Low Carbon Development Planning
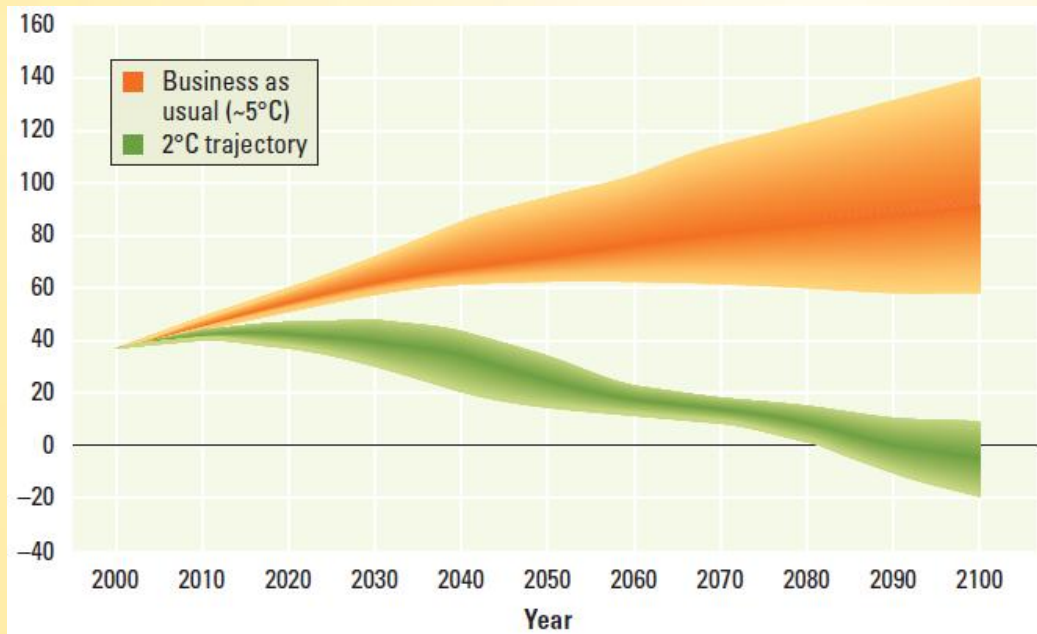
All countries must act now (but differently) to mitigate emissions or the 2°C trajectory is out of reach

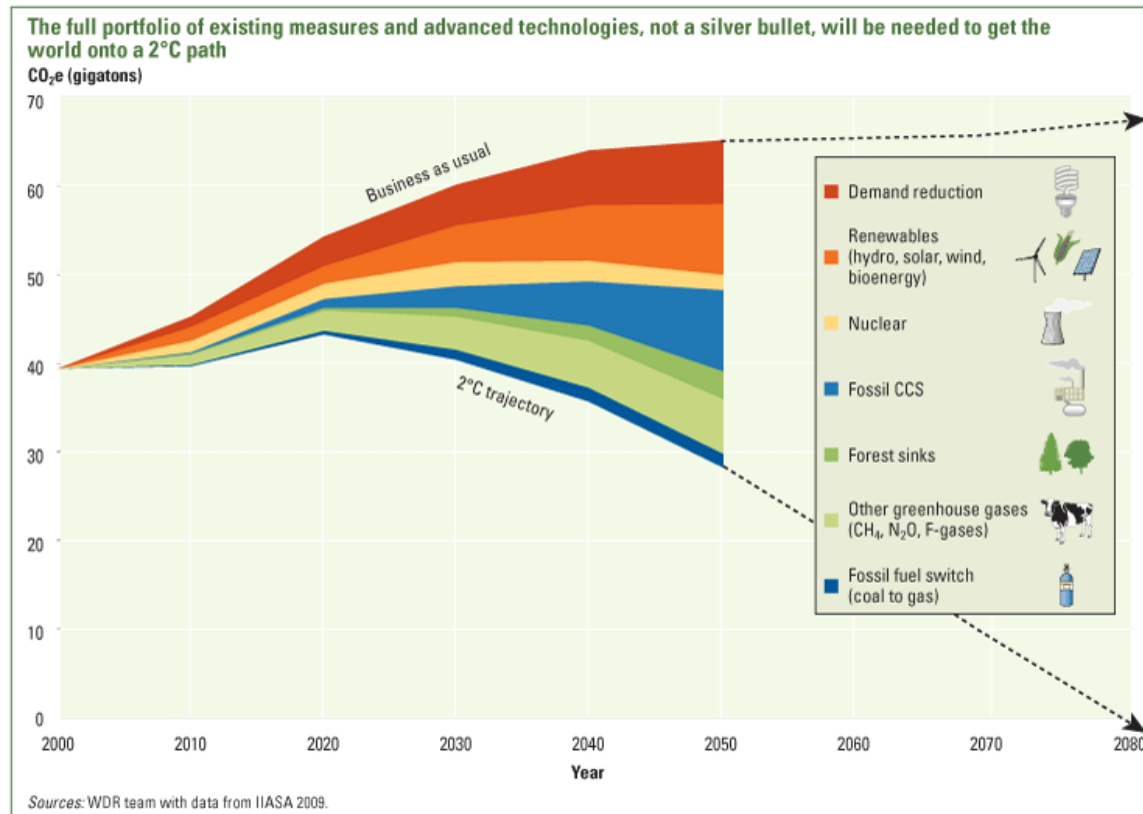**Projected annual total global emissions (billion tons of CO_2 equivalent)**

Low Carbon Studies:

✓Focused on high GHG emitters

✓Asked: Is there a low carbon option? Where is the GHG mitigation potential?

✓Looked at development objectives

✓Determined how to lower carbon footprints to 2030 economically

✓Assessed financing needs and other requirements

Smart Development

Involves a portfolio of cross sector adaptation and mitigation measures

The full portfolio of existing measures and advanced technologies, not a silver bullet, will be needed to get the world onto a 2°C path

CO_2e (gigatons)

Business as usual

2°C trajectory

- Demand reduction
- Renewables (hydro, solar, wind, bioenergy)
- Nuclear
- Fossil CCS
- Forest sinks
- Other greenhouse gases (CH_4, N_2O, F-gases)
- Fossil fuel switch (coal to gas)

Year

Sources: WDR team with data from IIASA 2009.

Low Carbon Studies:

✓Need cross sector approach

✓It will require strong commitments and new technology, finance and capacity

✓National (cross ministry) coordination essential

✓Countries must address difficult barriers

✓It is not an easy process

Low Carbon Development cannot be achieved without a proper enabling environment…

Incentives → Rationalize energy, water and agricultural price, tax incentives, fiscal and expenditure policies

Regulations → Efficiency standards; codes, zoning; climate screening/ proofing of investments

Institutions → Capacity of public, private and financial sector institutions to assess and act on climate risks
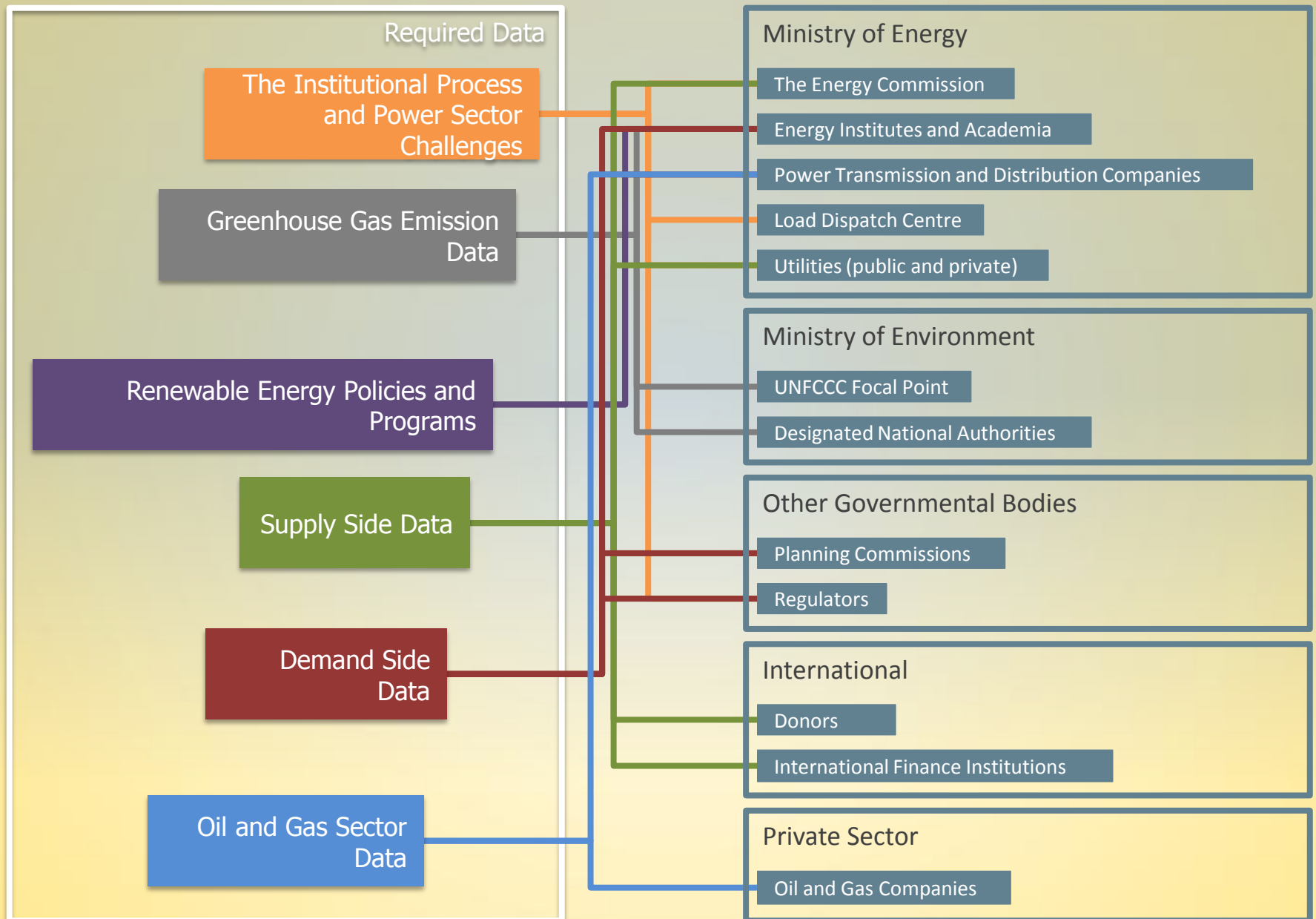
Markets → Improve investment climate; deepen financial and capital markets; new markets (cap & trade, CDM)

Public Outreach → Education, raising awareness and promoting change in consumer behavior and preferences
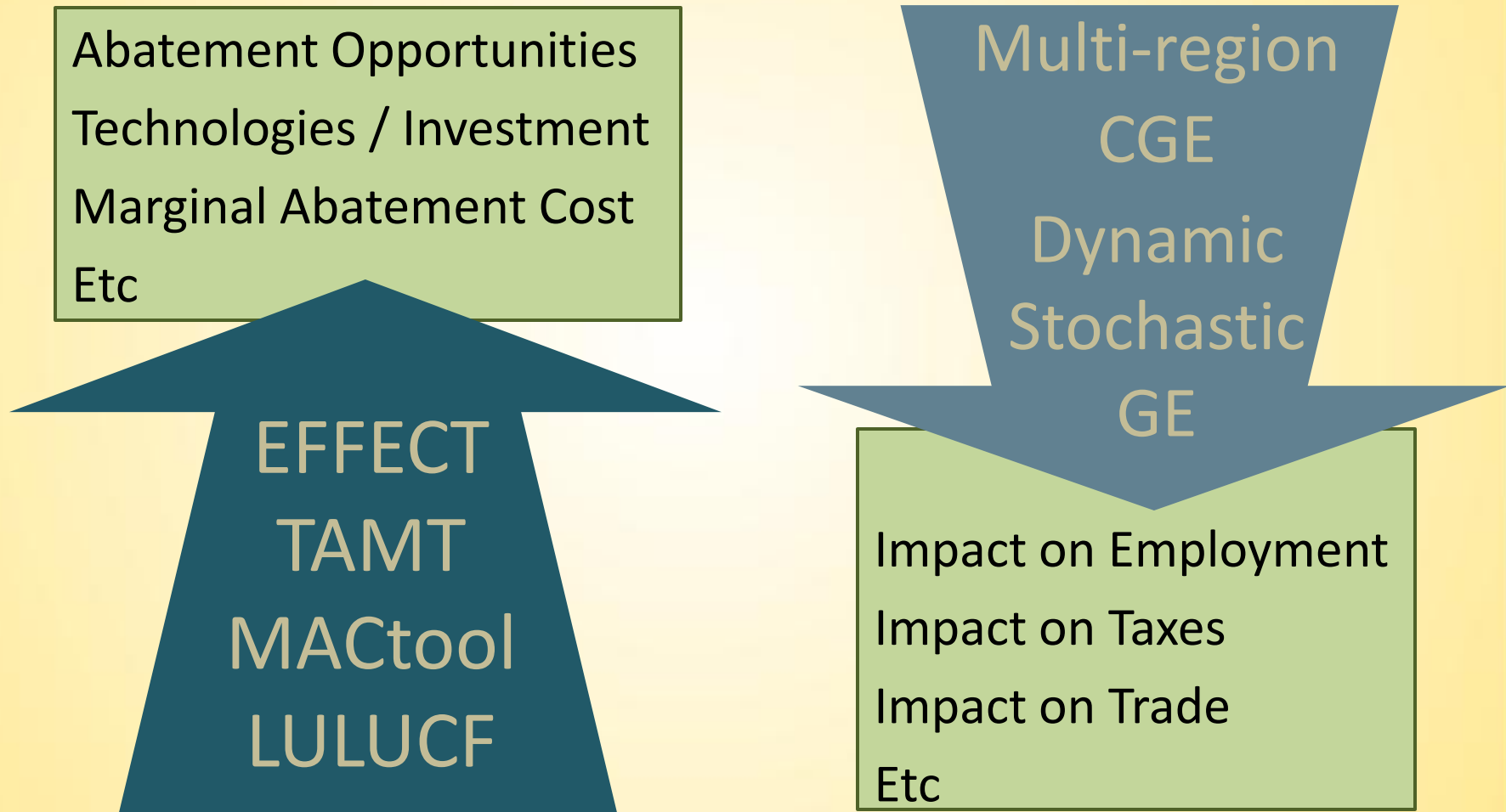
Types of Data and where to find it (Power sector only)

Required Data
- The Institutional Process and Power Sector Challenges
- Greenhouse Gas Emission Data
- Renewable Energy Policies and Programs
- Supply Side Data
- Demand Side Data
- Oil and Gas Sector Data

Ministry of Energy
- The Energy Commission
- Energy Institutes and Academia
- Power Transmission and Distribution Companies
- Load Dispatch Centre
- Utilities (public and private)

Ministry of Environment
- UNFCCC Focal Point
- Designated National Authorities

Other Governmental Bodies
- Planning Commissions
- Regulators

International
- Donors
- International Finance Institutions

Private Sector
- Oil and Gas Companies

Involves Multiple Stakeholders

Principal stakeholders involved in developing India's First National Communication

Table 1 - Principal stakeholders involved in developing India's First National Communication	
Planning Commission	
Ministries	*Institutes*
Ministry of Agriculture	Central Fuel Research Institute
Ministry of Coal	Central Glass and Ceramic Research Institute
Ministry of Environment & Forests	Central Leather Research Institute
Ministry of External Affairs	Central Mining Research Institute
Ministry of Finance	Central Rice Research Institute
Ministry of Heavy Industries & Public Enterprises	Central Road Research Institute
Ministry of Non-Conventional Energy Sources	Forest Research Institute
Ministry of Petroleum & Natural Gas	G.B. Pant Institute of Himalayan Environment & Development
Ministry of Power	Indian Agricultural Research Institute
Ministry of Road Transport & Highways	Indian Institute of Forest Management, Bhopal
Ministry of Science & Technology	Indian Institute of Management
Councils	Indian Institute of Petroleum
Confederation of Indian Industry	Indian Institute of Science
Council of Scientific and Industrial Research	Indian Institute of Technology
Federation of Indian Chambers of Commerce and Industry	Indian Institute of Tropical Meteorology
Indian Council for Agricultural Research (ICAR)	Indira Gandhi Institute of Development Research
Indian Council of Medical Research	Institute for Social and Economic Change
National Council for Cement and Building Materials	Institute of Radio-physics and Electronics
Associations	Kerala Forest Research Institute
Associated Chambers of Commerce and Industry	Maulana Azad National Institute of Technology
Cement Manufacturers' Association	National Dairy Research Institute
Laboratories	National Environmental Engineering Research Institute
Forest Survey of India	National Institute of Advanced Studies
India Meteorological Departmen	National Institute of Oceanography
India Meteorology Department	The Energy and Resources Institute
Indian Space Research Organisation	Wildlife Institute of India
National Chemical Laboratory	*Universities*
National Physical Laboratory	Aligarh Muslim University
Regional Research Laboratory	Jadavpur University
Remote Sensing Applications Centre	Jawaharlal Nehru University
NGOs and Centers	School of Environmental Management
Centre for Environment Education	Tamil Nadu Agricultural University
Centre for Inter-Disciplinary Studies of Mountain and Hill Environment	Tripura University
Centre for Sustainable Technologies	University of Agricultural Sciences
Development Alternatives	University of Delhi
Integrated Research and Action for Development	
Integrated Research and Action for Development	
Malaria Research Centre	
Nehru Foundation for Development	

Several Tools are needed to answer the questions........and prepare a LCD plan

Abatement Opportunities

Technologies / Investment

Marginal Abatement Cost

Etc

Multi-region

CGE

Dynamic

Stochastic

GE

EFFECT

TAMT

MACtool

LULUCF

Impact on Employment

Impact on Taxes

Impact on Trade

Etc

Bottom-up   vs. Top-down

Low Carbon Study takes time…….

- Scoping

- Data Gathering and Validation

- Stakeholder Involvement

- Developing Dynamic Baseline

- Analyzing Low Carbon Options

- Developing Implementation Plan

In this presentation we will cover

EFFECT

Energy Forecasting Framework & Emissions Consensus Tool

MACtool

Marginal Abatement Cost Tool

TAMT

Transport Activity Measurement Toolkit

LULUCF

Land Use, Land Use Change and Forestry Modeling

Linking Bottom-up with Top-down

Linking Macroeconomic and Bottom-Up Models

What is EFFECT?

Energy Forecasting Framework & Emissions Consensus Tool

- Excel-based, bottom-up, engineering style model

- Supports consensus building and planning in key sectors of the economy

- Helps assess the impact of policy choices on GHG emission levels

- Used in Brazil, India, Poland, and six Asian-Pacific countries

EFFECT

Current modules

Transport

Power

Industry

Households

Low Carbon Development Model Structure

General Inputs

Transport · Industry · Agriculture · Households · Nonresidential

Power

Summary
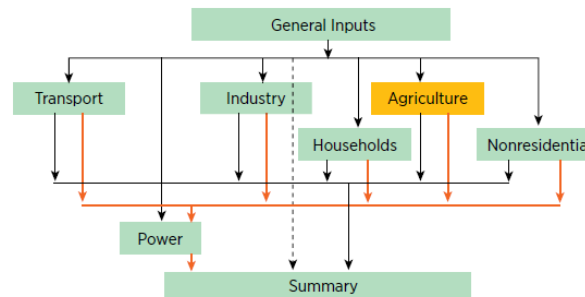
Note: The agriculture module has not been developed at this stage.

Non-residential

EFFECT

eLearning Courses

MACtool

Simultaneous comparison of Mitigation and Sequestration Options

To support efficient decision making processes

Economic Analysis in the Low-carbon Study:
Inform the Decision Making Process

Key questions	Example: Cogeneration from Sugarcane
Is there a low carbon option ?	YES: Extracting condensing turbine, 90 bars
What is the mitigation potential ?	158 MtCO2e (7.5MtCO2/year)
Does it make sense economically from a planning perspective ?	YES: Marginal Abat. Cost = - $ 105 /tCO2 *(8% social discount rate)*
Would it happen spontaneously ?	NO: Sector Expected IRR is 18% > 8% Incentive required = + $ 8 /tCO2
Break-Even Carbon Price = +$8/tCO2	
How much financing needed ?	Additional investment = + $ 35 billion *(+$1.6 bi /year)*

Microeconomic marginal abatement cost (MicroMAC) curve for Poland, 2030
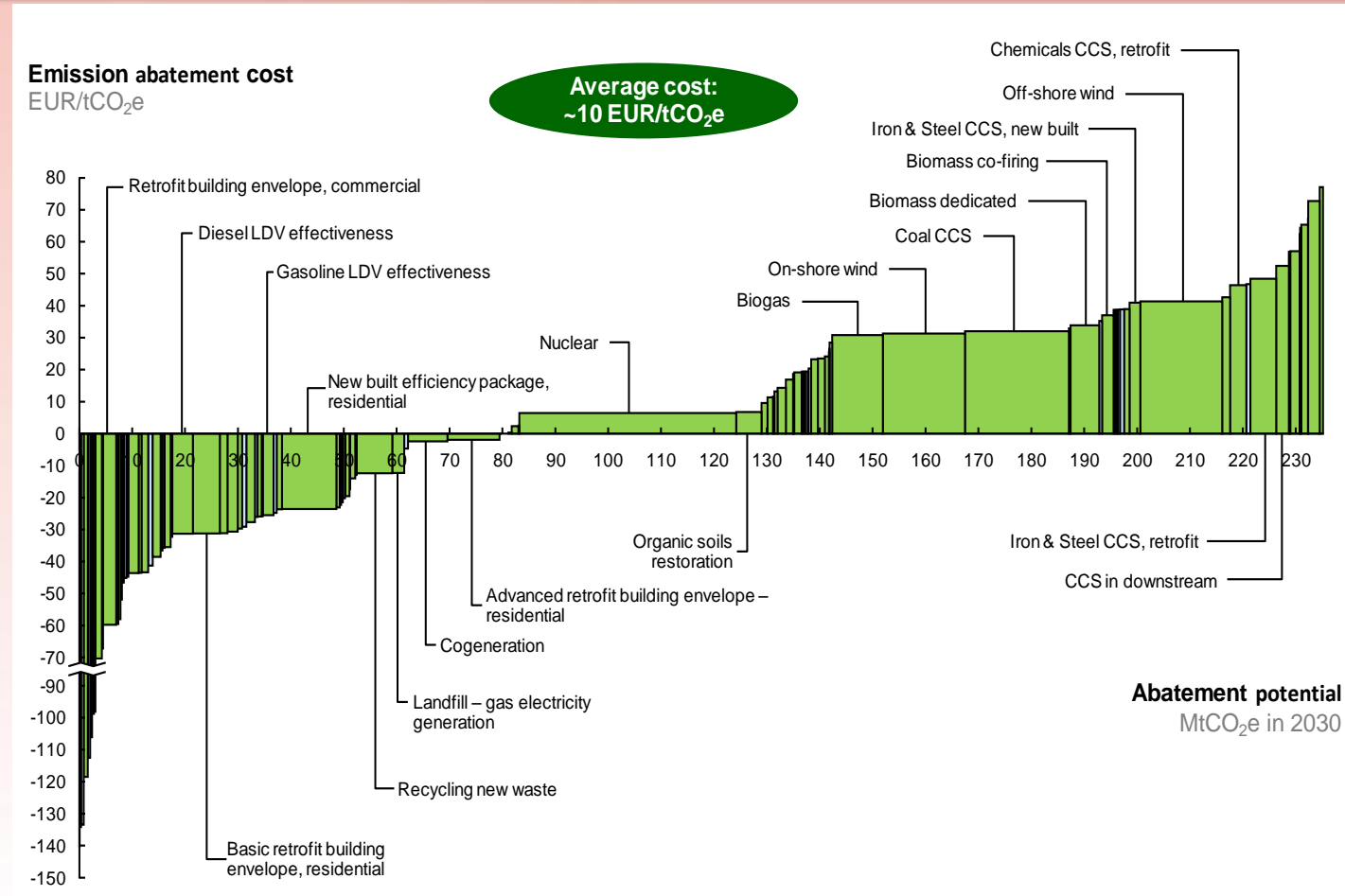
Note: Each column is one of the 123 abatement measures. The height of the columns is the cost in € per abated tCO₂e. The width is the amount emissions can be reduced against business-as-usual levels projected for 2030. Some measures are shown with net benefits (negative costs).

The User's Perspective

- *Road-tested on real cases (Brazil, etc.)*

- *Free of charge*

- *Easy to use (step-by-step, user-friendly interface)*

- *Customized ready to use outputs/graphs*

- *Integrated Help File*

- *Supported by a training program*

TAMT

Transport Activity Measurement Toolkit
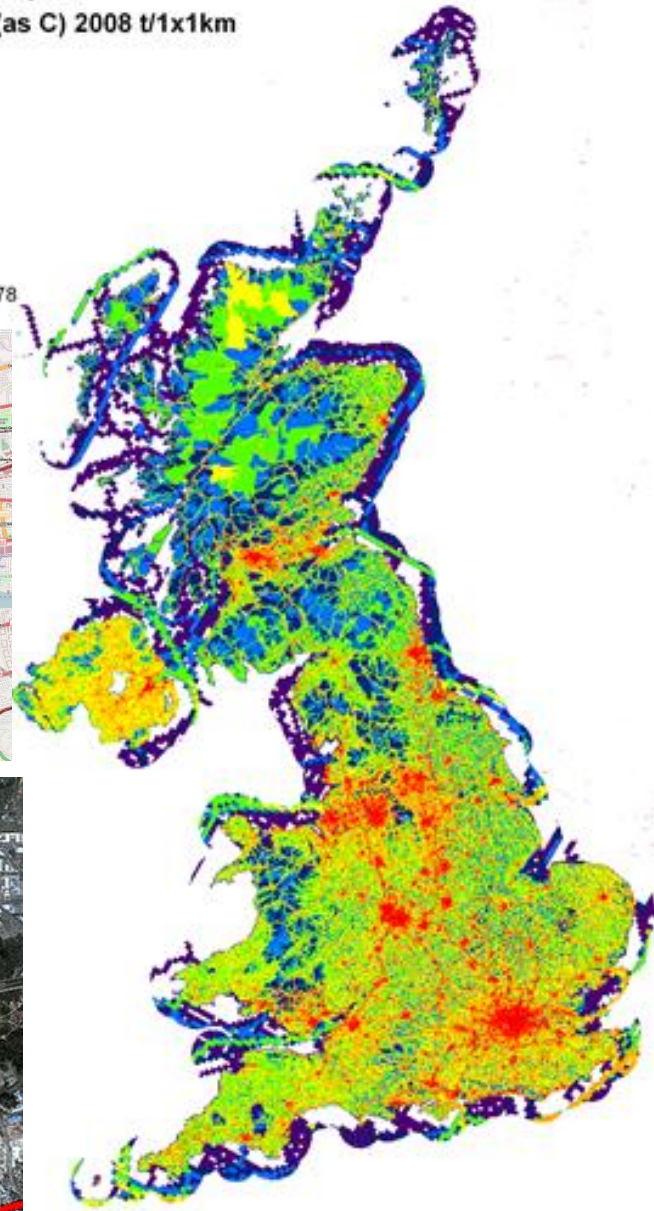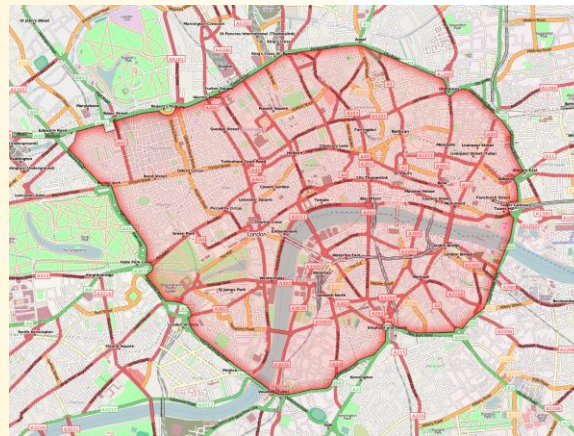
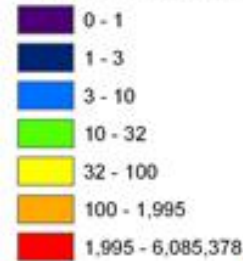1/27/2011

It's all about how to get from this…………

To this…..

GHG and local pollutant inventories at:

- National

- City

- Project levels

and scenario based
emissions forecasting
for distinct interventions

UK Emissions Map of
Carbon Dioxide (as C) 2008 t/1x1km

	0 - 1
	1 - 3
	3 - 10
	10 - 32
	32 - 100
	100 - 1,995
	1,995 - 6,085,378

Transport Activity Measurement Toolkit (TAMT) consists of:

Practitioners Guide
- That answers questions in a practical way:
  - What to measure
  - When to measure
  - How to measure
  - How many to measure
- Forms
- Quality Assurance and Quality control guides
- Help and demos on YouTube

Software tools to simplify data entry and processing
- For GPS collection and analysis
- For traffic counts and analysis

Steps to get an activity-based GHG and local pollutant emissions inventory

T A M T

1 Divide routes into sections
with consistent traffic patterns

2 Measure traffic flow on each section
by Day, Hour and Vehicle Class

3 Measure traffic speed and drive cycles
congested / uncongested flow

4 Measure Vehicle occupancy
to get passenger-km and freight-tonne-km

5 Use fleet composition data
Vehicle sales and registration data
Emissions test databases / Surveys

6 Use emissions (and traffic) models
to calculate GHG and local pollutant
emissions inventories and forecasts

Land Use,
Land Use Change
and Forestry Modeling

Prototypical version developed and road-tested under the Brazil Low Carbon Country Case Study

LULUCF MODELLING

Three main steps:

1) Calculation of the Available Area for agricultural expansion

2) Simulation model of <u>spatial</u> Land Use <u>Change</u> (2010 - 2030)

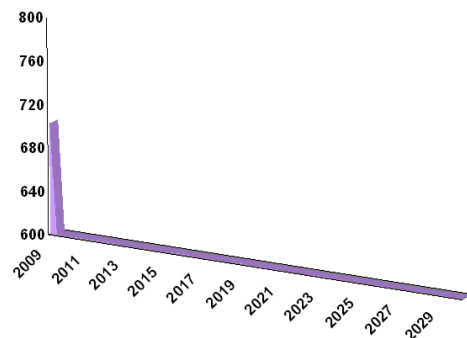*3) Model for GHG Emissions as a function of Land Use Change*
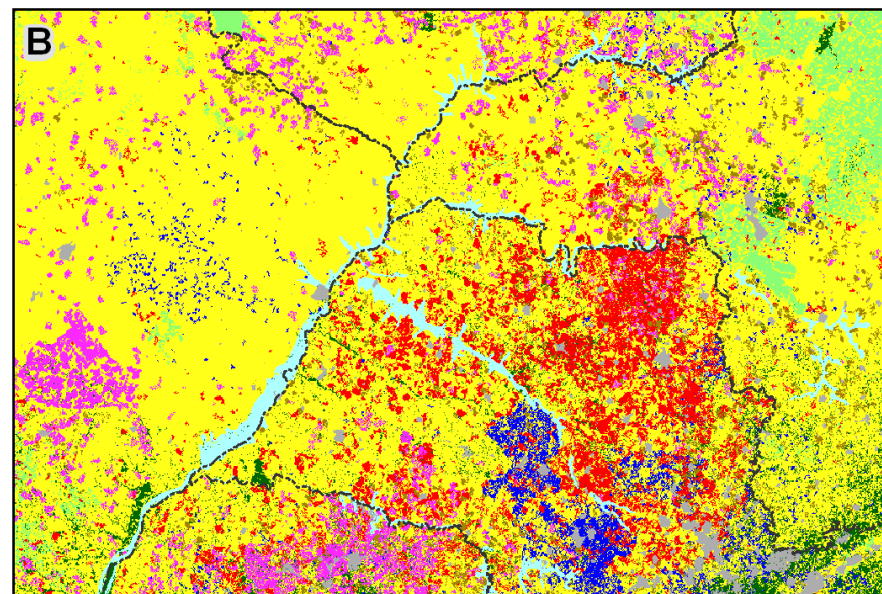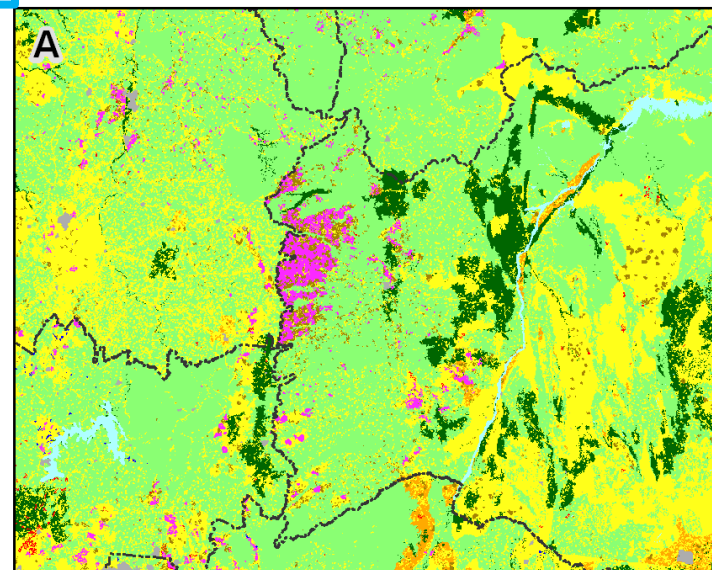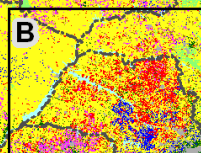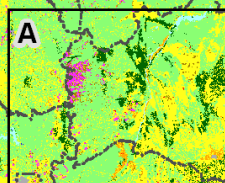
2009

SIM Brasil
(CSR UFMG)

Land Use and Land Use Change Modeling results

A

B

Land use

- urban
- pasture
- forest
- savanna
- secundary growth
- sugarcane
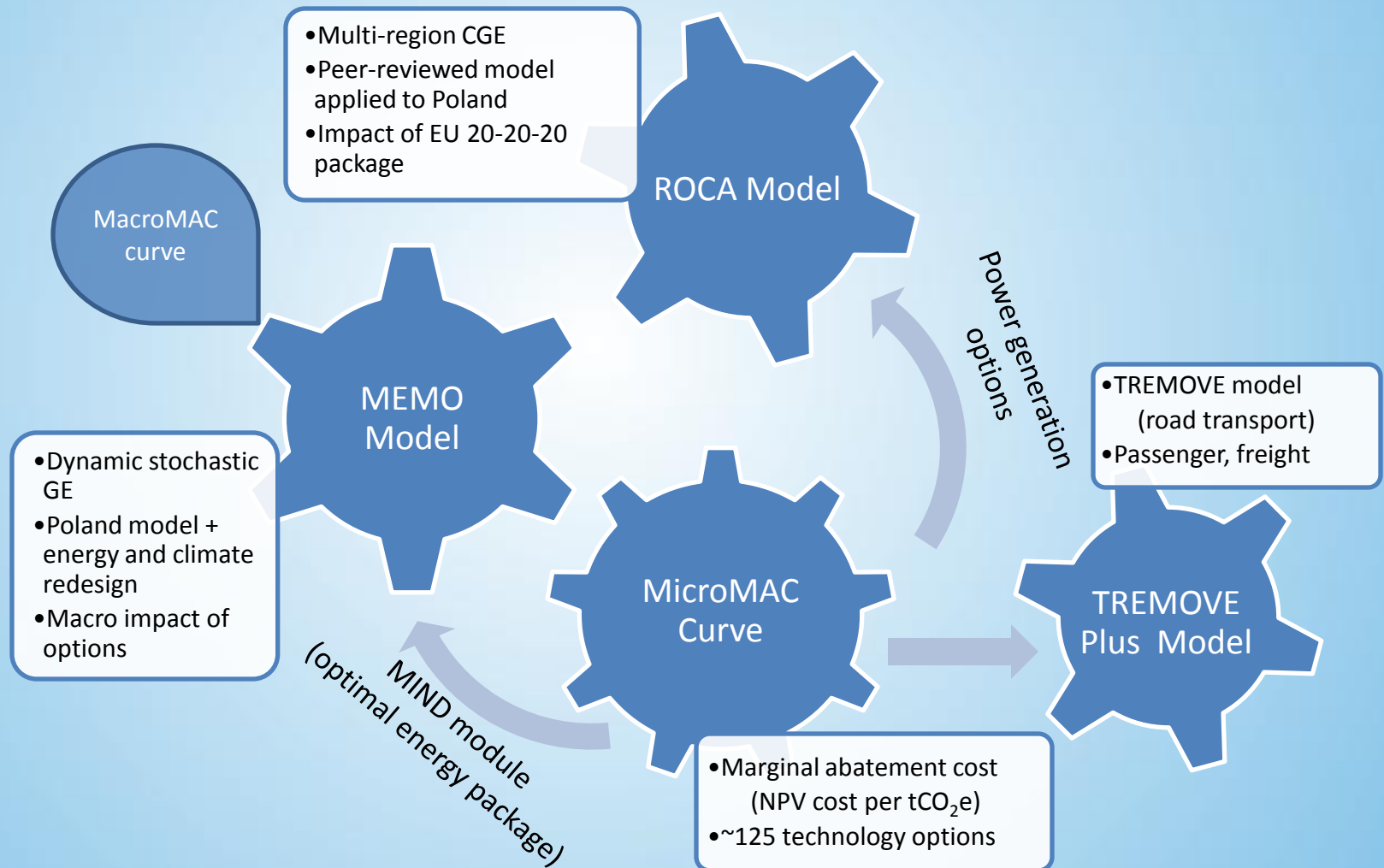- soy
- other crops
- production forest

Brazil´s LULUCF
emissions balance
(MTCO2) - 2009
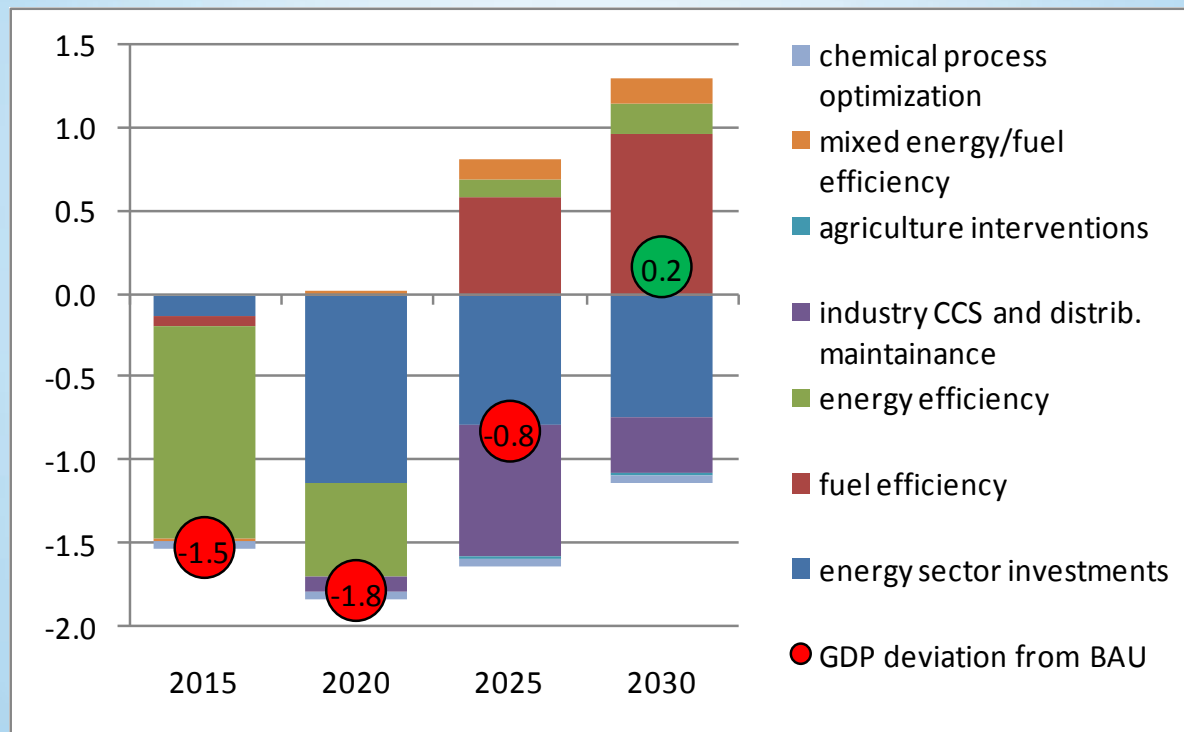
Linking Macroeconomic and Bottom-Up Models

A suite of models to assess carbon abatement

Model suite for low carbon growth assessment for Poland

MacroMAC curve

- Multi-region CGE
- Peer-reviewed model applied to Poland
- Impact of EU 20-20-20 package

ROCA Model

MEMO Model

Power generation options

- TREMOVE model (road transport)
- Passenger, freight

- Dynamic stochastic GE
- Poland model + energy and climate redesign
- Macro impact of options

MIND module (optimal energy package)

MicroMAC Curve

TREMOVE Plus Model

- Marginal abatement cost (NPV cost per tCO_2e)
- ~125 technology options

# Micro-packages with the largest abatement potential do not necessarily impose the biggest macroeconomic cost.

Decomposition of GDP impact of low carbon package, in %

Legend:
- chemical process optimization
- mixed energy/fuel efficiency
- agriculture interventions
- industry CCS and distrib. maintainance
- energy efficiency
- fuel efficiency
- energy sector investments
- GDP deviation from BAU

Note: Change in real GDP is measured against business-as-usual scenario. Categories are micro-packages (mitigation options grouped by economic characteristics).
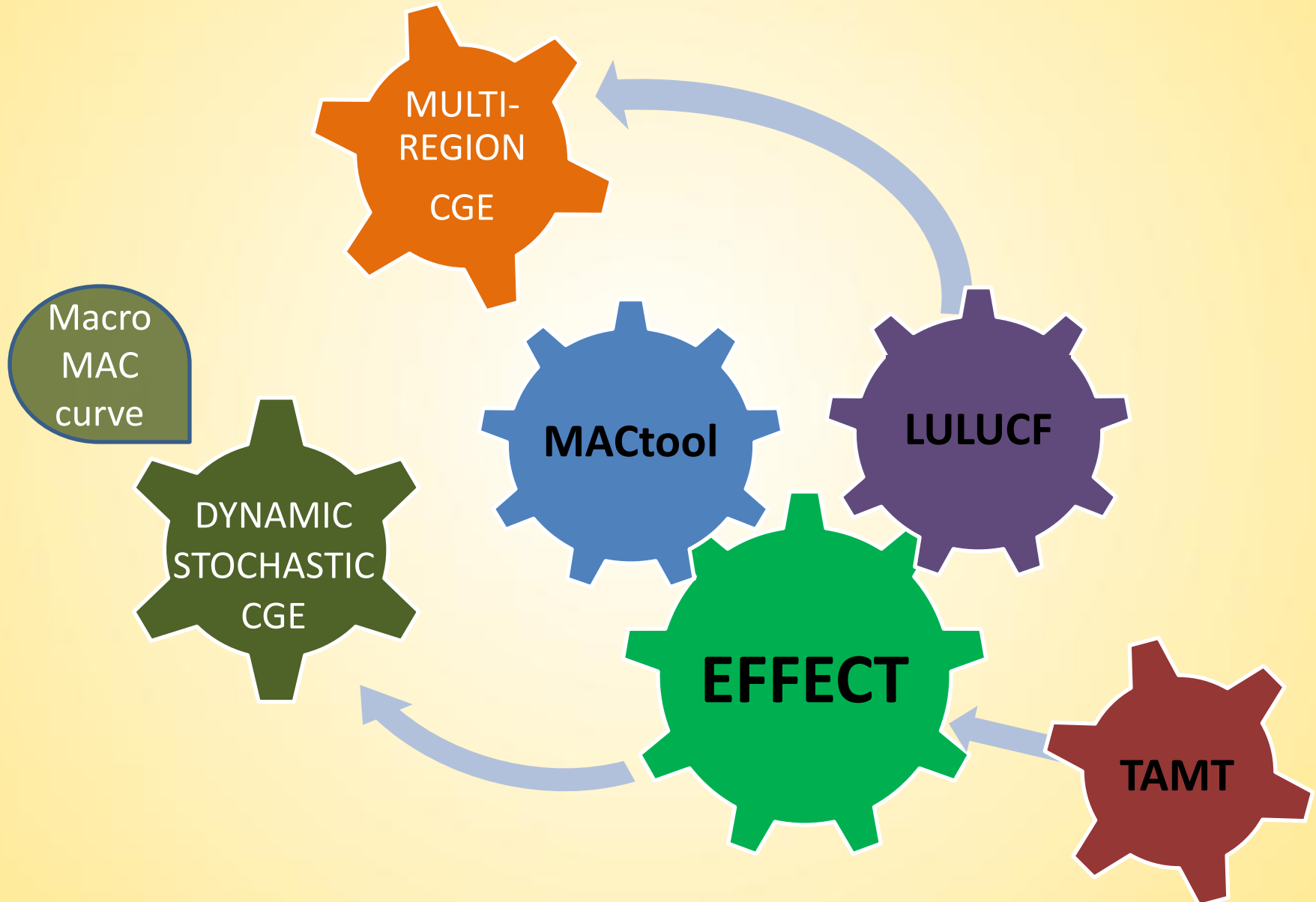
Macroeconomic marginal abatement cost MacroMAC curve, 2030
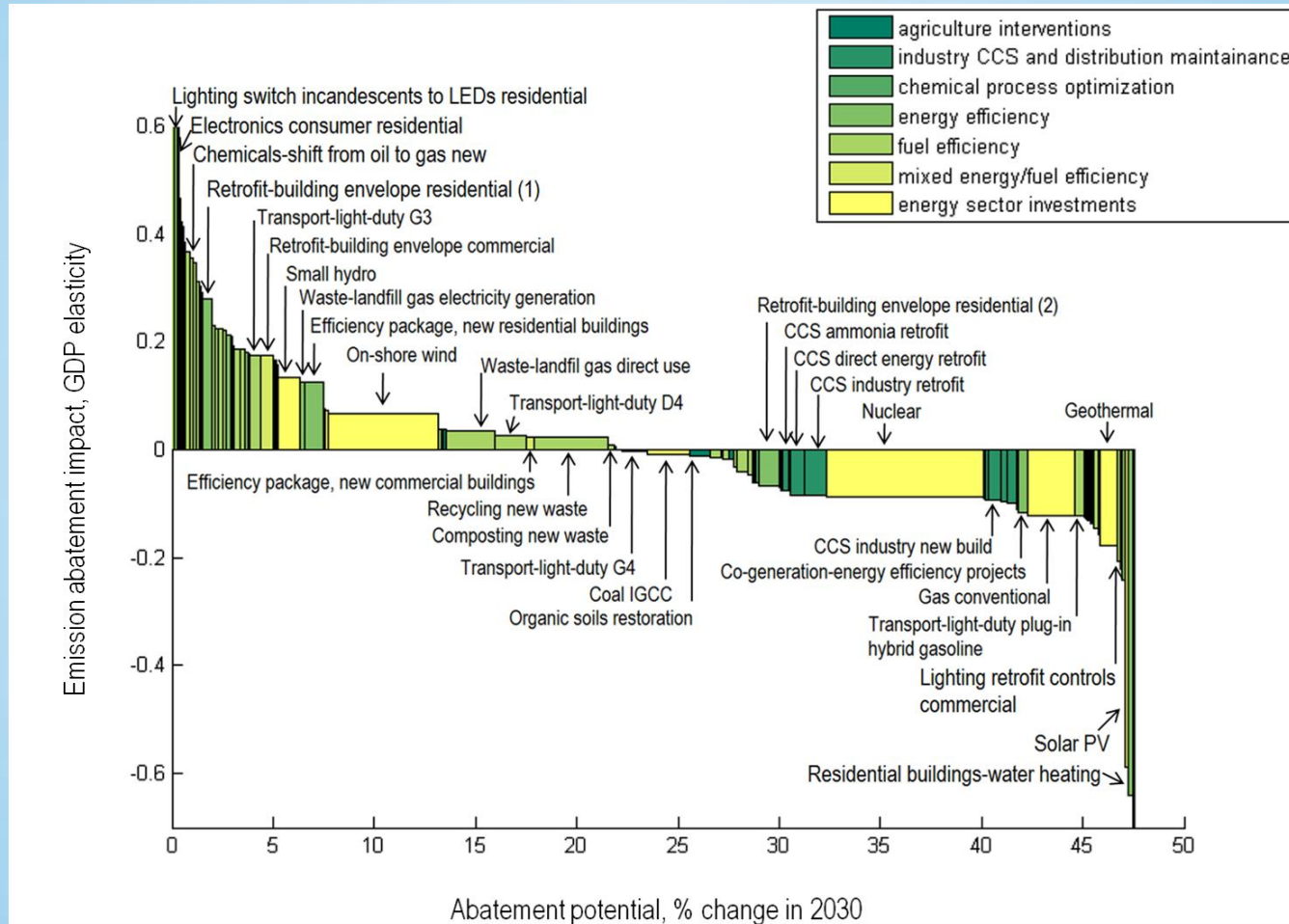
Note: Each column is one of the 119 abatement measures. The height of the columns is the marginal abatement impact in percent of GDP (for each percent of GHG abatement) compared to business-as-usual in 2030. The width is the percent emissions can be reduced. The area of any rectangle equals the GDP effect (loss or gain) of carbon abatement via any specific lever.

Take-away messages on modeling

- Consensus building needs data and assumptions to be openly and transparently shared

- Data gathering takes time but is foundation for future results monitoring

- You need a suite of different models to answer different questions

- Build on existing proven approaches and models

- Build capacity to maintain and update scenarios and models

Thank You

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THE WORLD BANK

ESMAP

Energy Sector Management Assistance Program