Key methodologies related to GHG emission scenario development in a LEDS context

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This presentation

- Definitions
- UNFCCC guidance on projections
- Bottom-up versus top-down
- Characteristics, pros and cons of top-down approaches
- Examples of top-down approaches
- Characteristics, pros and cons of bottom-up approaches
- Examples of bottom-up approaches
- Baseline scenarios
- Additional measure scenarios
- Key assumptions

Definitions

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- What do we mean by emissions scenarios?

IPCC – "Scenarios are alternative images of how the future might unfold and are an appropriate tool with which to analyze how driving forces may influence future emission outcomes and to assess the associated uncertainties". [*'Emissions Scenarios', IPCC, 2000*]

- Emissions scenarios = projections
- Not part of BUR reporting, but an element of LEDS
- Relevance for LEDS
  - Economy-wide, long-term mitigation goals (in the range of 15 to 30 years)
  - An assessment of cost-efficient mitigation options and their prioritisation
  - The stipulation of concrete short- and mid-term mitigation actions

Analysis of low-carbon development alternatives

UNFCCC guidance on projections

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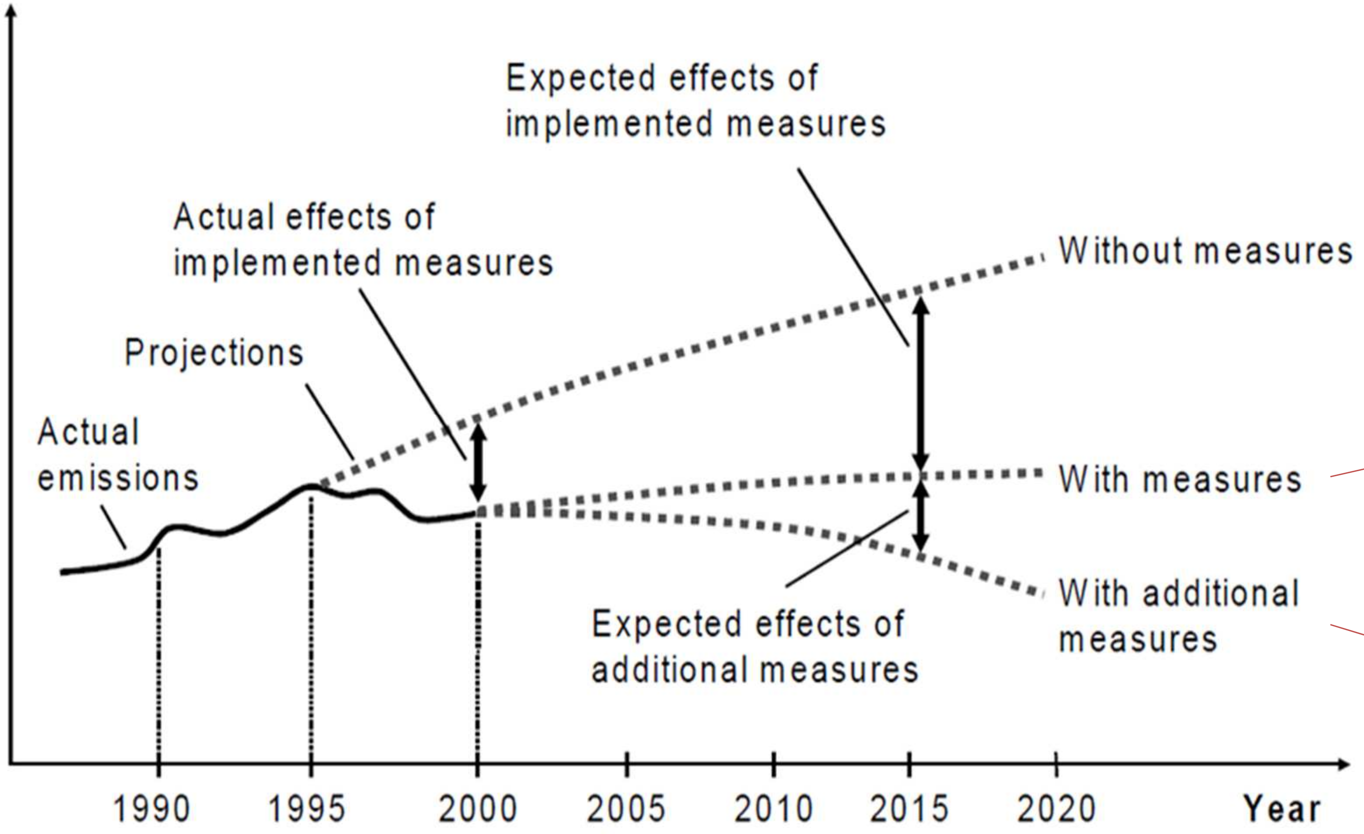

'Without measures' - excludes all policies and measures implemented, adopted or planned after the base year

'With (existing) measures' - encompasses currently implemented and adopted policies and measures.

"With additional measures" - also encompasses planned policies and measures but includes an estimate of the impact of additional mitigation measures

Implemented policies and measures

- 1 or more of:
- National legislation in force
- One or more voluntary agreements have been established
- Financial resources have been allocated
- Human resources have been mobilized

Adopted policies and measures

- Official government decision has been made; and
- Clear commitment to proceed with implementation

Planned policies and measures

- Under discussion
- Have a realistic chance of being adopted and implemented in future

Bottom-up versus top-down

Top-down:

Simple extrapolation model

Economic equilibrium model/CGE (e.g. WorldScan

Econometric models (E.g. E3MG)

Or hybrid (e.g. PRIMES, LEAP, POLES)

Bottom-up:

Dynamic optimisation (e.g. MARKAL)

Accounting (e.g. end-use sector models)

Simulation (elements of POLES, NEMS)

Top-down

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- Characteristics
  - System Integration
  - Focus on macroeconomics, based on historical trends
  - Focus on monetary units
  - Can be very simple, e.g. Excel model of projected GDP and project carbon intensity of GDP, or forecasts of activity data and emissions factors (i.e. 'projected' inventory data)
  - ……or very complicated, e.g. Dynamic general equilibrium models
- Strengths
  - Can take account of 'economic interlinkages' (top-down optimisation models, or CGE models)
  - Good for long-term analysis, as more stable due to econometric relationships
  - Behaviour outside of energy sector endogenous to model
  - Useful for financial instruments
- Weaknesses
  - Limited technology detail
  - But less informative in terms of the specific reasons for GHG trends
  - Some top-down models can be somewhat 'black-box' (difficulty to validate)

Examples of top-down models

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- PRIMES - a partial equilibrium model for the European Union energy markets. It is used for forecasting, scenario construction and policy impact analysis up to the year 2030. It simulates a market equilibrium for energy demand and supply within the European Union and it focuses on market-related mechanisms influencing the evolution of demand and supply.

- The Second Generation Model (SGM) is a computable general equilibrium model designed specifically to analyze issues related to energy, economy, and greenhouse gas emissions.

- Econometric model example http://camecon.com/EnergyEnvironment/EnergyEnvironmentGlobal/ModellingCapability/E3MG.aspx

Cement example – simple top-down forecasting

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- Calculate current CO_2 emissions (including combustion and process emissions) emitted per tonne produced in various routes.
- Project forward production; base in short term on industry projections of production; in longer-term based on information from IEA report which gives projections of demand on per capita basics combined with projections of population and economic growth.
- Assume exports follow same trend as domestic demand i.e. production follows trend in domestic demand.
- For reference case use industry view about any trends in the relative proportions of production coming from the different production routes, e.g. relative proportion of EAF output increasing in response to growing availability of steel scrap.
- Use industry view about business as usual improvements in energy efficiency pertaining to the future, through incremental improvements and routine plant upgrades.
- From this data calculate total energy related GHG emissions and process related emissions

(Example taken from *IEA, 2009 Energy Technology Transitions for Industry, Strategies for the next Industrial Revolution)*

Bottom-up

- Characteristics
  - Technological detail
  - Macroeconomic variables exogenous to model
  - Focus on material units
  - Varies from partial equilibrium to simulation to emission reduction option database approach (GENESIS)
- Strengths
  - Rich in technology detail - easier to understand the reasons behind GHG trends
  - Decoupling economic growth from energy demand
  - Useful for technology oriented policy analysis, and other non-financial instruments
- Weaknesses
  - Data intensity – can be hard to obtain data
  - Lack of stability over longer time-frames

Example of bottom-up models

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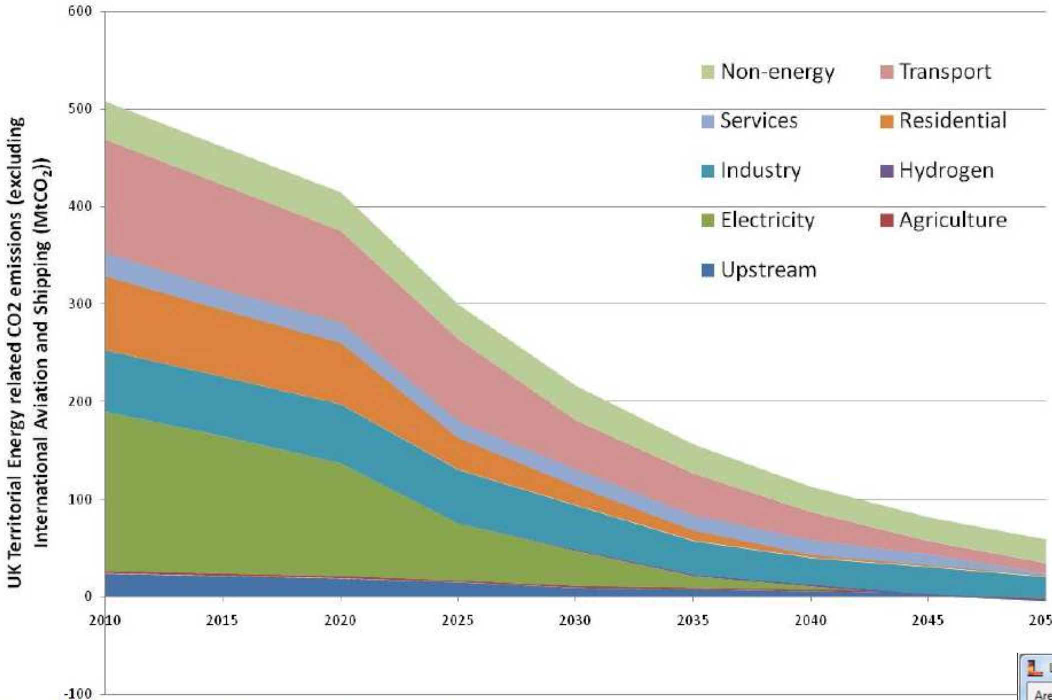
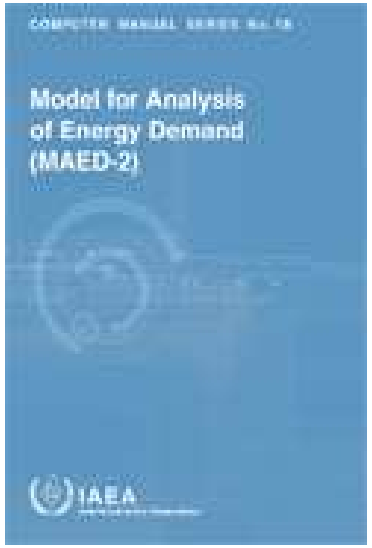
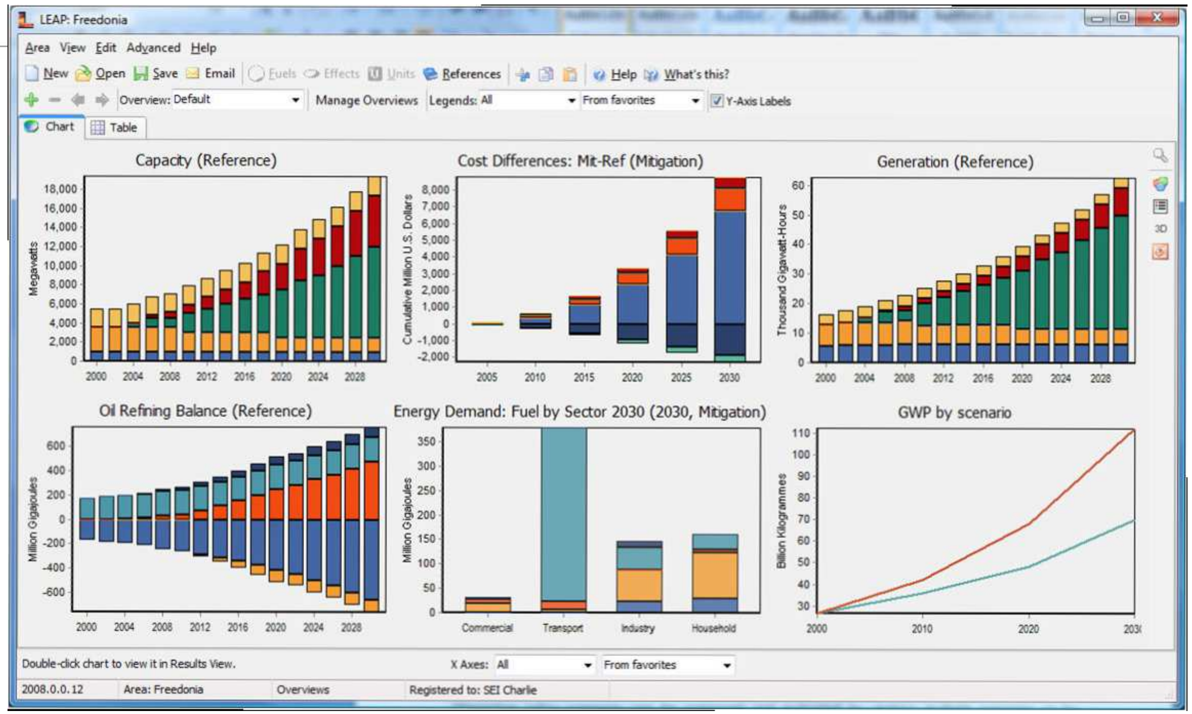


Source: MARKAL modelling, AEA project for DECC (2011)





MEDEE model

Baseline scenario

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- Scenario against which mitigation options are measured
- Usually the ‘with existing measures’ scenario…

> In report by Danish Energy Agency, OECD and UNEP Riso Centre, baseline scenario defined as “a scenario that describes future greenhouse-gas emissions levels in the absence of future, additional mitigation efforts and policies”.

- …but can be ‘without measures’ (e.g. South Africa)
- Need to consider issue of ‘early action’ – should this be part of the baseline scenario?
- Choice of base year – may depend on data availability?
- Currently no international guidance on how to develop baseline emissions scenarios

Further ‘additional measures’ scenarios

- Need to decide basis for developing alternative scenarios:
  - Different end points
  - Different pathways to same end-point
- Examples:
  - Ranking plus cut-off (simple extrapolation top-down approaches)
  - Different policy scenarios
  - ‘Thematic’ scenarios
    - E.g. UK Carbon Plan – 3 scenarios (higher renewables/more energy efficiency, higher CCS/more bioenergy, higher nuclear/less energy efficiency)
  - Sensitivity analysis – a form of scenario?

UK carbon plan

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Table 1: Summary of 2050 futures

(All figures in 2050)	Measure	Core MARKAL	Renewables; more energy efficiency	CCS; more bioenergy	Nuclear; less energy efficiency
Energy saving per capita, 2007–50		50%	54%	43%	31%
Electricity demand increase, 2007–50		38%	39%	29%	60%
Buildings	Solid wall insulation installed	n/a[16]	7.7 million	5.6 million	5.6 million
	Cavity wall insulation installed	n/a[16]	8.8 million	6.9 million	6.9 million
	House-level heating	92%	100%	50%	90%
	Network-level heating	8%	0%	50%	10%
Transport	Ultra-low emission cars and vans (% of fleet)	75%	100%	65%	80%
Industry	Greenhouse gas capture via CCS	69%	48%	48%	0%
Electricity generation	Nuclear	33 GW	16 GW	20 GW	75 GW
	CCS	28 GW	13 GW	40 GW	2 GW
	Renewables[17]	45 GW	106 GW	36 GW	22 GW
Agriculture and land use	Bioenergy use	~350 TWh	~180 TWh	~470 TWh	~460 TWh

Key assumptions

- GDP – could be from existing literature, or modelled
- Climatic patterns
- Population
- Technologies
- Costs
- Etc.

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Discussion

- In groups, discuss the following:
  - Have GHG scenarios been done in your country? If so, please explain to the others what approach was taken.
  - If not, please discuss with others what approach might be appropriate and why.
  - What data sources might you use?
  - What role do you think emissions scenarios might play in your LEDS?