best" set of project activities for USAID/country funding
- "Bottom-up" economic analytical skills and applications
- Not discussing "macro-economic" level impacts (growth, sustainability, gender, equity per se)

Integrating Mitigation Economics

Purpose of knowing these methods

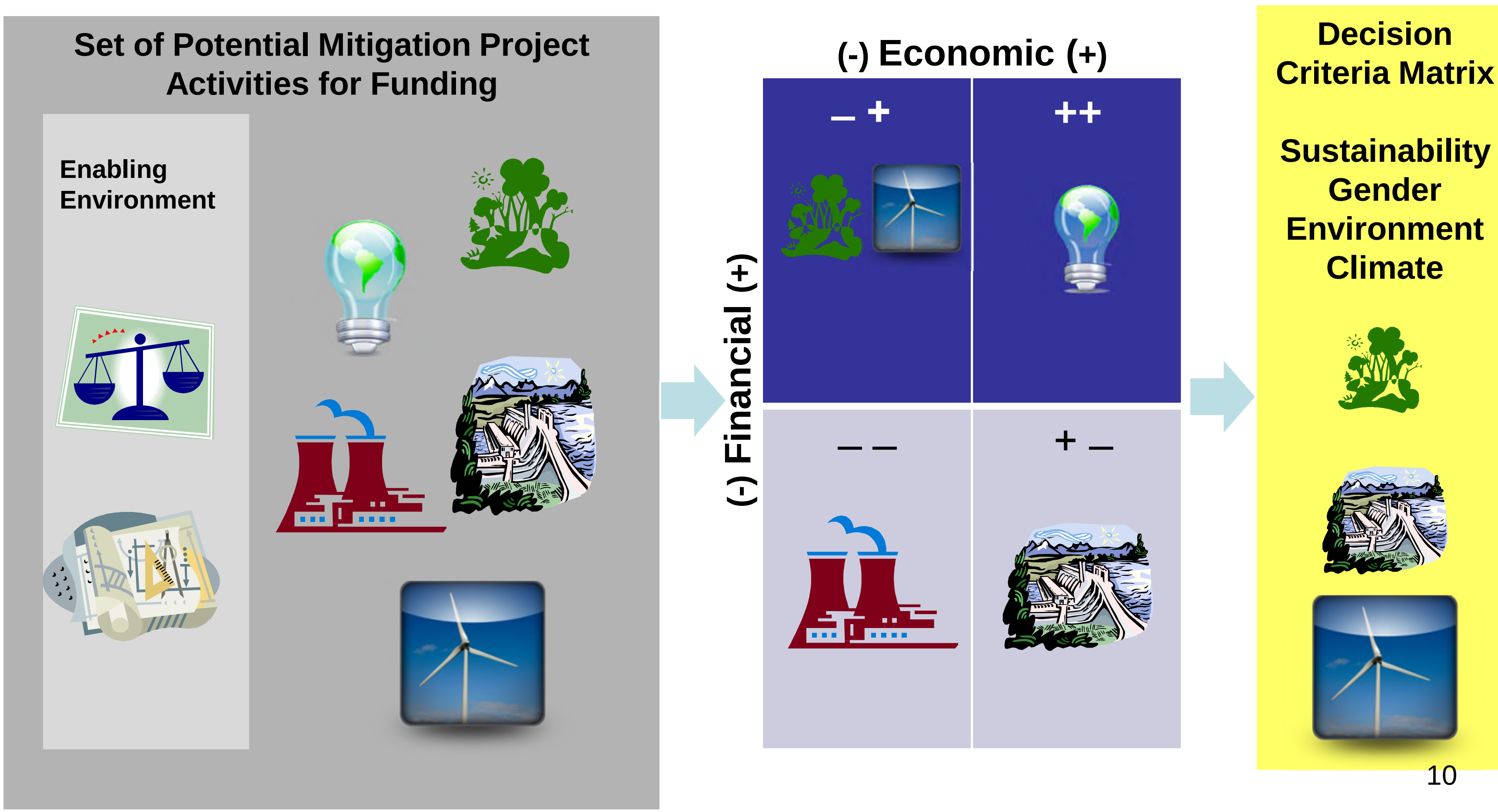
- Standardized framework to compare similar assets
- Understand best practices
- Select priority development options
- Apply practical proven methods in the field
- Integrate

Taking them to the Field: Participant discussion

- Successes?
- Barriers?
- Needs?

Decision Process for selecting Mitigation Projects

PROBLEM: How to Allocate Mitigation Funding?



Global and USAID Context

Goals

Global & USAID Context

Agreements and initiatives on climate change and mitigation

Scope of Mitigation

Your Experiences

QUIZ: True/False?

A. Climate change impacts may affect severe weather events, temperatures, precipitation, and sea level rise

QUIZ: Climate change impacts may result in severe weather events…

A. TRUE

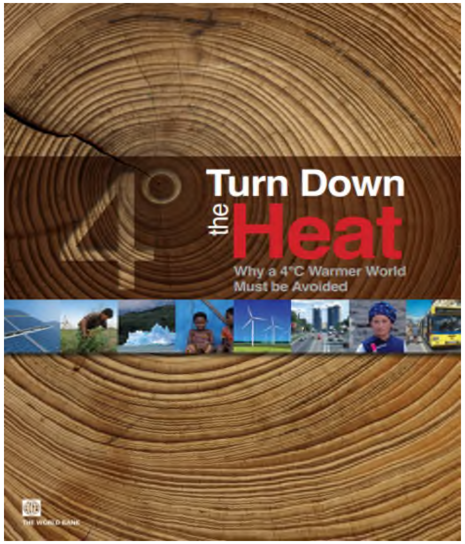
IPCC General Circulation Models (GCMs) predict:

- More severe events: floods, droughts, hurricanes
- Temperature variability in terms of highs & lows – possible 4 degrees Celsius w/in century
- Rainfall variations more intense with flooding and/or droughts
- Sea level rises

World Bank Study for UNFCCC COP

Turn Down the Heat

- Potential for 4°C warming within century
- Mitigation necessary to reduce emissions and increase sink absorption
- Mitigation plans needed by countries to access climate change funding



World Bank (November 2012)

USG/USAID Climate Change History

1994 – USAID drafts climate change strategy

1997 – Pres. Clinton announces $1 billion in climate change for 5 years

2000-09 – GCC earmarks & directives ($150-200M/year)

2009 – Global Fast-Start Initiative: $30 billion by 2015

Global Climate Change Initiative ($305-346M/year)

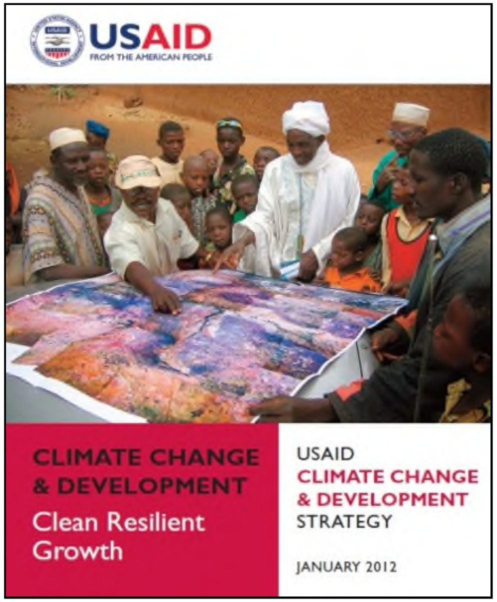
"…the threat from climate change is serious, it is urgent, and it is growing. Our generation's response to this challenge will be judged by history, for if we fail to meet it—boldly, swiftly, and together—we risk consigning future generations to an irreversible catastrophe."

– President Obama, United Nations Summit on Climate Change
September 22, 2009

USG/USAID Climate Change Initiatives

Jan 2012 – CC Strategy

- Mitigation
  - Clean Energy
  - Sustainable Landscapes
- Adaptation
- Integrated Development
  - Low Emission Development Strategies



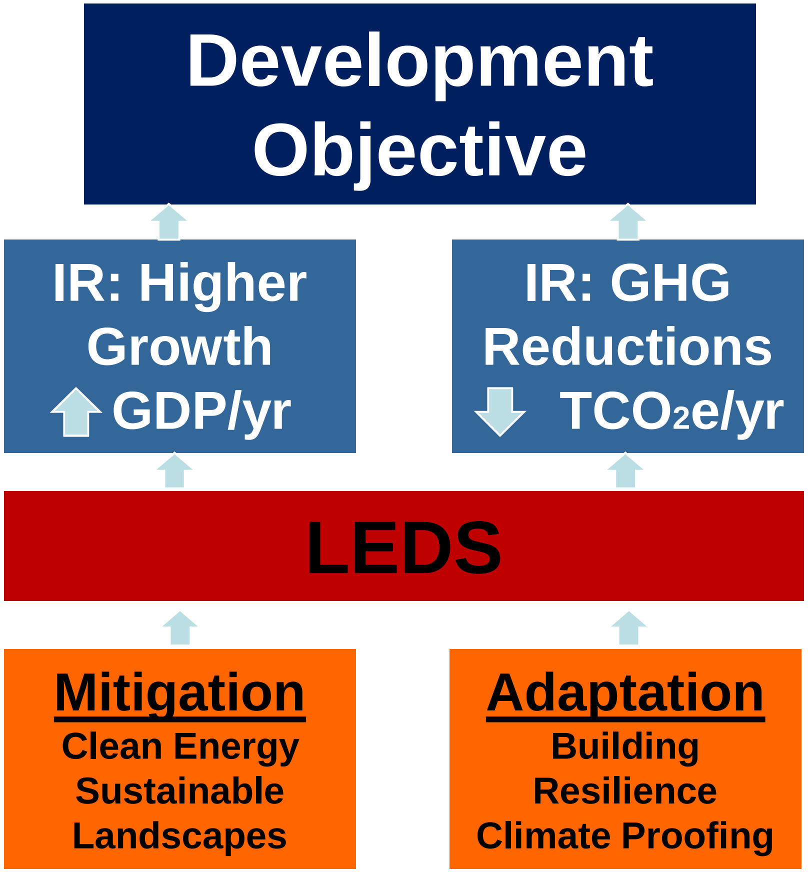
March 2012 – USG/USAID Consolidated GCC Guidance

All operating units must file GCC Implementing Mechanisms Narratives for USG Fast Start Financing and Congressional Clean Energy reports

Low Emission Development Strategies

LEDS is an umbrella climate change initiative with strategic country partners

- ***Definition:*** A transition to lower GHG emissions trajectory while meeting development goals



Mitigation Economics Assessment in USAID PAD

Mandatory

Optional

Scope of Mitigation Projects for CBA

Goals

Global & USAID Context

Scope of Mitigation

Types of mitigation projects and how they reduce emissions or enhance sink absorption

Your Experiences

Key Mitigation Measures

Energy Efficiency

Very high levels of insulation of buildings, lighting, heating, cooling, industrial processes, road vehicles, shipping and airplanes.

Renewable Energy

Helps achieve efficiency goals and eliminate CO_2 in end-use sectors. Requires that electricity production has close to zero emissions of CO_2 (renewables and CCS).

Sustainable Landscapes

Enhances or maintains the CO_2 sinks in terms of avoided deforestation, reforestation, and other land-use changes (REDD, REDD+).

Quiz: Mitigation

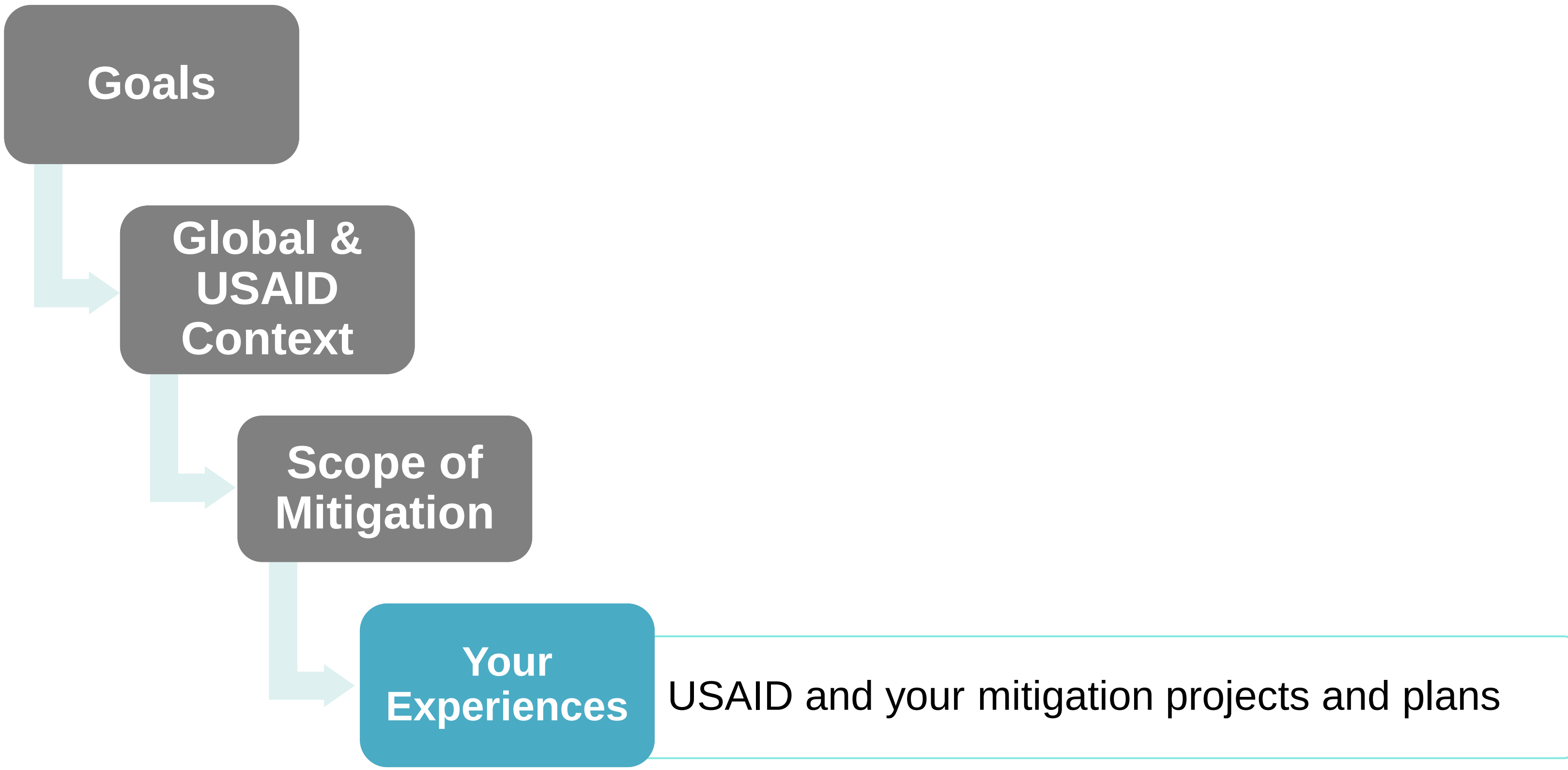
A. Mitigation economics includes just calculating cost/benefits of these projects

Quiz: Mitigation economics includes just calculating the cost/benefits of these projects

A. FALSE

- Conducting economic assessments of mitigation projects means estimating costs/benefits PLUS amount of GHG emissions affected over time from the project vs. the business as usual (BAU) option
- GHG emission impacts are estimated using IPCC mandated metrics of carbon dioxide equivalents (CO_2e)

Clean Energy and Sustainable Landscapes Projects



USAID Clean Energy Projects

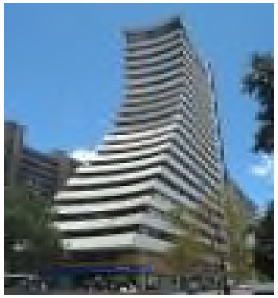
Renewable Energy

Wind Energy Farms: Development of wind farms in Baja, Mexico (Mexico Competitiveness Project, USAID).

Solar: Brazilian youth install panels for community center.
Photo: Luis Massilon, IDER

Energy Efficiency

Efficient Buildings: Efficient lighting & energy use in commercial and residential buildings in Colombia.



Efficient Transport: Promoting rapid mass transit in Jakarta, Indonesia.
Photo: USAID

USAID Sustainable Landscapes Projects

Sustainable Landscapes

REDD: Deforestation in Aceh, Indonesia for palm oil plantations.
Photo: USAID

REDD+ in Mexico for forest conservation (USAID).
Photo: Abt Associates

Mitigation/Adaptation
Testing SRI in Mali (IICEM, USAID)
Photo: Abt Associates

Environmental valuation of the Paramo ecosystem in Colombia (AILEG, USAID).
Photo: Abt Associates

Habitat & forest management
Democratic Republic of Congo (USAID).
Photo: WCS

Participants' Mitigation Projects

What mitigation projects are you involved in planning or managing?

Compile a list of your mitigation projects

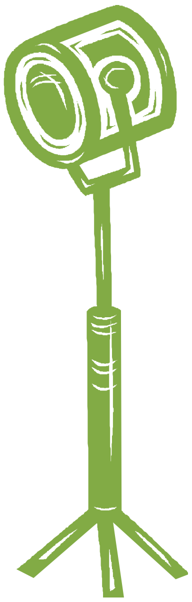
Group Break-out to discuss Mitigation Projects

Introductions:

- USAID background (positions, years with USAID)

Relevant Projects and Interests

- Interest in mitigation economics
- Involvement in mitigation project
- What do you want from course?
- Interest/Project Bulletin Board



References

- USAID Climate Change Strategy: January 2012
- USAID Climate Change Strategy: ppt April 2012
- USAID and U.S. State Department. Consolidated GCC Guidance for FY12. March 2012.
- USAID. Cost-Benefit Analysis: Guidelines for USAID. Washington, D.D. 2012.

Resources (1)

Climate Change

- World Bank. 2012. Turn Down The Heat. Washington, D.C.
- USAID. Climate Change & Development: Climate Resilient Growth. January 2012.

Low Emission Development Strategies

- UNDP: Preparing Low-Emission Climate-Resilient Development Strategies tinyurl.com/b54wcpq
- OpenEI Low Emission Development Strategies Gateway tinyurl.com/av6sjj2

Resources (2)

CBA & CEA

- Belli, Pedro et al. 1998. Handbook on Economic Analysis of Investment Operations. Washington, DC: World Bank
- Campbell, Harry and Richard Brown. 2003. Benefit-Cost Analysis: Financial and Economic Appraisal Using Spreadsheets. Cambridge: Cambridge University Press.
- Gittinger, J. Price. 1982. Economic Analysis of Agricultural Projects. Baltimore: Johns Hopkins University Press.
- Jenkins, Glenn, Chun-Yan Kuo, and Arnold Harberger. 2011. Cost-Benefit Analysis for Investment Decisions.
- MCC. 2009. Guidelines for Economic and Beneficiary Analysis. Washington, DC: Millennium Challenge Corporation.

Cost-Benefit Analysis of
Global Climate Change Mitigation

Cost Benefit Analysis for Renewable Energy Projects

Tulika Narayan, Ph.D.
Abt Associates, Inc.

March 4, 2013

Session Outline

Role of CBA — The role of Cost-Benefit Analysis in choosing mitigation projects

Financial CBA — CBA using the private perspective with market prices

Economic CBA — CBA using society's perspective with full opportunity costs

Cost-Effectiveness Analysis — The role of CEA in choosing mitigation projects when benefits are difficult to measure

Session Objectives

- For Non-Economists:
  - Provide foundation to understand cost-benefit and cost-effectiveness analyses and its application to climate change mitigation projects, to develop scopes of work—and explain the results to management
- For Economists (in addition):
  - Provide foundation for the *production* of simple cost-benefit and cost-effectiveness analyses for climate change mitigation projects

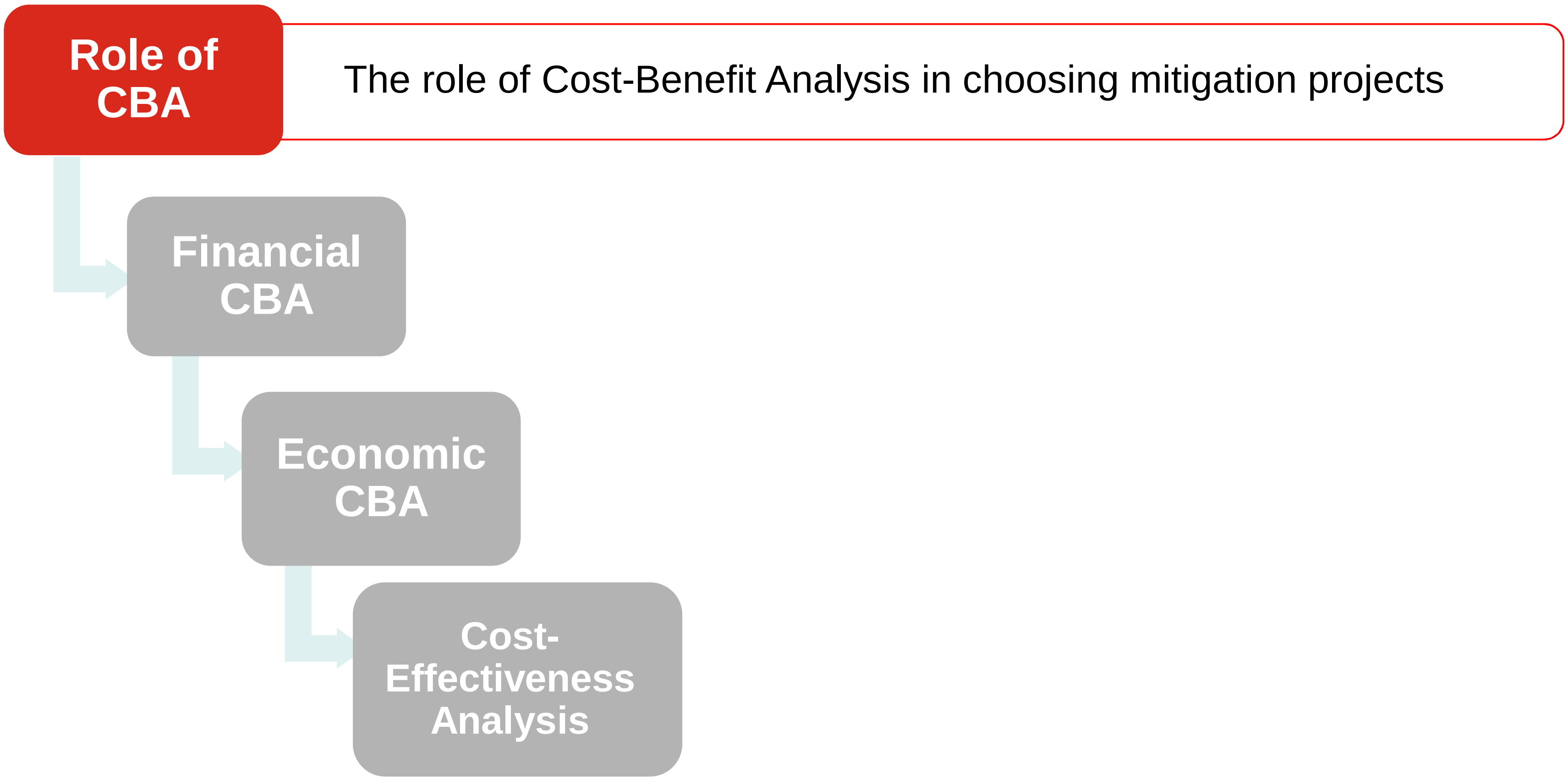
CBA for Climate Change Mitigation

How do we use Cost-Benefit Analysis (CBA) and Cost Effectiveness Analysis (CEA) to choose among alternative mitigation projects to enhance development and the environment?

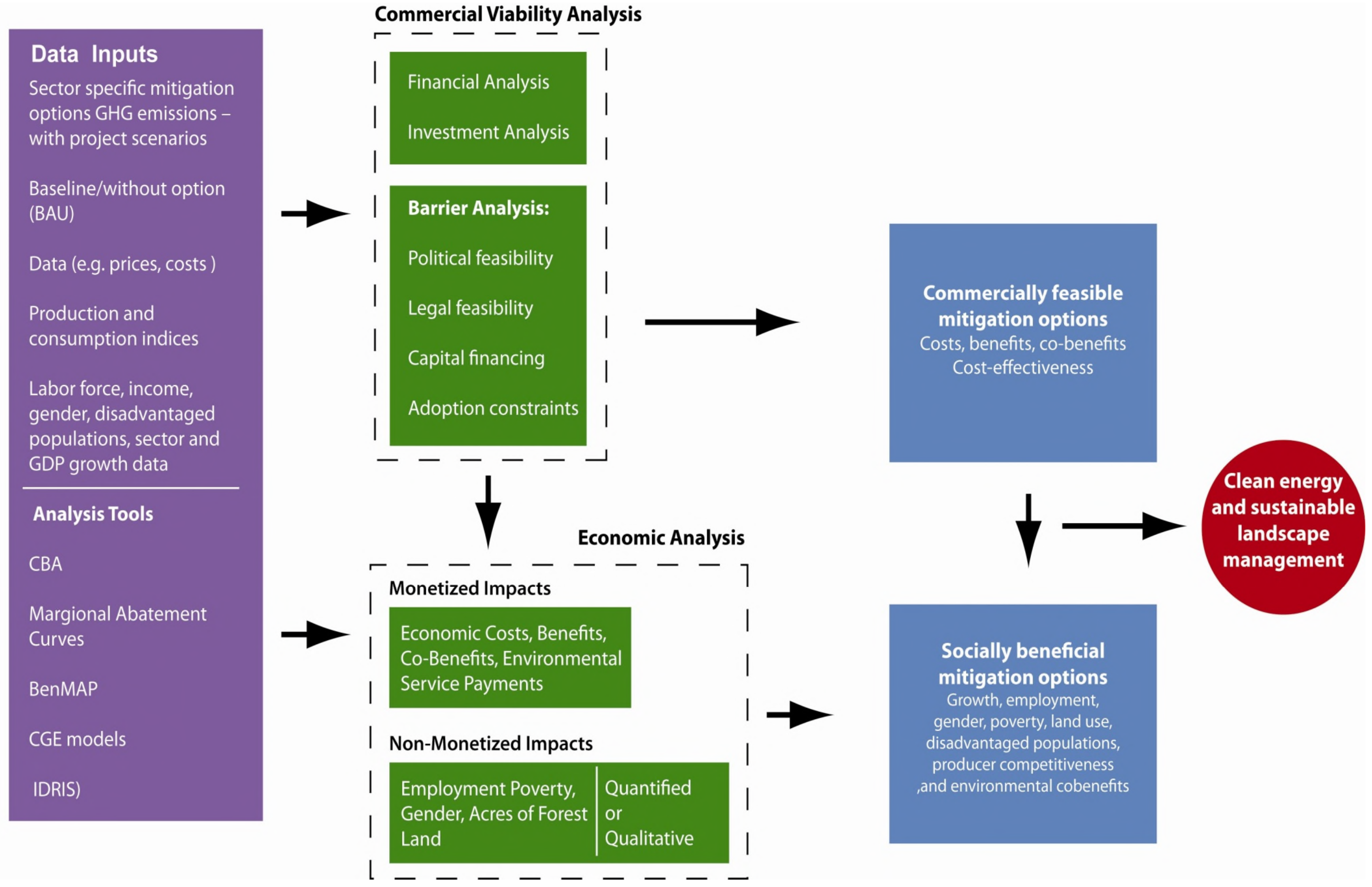
CBA vs. CEA for Analyzing Mitigation Options

- **Cost-Benefit Analysis (CBA)**
  - A comparison of net benefits, that includes monetized value of emissions reduction (or outcome) of mitigation options to the Business-as-Usual (BAU) baseline or without project option
- **Cost-Effectiveness Analysis (CEA)**
  - A comparison of the net discounted annual costs of a mitigation option with BAU, *per unit of reduction in GHG emissions (or per unit of outcome)*

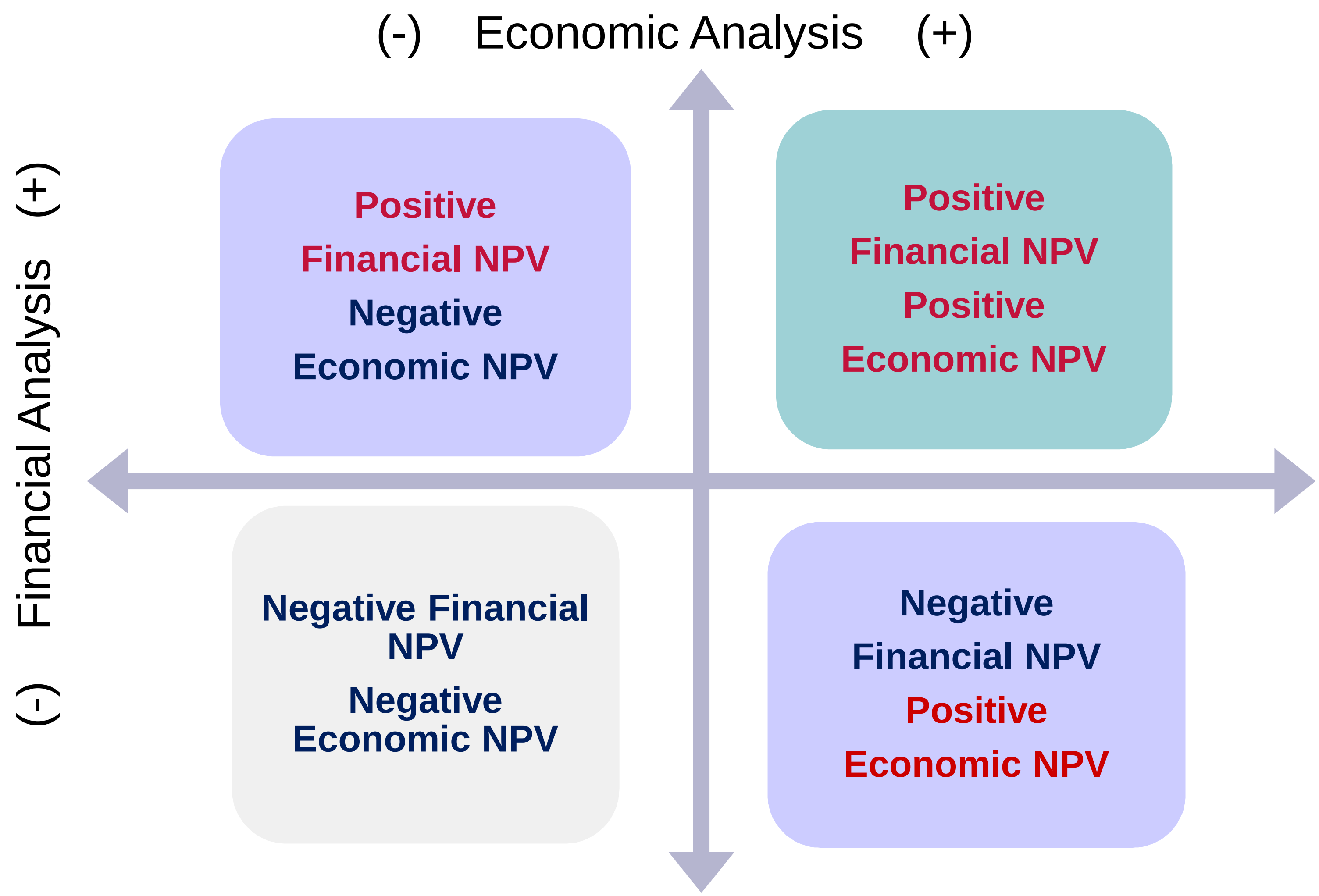
Role of CBA


Role of CBA
The role of Cost-Benefit Analysis in choosing mitigation projects
Financial CBA
Economic CBA
Cost-Effectiveness Analysis

CBA Role in Choosing Mitigation Projects



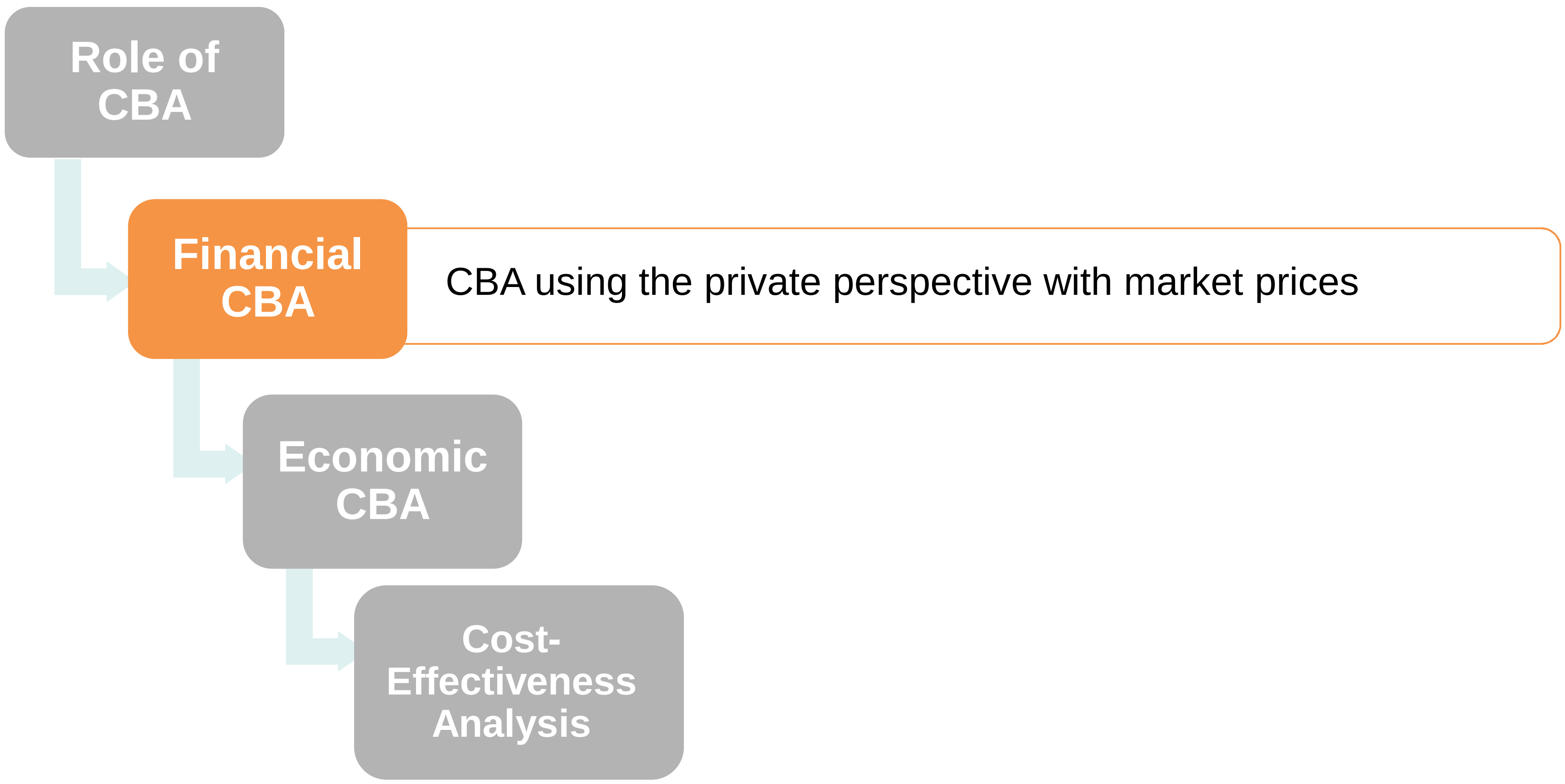
Selecting the "Best" Clean Energy Projects



CBA: Financial vs. Economic Approaches

Financial Analysis	Economic Analysis
• Conducted from perspective of investor • Uses market prices for all benefits and costs • Transfers included (e.g. taxes and subsidies) • Externalities excluded	• Uses social opportunity values of all benefits and costs • Conducted from perspective of social planner • Transfers excluded • Externalities/co-benefits included (if quantifiable)

Financial Analysis



Financial CBA

- Costs – financial outflows (capital plus operating costs) resulting from the project.
- Benefits – financial inflows (revenues, subsidies etc.) resulting from the project

Net Present Value

- Sum of projected annual financial benefits (revenues) minus financial costs, discounted to the present to reflect the **time value of money**: all prices are the values observed in the marketplace

- Net Present Value

$$NPV = \sum_{i=1}^{t} \frac{B_i - C_i}{(1+r)^i}$$

where

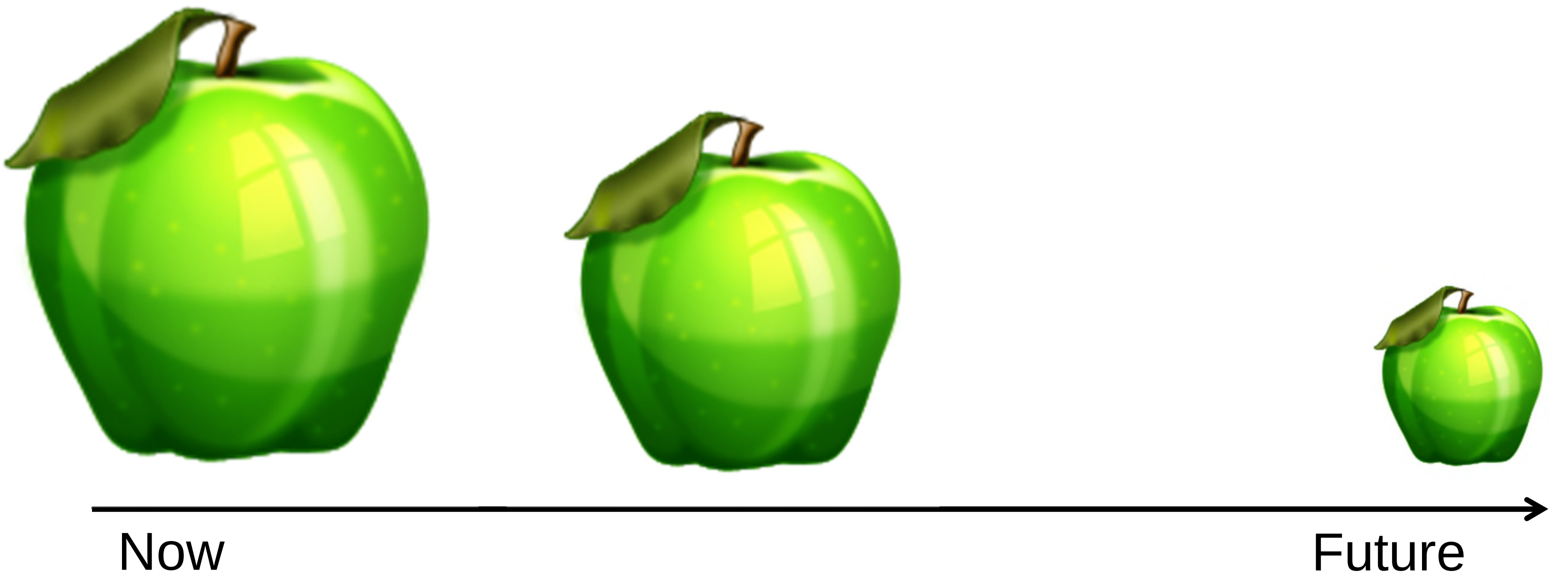
B_i is the financial inflow in year *i*

C_i is the financial outflow in year *i*

r is the discount rate

t is the time period of analysis

Why Do We Consider The Time Value Of Money (the Discount Rate "r")?



Time value of money is the single most important factor in financial analysis

Example 1: Time Value of Money (the role of "r")

- Would you want $400 now or 5 years later?
- Why?
  - Inflation.
  - Return on $100.
  - What else?

Let's see how it works:

Discount Rate - r

- In financial analysis the discount rate used is the opportunity cost of capital that the private investor faces.
- In economic analysis, the social discount rate is used, one that reflects society's relative valuation on today's well-being versus well-being in the future.
- However, it is important to compare apples to apples.
- Can it vary for developing and developed countries? Why?

Example 2: Importance of "r" in Wind Projects

- Wind power systems are characterized by high initial capital, low operating costs and returns in the future
- Lets go back to our example:

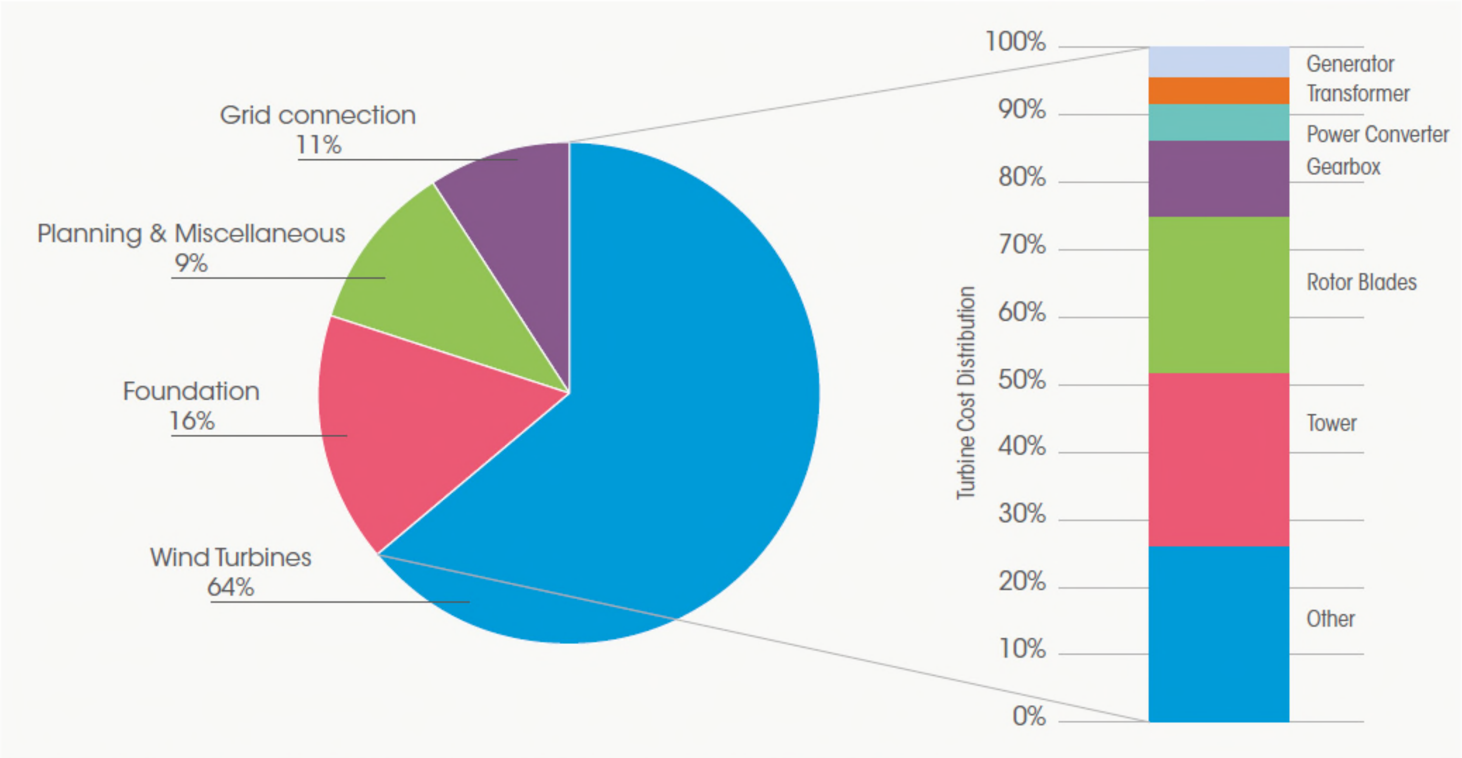


FIGURE 4.1: CAPITAL COST BREAKDOWN FOR A TYPICAL ONSHORE WIND POWER SYSTEM AND TURBINE

Source: Blanco, 2009.

How Does CBA Consider Inflation?

- Usually, all costs and benefits in **real** terms (inflation-adjusted or **constant values**)
- Use real prices and not nominal prices
- Same net results if all costs and benefits in **nominal** terms (not inflation-adjusted or **current values**). However, more meaningful to pin it to constant dollar.

How Does CBA Treat Capital, Depreciation and Taxes?

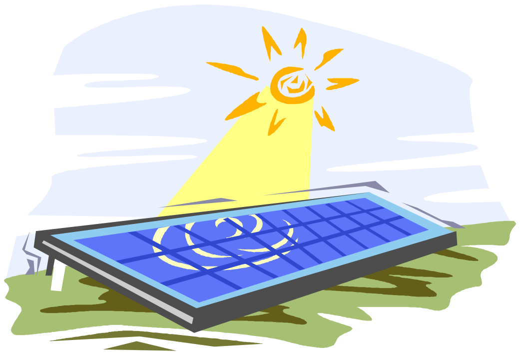
Quiz:

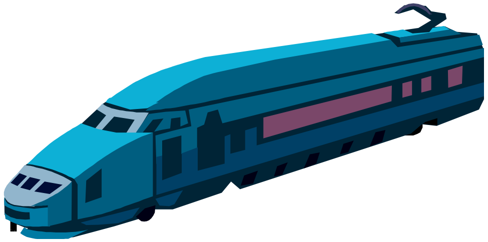
How should **capital** be accounted for in financial CBA?

a) Not included, as fixed costs do not matter

b) Accounted for as depreciation expense of the project

c) Accounted for as costs are incurred, with residual value added in the end.



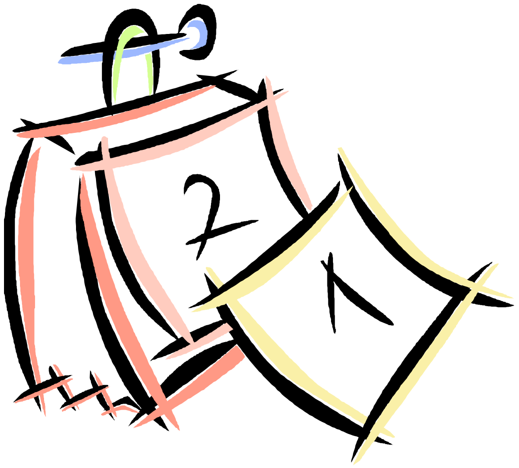


Treatment of Capital Costs

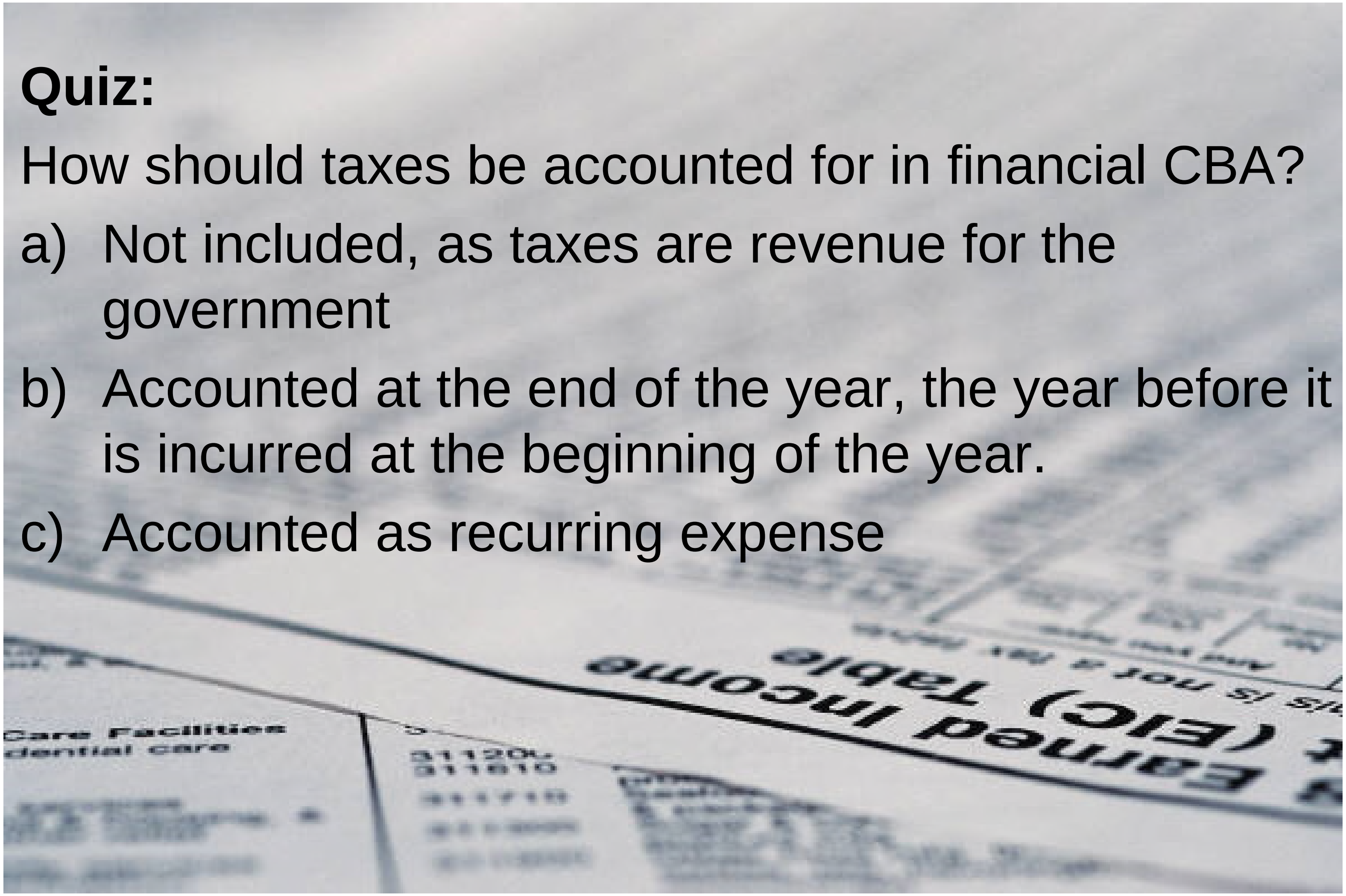
- Expected life of main asset, could be 5-50 years
- Not USAID project life since investments have longer impact

Time Period Of Analysis

- For a single project, the useful life of the most important asset
- When comparing projects use the same time period of analysis (20 years)



Treatment of Capital, Depreciation And Taxes



Quiz:

How should taxes be accounted for in financial CBA?

a) Not included, as taxes are revenue for the government

b) Accounted at the end of the year, the year before it is incurred at the beginning of the year.

c) Accounted as recurring expense

Applying Financial Analysis To Wind Project

Let's put all this together in an example:

Selection of Projects Using CBA

- **Net Present Value (NPV)** is the sum of the discounted annual benefits (revenues) minus discounted annual costs of a mitigation option over a given time period (t)
- **Benefit-Cost Ratio (B/C)** the sum of discounted annual benefits divided by the sum of discounted annual costs for a mitigation option
- **Internal Rate of Return (IRR)** the discount rate at which NPV from financial analysis is zero. It is an estimate of a project's financial rate of return.
- **Economic Rate of Return (ERR)** the rate of return at which NPV from economic analysis is zero. It is an estimate of a project's economic rate of return.

Selection of Mitigation Projects

Select project if:

- NPV>0
- IRR> discount rate (r)
- If BC ratio > 1

For a single activity, use of these methods will yield the same result.

When comparing activities, this will not necessarily be the case.

Let's see how: ▶

Financial vs. Economic CBA

Quiz: Can we rely on financial analysis for choosing mitigation projects?

Key benefit of mitigation projects is reduction in GHGs or the enhancement of GHG sinks — likely not realized in financial cash flows. Secondary benefits also often high with mitigation projects.

Economic Analysis

Role of CBA

Financial CBA

Economic CBA

CBA using society's perspective with full opportunity costs

Cost-Effectiveness Analysis

The role of CEA in choosing mitigation projects when benefits difficult to measure

Economic Analysis of Clean Energy Projects

What are the non-carbon social benefits important when estimating & selecting mitigation projects?

- Health impacts
- Environmental impacts

→ Externalities/Co-benefits/Costs

- Equity impacts
- Gender impacts

→ Distributional justice

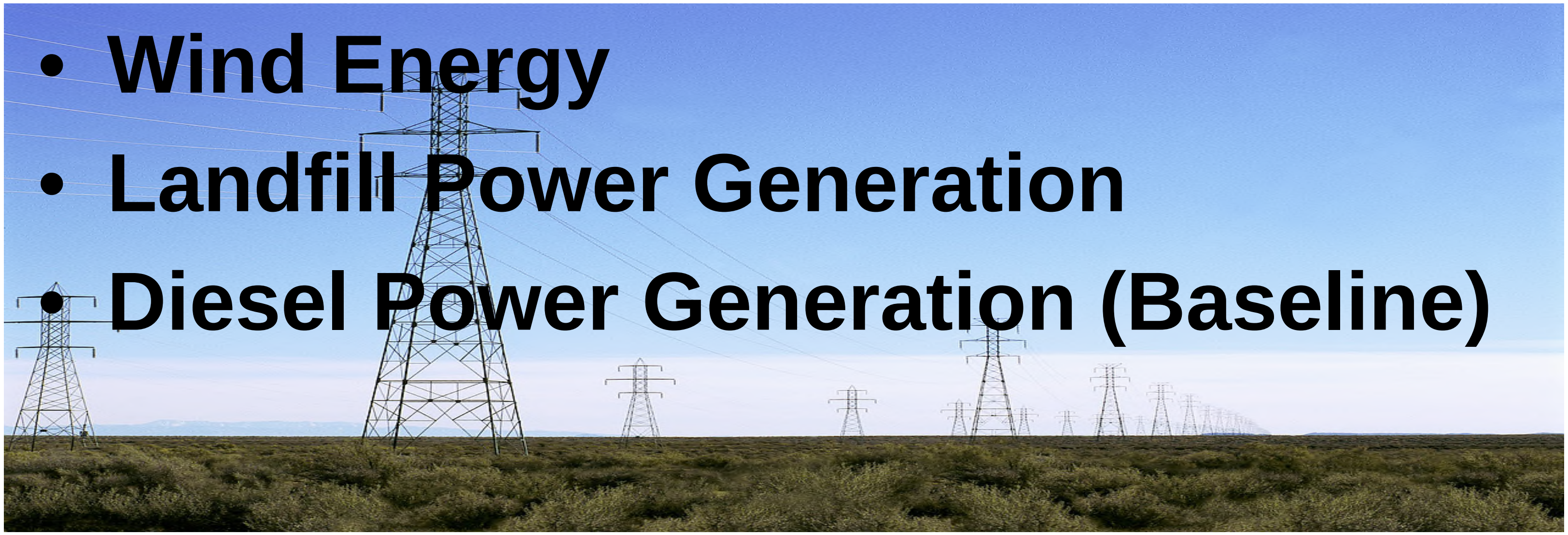
- Poverty impacts
- Growth

Going from Financial Analysis to Economic Analysis

- Step 1: remove transfers (taxes, subsidies)
- Step 2: market prices of goods and services have to be replaced by economic prices
- Step 3: all positive and negative external effects have to be included, including carbon and non-carbon benefits

- Let's make these changes in our example:

Comparing Mitigation Projects



- **Wind Energy**
- **Landfill Power Generation**
- **Diesel Power Generation (Baseline)**

Let’s go back to our example:

Comparing Mitigation Projects Using Financial Analysis

r = 12 %	Wind Power	Landfill Power Generation	Diesel Generator (BAU)
NPV	$4,773,070	$1,471,229	$4,996,682
IRR	16%	24%	38%
LCOE	$0.17	$0.18	$0.29
ACER	$1	$7	
Emissions Reduction (tCO2e)	339,340	483,896	

Comparing Mitigation Projects Using Economic Analysis

r = 12 %	Wind Power	Landfill Power Generation	Diesel Generator (BAU)
NPV	$4,277,308	$7,972,647	$4,996,682
IRR	16%	43%	38%
LCOE	$0.17	$0.18	$0.29
Emissions Reduction (tCO2e)	339,340	483,896	

Cost-Effectiveness Analysis

- Role of CBA
  - Financial CBA
    - Economic CBA
      - Cost-Effectiveness Analysis: The role of CEA in choosing mitigation projects when benefits difficult to measure

A Case for Cost-Effectiveness Analysis

Definition: A comparison of the net discounted annual costs of a mitigation option with BAU, *per unit of reduction in GHG emissions (or per unit of outcome)*

$$\frac{\sum_{i=1}^{t} \frac{C_{ij} - C_{iBAU}}{(1+r)^i}}{E_{BAU} - E_j}$$

C_j – *Cost under option* j (tCO_2e)

E_j – *Emissions from option* j (tCO_2e)

Let's make our comparisons: ▶

This is the building block for MAC that provides this information for each technology, *j*, considered.

CEA Decision Criteria For Clean Energy Projects

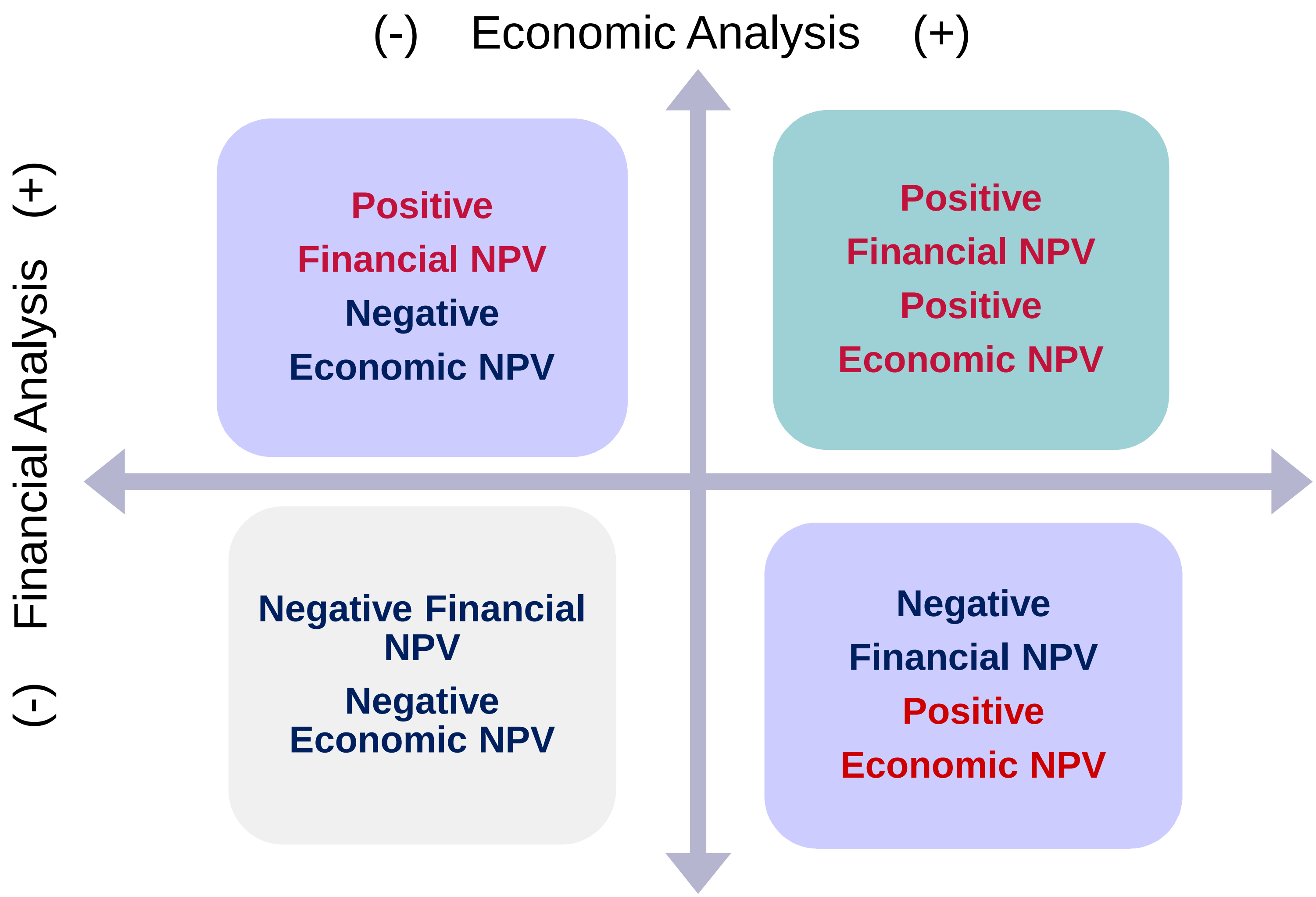
- **Levelized Cost of Energy (LCOE)**
  - The price at which electricity must be generated from a specific source to break even over the lifetime of the project.
- **How to measure it?**
  - Simple: cost of generation per unit of electricity ($/kwh)

Let’s revisit our example: ▶

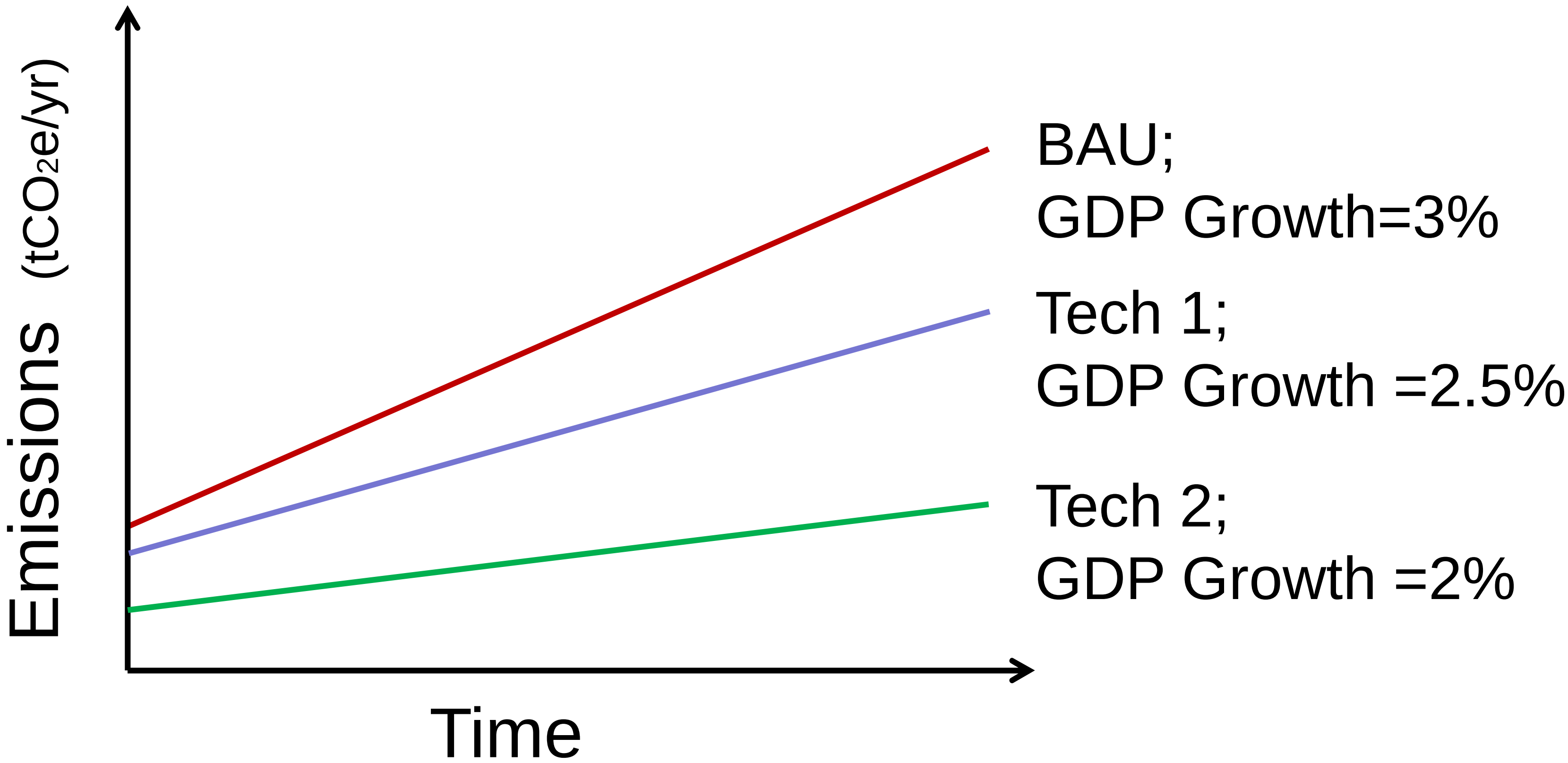
Levelized Cost of Energy

Levelized Cost of Energy Calculation		Wind	LandFill	Diesel
(a) Capital Cost/Installed Capacity ($/kw)		$1,980	$1,400	$371
(b) Annualized Capital Cost($/kw/year)	*(Capital Recovery Factor*Capital Cost)*	*$240*	$178	$50
(c) Annualized Capital Cost per unit of Generation ($/kwh)	*(Annualized Capital Cost/(Capacity Factor*24*365)*	$0.09	$0.02	$0.006
(d) Operating cost ($/kwh)		$0.08	$0.16	$0.28
LCOE (Present Value of Costs/Electricity Generation) $/kwh	c + d	$0.17	$0.18	$0.29

Selecting the "Best" Clean Energy Projects



What Affects Our Choice of Clean Energy Projects?



Review of What We Have Learned

- Understand the role of CBA in choosing climate change mitigation projects to support low emissions growth.
- Understand the elements of financial and economic analysis, and how they differ
- Conduct basic cost benefit analysis.
- Conduct basic cost-effectiveness analysis.
- Compare projects using concepts such as NPV, IRR, ACER and LCOE (for energy generation projects).

Questions?

Cost-Benefit Analysis (CBA) and the Economics of Climate Change Mitigation

Economic Analysis of Sustainable Landscape Projects

Brian C. Murray

Director for Economic Analysis, Nicholas Institute for Environmental Policy Solutions

Research Professor, Nicholas School of the Environment

Duke University

March 4, 2013

Session objectives

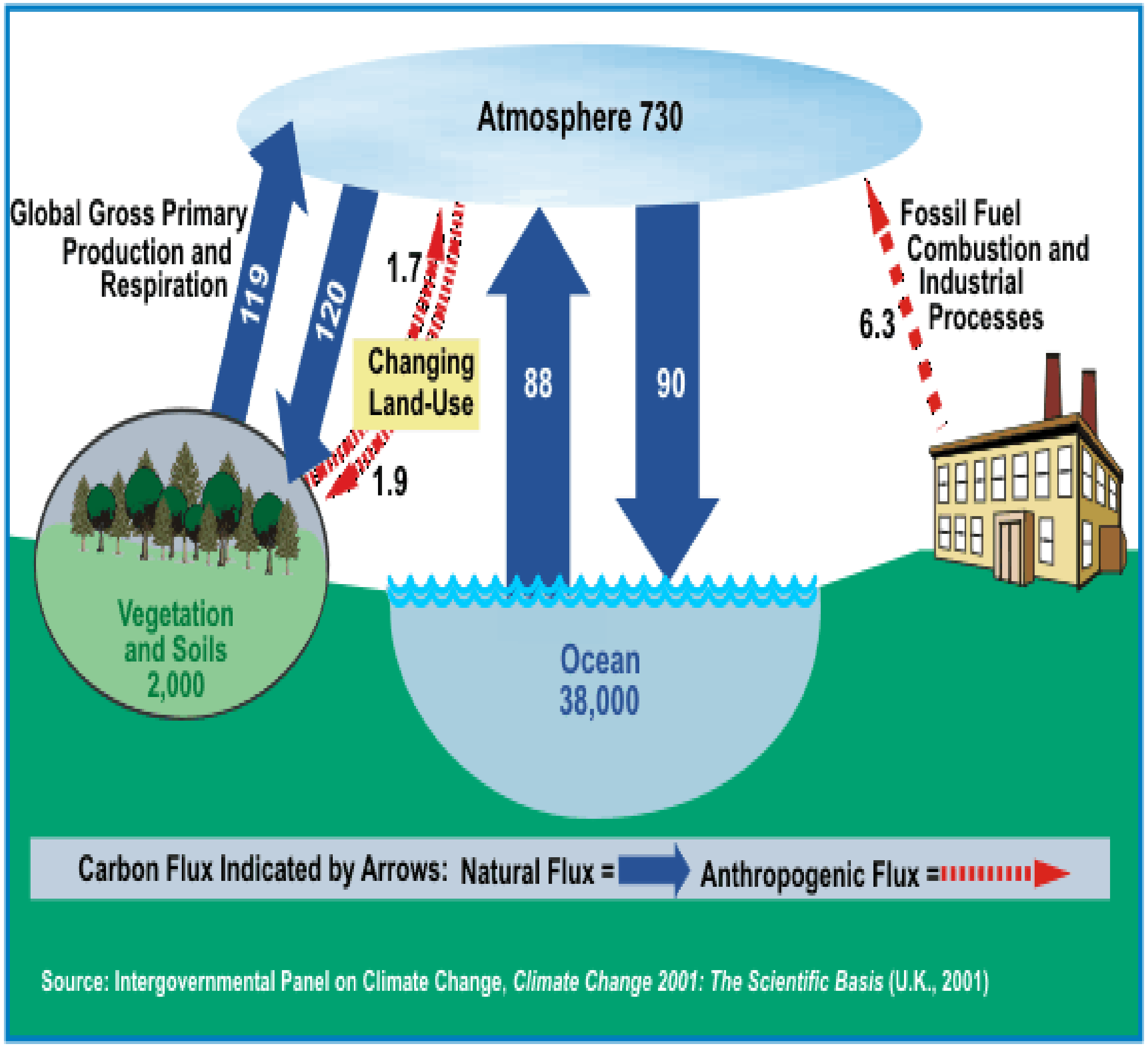
- Understand the importance of sustainable landscape (SL) projects for greenhouse gas mitigation
- Explain challenges faced by SL projects when making financial and economic assessments
- Describe best practices to apply CBA to SL projects
- Present current international UNFCCC mechanisms and funds to help SL projects

Sustainable landscapes projects in context

- **Goal**: To slow, halt, and/or reverse deforestation and degradation to retain or enhance carbon dioxide absorption of a key sequestration sink.

- **How to address deforestation and degradation drivers?**
  - Change the incentives and/or institutions
  - ***Focus in presentation is on efforts to change the economic incentives***

Forests/land use and the carbon cycle

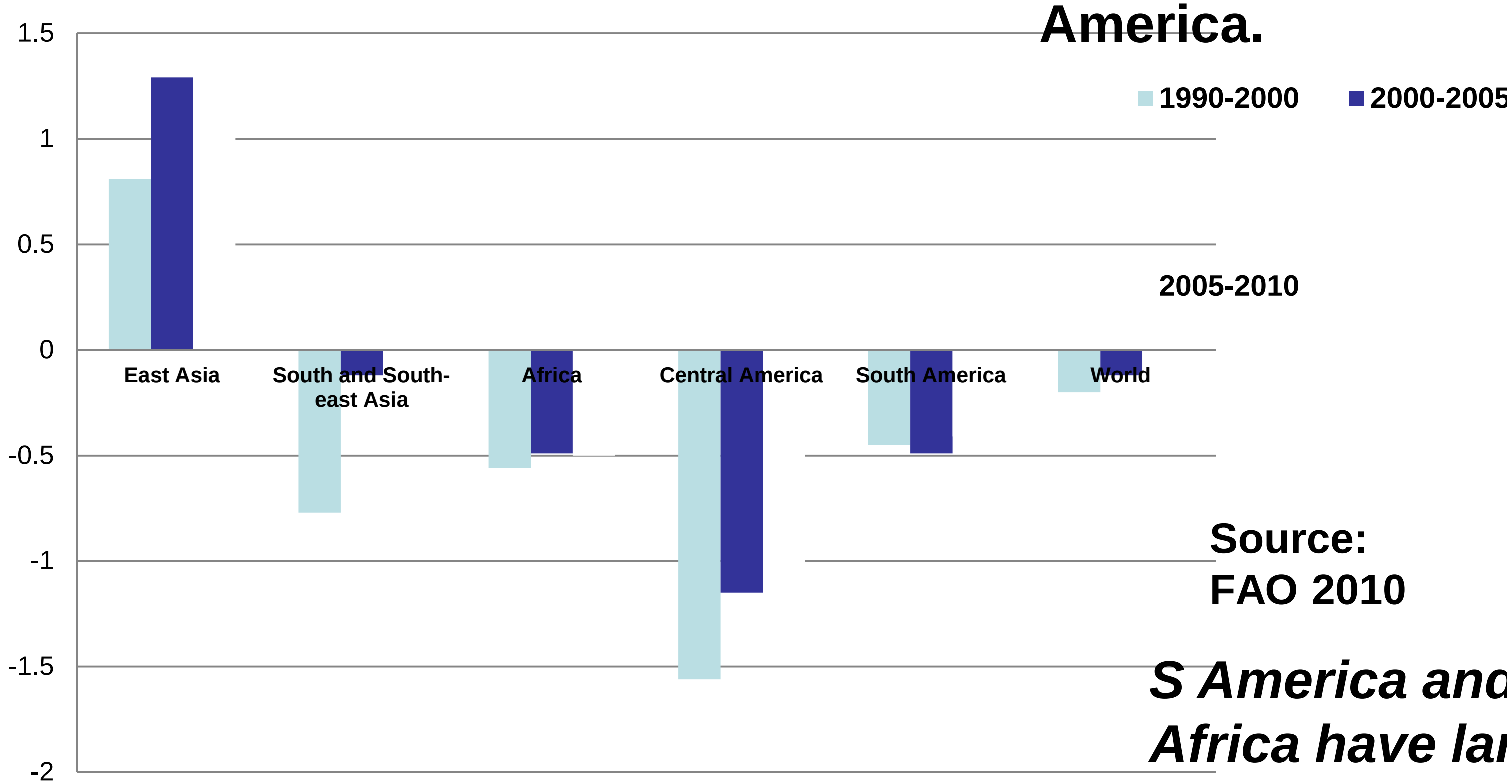


Forestry/land use losses contributed over 17% of global GHGs released to the atmosphere in 2004. (IPCC)

Slightly less now…

Forests/land use losses by regions

Percent Forest Area Change by Major Region



Large rates of forest losses are occurring in Asia and Central America.

Source: FAO 2010

S America and Africa have larger absolute areas of loss

Deforestation/degradation drivers by region

S/SE Asia – Palm oil, logging, and aquaculture

Congo Basin – Logging, and subsistence, small-scale agriculture

Amazon – Large scale agriculture and Road-building

Incomplete market incentives drive SL losses

- **For a private good:** Landholder receives compensation from commodity markets (soy, beef, timber, shrimp,…) for extractive behavior: S/he cannot fully capture the value from other ecosystem benefits

- **For a public good:** Non-monetized forest ecosystem services (e.g., habitat, biodiversity, carbon sequestration) benefit all but there are not easy ways to charge for these services

- **Externality:** Extraction negatively affects downstream parties (e.g., water consumers) but this cost remains external to the transaction

Potential incentive fixes

- **Regulate:** Prohibit overuse & protect but not easily legislated and enforced in many settings

- **Compensate: change financial/market incentives**
  - Compensate for provision of public goods to retain sustainable landscapes, e.g. offer payments for ecosystem services (PES)
  - Payments to reduce CO_2 emissions from deforestation and degradation and enhance forest carbon stocks (REDD+)

UNFCCC approach: REDD+ finance (moved from P. 8 in handouts)

REDD+ : Reduced Emissions from Deforestation & Degradation + carbon stock enhancement

Steps:

1. Screen/Identify Project or Program Area by criteria:
   - Conduct avoided deforestation/degradation GHG emissions assessments
   - Financial: Benefits and costs
   - Institutional
2. Register project with international carbon registry
3. Implement and monitor project
4. Generate benefits/payments from verified credits
5. Revise project and benefits as needed

Assessing SL benefits and costs (CBA)

- What are the current best practices to quantify the benefits and costs of sustainable landscape projects?

Overall Assessment Approach

- **Financial assessment:** Compare present value of alternative land uses (project versus baseline use, e.g., agriculture)
  - Identify, quantify and monetize all benefits and costs
  - Select time frame for assessment (20 yr+) and discount rate for future benefit/cost flows
    - Financial decision making: opportunity cost of capital
    - Economic: social rate of time preference
  - Compute and compare for NPV of project: What if NPV>0?
- **Environmental assessment**
  - Does the project support/undermine other environmental objectives?
- **Institutional assessment: can this work?**
  - Social assessment/Local buy-in
  - Benefit-sharing
  - Legal: Ability to enforce agreements

SL project benefits and costs

- **Benefits (monetized and non-monetized)**
  - Carbon
  - Non-carbon: selective logging, multi-cropping options (agro-forestry), watershed management, eco-tourism, non-timber forest products, biodiversity
  - Social
- **Costs**
  - Establishment and planting
  - Opportunity cost of land in another use
  - Operating and Maintenance costs

Assessing SL carbon benefits

- **Process:**
  1. **Estimate amount of GHGs saved** (not released to atmosphere) from sustainable land management from avoided deforestation and/or degradation: tCO_2e/yr
     a) Estimate GHG reference baseline w/o project
     b) Estimate GHG absorption w/project

  2. **Know carbon market value** and the social cost of carbon of SL projects: $\$/tCO_2e$

- **Potential carbon stock pool categories:**
  - Live biomass: Above and below ground
  - Dead wood, litter, soil
  - Harvested wood products

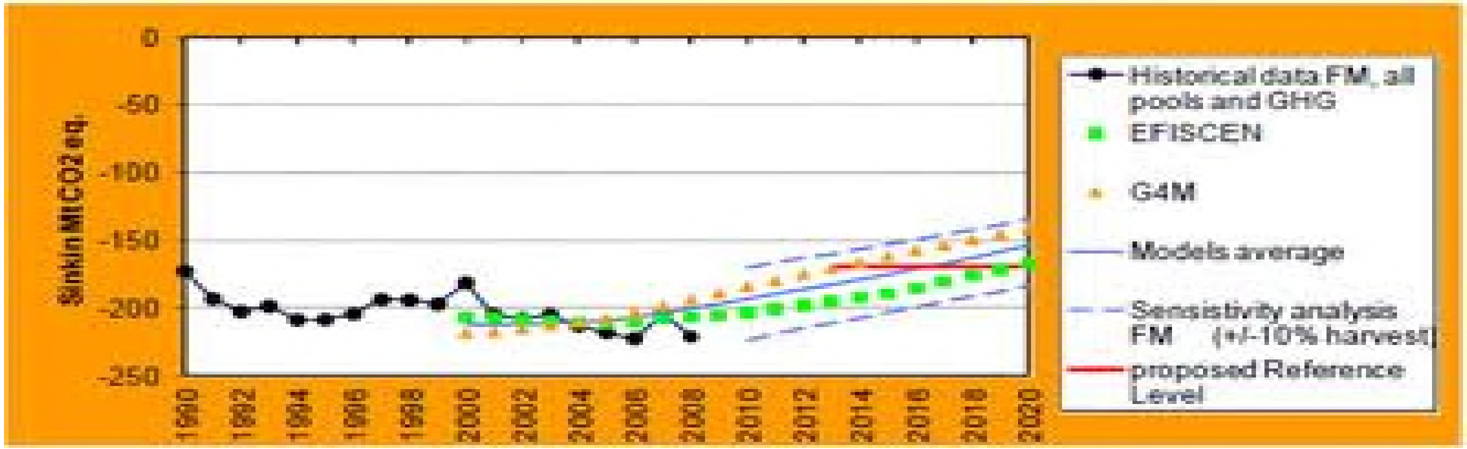
Establishing SL GHG reference (baseline)

- **Challenge:** estimating the counterfactual BAU baseline emissions (without project)

- **Baseline carbon stock:**

  $S^B_t = A^B_t * D^B_t$

  - A^B_t = Forest area in baseline, Year t
  - D^B_t = Carbon density of forest area
  - **Baseline emissions** = change in S^B from Yr t-1 to t



GHG release avoided (emissions saved)

- **Project emissions**
  - An estimate of the carbon trajectory within the project boundaries expected to occur ***if project took place (ex ante), or actual emissions (ex post)***
- **Net GHGs saved/avoided release:** Compare baseline to the actual project emissions to quantify reduction credits

$$C^C_t = [S^P_t - S^P_{t-1}] - [S^B_t - S^B_{t-1}] - \text{adjustments*}$$

Where

- $\mathbf{C^C_t}$ = Credits issued at the end of period t (tCO_2e)
- $\mathbf{S^P_{t\ (t-1)}}$ = Observed carbon stock in place in the project area at the end of period t (t-1)
- $\mathbf{S^B_{t\ (t-1)}}$ = Crediting baseline: estimated carbon stock that would be in the project area at the end of period t (t-1) if the project did not take place

What are issues with the baseline?

- **Data needs**
  - Forest area:
    - Initial: GIS, inventory,…
    - Area change*: Land use model, qualitative assertion
  - Carbon density (tCO2e/ha):
    - Initial: default factors, sampled data
    - Change* : forest stand models, observed degradation trends
- **Ex-Post monitoring of project emissions easier:**
  - Quantifying actual carbon stocks as the project proceeds is (somewhat) more straightforward

Carbon market benefits approach

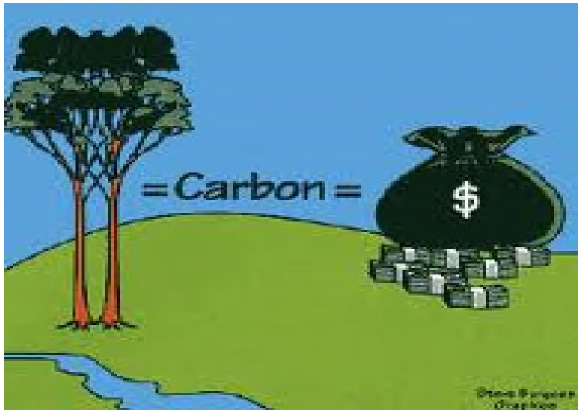
- Developing country carbon buyers (compliance or voluntary regimes) pay carbon benefits over time period (t)

  Carbon benefits (\$) = $\mathbf{C^{C}_{t} * V^{C}_{t}}$

  - $\mathbf{C^{C}_{t}}$ = Credits issued at the end of period t (tCO_2e)
  - $\mathbf{V^{C}_{t}}$ = Market value of credits ($\$/tCO_2e$)

Current Market Prices:

- USA carbon projects ~ \$10/per ton
  - No price discovery yet
- non-USA projects~ \$6-10 (Ecosystem Marketplace)
- CDM < \$1 (A/R only)



triplepundit.com

What are Issues with carbon credits?

- **Uncertainty**
  - Uncertainty "haircuts"/reserves: Crediting registries have protocols that require projects to take a discount on their credits
  - Provides incentive for better methods
- **Leakage**
  - Shifting land use (deforestation/degradation) to another place
    - Local activity shifting
    - Distant shifting via markets
  - Diminishes net benefits, various methods for estimating leakage using economic models
- **Permanence**
  - Buffers to protect against carbon "reversals" – future loss of credited carbon from natural or human-caused disturbance

"Fund" approach to paying benefits

- Bilateral or Multilateral agreement to pay for
  - Broad: Ecosystem services provision
  - Specific: CO_2 emission reductions (focus on climate/carbon)

- Emission reduction payments are <u>performance-based</u>
  - Practices (e.g., policy changes)
  - Outcomes (reductions accomplished)

- Examples
  - Amazon Fund - $1 billion commitment from Norway to Brazil to achieve 70% reduction in Brazilian deforestation
  - World Bank Carbon Fund (under FCPF)

Carbon market approach (moved from p. 2 in handouts '= "Rationale…")

- **Market Rationale:**
  - **Some countries/sectors are obligated to reduce emissions**
    - Primarily developed countries
    - Focus on fossil fuels
  - **Fossil fuel reductions take time and can be expensive**
    - Replacing power plants, factories, auto fleets
  - **Stopping deforestation and degradation can be done right away**
    - Often less expensive that fossil fuel reductions
- **Forest opportunities generally in countries not facing an emissions cap**
  - Sell reductions to capped countries through a carbon offset market
  - Capped countries' willingness to pay to avoid more expensive cuts at home
  - Revenue flow to the forest country
- **Still under deliberation in UNFCCC negotiations**

Are you involved with REDD+ or Funds?

Monetizing non-carbon benefits

- Ecosystem services of retained forest (e.g.)
  - Sustainable harvests
  - Non-timber forest products (NTFP)
  - Water quality provision
  - Micro-climate regulation
  - Species habitat (consumption and existence values0
  - Cultural and aesthetic values

- These can all be valued in principle, using a variety of market and non-market valuation methods
  - **See other presentations in this workshop**

Quiz: Issues in the Field

Have you tried monetizing non-carbon benefits?

If so, how?

How can landholders receive compensation for providing these services?

Assessing costs of SL projects

- **Start-up (pre-project) costs:**
  - Project planning
  - Assessment
  - Registration,..

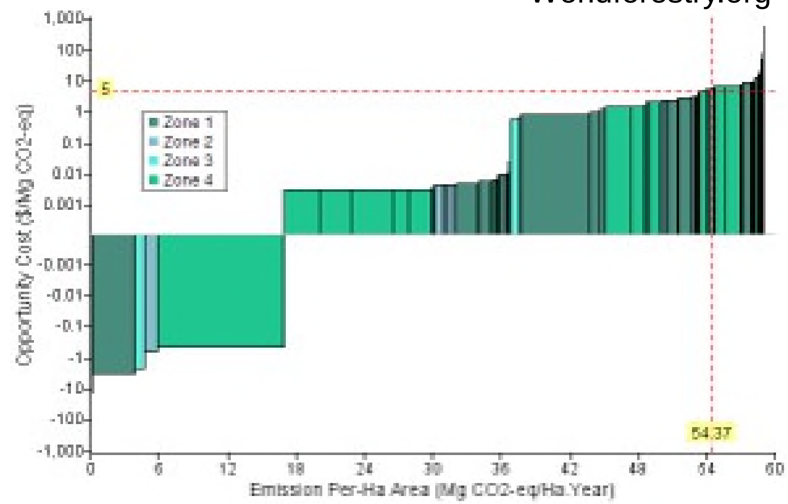
- **Implementation costs:**
  - Capital costs
  - Ongoing operating and maintenance costs
  - Measurement, reporting and verifying (MRV)

Other costs of SL projects

Guardian

- **Opportunity costs**
  - What economic opportunities do landholders forego in order to engage in the sustainable landscapes project: revenue from timber, agriculture, development,… ?
    - “Land rents” – net returns from alternative land uses
    - Estimation – using budget data, existing land values, econometric models

Worldforestry.org



- **Q: Will buyers pay each seller their actual costs or will they pay more (price determined on the margin)?**

- **Other social costs**
  - Access to forests for locals
  - Loss in local economic activity?

Resources (I)

- IPCC 2003 Good practice guidance for land use, land-use change and forestry. Penman, J et al (eds.). The Institute for Global Environmental Strategies for the IPCC and IPCC National Greenhouse Gas Inventories Programme. Hayama, Kanagawa, Japan. http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf.html (10 October 2010).
- IPCC 2006 2006 IPCC guidelines for national greenhouse gas inventories, volume 4:agriculture, forestry, and other land use. Eggleston H.S., et al (eds). IGES, Japan. http://www. ipcc-nggip.iges.or.jp/public/2006gl/index.html (10 October 2010).
- UNFCCC. Methodological tool: Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities.
- Verified Carbon Standard (VCS). 2010. Methodology for Carbon Accounting in Project Activities that Reduce Emissions from Mosaic Deforestation and Degradation. Approved VCS Methodology VM0006, Version 1.0.

Resources (II)

- VCS. 2012. Jurisdictional and Nested REDD Requirements (JNR). JNR Requiremnents Version 3. http://v-c-s.org/sites/v-c-s.org/files/Jurisdictional%20and%20Nested%20REDD%2B%20Requirements%2C%20v3.0.pdf
- Jonah Busch et al. 2009. Comparing climate and cost impacts of reference levels for reducing emissions from deforestation. *Environmental Research Letters* 4(2009).
- Bird, D.N., N. Pena, H. Schwaiger, and G. Zanchi. 2010. Review of existing methods for carbon accounting. CIFOR occasional paper series. http://www.cifor.org/publications/pdf_files/WPapers/WP54CIFOR.pdf
- Olander, L.P., H.K. Gibbs, M. Steininger, J. J. Swenson, and B.C. Murray. 2008. "Reference Scenarios for Deforestation and Forest Degradation in Support of REDD: A Review of Data and Methods." *Environmental Research Letters* 3(2008).
- Murray, B.C., B.A. McCarl, and H. Lee. 2004. "Estimating Leakage from Forest Carbon Sequestration Programs." *Land Economics* 80(1):109-124.

Resources (III)

- Murray, B.C., et al. 2012. "Alternative Approaches to Addressing the Risk of Non-Permanence in Afforestation and Reforestation Projects under the Clean Development Mechanism." Paper prepared for World Bank Carbon Finance Unit. http://nicholasinstitute.duke.edu/climate/policydesign/alternative-approaches-to-addressing-the-risk-of-non-permanence/at_download/paper

Additional background issues to consider in SL

Rationale for carbon market approach

- **Market Rationale:**
  - **Some countries/sectors are obligated to reduce emissions**
    - Primarily developed countries
    - Focus on fossil fuels
  - **Fossil fuel reductions take time and can be expensive**
    - Replacing power plants, factories, auto fleets
  - **Stopping deforestation and degradation can be done right away**
    - Often less expensive that fossil fuel reductions
- **Forest opportunities generally in countries not facing an emissions cap**
  - Sell reductions to capped countries through a carbon offset market
  - Capped countries' willingness to pay to avoid more expensive cuts at home
  - Revenue flow to the forest country

Monetizing carbon benefits

- **Market prices**
  - **Regulatory market**
    - nascent for landscape carbon
    - Only real example at this time is Clean Development Mechanism (CDM) for afforestation/reforestation
      - Temporary credits $0.50-$4 per ton
    - New markets emerging for REDD+ (California, UN process?)
      - USA carbon projects ~ $10/per ton
      - No price discovery yet for non-USA projects
  - **Voluntary markets**
    - ~ $6-10 (Ecosystem Marketplace)
- **Social cost of carbon**
  - Damage-cost based estimates from climate change
  - Sources: IPCC, US government interagency task force, economic studies (Tol, Nordhaus, …) →
  - Wide range:

POINT CARBON

THOMSON REUTERS

Ecosystem Marketplace
A FOREST TRENDS INITIATIVE

Social Cost of CO_2, 2010 – 2050 (in 2007 dollars)

Discount Rate Year	5% Avg	3% Avg	2.5% Avg	3% 95th
2010	4.7	21.4	35.1	64.9
2015	5.7	23.8	38.4	72.8
2020	6.8	26.3	41.7	80.7
2025	8.2	29.6	45.9	90.4
2030	9.7	32.8	50.0	100.0
2035	11.2	36.0	54.2	109.7
2040	12.7	39.2	58.4	119.3
2045	14.2	42.1	61.7	127.8
2050	15.7	44.9	65.0	136.2

Complex REDD+ market

- **GHG MRV: Measurement, Reporting and Verification**
  - Many existing resources and initiatives that focus on MRV for REDD+ are available and emerging (WB FCPF)
    - Emerging UNFCCC rules
    - GOFC-GOLD, UN-REDD, VCS JNR, ROW, etc.
    - Likely that existing resources can be leveraged
    - Existing resources vary in level of prescription provided
- **IPCC Tiered approach**
  - **Tier 1**: uses default parameters for the estimation and simplified methodologies that are land use change specific
  - **Tier 2**: similar methodologies as Tier 1 but includes national or regional data to make the estimate
  - **Tier 3**: uses complex flow models that are parameterized with regionally specific information (full carbon accounting)

Evaluation Case Study: Sustainable Landscape/ REDD Project in Soya producing area (Brazil)

- Area deforestation rate (~4%/yr) – use this as reference emissions level (baseline)

- Proposed SL project area (10,000 ha) forest under pressure from soya production in Amazonian frontier

Gaiajournal.org

- Evaluate, returns from REDD (deforestation emission reductions) revenues, net of costs (up-front an ongoing)
  - Non-carbon benefits not monetized for simplicity, but could be (see other sessions)

- Compare returns from SL project to marginal soya production returns ($275/ha/year) to assess economic viability of SL project

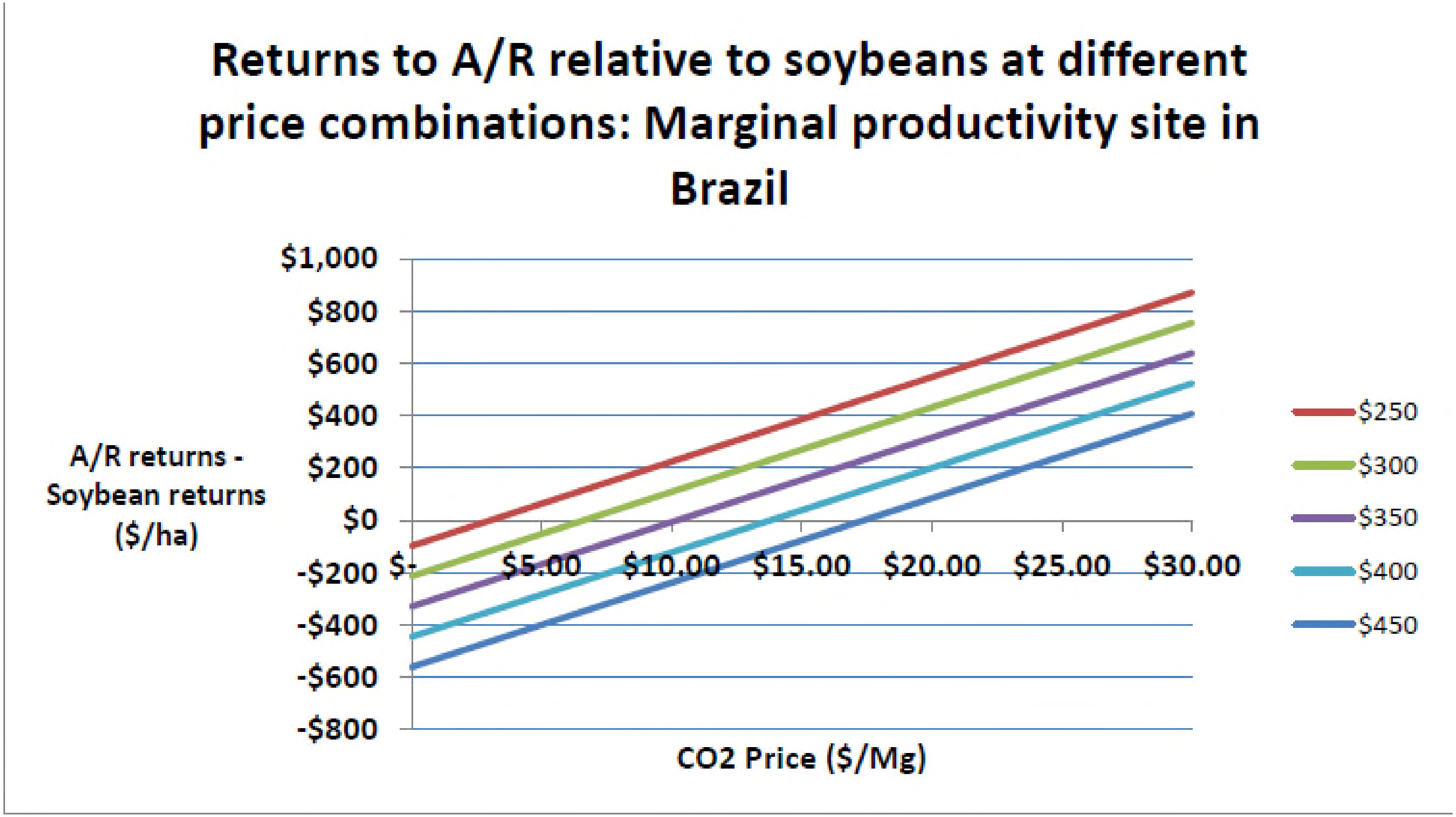
NPV of SL Project Returns (relative to Soya)

Year	Observed Emissions	Baseline Emissions	Project C Benefits = Baseline – Actual	Deductions for uncertainty and leakage (25%)	Credits = C Benefits - Deductions	Credit Price	Credit Revenue	O&M costs	Net revenue
0									
1	0	400	400	-100	300	$10.00	$3,000	$200	$2,800
2	0	400	400	-100	300	$10.50	$3,150	$210	$2,940
3	0	400	400	-100	300	$11.03	$3,308	$221	$3,087
4	0	400	400	-100	300	$11.58	$3,473	$232	$3,241
5	0	400	400	-100	300	$12.16	$3,647	$243	$3,403
6	0	400	400	-100	300	$12.76	$3,829	$255	$3,574
7	0	400	400	-100	300	$13.40	$4,020	$268	$3,752
8	0	400	400	-100	300	$14.07	$4,221	$281	$3,940
9	0	400	400	-100	300	$14.77	$4,432	$295	$4,137
10	0	400	400	-100	300	$15.51	$4,654	$310	$4,344
11	0	400	400	-100	300	$16.29	$4,887	$326	$4,561
12	0	400	400	-100	300	$17.10	$5,131	$342	$4,789
13	0	400	400	-100	300	$17.96	$5,388	$359	$5,028
14	0	400	400	-100	300	$18.86	$5,657	$377	$5,280
15	0	400	400	-100	300	$19.80	$5,940	$396	$5,544
16	0	400	400	-100	300	$20.79	$6,237	$416	$5,821
17	0	400	400	-100	300	$21.83	$6,549	$437	$6,112
18	0	400	400	-100	300	$22.92	$6,876	$458	$6,418
19	0	400	400	-100	300	$24.07	$7,220	$481	$6,739
20	0	400	400	-100	300	$25.27	$7,581	$505	$7,075

PV of revenue	$53,333
Up front cost	$1,500
NPV_REDD	$51,833
NPV_Soy	$34,271
Return to REDD	$17,562

Only carbon monetized here but non-carbon benefits can be added. Monetized, and added to NPV

Sensitivity Analysis to CO2 price and Soybean price: Afforestation/reforestation project in Brazil *



* Note – this is not the REDD example from previous page

Cost-Benefit Analysis of
Global Climate Change Mitigation

Ecosystem Service Valuation – Methods and Application to Climate Change Mitigation Projects

Elena Besedin
Abt Associates

March 5, 2013

AILEG Analysis and Investment for Low-Emission Growth

Objectives

Many climate change mitigation projects affect various ecosystem goods and services valued by society

Valuation of broader ecosystem services is often overlooked in project valuation → underestimation of social benefits & potentially inefficient resource allocation

- **Objectives of this session**
  - **Identifying and characterizing co-benefits applicable to climate change mitigation projects**
  - **Understanding ecosystem service valuation methods**
  - **Applying valuation methods to estimation of different co-benefit categories**

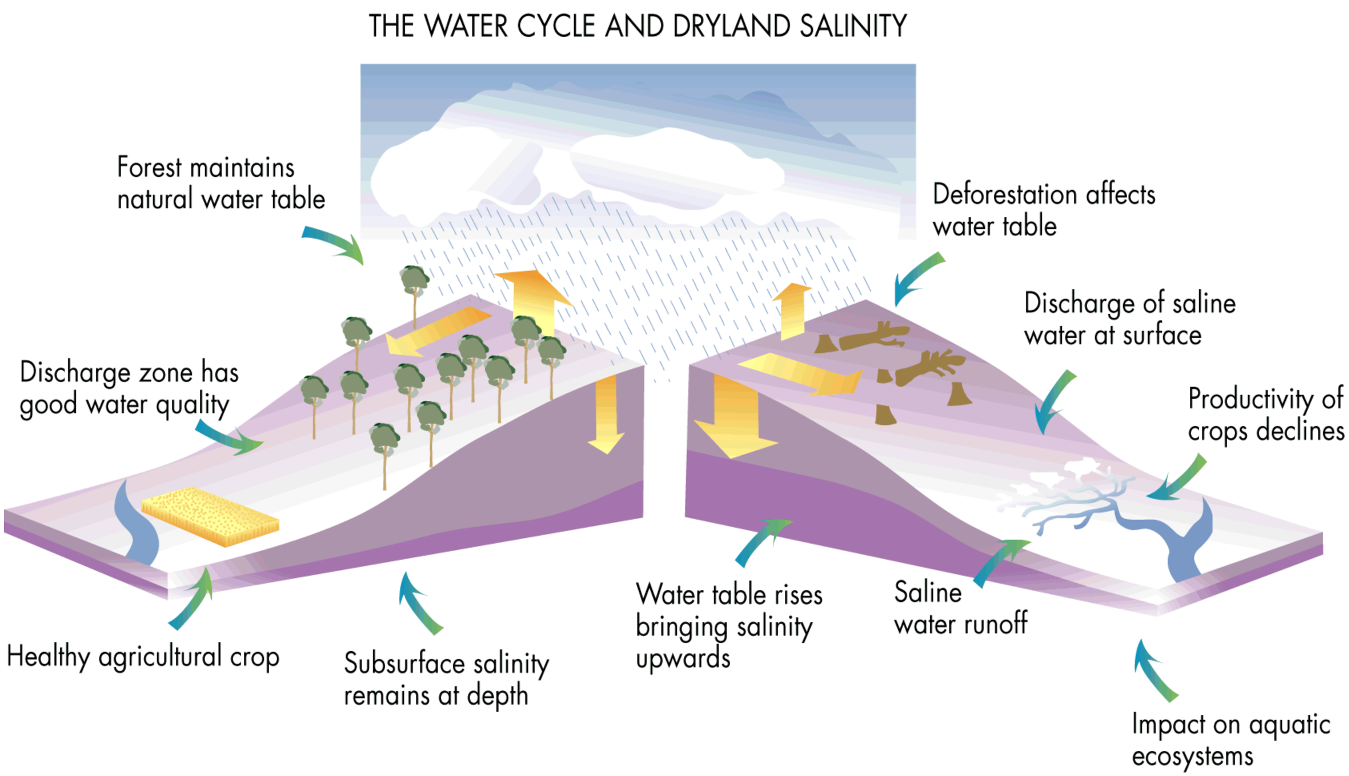
Session Outline

- **Benefit Categories**: Consistent definition and illustration of benefits from climate change mitigation projects; Identification of the policy baseline, scale and scope, and affected population
- **Market Valuation Methods**: Tradable goods, non-tradable goods, consumer and producer surplus; Examples; Pros and cons
- **Cost-Based Methods**: Productivity methods; Replacement costs; Costs of mitigation of ecosystem degradation; Avoided damages; Examples; Pros and cons
- **Nonmarket Valuation**: Revealed preference approaches; Stated preference approaches; Benefit transfer; Examples; Pros and cons
- **Case study**: What are we missing if co-benefits are not included?

Benefit Categories

- Primary: GHG emissions abatement
- Co-benefits: non-climate benefits explicitly incorporated into the creation of GHG mitigation policies
  - reducing deforestation rates
- Co-benefits that arise subsequent to any proposed mitigation policy
  - effects on agriculture
  - land use practices
  - biodiversity conservation
  - tourism & recreation
  - preservation of water resources and etc.

Identification and Estimation of Ecological Endpoints



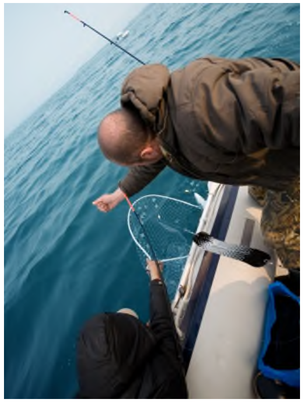
Source: Brand 2003

Co-benefits of Mitigation Projects

Service Type	Forest	Water Resources
Provisioning	Timber NTFP (food & fuel wood) Medicinal/ biochemical	Drinking water supply Agricultural & industrial water supply Hydropower Commercially harvested fish/shellfish Medicinal/biochemical
Cultural	Recreation (ecotourism) Education Sense of place/cultural Aesthetic Nonuse (existence, bequest)	Water-based recreation (e.g., fishing) Education Sense of place/cultural heritage Aesthetic Nonuse (existence, bequest)
Supporting	Maintenance of biodiversity Primary production Nutrient cycling Soil formation	Maintenance of biodiversity Primary production Nutrient cycling
Regulating	Carbon sequestration Air purification Moderation of temperature extremes Land degradation	Drought and flood mitigation Water purification Regulation of water flow and supply

Carbon sequestration and human health were addressed in other presentations

What ecosystem services or goods did you have to analyze or value in your projects?



Market ($$$$$) Nonmarket (Priceless)

Scope of Benefits

- Define geographic boundaries of the project impact:
  - Global, regional and country level
- Temporal scale
  - Short, medium and long term
- Scope of the approach:
  - General (aggregated) benefit (e.g., benefit per acre of forest)
  - Sector benefit
    - Energy
    - Agriculture
    - Tourism & recreation
    - Fisheries
    - Water supply end etc.

Valuation Methods

Direct Market Use Values

Goods and products consumed or processed: timber, fuel, NTFP, medicine

→ **Market –based Approaches**

Indirect Use Values

Ecosystem services: flood control, regulation of water flow and supply, nutrient retention and etc.

→ **Productivity & Cost -based Approaches**

- Effect on production
- Replacement costs
- Cost of providing substitute services
- Cost of avoided damages

Nonmarket Values

Use values: recreation, education, aesthetic

Nonuse values: existence, aesthetic, bequest

→ **Nonmarket Valuation Methods**

- Revealed preferences approach
- Stated preference approaches
- Benefit transfer

Market Valuation Methods

- Benefit Categories
- **Market Valuation Methods**: Tradable goods, non-tradable goods, consumer and producer surplus; Examples; Pros and cons
- Cost-Based Methods
- Nonmarket Valuation
- Case study

Market-based Approaches

- **Valuations are directly obtained from what people must be willing to pay (WTP) for the service of good (e.g., timber harvest)**
- **Market methods include valuations of consumer surplus (CS) and producer surplus (PS)**

- Tradable market goods (e.g., timber and agricultural products)
  - Valuation includes estimation CS and PS
- Non-tradable goods(e.g., roads and utilities)
  - Valuation focuses on CS only

Market-based Approaches (Continued)

What it costs to buy or sell a good or product
People's actual WTP

Value of NTFP use for Vientgthong
District Villages, Vietnam

Cash income	$634,000
Plant foods	$45,000
Wild meats	$476,000
Fuel and housing	$480,000
Crop consumption	$241,000
Total Value	**$1,876,000**

Source:IUCN 2001

Market-based Approaches: Pros and Cons

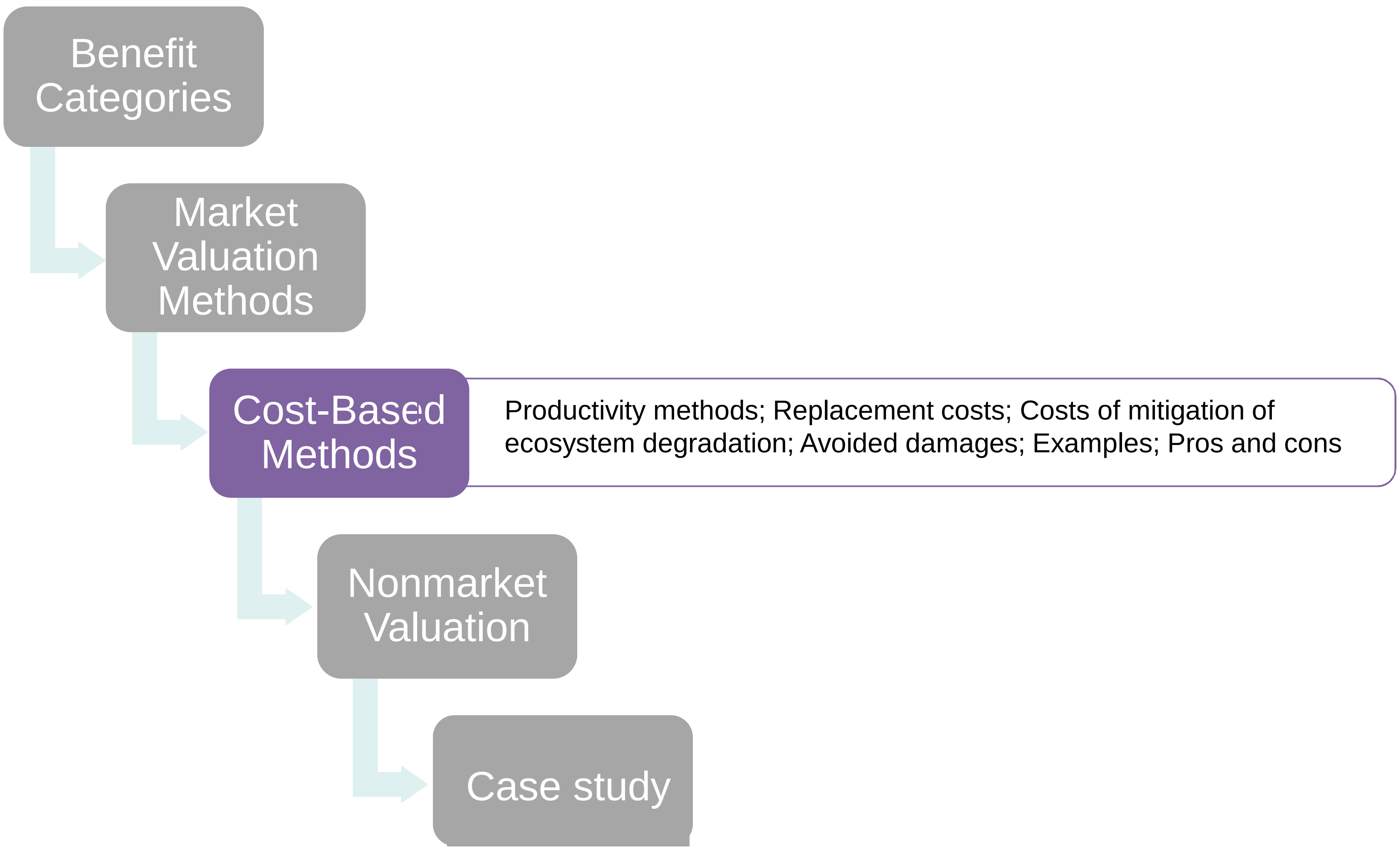
Advantages

- Easy to use if EG&S have a commercial market and prices and quantities are easy to obtain
- Uses observable data and actual consumer's preferences
- Relies on standard well-developed economic methods (consumer and producer surplus)

Disadvantages

- Many ES don't have markets or markets are distorted
- Prices do not reflect the true value of ES to society (WTP)
- Need to consider
  - Costs of transport (usually omitted)
  - Seasonal variation in prices
  - Other effects

Cost-Based Methods



Productivity Method

Economic contribution of ecosystems services to other production or consumption activities (e.g. agricultural crop)

Flood attenuation benefits from Mantadia NP

Madagascar

Value of flood damage to paddy production

NPV for forest watershed protection benefits: $126, 700

Source: Kramer at el. 1997

Calculation of NPV of Watershed Protection Benefits from Mantadia NP

Calcuation of the Flood Related Agricultural Damage from Deforestation					
Flood Return Period	Probability of Damage	% of Crops Damaged in Flood Plains	Annual Growth in Damage	1st Year Expected Loss without Park*	1st Year Expected Loss with Park*
2	0.34	13.1	0.03	$13,360 >	$12,971
5	0.17	30.4	0.02	$15,366	$15,050
10	0.09	43.5	0.02	$12,185	$11,993
25	0.04	60.8	0.01	$7,100	$7,030
50	0.02	73.8	<0.01	$4,402	$4,376
100	0.01	100	<0.01	$2,965	$2,965
200	<0.01	100	<0.01	$1,482	$1,482

* Values incorporate the probability of the flood event

NPV of Agricultural Yield Losses over the Life of the Park		
	NPV of Year 1 Total Expected Loss ($)	Aggregate NPV of Total Expected Loss over 46 Years ($)
Without Park	$51,690	$678,390
With Park	$50,790	$551,690
NPV of Benefits	$900	$126,700

Productivity Methods – Pros and Cons

Advantages

- Straightforward methodology
- Data requirements are limited and relevant data may be readily available
- Relatively easy and inexpensive

Disadvantages

- Only marketed resources & services can be valued
- Difficult to link changes in supply of quantity of ES with environmental changes
- Often relies on simplified assumptions
- If market price is affected, the method could be complicated to apply
- If changes in ES are too drastic users can switch to other alternatives

Replacement Costs

The cost of replacing an environmental good or service
Minimum estimate of $ saved

Ream National Park
Cambodia

Value of mangrove ecological services:

- flood barriers
- upstream erosion control

Storm protection	$60,000
Silt trapping	$220,000
Total Value	**$280,000**

Source: IUCN 2001

Costs of Mitigating Ecosystem Degradation

Cost of mitigating or averting effects of loss of environmental good or service
Minimum estimate of $ saved

Thua Thien Hue
Vietnam

Value of watershed catchment protection for urban and rural water supplies:

- Infrastructure to mitigate erosion
- Seasonal low water supplies and flooding

Investment costs	$27 million
Maintenance costs	$1.8 million
Total value	**$28.8 million**

Source: IUCN 2001

Avoided Damages

Costs avoided from destruction of ecosystem
Minimum estimate of $ saved

Phnom Bokor National Park
Cambodia

Value of watershed protection and hydropower generation

Failure to invest in watershed management could result in $2 million of power revenue foregone per year due to reduced water flow

Source: I UCN 2001

Cost-Based Methods – Pros and Cons

Advantages

- Relatively easy to apply and analyze
- Rely on secondary data on benefits from ES and costs of alternatives
- Easier to measure costs of producing benefits than nonmarket benefits themselves
- Inexpensive

Disadvantages

- Provides only rough estimates of EG&S values
- **Replacement costs** – difficult to find replacements for EG&S; tend to understate true value
- **Mitigation expenditures** - people's and expert perception of EG&S loss and what's needed to mitigate them don't always match
- **Avoided damages**– provides a hypothetical value; difficult to link to changes in ES

Non-Market Valuation Methods

- Benefit Categories
- Market Valuation Methods
- Cost-Based Methods
- **Nonmarket Valuation**
  - Revealed preference approaches; Stated preference approaches; Benefit transfer; Examples; Pros and cons
- Case study

Nonmarket Valuation Methods

- **Revealed Preference: Use Value Only**
  - Recreation demand models
  - Hedonic (property value) method
  - Hedonic wage methods
  - Averting behavior methods
  - Factor input methods
- **Stated Preference (SP): Use and Nonuse Value**
  - Contingent valuation or choice
  - Choice experiments
- **Benefit Transfer (BT)**
  - Involves adapting research conducted for another purpose in the available literature to address the policy questions at hand

Revealed Preference Approach: Travel Cost

Values of ES are implied by how much people spend to use them (e.g. for recreation)
People's implied WTP

Mantadia National Park
Madagascar

Benefits to international tourists

- 3,900 foreign tourists are expected to visit the new park (the same number as currently visit the Perinet Reserve)
- An average increase in WTP per trip is $24 (conditional on seeing lemurs)
- Annual 'benefits' to foreign tourists are $93,600
- **In comparison, SP approach resulted in mean WTP of $65 and annual benefits of $253,000**

Source: Kramer et al. 1994

Revealed Preferences – Pros and Cons

Advantages

- Based on observable behavior
- Well-accepted method

Disadvantages

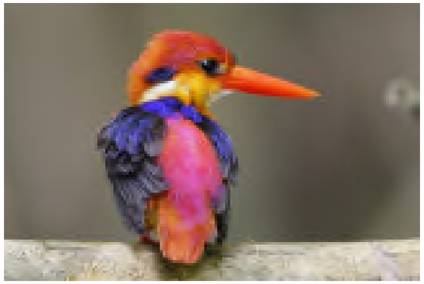
- Limited to use values only (e.g. recreation)
- Requires significant data collection:
  - Recreation trip profile
  - Expenditures
  - Substitute sites
  - Resource attributes
  - Demographic data and etc.
- Likely to estimate value of one factor (e.g., water quality)

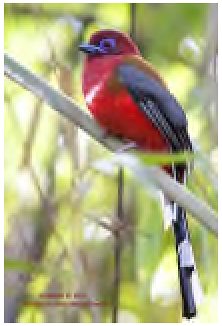
Stated Preference Approach

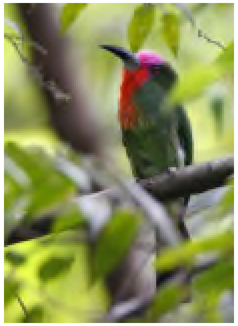
People are asked about their WTP or accept compensation for some change in resource characteristics
People's stated WTP

Doi Inthanon and Suthep Pui National Parks
Thailand

WTP for park entry fees







Doi Inthanon	40 Baht per person
Suthep Pui	20 Baht per person
Total Value	$1.2 million/year

Source: Isangkura. 1998

Stated Preferences – Pros and Cons

Advantages

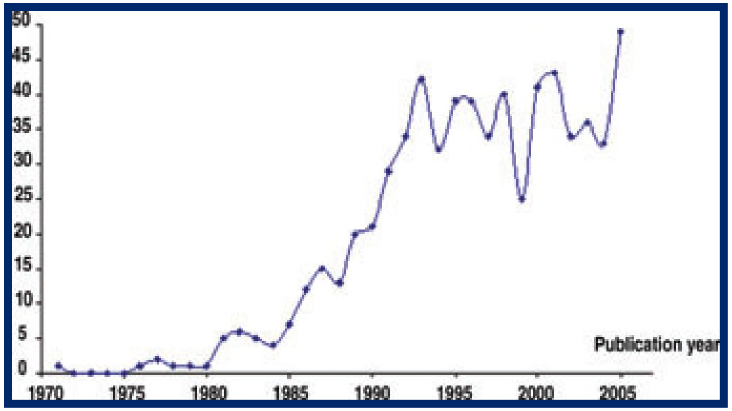
- The only available method for estimating nonuse values (e.g., existence)
- Can be used to estimate values of any EG&S understood by general public

Disadvantages

- Some controversy regarding reliability of SP estimates
- Results are sensitive to choice scenarios and how survey is conducted
- Resource-intensive
- Requires complex data sets and sophisticated statistical analysis
- SP approaches could be prone to:
  - Strategic bias
  - Non-response bias
  - Warm glow effect
- SP approaches sensitive to payment vehicles

Benefit Transfer (BT)

- Most BCA (~90%) rely on benefit transfer. There are two types of BT
  - Value transfers:
    - Use a single value from a study site or a mean from multiple studies
  - Function transfers:
    - Use a valuation function to estimate benefits calibrated to policy-site conditions using the variables in the equation.
    - The benefit function can be obtained from a single study or a meta-analysis of multiple studies.



Number of ecosystem valuation studies published each year

Source : Liu et al., 2010

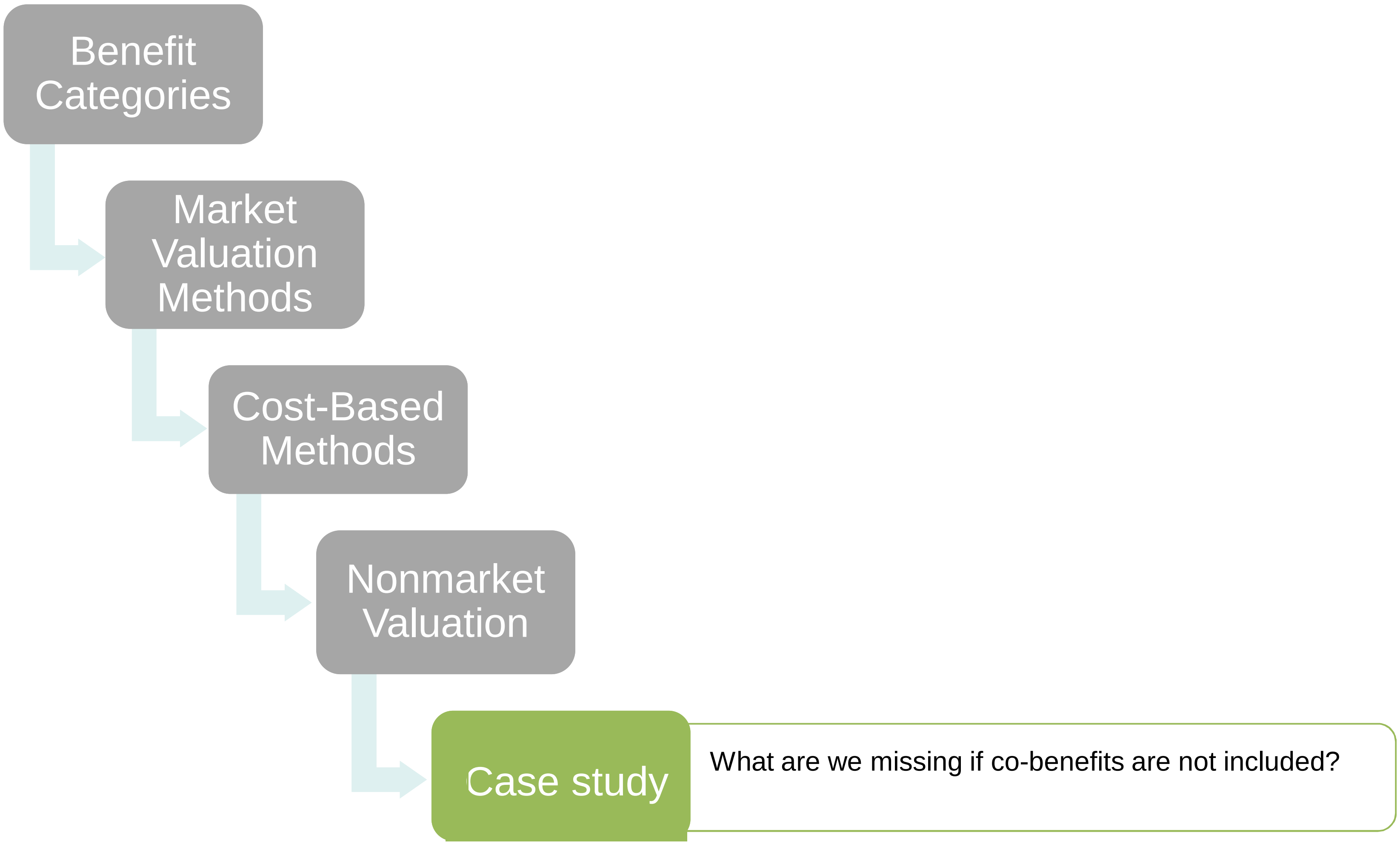
Challenges: Valuation of Nonmarket Goods and Services

- Estimation of ecological endpoints (e.g., flood control) is not so simple
  - Complex biophysical linkages
  - Sparse ecological data
  - Site-specific models may be needed
- Primary studies of nonmarket benefits may not be feasible due to time and budget constraints
- Developing a benefit transfer approach may be challenging
  - Studies suitable for benefit transfer are limited
  - Ability to transfer values from one context to another is service – specific
    - Local scale services (e.g., flood control) are not easily transferrable
- Resulting estimates can be highly uncertain

Key recommendations

- Identify early in the valuation process what is likely to be of greatest importance to people and focus the valuation efforts on these ES
- Predict ecological responses in terms of what is relevant to valuation (e.g., lbs of agricultural products)
- Consider a range of valuation methods to better capture the full range of contributions from ES protection

Case Study


Benefit Categories
Market Valuation Methods
Cost-Based Methods
Nonmarket Valuation
Case study
What are we missing if co-benefits are not included?

Monetizing non-carbon benefits from reforestation projects (Quiz)



Ecosystem services of retained forest (e.g.)

- Sustainable harvests
- Water quality provision
- Water quantity provision
- NTFP (e.g., fuel wood, food , medicine)
- Species habitat (consumption)
- Species habitat (existence)
- Recreation & tourism
- Cultural, educational, science values
- Aesthetic values

Monetizing non-carbon benefits from reforestation projects (Quiz!)

What market and non-market valuation methods can be used to value these services?

- Sustainable harvests
  - M, P
- Water quantity /quality provision
  - M, RC, TC, AC
- NTFP
  - M, P
- Species habitat
  - Consumption – M
  - Existence – SP
- Recreation /tourism
  - TC, SP
- Cultural and aesthetic values
  - SP

AC, avoided cost; M, market pricing; P, productivity approach; RC, replacement cost; SP, stated preference; TC, travel cost

Case Study: Sustainable Landscape/ REDD Project in Soya producing area (Brazil)

Benefit category	NPV
Carbon sequestration	**$34,271**
NTFP	
Plant foods	$45,000
Wild meets	$476,000
Fuel and housing	$480,000
Watershed protection	**$126,700**
Ecotourism	**$93,000**
Total	**$1,254,971**

Source: B. Murray presentation

Hypothetical values from the case studies discussed above

QUESTIONS?

What ES valuation methods does USAID use?

How successful was USAID in application of these methods?

What are the most common challenges ?

Other questions?

References

Millennium Ecosystem Assessment. 2003. *Ecosystems and Human Well-being: A Framework for Assessment*. Island Press. Washington, DC.

Millennium Ecosystem Assessment. 2005. *Ecosystems and Human Well-being: Current States and Trends*. Island Press.Washington, DC.

Farber, S., R. Costanza&M.A.Wilson. 2002. Economic and ecological concepts for valuing ecosystem services. *Ecol. Econ.* **41:** 375–392.

Shuang Liu,Robert Costanza, Stephen Farber, and Austin Troy. 2010. Valuing ecosystem services Theory, practice, and the need for a transdisciplinary synthesis. Annals of the New York academy of sciences. ISSN 0077-89-23 pp.54-78

R. Kramer, D. Richter, S. Pattanyak and N. Sharma. 1995. Ecological and Economic Analysis of Watershed Protection in Eastern Madagascar. Journal of Environmental Management (1997) 49, 277-295

References

Kramer, R.A., M. Munasinghe, N. Sharma, E. Mercer, and P. Shyamsundar, 'Valuation of Biophysical Resources in Madagascar' in M. Munasinghe, *Environmental Economics and Sustainable Development*, World Bank Environment Paper Number 3. Washington, D.C.:The World Bank, 1993.

Kramer, R.A., N. Sharma, P. Shyamsundar, and M. Munasinghe, 'Cost and Compensation Issues in Protecting Tropical Rainforests: Case Study of Madagascar', Environment Working Paper No. 62, Washington, D.C.: The World Bank, January 1994.

Adis Isangkura. 1998. Environmental Valuation: An Entrance Fee System for National Parks in Thailand. Economy and Environment for South East Asia RESEARCH REPORT SERIES. August 1998.

References

International Union for Conservation of Nature. 2001. Field Study: Lao PDR. Nam Et and Phou Loei National Biodiversity Conservation Areas. Report.

Emerton, L., & Bos, E. (2004). *Value: Counting ecosystems as water infrastructure.* Gland: IUCN Water & Nature Initiative. International Union for Conservation of Nature. 2004. Field Study: Vietnam Thua Thien Hue Province. Study Report.International Union for Conservation of Nature. 2001. Field Study: Cambodia, Bokor, Kirirom, Kep and Ream NP. Study Report

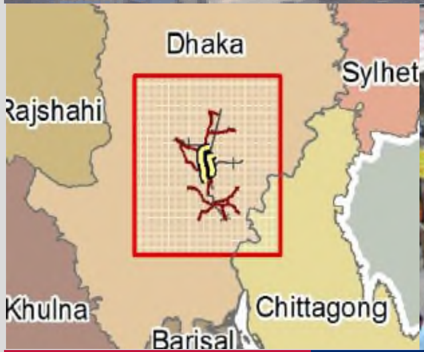
InVEST: A Tool for Integrating Ecosystem Services into Policy and Decision-Making: http://www.naturalcapitalproject.org/InVEST.html

USAID
FROM THE AMERICAN PEOPLE

Cost-Benefit Analysis of Global Climate Change Mitigation

Health and Air Quality Co-Benefits of LEDS

Case study: Greater Dhaka Sustainable Urban Transport Corridor Project



AILEG Analysis and Investment for Low-Emission Growth

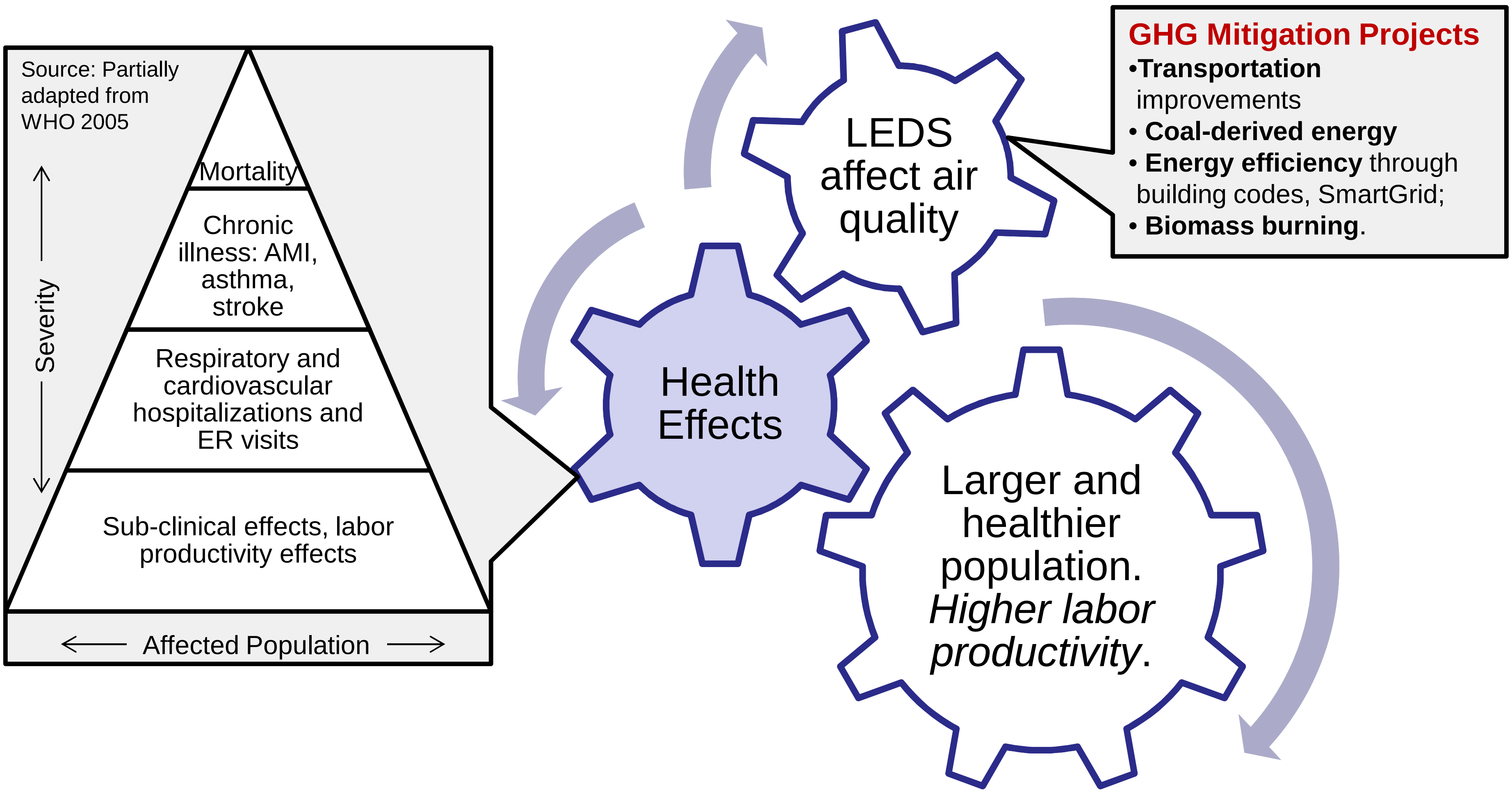
Anna Belova
Abt Associates

March 5, 2013

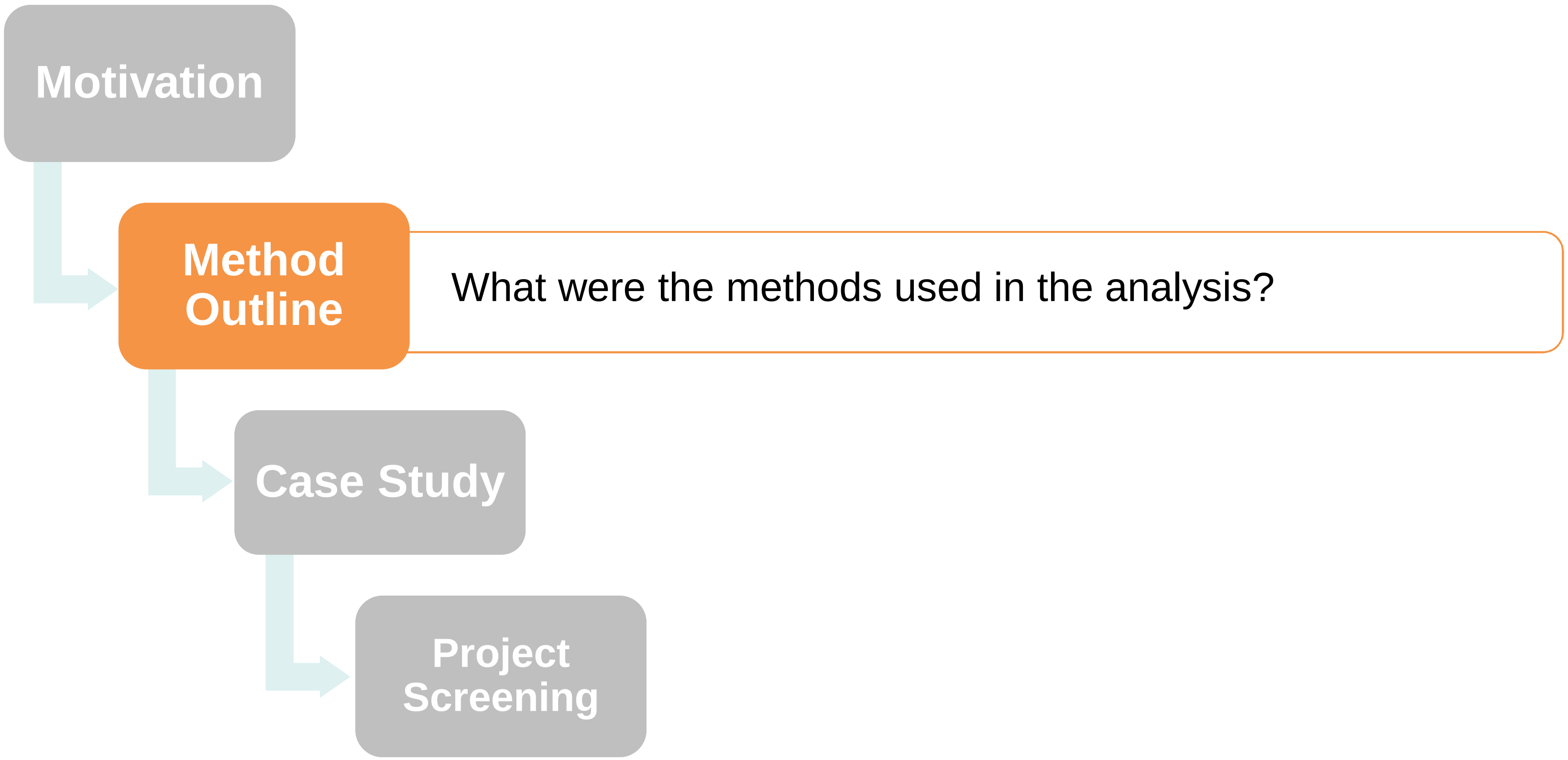
Session Outline

Motivation	What was the motivation for the analysis?
Method Outline	What were the methods used in the analysis?
Case Study	Discuss the results of the case study in Dhaka
Project Screening	Describe project screening for health co-benefits

Why Consider Health Co-Benefits in LEDS Context?



Method Outline



What is Involved in Health Co-Benefits Estimation?

1. Change in Emissions

- Estimated activity
- Emission factors for air pollutants

2. Reductions in Ambient Air Pollution

- **Dispersion modeling**
  - Specialized software
  - Domain definition
  - Meteorology & air pollution sampling data

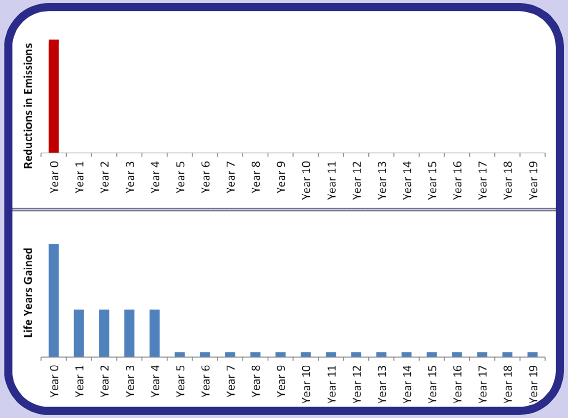
3. Improvements in Health Outcomes

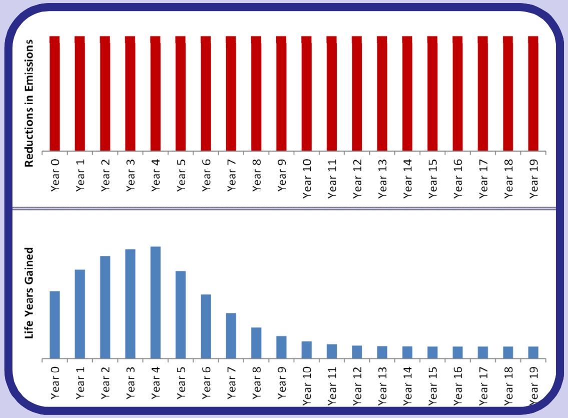
- Epidemiological relationships
- Baseline health data
- Population size

4. Value of Avoided Mortality & Morbidity

- Unit values for health effects
- Direct increases in value added

Why is Population Modeling Approach Important?





Pulse Change

- Static or dynamic population models can be used

Sustained Change

- Dynamic population model recommended
- Static population model is biased low

Any Special Challenges?

Valuation — Absent Markets for Health Improvements

- **COI** estimates may be difficult in low income countries
- **WTP** studies are expensive, but WTP transfers are possible
- **CEA** of various metrics (avoided cases of disease, QALYs or LE gained, etc.) via either constant effects or constant cost

Tracking Progress — Difficulties with Baseline Assessment

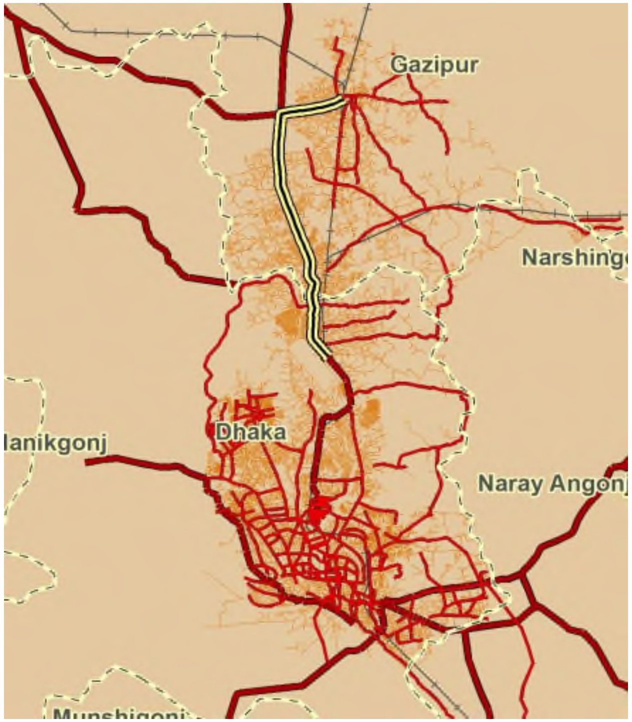
- **Population health affected by many other risks**. GBD estimates 2% of world's deaths is due to urban air pollution
- **Air pollution is a trans-boundary phenomenon**. Some SO_2 emissions contributing to $PM_{2.5}$ in Dhaka come from Indian coal power plants

Case Study

- Motivation
- Method Outline
- **Case Study** — Discuss the results of the case study in Dhaka
- Project Screening

Greater Dhaka BRT: ADB Project Background

Objective: Reduce congestion and air pollution in Dhaka, Bangladesh.



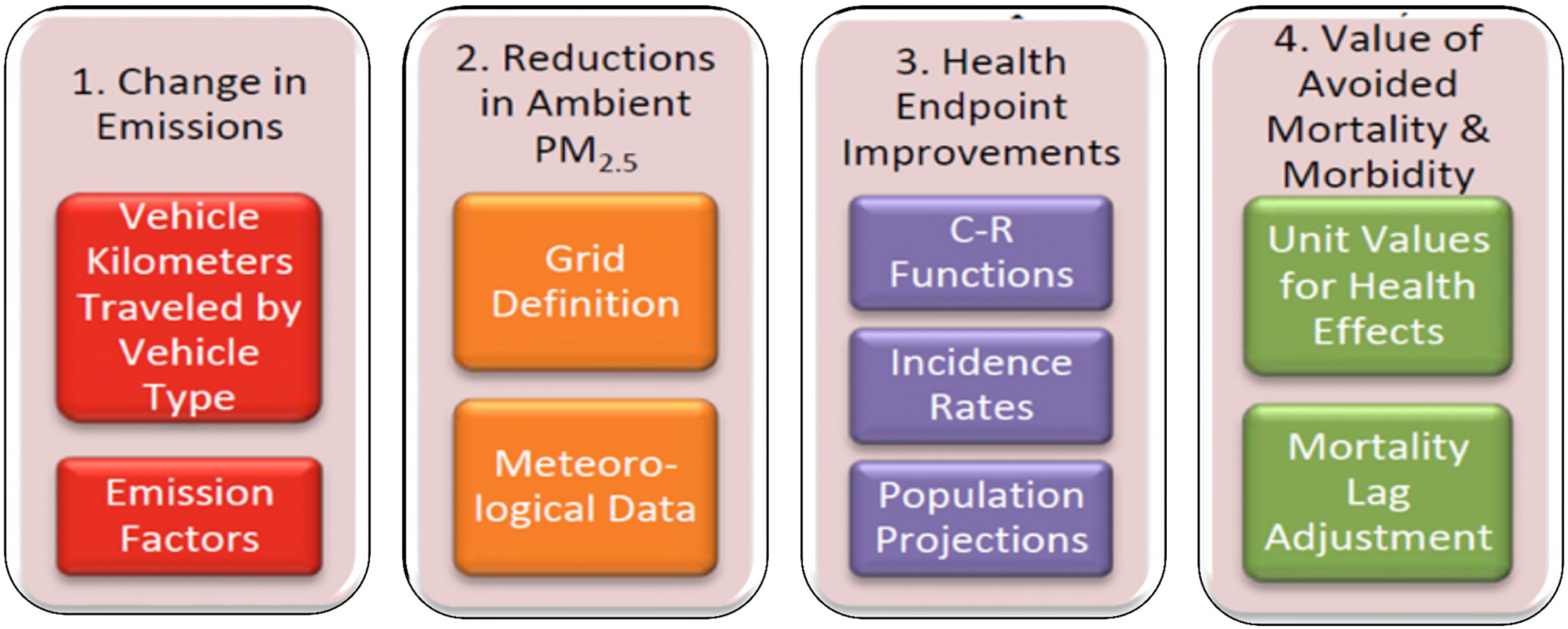
Choices: 6 transportation corridors in Greater Dhaka assessed for urban development and mass-transit support potential using surveys and TransCAD® software

Intervention: BRT selected as best mass-transit mode

Evaluation period: 30 years
NPV: $71 million (at 12% DR), ***excluding public health benefits***

Greater Dhaka BRT: Estimating Health Co-Benefits

Co-benefits analysis: Monetized reductions in **premature mortality** and **chronic bronchitis** due to BRT line, CNG buses replacing diesel buses.



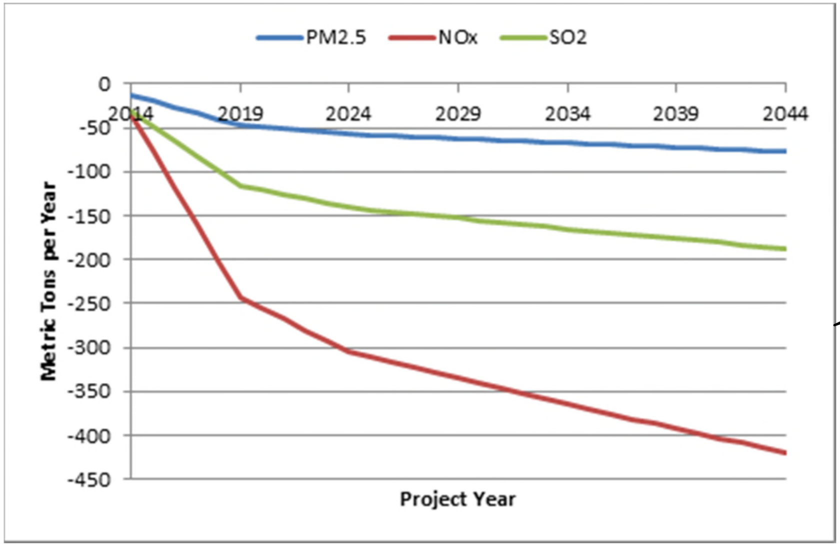
Custom-derived factors for GHGs, $PM_{2.5}$, NO_X, and SO_2 from studies in Asia

Open-source ATMoS dispersion model

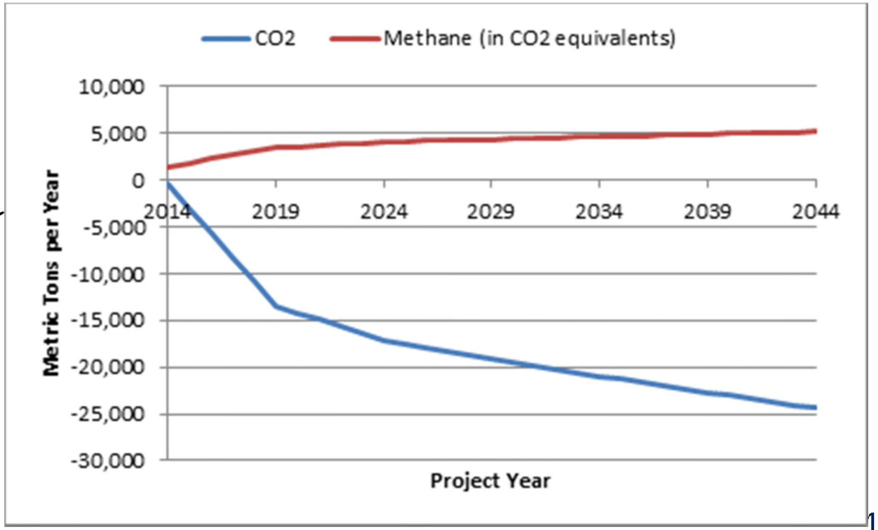
WHO adjustment of estimated effects of $PM_{2.5}$ on mortality and chronic bronchitis to Bangladesh high $PM_{2.5}$ background

WTP transfer to scale US VSL and value per case of chronic bronchitis

Greater Dhaka BRT: Co-Benefits Analysis Results



Reduced air pollutant emissions

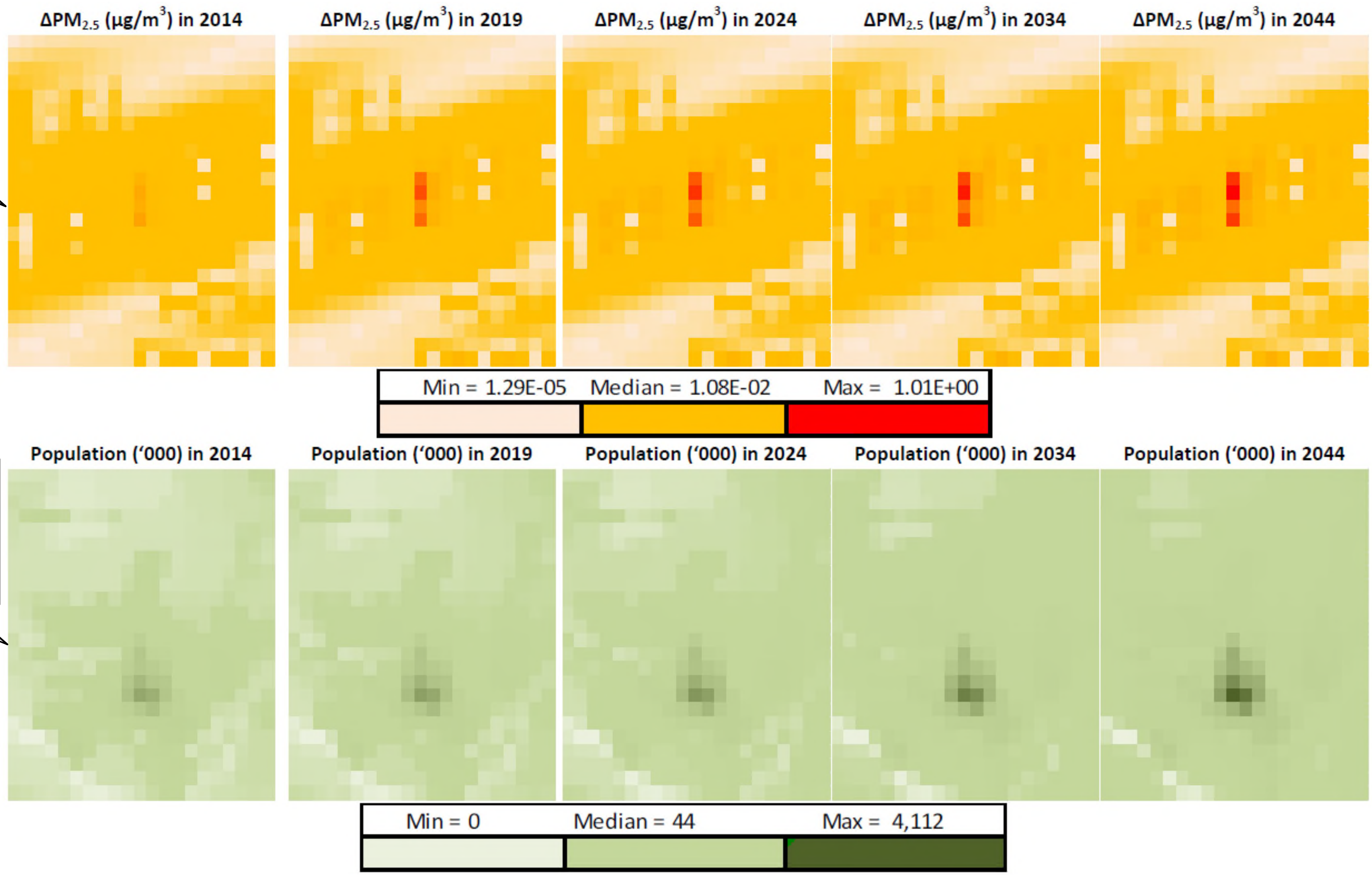


Reductions in GHG emissions

Greater Dhaka BRT: Co-Benefits Analysis Results

Reductions in air pollution

Spatial population patterns



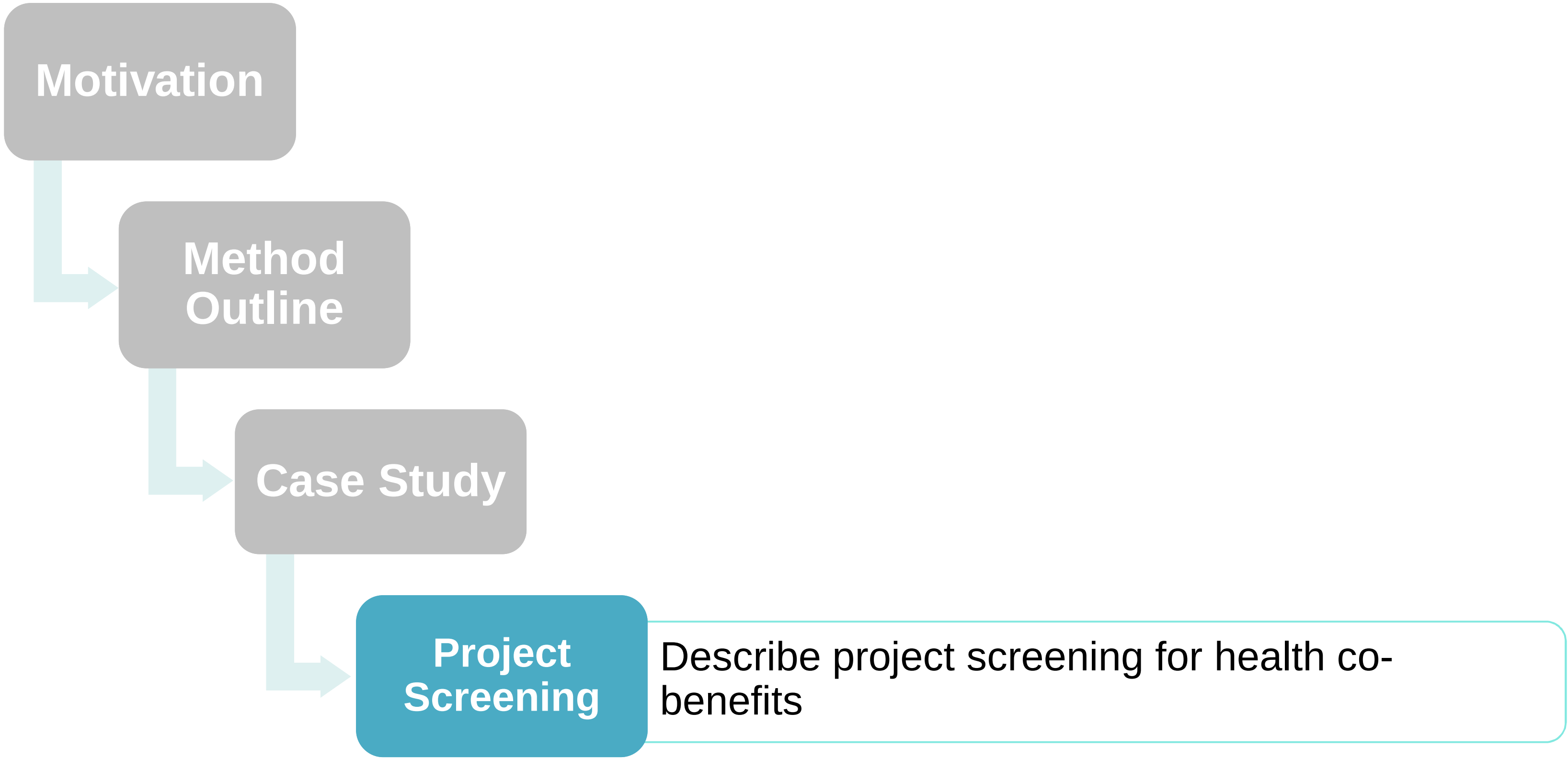
Greater Dhaka BRT: Co-Benefits Analysis Results

	Deaths Avoided (Age > 30)		Deaths Avoided (Age < 5)		Chronic Bronchitis Cases Avoided (Age > 25)	
	No.	**Value $2010**	**No.**	**Value $2010**	**No.**	**Value $2010**
10-Year Intervals						
2014–2023	120	$10,286,000	9	$700,000	123	$580,000
2024–2033	247	$27,685,000	17	$1,882,000	254	$1,560,000
2034–2044	431	$65,370,000	29	$4,442,000	442	$3,681,000
Total for 2014–2044	798	$103,341,000	55	$7,024,000	819	$5,821,000
PDV @ 12% DR		$8,127,000		$705,000		$574,000
Total Health Benefits, $2010						**$116,186,000**
PDV @ 12% DR						**$9,406,000**

Greater Dhaka BRT: Limitations and Uncertainties

- Not all possible types of **health endpoints** could be assessed due to lacking epidemiological information
- Assumed that large **diesel buses** and diesel minibuses buses were displaced by articulated CNG buses
- Comparison of **dispersion model** output to published modeling results indicated potential downward bias
- Studies used to **link air quality improvement to health** outcomes were adjusted for high background pollution
- **WTP transfer approach** to extrapolate US values assumed that health risk reductions are a luxury good
- **Static population** model was used as an approximation

Project Screening



What are the Minimal Information Requirements?

1. A method of estimating with (and without) project activity data relevant to air pollution
2. Plausible air pollutant emission factors
3. Dispersion modeling results for the location
4. Background pollutant concentrations for the location
5. Population size and age structure in study domain
6. Baseline disease incidence rates
7. A method of generating population projections that are consistent with the overall CBA

When to Assess Health Co-Benefits?

- Transportation projects IF
  - Many vehicles emitting air pollutants at a high rate (e.g., diesel) are displaced
  - Dusty roads are paved
- Energy efficiency projects IF
  - Energy saved comes from coal power plants
- Biomass burning for energy IF
  - Potential for air pollutant emissions
- Low background air pollution IF
  - Improvements in air quality affect a large population

Discussion Questions

- What are the air pollution issues in your country?
- Any projects underway or planned by USAID (or other donors) with potential air quality improvements?
- Have you worked on any projects for which the health benefits of air quality were assessed? Any advice to others?

References

1. Begum, B.A., et al., Key issues in controlling air pollutants in Dhaka, Bangladesh, Atmospheric Environment (2010)
2. Graff Zivin, Joshua, and Matthew Neidell. "The Impact of Pollution on Worker Productivity." American Economic Review 102 (2012): 3652-3673.
3. Greco, S., Belova, A., McCubbin, D., Weaver, C., Huang, J., Dey, B. 2011. Quantifying the Health Benefits of the Greater Dhaka Sustainable Urban Transport Corridor Project. Technical report prepared for Asian Development Bank. October 2011.
4. Hammitt, James K. and Robinson, Lisa A. 2011. The Income Elasticity of the Value per Statistical Life: Transferring Estimates between High and Low Income Populations," Journal of Benefit-Cost Analysis: Vol. 2: Iss. 1, Article 1
5. Miller, B. G., and J. F. Hurley. "Life table methods for quantitative impact assessments in chronic mortality." Journal of epidemiology and community health 57.3 (2003): 200-206.
6. Miller B , Hurley F , Shafrir. 2011. A Health Impact Assessment for the National Emissions Ceiling Directive (NECD) - Methodological Issues. Institute of Occupational Medicine (IOM) Research Report TM/11/03 June 2011, Edinburgh, UK
7. World Health Organization. "WHO Air Quality Guidelines for Particulate Matter, Ozone, Nitrogen Dioxide and Sulfur Dioxide. Global Update 2005, Summary of Risk Assessment." Geneva: WHO (2006).
8. World Health Organization. Global health risks: mortality and burden of disease attributable to selected major risks. World Health Organization, 2009.

Cost-Benefit Analysis of
Global Climate Change Mitigation

Building Marginal Abatement Cost Curves (MACCs) for LEDS Programming

William A. Ward, Ph.D.
USAID/Washington
Professor, The John E. Walker Department of Economics
Clemson University

March 6, 2013

AILEG Analysis and Investment for Low-Emission Growth

Session Outline

Part 1- Reading MACCs

- What do MACCs depict?
- How do they help in designing economically effective public interventions for sustainable development?

Part 2- Analyzing MACCs

- How are they put together?
- Were they were done correctly?

Part 3- Case Studies

Reviewing MACC applications

Session Objectives

- Know the origins and uses of the MACC -- including how it is used not only in GCC analysis but also in energy efficiency programming, in water pollution abatement, and in other applications
- Be able to *interpret* the information displayed in MACCs used for GCC analysis
- Be able to *review* and *analyze* MACCs created by others

Part 1 – Reading MACCs

Part 1- Reading MACCs

- What do MACCs depict?
- How do they help in designing economically effective public interventions for sustainable development?

Part 2- Analyzing MACCs

Part 3- Case Studies

Part 1. Reading MACCs

How did MACCs evolve?

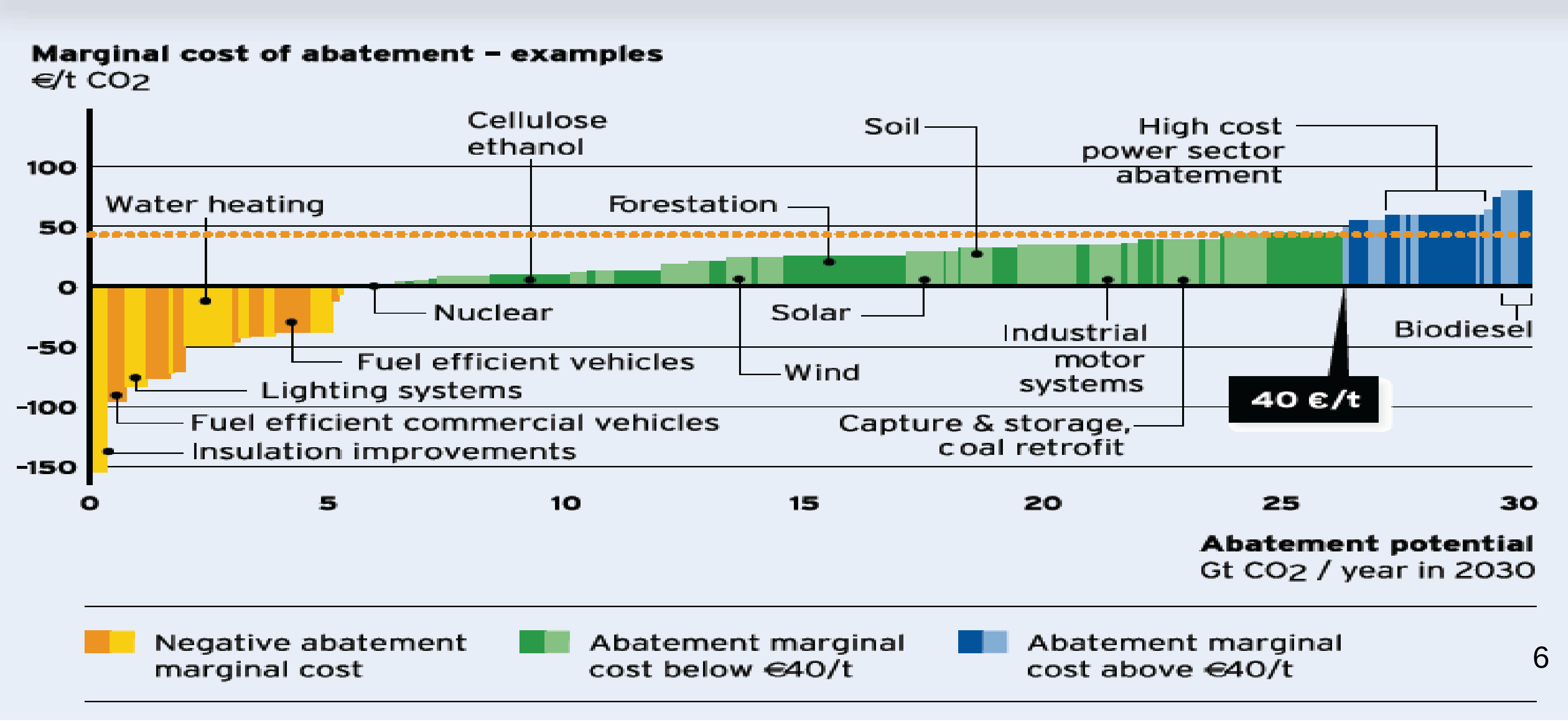
What purpose do they serve in investment programming and in sustainable development?

Funding allocation among potential mitigation project activities

MACC Definition

Marginal Abatement Cost Curve (MACC) analysis

- Uses cost-effectiveness analysis to create a “marginal cost curve” for GHG mitigation & abatement
- Does so by comparing a series of ‘lower-carbon’ options to ‘BAU’ alternatives



MACCs are a Type of Cost-Effectiveness Analysis

MACCs show comparisons of net discounted annual costs of a mitigation option with BAU, *per unit of reduction in GHG emissions (or per unit of outcome)* across different projects

$$\frac{\sum_{i=1}^{t} \frac{C_{ij} - C_{iBAU}}{(1+r)^{i}}}{E_{BAU} - E_{j}} \qquad E_j - Emissions\ \ from\ option\ \ j\,(tCO_2e)$$

Where:

C_j = costs of mitigation project j

C_{BAU} = costs of the baseline project

i = time period from year 1- *j*

E = Emissions *(tCO2e/year)*

Key Definitions of MACC 'Projects'

- ***"Real" projects:***
  - Defined as class of clean energy mitigation intervention w/in 5 years of commercial adoption.
  - With and w/o project comparisons must deliver similar assets (e.g., same amount of power, set of benefits)
  - Similar definition of commercialization/market readiness for technology is crucial for comparative purposes.

- ***Technology comparisons***:
  - Potential options not yet ready for commercialization.

Key Definitions of MACC ‘Projects’

- ***“Chimera”***
  - Hybrid project/technology option – neither one nor other
  - Technologies partially prepared into projects but not completely ready for comparison)

- ***Meta-interventions (enabling environments):***
  - Well-prepared institutional-organizational interventions (regulations, policies) that ‘fix’ the failure for interventions to be commercialized (e.g., mkt failure, policy failure, institutional failure, government failure….)
  - *These are rare in MACCs*

History and Use of MACCs

- MACCs date from the 1960s – used in early US water pollution studies

- One of many ‘ranking’ measures used to screen GCC-related public intervention
  - MACCs focus on economic cost of sustainable growth
  - Other screens for gender impacts, private incentives, etc.

- MACCs now used to prepare Nationally Appropriate Mitigation Actions (NAMAs) for international climate change funding (Cancun Agreement, 2010)

What Do MACCs Tell Us?

Let's look at a couple of widely-circulated MACCs to understand what they do & do not tell us:

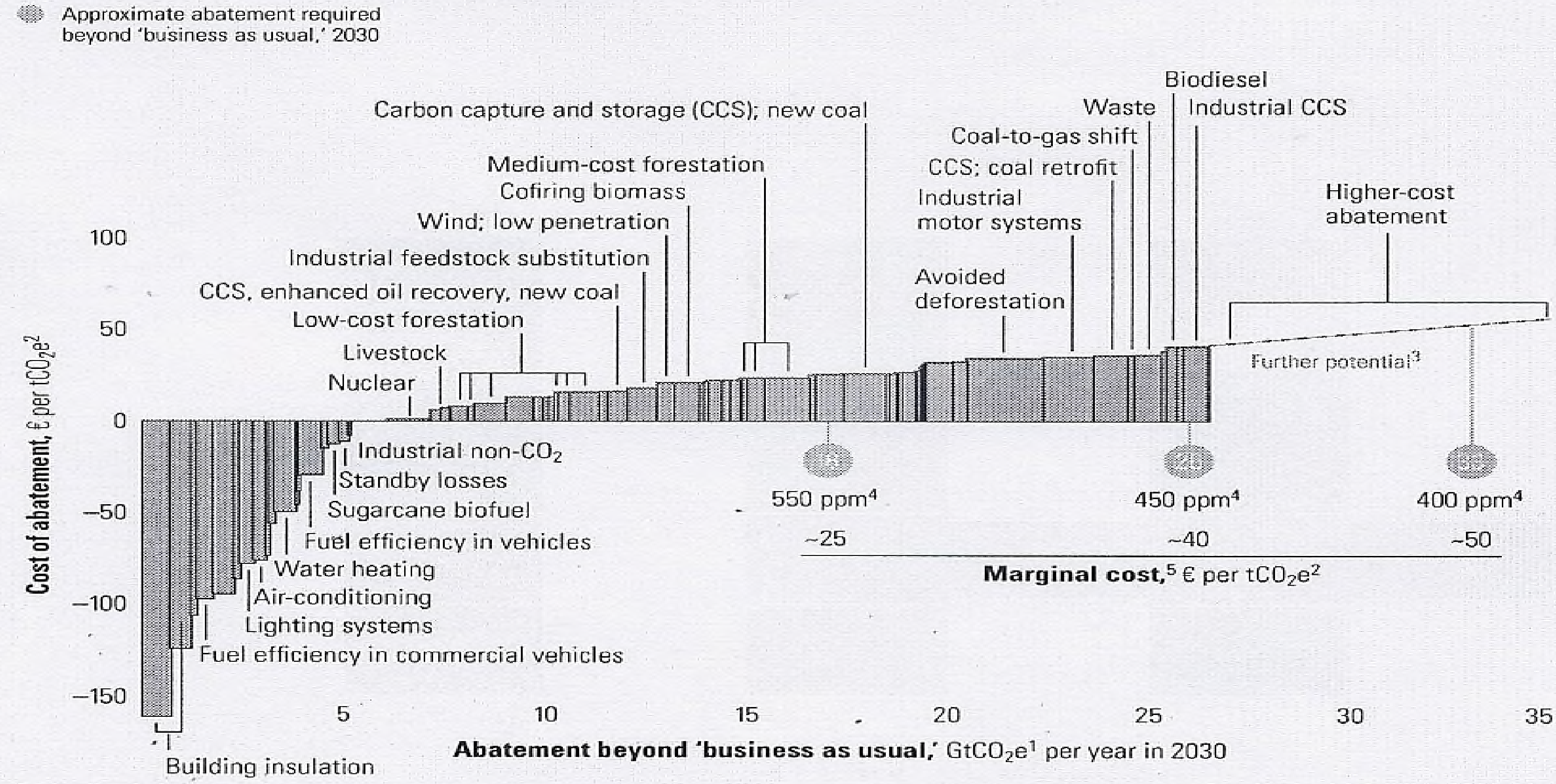
- The 'classic' **McKinsey & Co (2007)** global MACC for GHG mitigation & abatement

- The Gov of Mexico-World Bank MACC for **Mexico (MEDEC 2009)** LEDS planning

The McKinsey (2007) Global MACC

What might it cost?

Global cost curve for greenhouse gas abatement measures beyond 'business as usual'; greenhouse gases measured in $GtCO_2e$[1]



[1] $GtCO_2e$ = gigaton of carbon dioxide equivalent; "business as usual" based on emissions growth driven mainly by increasing demand for energy and transport around the world and by tropical deforestation.
[2] tCO_2e = ton of carbon dioxide equivalent.
[3] Measures costing more than €40 a ton were not the focus of this study.
[4] Atmospheric concentration of all greenhouse gases recalculated into CO_2 equivalents; ppm = parts per million.
[5] Marginal cost of avoiding emissions of 1 ton of CO_2 equivalents in each abatement demand scenario.

What are the Rectangles on the MACC?

- Height of rectangle generated from cost-effectiveness **(C/E or CEA) Ratios** comparing pairs of alternatives.

- Width of rectangle from **replicability** of alternative (e.g., ‘avoided deforestation’ on McKinsey MACC)

- **Arrayed low-to-high** by C/E ratio –a.k.a. costs per tonne of GHG (CO2e)

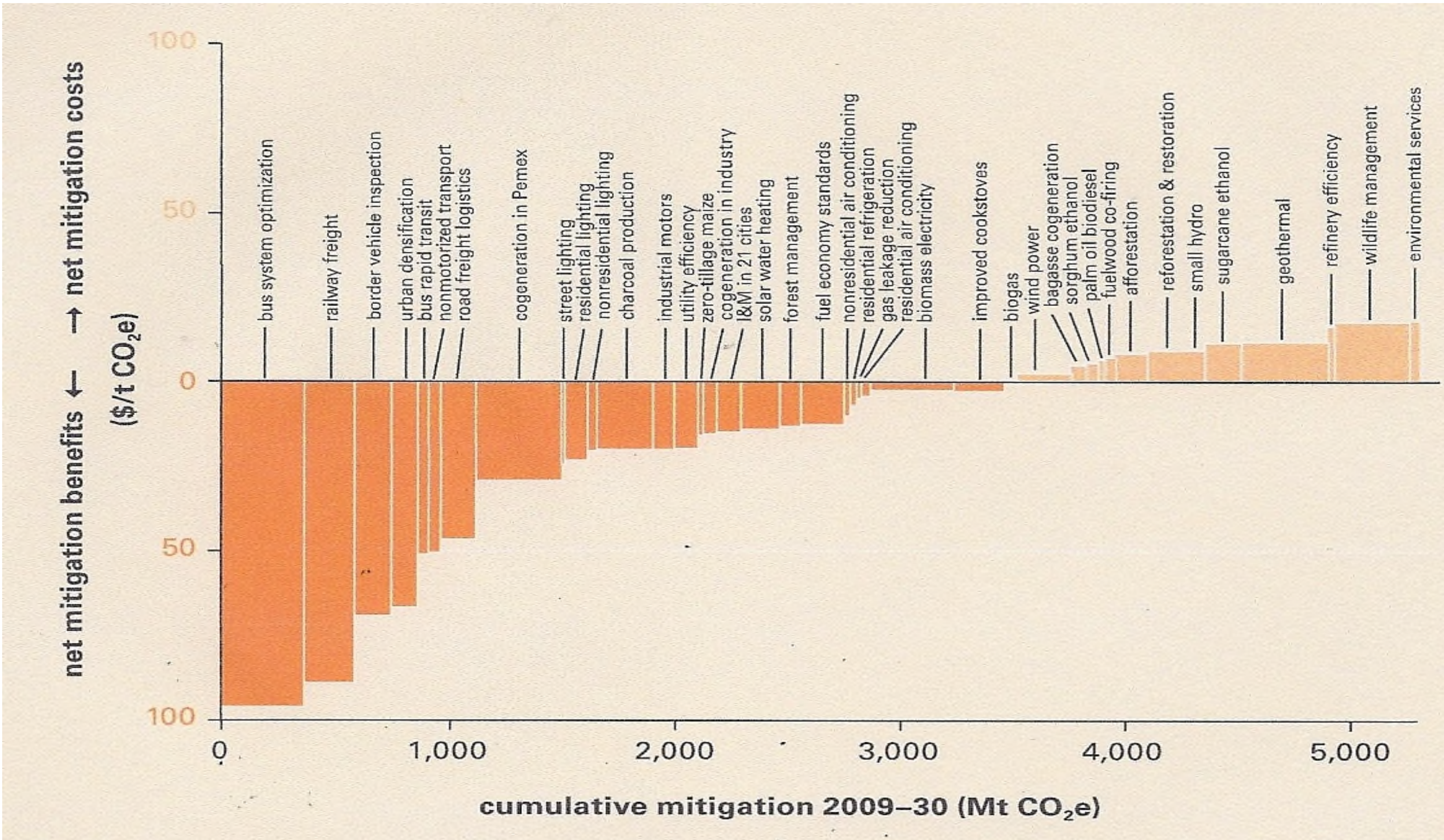
How Analysts Determine Options to Put in MACC

Sector expertise* is called upon to identify activities with potential to have bars that are

- "Wide" and
- "Short" (or even negative)

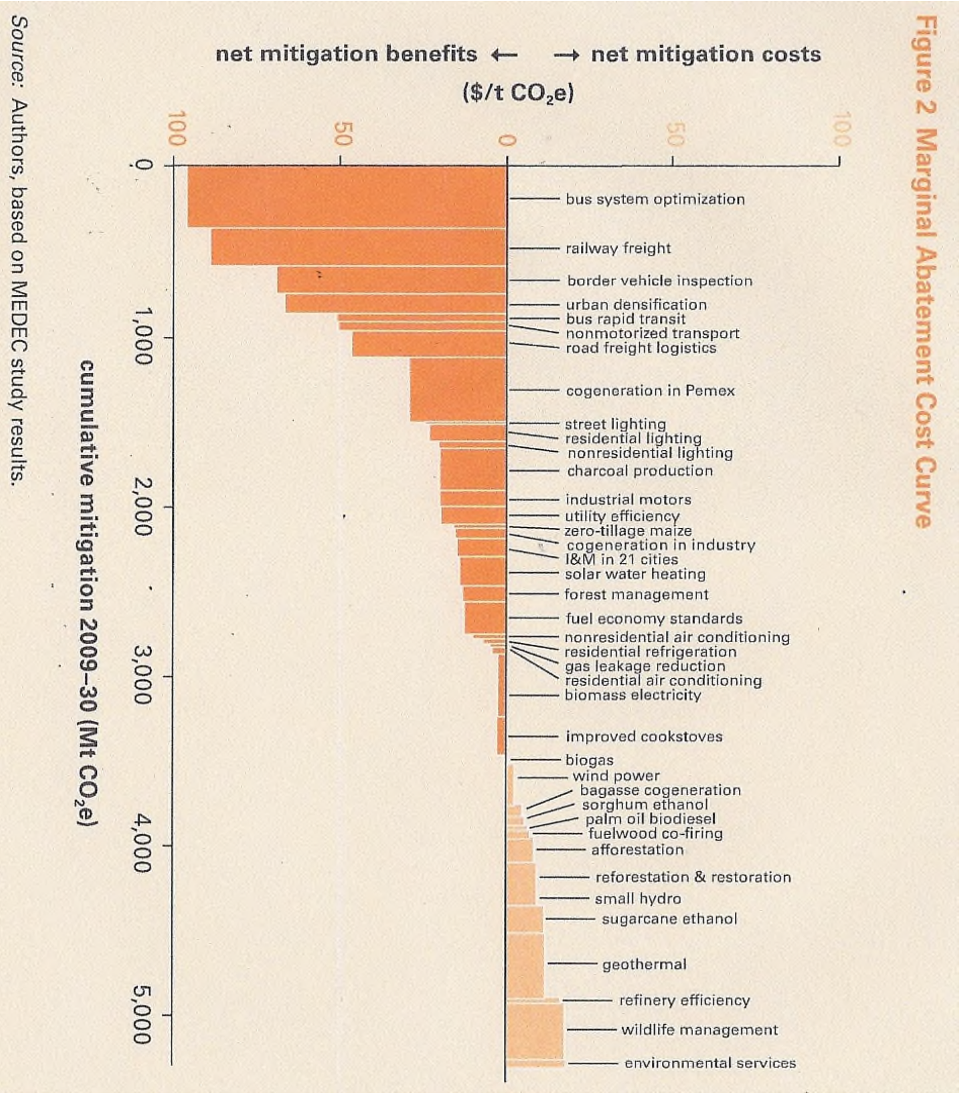
** Caveat: According to Andy Jarvis of CIAT/CGIAR, "If you're not careful, each sector portfolio can end up reflecting the people who did it more than it reflects the sector itself."*

Example 1: GHG MACC for Mexico (MEDEC)



Todd M. Johnson, Claudio Alatorre, Zayra Romo and Feng Liu.2009. *Low-Carbon Development for Mexico.* The World Bank. Washington, D.C.

Example 1: GHG MACC for Mexico (MEDEC)



Flipped 90 degrees for reading

What Projects (Interventions) Does MACC Typically Include vs. Omit?

Typically, the MACC will ***include mitigation*** and ***abatement projects***

Can be shown in terms of cost-effectiveness in reducing/preventing GHG build-up in atmosphere

The MACC usually will ***not include adaptation*** projects

- i.e., preparing for environmental changes that create GHG build-up in the atmosphere
- Now improving CBA methods for adaptation projects (objective fn does not match up to axes of MACC)

Part 2- Analyzing MACCs

Part 1- Reading MACCs

Part 2- Analyzing MACCs

- How are they put together?
- Were they were done correctly?

Part 3- Case Studies

Part 2: Analyzing MACCs

1. Three things to look for on the MACC to analyze its meaning/implications

2. Using MACC sections to identify next round of ventures

3. Looking critically at the sections of the MACC to identify faulty analyses

Three Elements of a MACC

Negative cost options are called the "win-win" or "no regrets"

- How many are there?
- How wide is each respective rectangle?
- Are they being implemented? If not, why not?

'Knee' of the MACC function (also called the 'elbow')—where costs/tonne turn up steeply

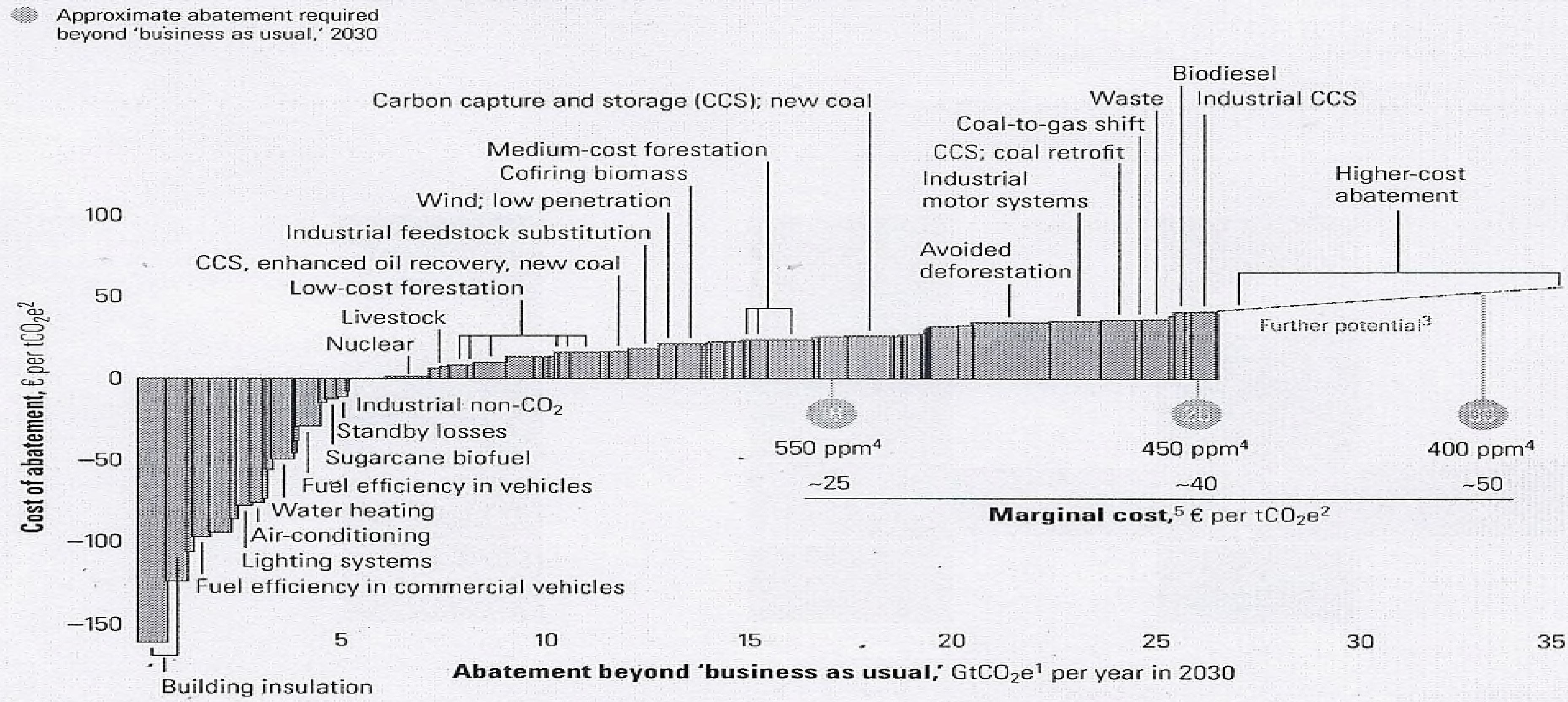
Is MACC developed **in financial or economic accounting** stance?

- Do not include both in same curve
- Cannot usually tell just by looking at the MACC

McKinsey MACC Negative Cost Options?

What might it cost?

Global cost curve for greenhouse gas abatement measures beyond 'business as usual'; greenhouse gases measured in $GtCO_2e$[1]

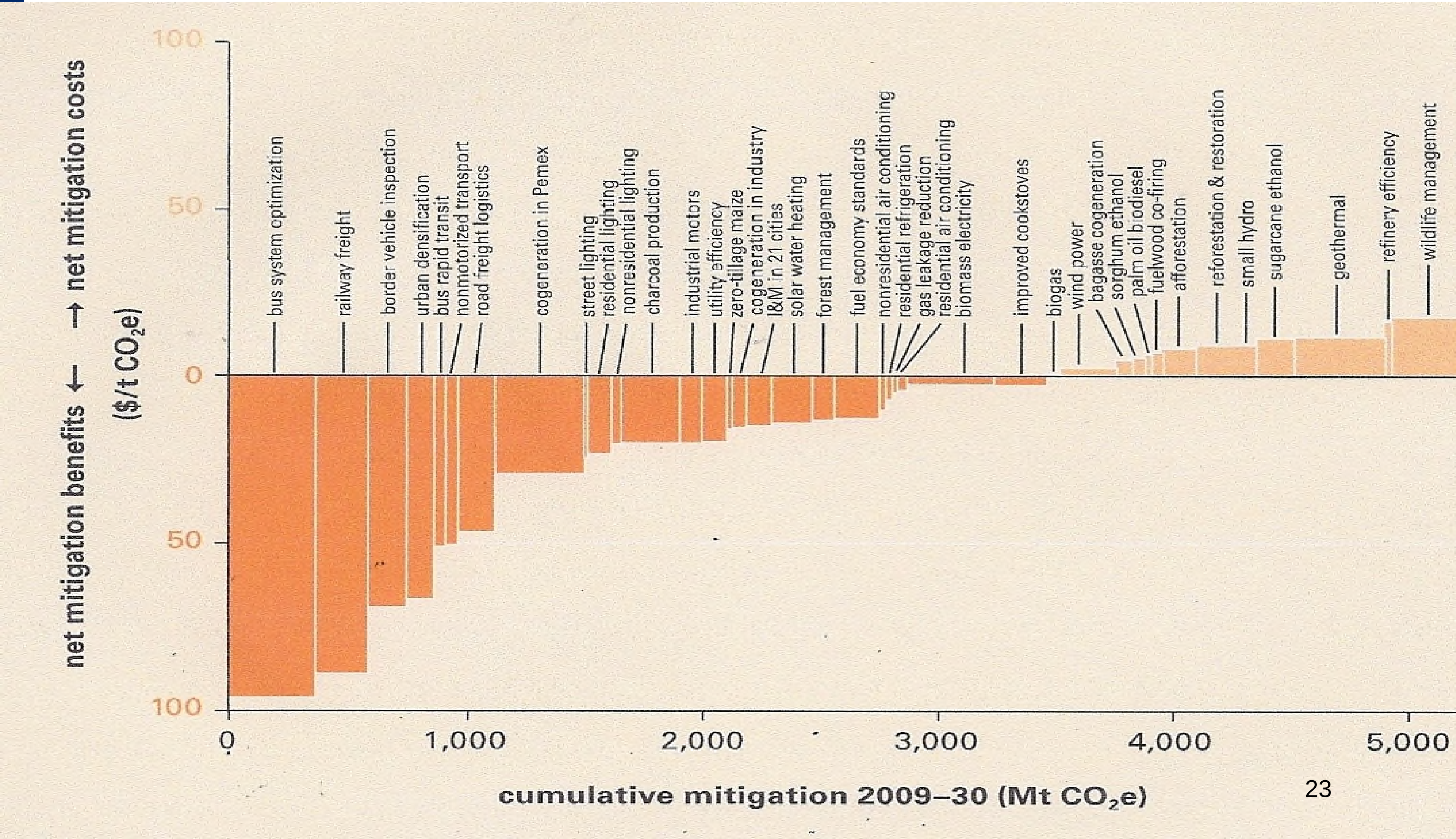


[1] $GtCO_2e$ = gigaton of carbon dioxide equivalent; "business as usual" based on emissions growth driven mainly by increasing demand for energy and transport around the world and by tropical deforestation.
[2] tCO_2e = ton of carbon dioxide equivalent.
[3] Measures costing more than €40 a ton were not the focus of this study.
[4] Atmospheric concentration of all greenhouse gases recalculated into CO_2 equivalents; ppm = parts per million.
[5] Marginal cost of avoiding emissions of 1 ton of CO_2 equivalents in each abatement demand scenario.

McKinsey MACC Negative Cost Options

- Building insulation (2 options)
- Fuel efficiency in commercial vehicles
- Lighting systems
- Air-conditioning
- Water heating
- Industrial non-CO_2

Mexico MEDEC GHG Negative Cost Options



Mexico MEDEC GHG Negative Cost Options

- Non-motorized transport [e.g., bicycles]
- Road freight logistics
- Co-generation in Pemex
- Residential lighting
- Non-residential lighting
- Charcoal production
- Industrial motors
- Zero-tillage maize
- Co-generation in industry
- Solar water-heating
- Forest management
- Non-residential air conditioning
- Residential refrigeration
- Gas leakage reduction
- Residential air-conditioning
- Bio-mass electricity generation
- Improved cook stoves

Negative Cost Options

You EXPECT negative costs options if MACC is built in economic terms.

You do NOT expect negative cost options on MACCs built in financial terms – WHY?

"That cannot possibly be a $5 bill laying on the sidewalk – somebody already would have picked it up!"

Negative Costs In Economic vs. Financial MACC

- ‘Economic analysis’ MACC: negative cost options explainable by ***Theory of Public Goods & Market Failures***

- ‘Financial analysis’ MACC: negative cost option must be explained by
  - Behavioral failures (e.g., bounded rationality)
  - Faulty set-up of CEA (failure to handle secondary objectives correctly, analytical framework not correctly reflecting clients’ objectives, etc.)

What Causes Negative Costs in Economic CEA?

- Negative costs occur when ‘co-benefits’ are larger than cost difference between low-carbon option vs BAU option
- Co-benefits are secondary (i.e., non-carbon) impacts that accompany choice
  - Burning less fuel not only reduces CO2 emissions, it also reduces particulate and sulfur emissions
  - Improving bus routes not only reduces fuel use and GHG emissions, it also saves passengers’ time
- Co-benefits (and co-costs) occur mostly as ‘spillovers’ or externalities

MACC Should Always Be an Economic Analysis

Financial analysis is important for analyzing incentives, but we do not need MACC for that

MACCs are for societal (not investor) planning

- Understanding negative cost options may provide government and donors with a basis for identifying new projects/meta-interventions

- In particular, institutional interventions in LEDS planning.

Do Countries Implement Micro-MACCs from Low-to-high?

No, not really

- Cost-effectiveness in mitigating GHG emissions is only one objective of the country
- Costs are ‘economic’ and, thus, will be spread amongst different stakeholders with differing incentives
- Budget implications of each option’s cost varies and is important
- Some options require behavior change (which can take a long time to achieve)
- Some involve private expenditure, which can be difficult to control
- And, finally, low-to-high on Micro-MACC does not necessarily mirror ‘good’ to ‘bad’ on Macro-MACC

Why is Microeconomic MACC not Sufficient?

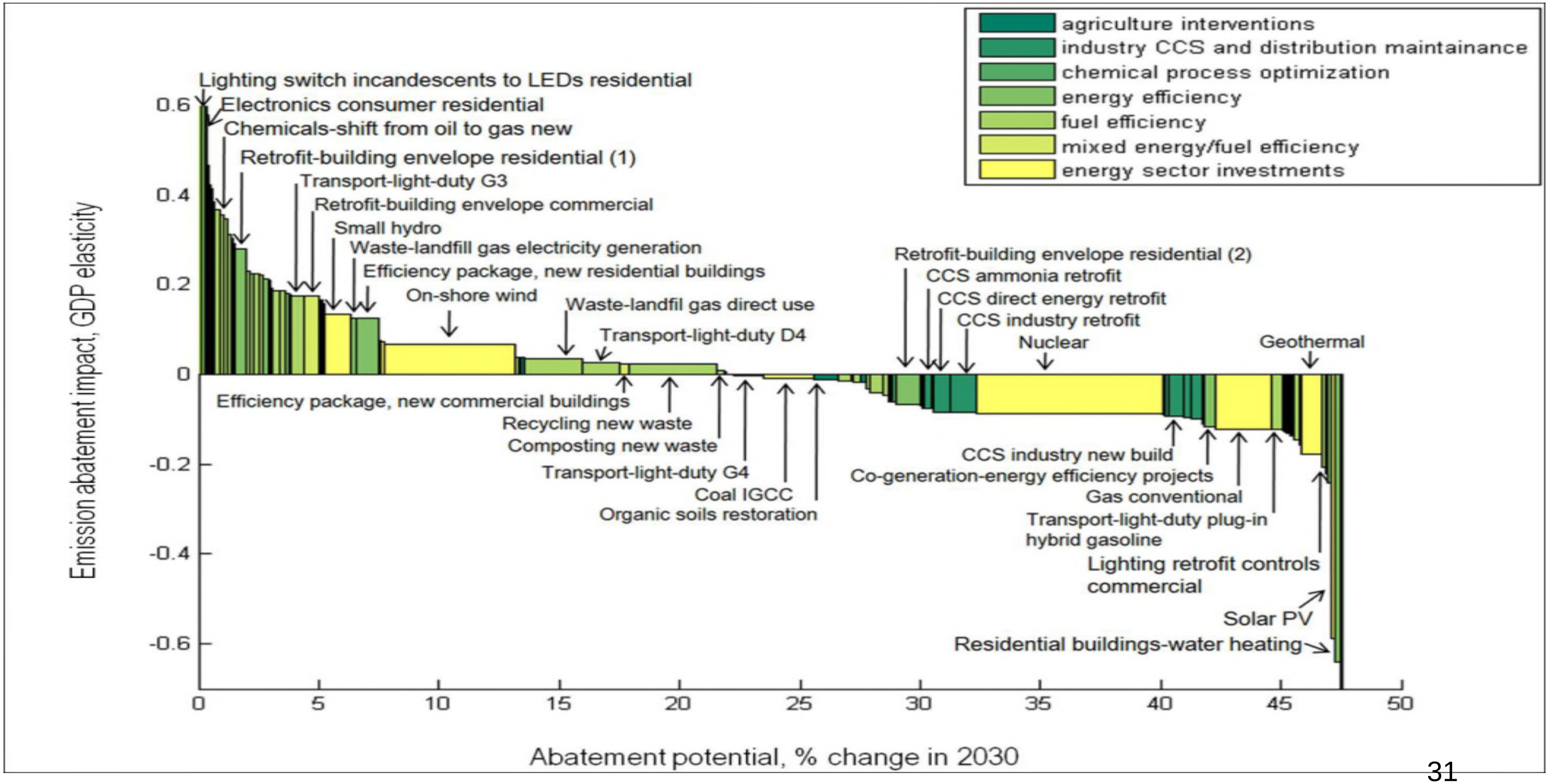
- Micro-MACC shows static costs per tonne of CO_2e reduction

- Static cost per tonne of CO_2e does not necessarily match up with GDP cost of activity change in that industry—i.e., some industries with ‘good’ C/E ratios for GHG mitigation may show larger negative changes in GDP growth from those interventions

- Thus, Micro-MACC does ***not*** directly show the impact on GDP

Macro-MACCs

Evolving World Bank concept that assesses macro-economic impacts of alternative mitigation projects vs. a baseline (BAU)



Erika Jorgensen and Leszek Kasek. 2010. Transition to a Low-Carbon Economy in Poland. The World Bank, Europe and Central Asia Region. Washington, D.C.

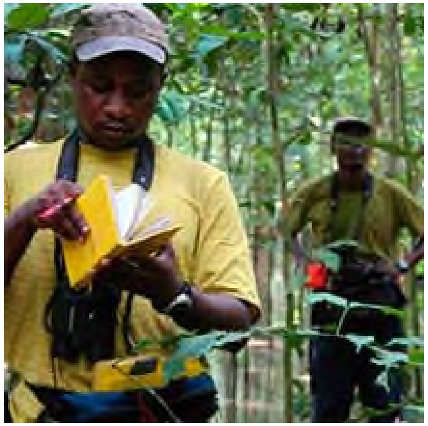
Getting to a Macro-MACC from a Micro-MACC

Generated from a series of intermediate models

- **MicroMACC**—Familiar bottom-up, engineering model.
- **Macroeconomic Mitigation Options (MEMO)—**Dynamic stochastic general equilibrium (DSGE) model revised to include energy and emissions; assesses macroeconomic impact of options costed in MicroMAC curve.
- Linked to MAC curve via a **Microeconomic Investment Decisions (MIND)** module which groups technology levers into seven packages, including optimized package of options for the energy sector.
- **Regional Options of Carbon Abatement (ROCA)—**Country-level CGE model, analyzes implementation of EU 20-20-20 policy with emphasis on feedback effects from international markets.
- **TREMOVE Plus—**Detailed model for road transport (fastest growing emissions and central to Poland's commitments under EU 20-20-20).Updates & adapts EU transport and environmental model, TREMOVE.

What about Ecosystem Services in MACCs?

- Critical ‘co-benefit’ commonly left out of MACCs (both Micro & Macro) is value of ecosystem services



- Ecosystem services can be very important to agriculture, water management, and community health

- *While ecosystem service valuation is in its infancy, its importance in sustainable development programming is growing exponentially**

** In 1995 Robert Costanza estimated value of ecosystem services to exceed value of all human production.*

Session Outline

Part 1- Reading MACCs

Part 2- Analyzing MACCs

Part 3- Case Studies

Reviewing MACC applications

Take-Aways

- Micro-MACCs provide a statement of *marginal cost of* mitigating GHGs
- Done correctly, Micro-MACCs provide useful if insufficient information
- Thus, Micro-MACCs should be supplemented by other models/studies (e.g., Macro-MACCs)
- Finally, remember what to look out for in both understanding & critiquing Micro-MACCs

1. Win-win range (only an economic concept)
2. 'Knee' of the function—generally don't implement options beyond the knee
3. Whether MACC is clearly 'economic' analysis
4. Whether the options are real projects, technologies, chimera, or meta-interventions

Resources (1)

Erika Jorgensen and Leszek Kasek. December 2010. Transition to a Low-Carbon Economy in Poland. The World Bank, Europe and Central Asia Region. Washington, D.C.

ESMAP. 2012. *Planning for a Low Carbon Future. Lessons from Seven Country Studies.* Low Carbon Growth Country Studies Program. The World Bank. Washington, D.C.
http://www.esmap.org/sites/esmap.org/files/ESMAP_LCD-LessonsLearned_2012_0.pdf

ESMAP. 2009. *Low Carbon Growth Studies Program. Mitigating climate change through development.* The World Bank. Washington, D.C.
http://wbi.worldbank.org/wbi/document/low-carbon-growth-country-studies-program-mitigating-climate-change-through-development

Resources (2)

Todd M. Johnson, Claudio Alatorre, Zayra Romo and Feng Liu.2009. *Low-Carbon Development for Mexico.* The World Bank. Washington, D.C.

William A. Ward. 2012. “Roles for Legal Scholarship in the Design of Meta-Interventions for Energy Efficiency and GHG Abatement: Lessons from Cost-Benefit Analyses of Low-Emission Development Strategies in China, Mexico, Colombia, and Beyond”. *Wyoming Law Review*, Vol. 12, Issue 2 (Summer 2012), pp. 339-362.

Cost-Benefit Analysis of Global Climate Change Mitigation

MACC Analysis in Northeast Asia

AILEG Analysis and Investment for Low-Emission Growth

Michael I. Westphal
Abt Associates

March 6, 2013

Session Outline

ABD Method — The ADB methodology for determining MACCs for NE Asia

Country MACCs — MACCs for Japan, Korea, China, Mongolia

Lessons Learned — Lessons from the studies and importance for USAID

Asian Development Bank: "Economics of Climate Change in Northeast Asia"

- Countries: China, Japan, Korea, Mongolia
- Asia Pacific Integrated Model (Enduse), Mizuho information and Research Institute
- Sectors: power generation, industry, residential and commercial, transportation, agriculture, non-energy
- Emissions projections, abatement potential, and marginal costs of abatement technologies for 2020 and 2030
- "Frozen" technology scenario (2008) and mitigation scenarios: selection of all technologies under price threshold of
  - $\$50/tCO_2e$
  - $\$100/tCO_2e$
  - $\$200/tCO_2e$
  - $\$1{,}000/tCO_2e$

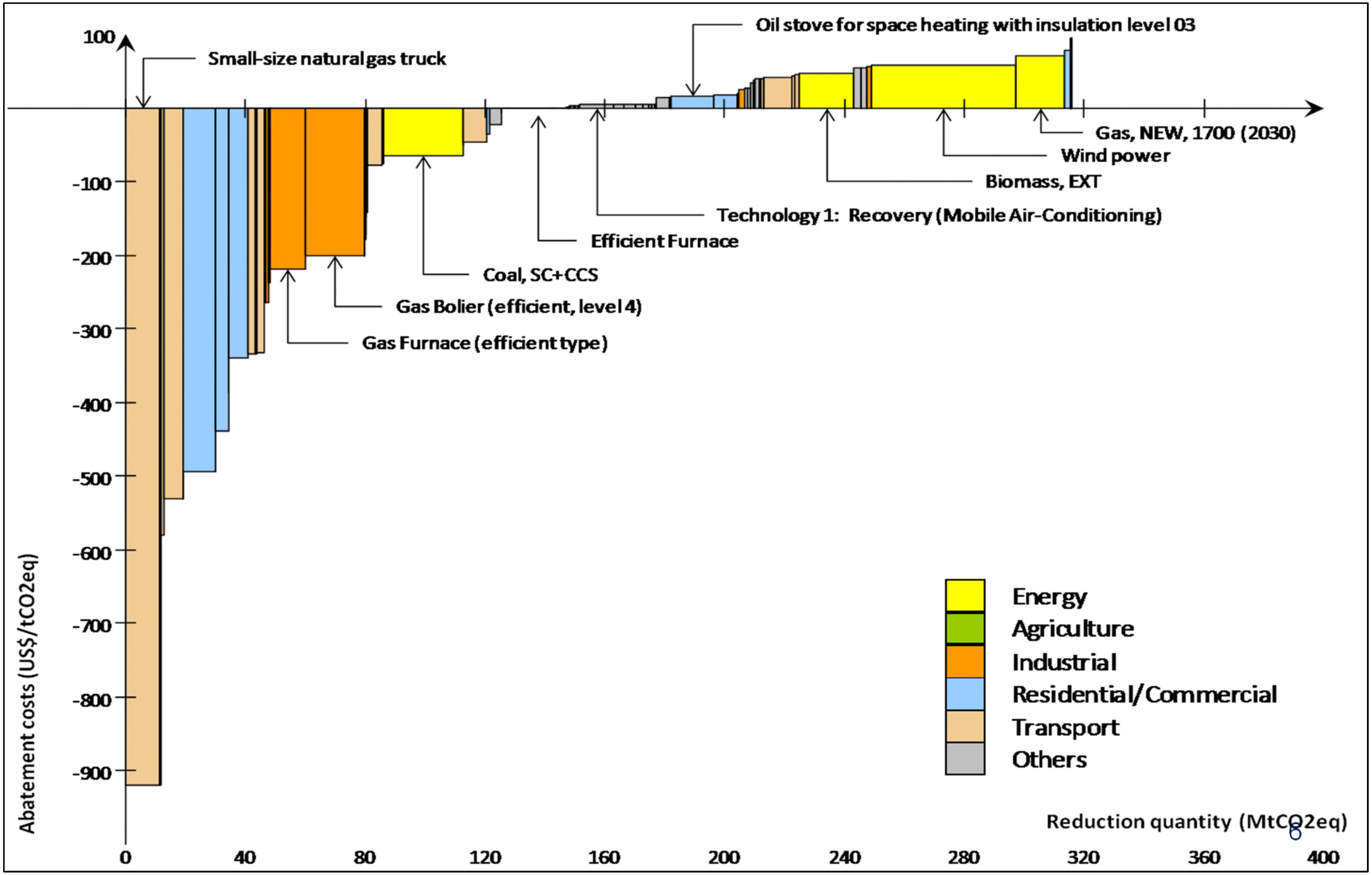
Asian Development Bank:
"Economics of Climate Change in Northeast Asia"

- Driven by ***Service Demands:*** measureable need in some sector of economy
  - o cement production
  - o person-km traveled in the transport sector
  - o amount of household heating and lighting
  - o number of livestock
  - ➢ Government projections directly or functions of GDP/population
- Two discount rate/ payback period scenarios (LDR: 5%)

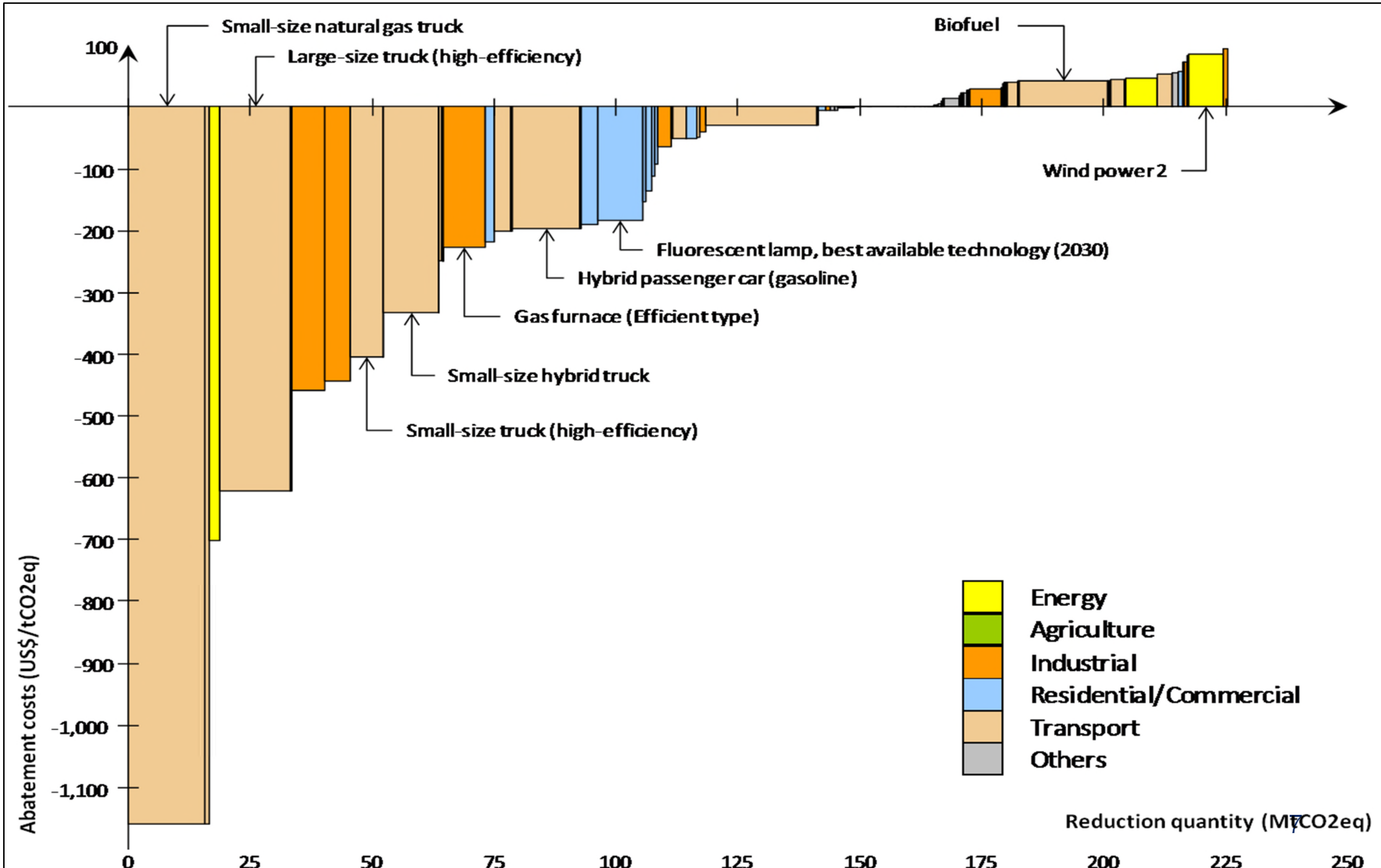
Session Outline

- ABD Method
- **Country MACCs** — MACCs for Japan, Korea, China, Mongolia
- Lessons Learned

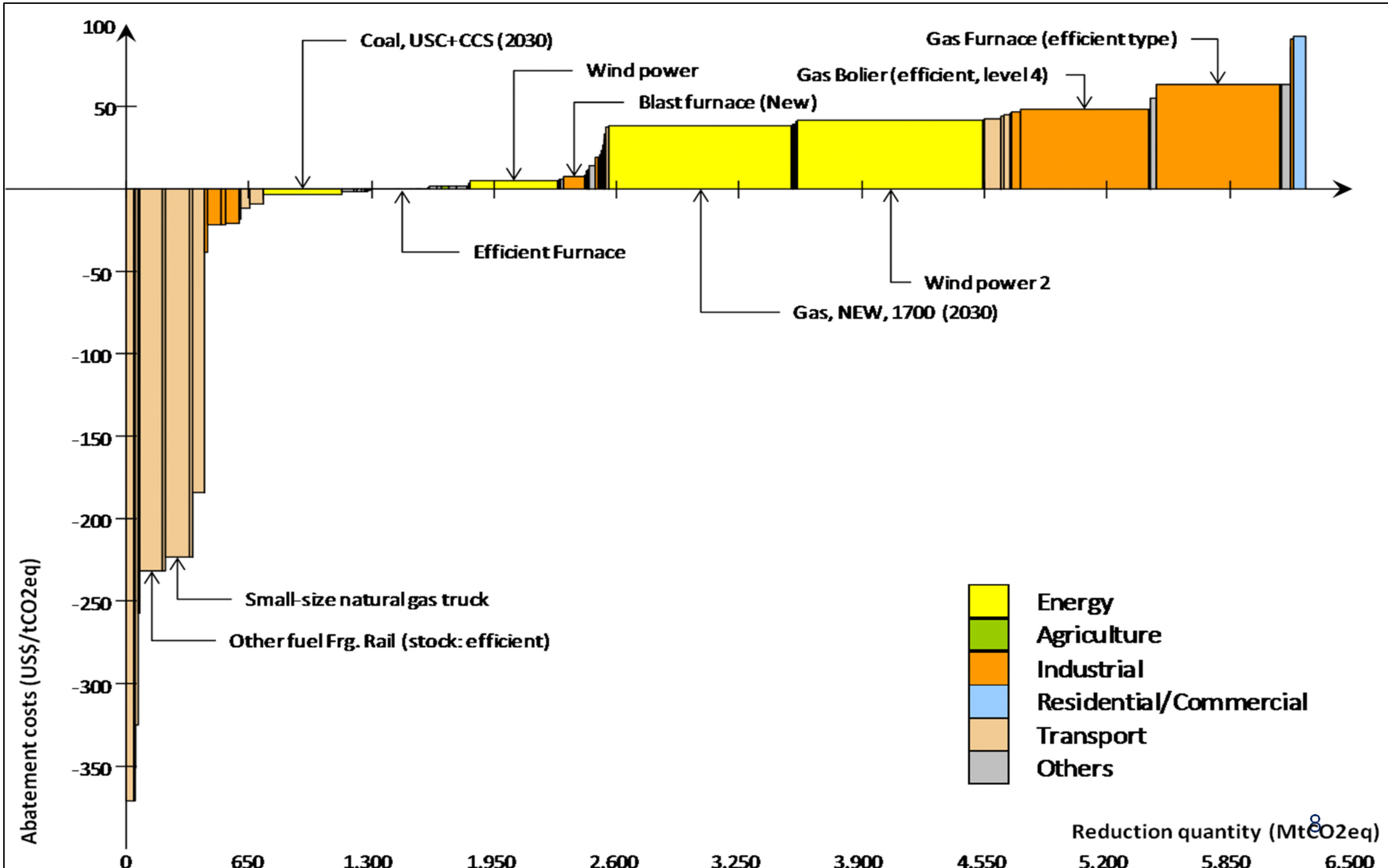
Japan (2030, HDR, $100/tCO$_2$e)



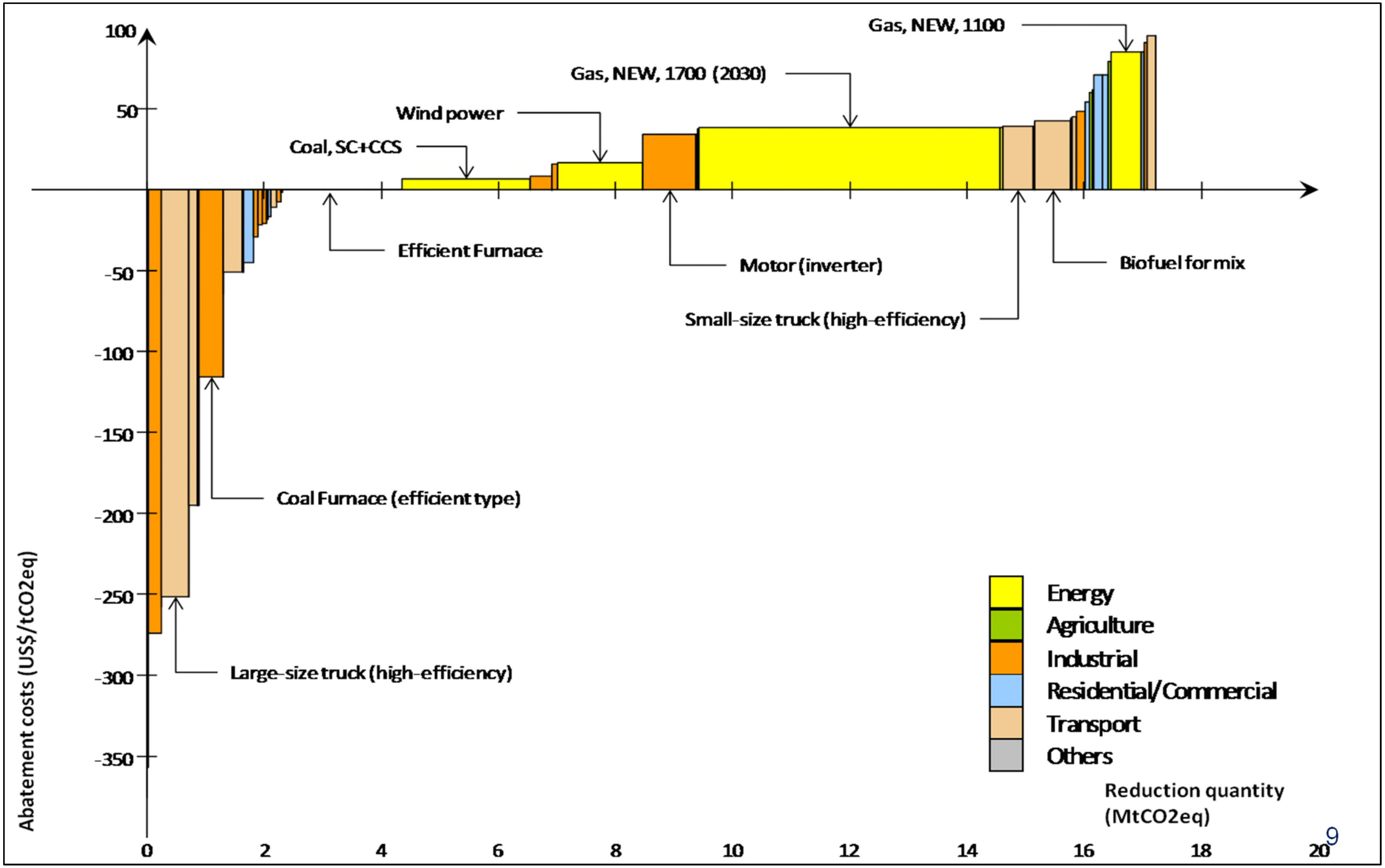
Korea (2030, HDR, $100/tCO$_2$e)



China (2030, HDR, $100/t$CO_2$e)



Mongolia (2030, HDR, \$100/tCO_2e)



Abatement Technologies by Cost

	Japan	Korea	PRC	Mongolia
HIGH	[E] Photovoltaic, hydro [I] Boiler (renewable) [T] Hybrid car (diesel, gas) [RC] Gas/coal stove/coal boiler (space heating)	[E] Photovoltaic, wind power 3 [I] Boiler (renewable) [RC] Gas/coal stove/coal boiler (space heating)	[E] Hydro, wind power 3, wind + storage [I] Boiler (renewable) [T] Hybrid car (gas, diesel)/bus, efficient gas car [RC] AC, biomass/coal stove/coal boiler (space heating)	[E] Hydro, wind + storage [I] Boiler (renewable) [T] Hybrid truck/car (gas, diesel)/bus, efficient gas car [RC] AC, biomass/coal stove/coal boiler (space heating)
$100				
MID	[E] Biomass, wind power, Gas (NEW, 1700) [I] Efficient gas furnace [T] Biofuels	[E] Biomass, wind power 2, coal (SC + CCS) [I] More efficient steel processes [T] Biofuels, hybrid bus	[E] Gas (NEW, 1700), wind power 2 [I] More efficient steel processes [T] Biofuels	[E] Coal (SC + CC), wind power, gas (NEW, 1700) [I] More efficient steel processes [T] Biofuels [RC] Gas stove (space heating)
$0				
LOW	[E] Coal (SC + CCS) [I] Efficient gas furnace, advanced motors [T] Efficient truck/ bus, natural gas truck, efficient rail [RC] CFL, FL lighting	[I] Efficient gas furnace [T] Efficient truck, hybrid truck/car (gas, diesel, efficient Rail [RC] CFL, FL lighting	[E] Coal (USC + CCS) [I] Advanced motors [T] Natural gas trucks, efficient trucks, efficient rail [RC] CFL, FL lighting	[I] Advanced motors [T] Efficient/electric Rail, efficient trucks (RC] CFL, FL lighting

E = electricity generation; T = transport, RC = residential/commercial, I = industry

Session Outline

ABD Method

Country MACCs

Lessons Learned — Lessons from the studies and importance for USAID

Lessons from Northeast MAC Curves

- **Devil is in the data**
  - Future cost, energy, diffusion; socio-economics
- Methodological details
  - Non-nested nature of the MAC curves for this study
- Discount rates important
  - Increases total abatement potential but does not substantially change MAC curves in this study
- Technologies are all relative
- Technologies assumed to be independent
  - Order of wind vs. DSM would give you much different cost and abatement potential estimates

Lessons from Northeast MAC Curves

- No co-benefits
  - Many coal-related abatement options (e.g. coal washing, improved boilers, co-generation) in China have negative costs when health co-benefits included (Shanxi Province)
- Engineering costs not programmatic costs
- Planning not just technology important
  - City planning is a tremendous determinant on a city's energy consumption and constrains the potential for reductions in GHG emissions
- MACs just first-cut screen -> one component in LEDS