Group exercise:

Methodologies of developing scenarios and their advantages and disadvantages

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International Partnership on Mitigation and MRV

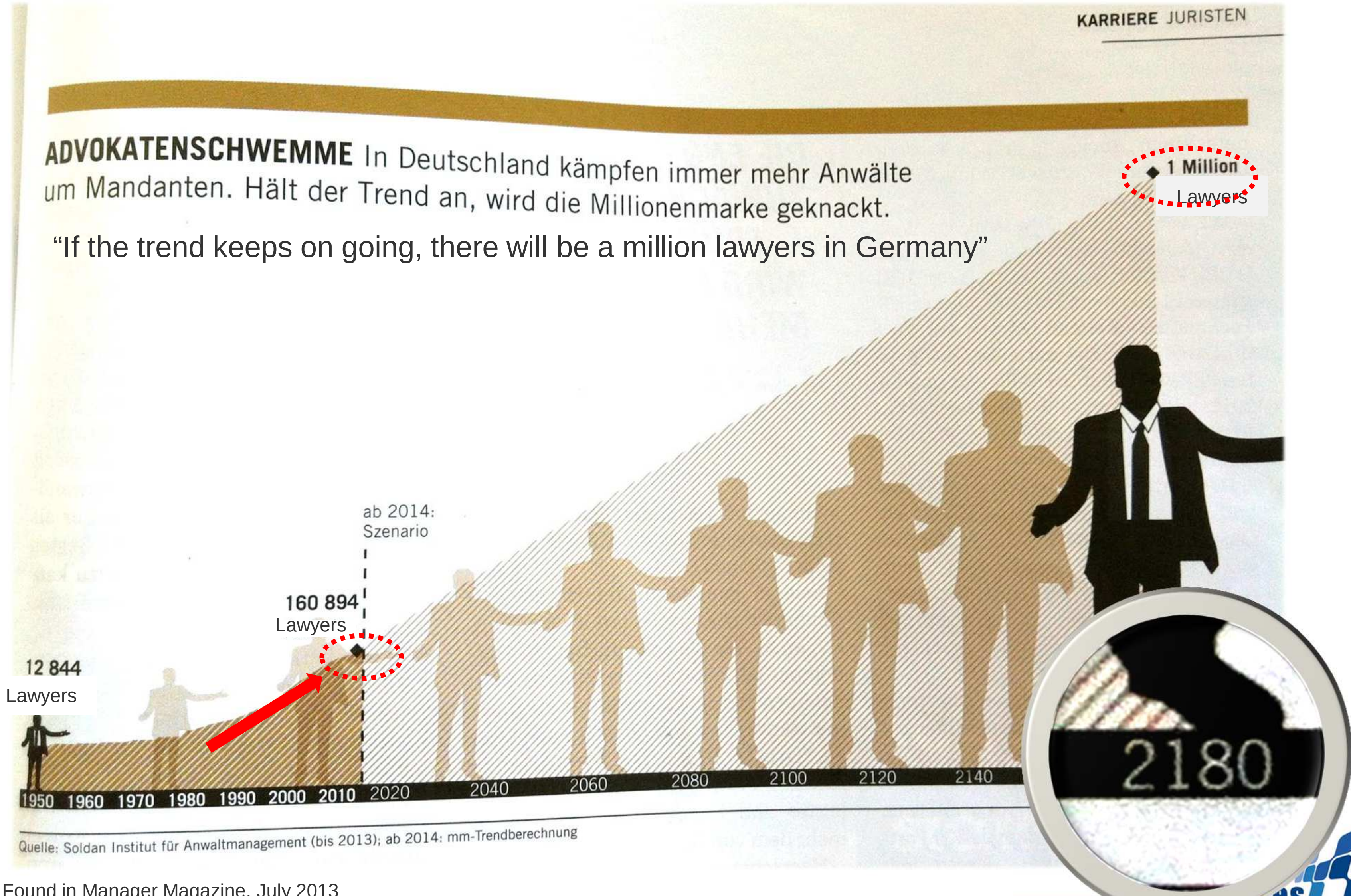
Agenda group exercise

- Brief country presentations: real-world country case study
  - Experiences from Belgium on emission projections
  - Setting baselines for national planning in the Indian context

- Group discussion
  - Discussion on methodologies of developing scenarios and their advantages and disadvantages

Different models

Trend extrapolation: Can mean anything and nothing…



Source: Found in Manager Magazine, July 2013

Methodologies for emission reduction scenarios - Examples

- Bottom-up
  - MARKet ALlocation (MARKAL)
  - Energy / Emission Projection Model (EPM)

- Top-down
  - Macro-sectoral model (e.g. HERMES)
  - Balancing / equilibrium model (e.g. PRIMES)
  - (Trend extrapolation)

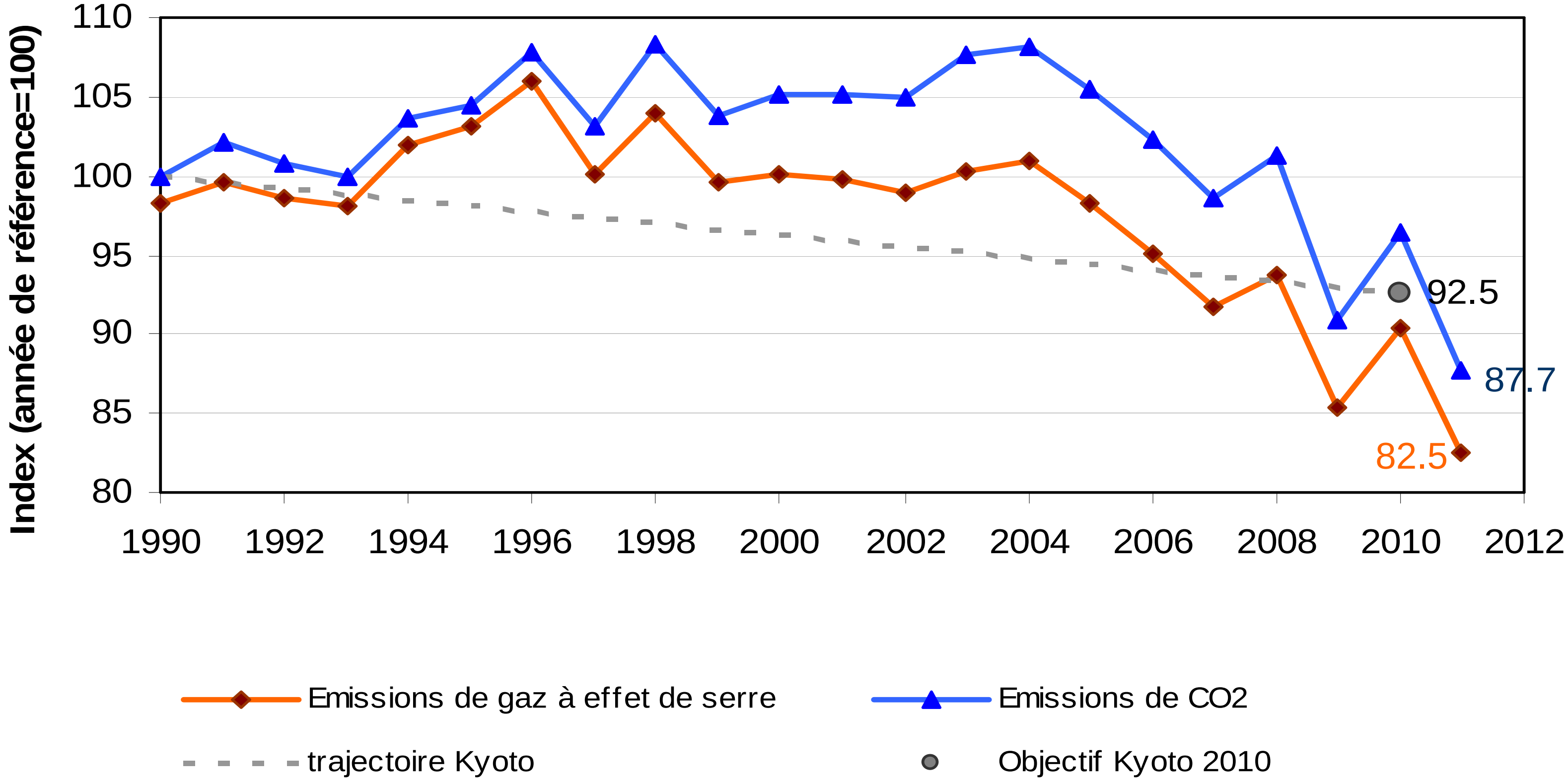
Projection models for sectors

Projections of energy consumption / supply projections	
PRIMES	http://www.e3mlab.ntua.gr/e3mlab/
POLES	http://www.enerdata.net/enerdatauk/solutions/energy-models/poles-model.php
MARKAL/TIMES	http://www.iea-etsap.org/web/index.asp
PROMETHEUS Model	http://www.e3mlab.ntua.gr/e3mlab/index.php?option=com_content&view=category&id=37&Itemid=72&lang=en
Agricultural projections:	
CAPRI model	http://www.ilr1.uni-bonn.de/agpo/rsrch/capri/caprifp4_e.htm
AGLINK-COSIMO model	http://agrilife.jrc.ec.europa.eu/AGLINK.htm
The Food and Agriculture Organisation	http://www.fao.org/
The European Fertilizer Manufacturer Association	http://www.efma.org/site/index.php?id=317
The International Fertilizer Industry Association	http://www.fertilizer.org/
Transport projections:	
TREMOVE Model	http://www.tremove.org/
PRIMES-TREMOVE model	http://www.euclimit.eu/Models.aspx#PRIMESTREMOVE
SCENES	http://netze.iww.kit.edu/102_200.php
EX_TREMIS	http://www.ex-tremis.eu/
TRANS-TOOLS model	http://energy.jrc.ec.europa.eu/transtools/index.html
AsTra model	http://www.astra-model.eu/structure-overview.htm
COPERT	http://www.emisia.com/copert/General.html

Experiences from Belgium on emission projections

Belgium is committed to reduce its GHG emissions by 7.5% under the Kyoto protocol

- Total GHG emission in 2011 decreased by 12,3 % wrt 1990 base year



Combination of models in Belgium

- Climate change is a ‘mixed competence’ in Belgium
- Each entity uses a different model to make its own projections: 5th National Communication
  - Flemish region: MARKAL
  - Walloon region: EPM (Energy/Emissions Projection Model)
  - Brussels region: Environment Brussels Energy Emissions Projections Model
  - Federal state (Federal Planning Bureau): HERMES (energy projections for the period 2010-2020 to prepare a projection at country level for the ‘with measures’ scenario)
- Transport emissions were modelled using TREMOVE (Flemish Region) and PRIMES (Walloon Region)

Main characteristics of the different models

- Regional models are bottom-up, involving higher level of disaggregation e.g. MARKAL based on technical-economic aspects, EPM based on activity levels. Those models can give a more precise representation of the technical determining factors of emissions while incorporating engineering data and technological choices

- Federal model is a top-down macroeconomic model, integrating economic international context such as changes in international fuel prices or in national export prices. It can provide consistent scenarios in terms of GDP, labour productivity, consumption and investment expenditure, government balance, etc. but not an accurate representation of the energy system and insufficient incorporation of technological options to reduce GHG emissions.

perspectives climate change

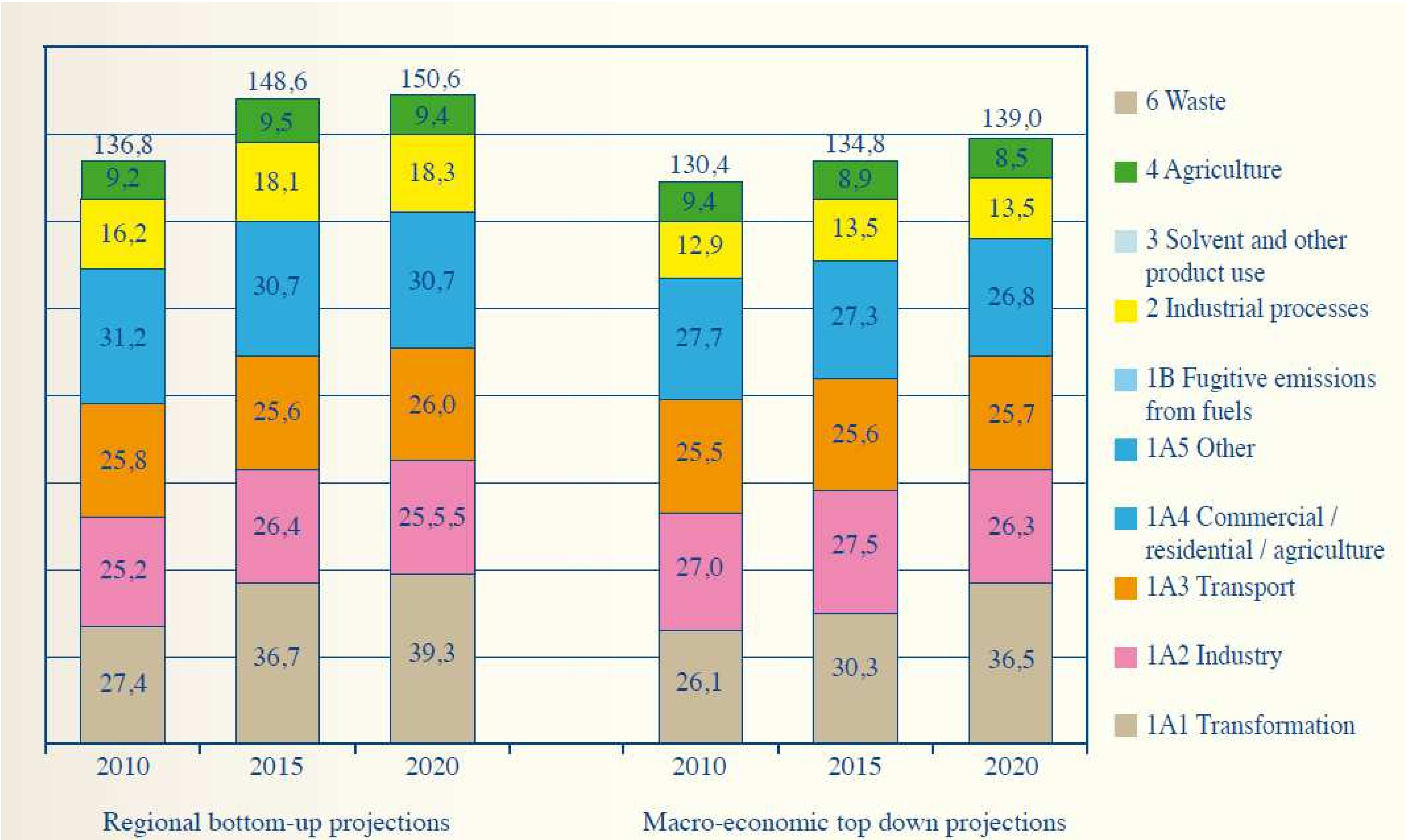
‘National projections’

- The projections reported are based on detailed bottom-up approach within each Belgian region. This approach starts from the demand side and the energy needs of the different sectors. As such, energy demand relates to an activity forecast for each sector in each region and is not necessarily consistent with international and national economic assumptions (GDP, oil prices, growth of non-oil commodity prices, etc)
- The national projections are the sum of regional projections based on bottom-up approaches without direct link to the macro-economic context (national and international)
- In order to validate the bottom-up approach the sum of the regional projections is compared with national projections developed by the Federal Planning Bureau (FPB) based on HERMES

‘National projections’

- Parameters such as energy prices, degree days, demographic assumptions, CO2 price, electricity production are harmonized
- Some parameters are specific to each region, e.g. economic assumptions, emission factors, assumptions of activities and energy intensity (amount of energy used per unit of activity) per subsector
- The end result (i.e. level of greenhouse gas emissions in 2020) of the top-down projections differs significantly from that of the bottom-up projections, both projections show similar tendencies for the period 2010 -2020, i.e. increase of emissions after 2010 in the transformation sector and industrial processes;
  - transport emissions remain at the 2007-level until 2020;
  - emissions from energy consumption in commercial, residential and agriculture sectors remain at the 2010 level until 2020.

Comparison of regional bottom-up and macro-economic top down projections



excluding LUCF
(Mton CO2-eq)

Source: BELGIUM'S FIFTH NATIONAL COMMUNICATION, 2009

Challenges and opportunities

- Different models can be seen as complementary and as offering more insights on possible future evolutions of GHG emissions and their relation to the evolution of other variables

- Comparability is challenging!

- Study: “Transition towards a low carbon society in 2050: Status of long term modelling in Belgium”.

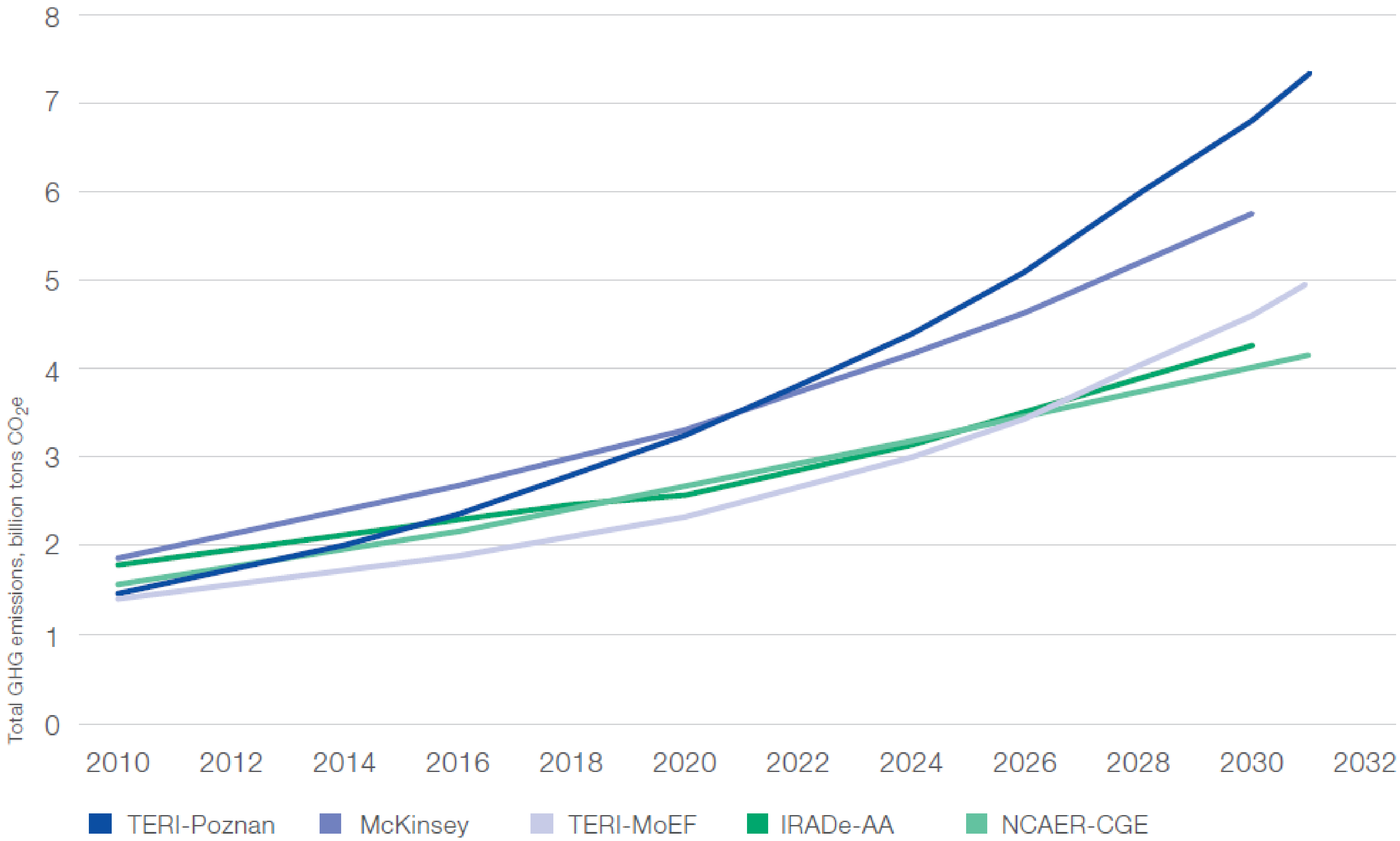
  Soon available at: http://www.climatechange.be/

Experiences from India on emission projections

Five climate modelling studies were developed

- India's GHG emission profile: "Results of Five Climate Modelling Studies"
  - India Computable General Equilibrium (CGE) model (National Council of Applied Economic Research and Jadavpur University, NCAER-CGE)
  - India MARKAL model: adapted from the generic version by TERI (TERI-MoEF)
  - India Activity Analysis model: developed by Integrated Research and Action for Development (IRADe-AA)
- Additionally:
  - MARKAL model analysis by TERI (with assumptions and data distinct from TERIMoEF)
  - Bottom-up study by McKinsey and Co., based on the McKinsey GHG Abatement Cost-Curve for India (McKinsey)

GHG emissions projections for India from five studies in illustrative scenarios



Source: Ministry of Environment and Forests, 2009, found in TERI/IEA

Model description and differences

	NCAER CGE Model	TERI MoEF Model	IRADe AA Model	TERI Poznan Model	McKinsey India Model
Model/ Methodology Type	Computable General Equilibrium	Linear Programming minimizing discounted energy system cost	Linear programming maximizing discounted value of consumption over defined time horizon	Linear Programming minimizing discounted energy system cost	Proprietary McKinsey India Cost Curve model to estimate GHG emissions from the 10 largest emitting sectors
Key features of model/ methodology	Top-down, sequentially dynamic, non-linear, market clearance, endogenous prices of commodities and factors	Bottom-up optimization over defined period, detailed energy technologies matrix, set of energy system technical and non-technical constraints, including limits to enhancement in energy efficiency of different technologies	Top-down optimization model over defined period (over 30 years with 3 years for each sequential run) with various resources, capacity and economic constraints	Bottom-up optimization over defined period, detailed energy technologies matrix, set of energy system technical and non-technical constraints with limits to energy efficiency enhancement based on past trends	Factors in estimates of bottom-up improvements in technology levers; analyses potential of a selected set from over 200 technologies to increase energy efficiency and reduce emissions; Includes CO_2, N_2O and CH_4 emissions (from agriculture) Demand feedback between sectors; between consuming sectors and power/ petroleum sectors

Source: Ministry of Environment and Forests, 2009, found in TERI/IEA

Model description and differences

	NCAER CGE Model	TERI MoEF Model	IRADe AA Model	TERI Poznan Model	McKinsey India Model
Key inputs	Population, global energy prices, foreign capital inflows, savings rates, labour participation rates	GDP growth rates, final demands of commodities (both from CGE model), global and domestic energy prices both consistent with the CGE model), population, and detailed technology characterization	Population, global energy prices, savings rates, discount rates, minimum per capita consumption growth rates	GDP growth rates based on doubling of per capita incomes every decade, final demands of energy end-use services, technology characterization, global and domestic energy prices, population based on government projections	• GDP growth rates • Projected demand (for number of inputs – e.g. steel, power, automotive) • Population • Global energy costs • Base and non-base load demand
Key outputs	CO_2e (CO_2 + N_2O weighted by GWPs) emissions, GDP, energy and CO_2e intensities, final demands of commodities, costs of mitigation policies	CO_2 emissions, energy use patterns, energy and CO_2 intensities, operating level of each technology, energy system costs, investment and marginal costs for each technology	CO_2 emissions, energy and CO_2 intensities, commodity-wise demand categorized by end-use, income-class wise commodity demand, costs of mitigation policies, poverty impacts	CO_2 emissions, energy use patterns, energy and CO_2 intensities, operating level of each technology, energy system costs, investment and marginal costs for each technology	Estimates illustrative Scenario emissions across GHGs (CO_2, N_2O, CH_4) over time by sector

Source: Ministry of Environment and Forests, 2009, found in TERI /IEA

Model description and differences

	NCAER CGE Model	TERI MoEF Model	IRADe AA Model	TERI Poznan Model	McKinsey India Model
Number of sectors	37 production sectors + government	35 energy consuming sub-sectors + energy supply options including conventional and non-conventional	34 activities with 25 commodities + government	35 energy consuming sub-sectors + energy supply options including conventional and non-conventional	10 sectors; Power, Cement, Steel, Chemicals, Refining, Buildings, Transportation, Agriculture, Forestry, Waste
Greenhouse Gases included	CO_2 + N_2O (energy and industry only)	CO_2 (energy and industry only)	CO_2 (energy, industry, households, and government consumption only)	CO_2 (energy and industry only)	CO_2 + N_2O + CH_4 (energy, industry and agriculture)
Primary Energy forms	Coal, oil, gas, hydro, nuclear, and biomass	Coal, oil, gas, hydro, nuclear, renewables, and traditional biomass	Coal, oil, gas, hydro, nuclear, wind, solar and biomass	Coal, oil, gas, hydro, nuclear, renewables, and traditional biomass	Coal, oil, gas, hydro, nuclear, wind, solar, geothermal and biomass

Source: Ministry of Environment and Forests, 2009, found in TERI/IEA

Experiences

- With regard to the use of models and the setting of baselines using models, it is clear that any discussion regarding commitments or target setting cannot be based on models.
- Models can help examine the consequences of emissions and/or can help provide a visualization of how emission trajectories may evolve and change over time.
  - However, these are based on several inherent assumptions that vary, depending on the choice of model
  - values ascribed to the multitude of parameters associated with the model

Source: TERI/IEA

Experiences

- Data, especially in developing countries like India, often requires careful analysis and possible re-distribution,
  - there are definitional changes, groupings of sub-data heads, missing data, and assumptions in published data.
- In-country reviews of planned versus likely activity data become an extremely important element in baseline setting
- integrated frameworks become increasingly relevant as baselines extend over longer periods
- Statistical/econometric projections may no longer be valid on a standalone basis
  - require judicious and systematic delineation of possible structural changes, such as changes in investment and trade patterns

Source: TERI/IEA

Experiences

- Trajectories with and without climate policy could result in fairly different interpretations
- Strong database is beneficial
  - Bringing the model database to sufficient level of detail, and frequently updating it to reflect India’s dynamic energy system, is a continual challenge
  - Maintaining modelling and data analysis skills
  - Keeping up with latest technology shifts, consumer behaviour patterns, and the play of national and international market forces on energy supplies and demands

Source: TERI/IEA

Group discussion

What experiences do you have with methodologies for developing scenarios ?

- Which methodologies of developing scenarios do you know?
- Which model and method is used in your country?
- What are your experiences?
- Did you encounter advantages and disadvantages of one or the other methodology?
- What makes a emission scenario conservative and credible?
  - Assumptions basis?
  - Appropriate time frame?
  - Institutions involved in the baseline development?
  - Data vintage and quality?
  - Level of aggregation?
- What are critical modelling issues?
  - Technology, behaviour, scale, time, uncertainty

Many thanks!

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