Covenant of Mayors
in Sub-Saharan Africa

CoM SSA SEACAP Toolbox

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For more information contact: helpdesk@comssa.org
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Covenant of Mayors in Sub-Saharan Africa

CoM SSA SEACAP Toolbox

2.6: Introduction to Energy Modelling

This chapter is one component of the SEACAP Toolbox for the full Toolbox, please visit: https://comssa.org/

What you will learn in this chapter:

- What we mean by a 'model'?
- The value of simplicity
- The basics of energy modelling
- Difference between scenario and optimisation modelling
- The uses of different tools in the SEACAP development process
- The basics of scenario building
- The basic functions of LEAP and CURB
- Pros and cons of each tool
- Where these models have been used in Cameroon and Kenya as an example
- Experiences from CoM SSA

This chapter has been designed for Local Government Officials and partners completing a SEACAP

Covenant of Mayors in Sub-Saharan Africa

Question:

Do you need a model to calculate how much electricity you use in one day?

- paste your response in the chat.

Question:

Is a paper plane a model?

- paste your response in the chat.

What is a 'model'?

- Models are representations of reality
  - Must ignore some complexities
  - What gets ignored depends on the purpose of the model

- Models will be used by someone in order to improve the management of some system
  - Management: understanding, planning, control

A model is an external and explicit representation of part of reality as seen by the people who wish to use that model to understand, to change, to manage and control that reality

What is an energy model?

- An abstract representation of an energy system
- Mathematical formulation that integrates information about the energy system of interest and mimics its behaviour
- Could be a simple diagram, a table, a set of equations, or lines of code that capture some aspects of an energy system

Why energy modelling for planning?

Why it could be important to look ahead?

- Society and economy rely on energy to function – shortages are expensive!
- Energy Infrastructure has high upfront costs, has long lead times and long lifetimes
- Planning is typically used by decision makers on investment decision for energy infrastructure, but it is also used by policy makers to define energy/climate/environment policy

National planning process

- Establish objectives/define questions
- Determine scope
- Analyze demand
- Investigate supply options
- Identify sources of uncertainty, and try and quantify uncertainty
- Integrate demand and supply analysis using a model(s)
- Report results and inform decision maker/policy

Keep it Simple!

- Complexity of many systems is extreme – have no hope of complete specification
- Often a simple representation is the key to deeper understanding of system, particular in experimentation
- Principle of parsimony/economy
  - Occam's razor: 'It is futile to do with more things that which can be done with fewer'
  - In practice: we should tend towards simpler theories until this comes at an unacceptable cost to explanatory power

Hard versus Soft models

Hard models

“Traditional” mathematical modelling

“Tame” problems

Well defined objectives

Good understanding of how the system operates

Few conflicting views

Soft models

- Multiple people involved, often with conflicting opinions
  - Confusion around “real” problem
  - Huge amount of possibly relevant information as scope of decision grows
  - Inter-relatedness of decisions requires many stakeholders
- Often the process of defining the problem is the most useful part
- Aim of soft modelling is to explore preferences, disagreements, and uncertainties, and arrive at a consensus and commitment to action

The only certainty is the uncertainty…

Hard models tend to be suitable in environments where uncertainty is relatively low, or tends to be of a probabilistic nature

When many types of uncertainty are present and/or uncertainty exists to such an extent that problem formulation is difficult, soft modelling approaches are more appropriate

Models are a representation of a reality, not reality

Outputs are only as good as the inputs

…But, models do:

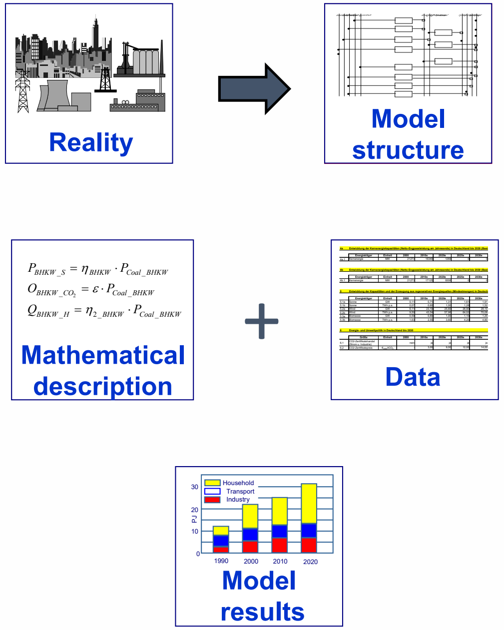
- Help to organize the information in a systematic way
- Help to handle and represent a complex system
- Helps to understand how the system works
- Help evaluate how different courses of action help towards meeting objectives given uncertainties

Model-based analysis

Approximated representation of relevant aspects in real-world system

Typically quantitative formulation with balance between accuracy and manageability

Attempt to explain and analyse aspects of the real system with the help of the model results



- Specific model captures only certain aspects of real system
- Model choice dependent on analysis questions, several models may be needed

Demand and Supply

Demand-side:

- Current and historical energy demand
- What are the drivers, and how do they link to demand?
- How are the drivers likely to evolve?
- Use an objective (and reproducible) process
- Be functional – must fit decision at hand
- Test sensitivity
- Maintain simplicity

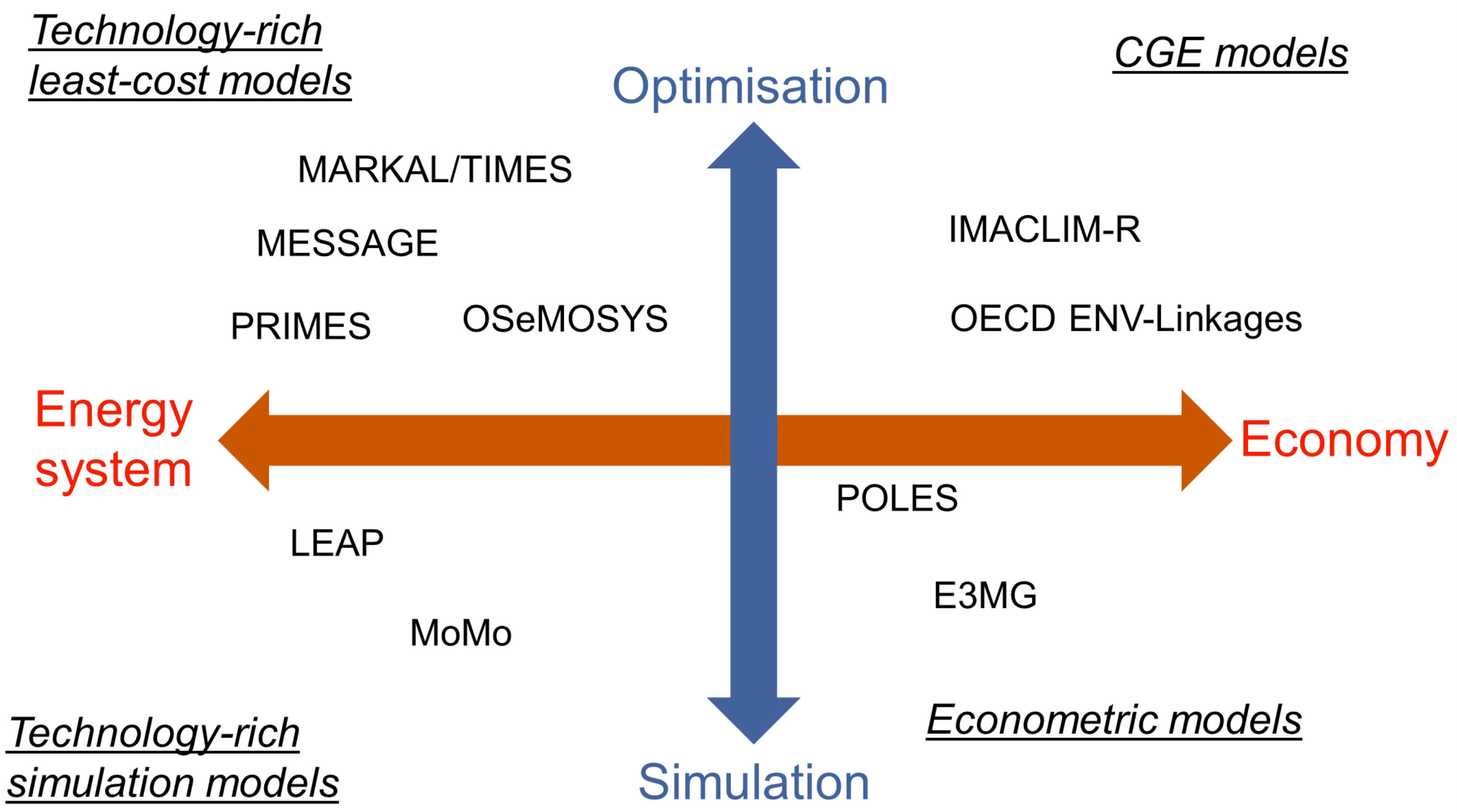
Supply-side:

- How is the system currently supplied (and in the past)?
- What are the resources available to the system (supply curve)?
- What are the technology and fuel options available?
- What are the technology costs and lead times?
- What are the fuel costs?

Optimisation versus Simulation

	Simulation	Optimisation
''What if'' analysis	Better suited	More to determine optimal system design
Constraints	Less important	Critical to identify these
Randomness	Can account for random variation	Better suited to clearly defined mathematical relationships
Planning and decision support	More explanatory: provides a basis for comparison	Provide a single, 'best' answer
Difficulty	Generally easier	Generally more difficult because more assumptions and computing power are required.

Universe of energy models



(Source: van Ruijven and van Vuuren, 2009)

Defining the scope

What specific questions need answering?
How much time/resources have we got?
What kind of data do we have?

Exercise:

Name 3 sustainable energy access/mitigation related actions a city/county could consider implementing.

- Paste these in the chat

Introduction to LEAP and CURB

Scenario building

Scenario building is the process of defining potential futures.

8 steps to Scenario building:

1. Identify focal issue or decision
2. Identify driving forces
3. Rank their importance and uncertainty
4. Select scenario logics
5. Flesh-out the scenarios
6. Select indicators for monitoring
7. Assess impacts under different scenarios
8. Evaluate alternative strategies

SEACAP Scenarios: Business as usual (BAU)

What is ‘business as usual’?

- A set of reasonable assumptions and data that best describe events or conditions that are most likely to occur in the absence of activities taken to meet a mitigation goal
- Key to understand how this is considered at the national level
- What are the drivers of the BAU?
- Structural changes in the economy?

SEACAP Scenarios: NDC

National targets

- Some local governments start with an ‘NDC’ scenario
- What combination of actions would achieve this?
- Hard model – optimisation model
- Soft model – stakeholder engagement to inform actions for the target

Top-down versus bottom-up
Is the emissions reduction a target or a result?

SEACAP Scenarios: Raised Ambition

- Driven by what is possible at the local level
- Greenhouse Gas Inventories
- Prioritise sectors
- BAU
- Identify future constraints/priorities
- Action planning
- Identify specific, prioritised actions/projects

Tools

Useful to build models that could be useful,
Alternatively, one could build a soft model

Deep dive: LEAP | CURB Tool — Climate Action for Urban Sustainability

SEI

WORLD BANK GROUP | C40 CITIES | GLOBAL COVENANT of MAYORS for CLIMATE & ENERGY

Comparing the tools

	LEAP	CURB Tool (Climate Action for Urban Sustainability)
What is it?	An integrated modelling tool	Interactive planning tool
What is it not?	Not a model of a particular energy system	Not an energy systems modelling tool
Focus	Energy demand and supply	Climate Action Planning
Does it require training?	Yes	No
Is it free?	Conditionally	Yes
More suited to contexts where:	• It would be useful to compare actions and scenarios • Complex energy problems that require 'hard' models • There are less time and budget constraints	It would be useful to compare actions and scenarios A number of stakeholders and the results require a consensus
Are results comparable to other cities?	Depends on the methodology used	Yes

Phase I: Detailed energy modelling

Completed by Sustainable Energy Africa
- Dakar, Bouaké, Tsévié and Yaounde IV

Advantages
- Able to compare energy profiles of cities
- Capture additionality and trade-offs
- Interesting academic exercise

Disadvantages
- Data heavy
- Needs a lot of dedicated time
- Not necessarily the most efficient way to present results – too complex for decision makers

LEAP

Phase I Dakar: PATHWAYS Model

Used by a consultant for the case of Dakar
Detailed ‘stock roll-over’ model for energy infrastructure
Technology-specific
Vehicles and buildings
Focuses on equipment and replacement.
Main inputs:
energy demand drivers
technology and energy supply adoption rates
Main outputs:
energy demand,
Emissions
technology stocks and associated
capital and
fuel costs

Paid model, mostly used in the United States

Energy+Environmental Economics

Model	Key Features	Suitability
LEAP	• Gives a detailed account of energy consumption, conversion and production . • It models energy demands by sectors, sub-sectors and equipment. • The model is specifically used for energy demand, supply and environmental impacts study. It can be used for energy and environmental policy analysis, biomass and land-use assessment, fuel cycle analysis and energy planning.	• Most suitable for scenario-based analysis • It requires fewer skills and input data is less intensive
MAED	• MAED is a scenario-based simulation model and it is used for projecting energy and electricity demands on a long-term basis. • The future energy demand is projected by using a bottom-up approach in which energy demand is disaggregated into several numbers of end-use categories such as services or production of certain goods.	• Along with LEAP, it's suitable for energy demand analysis and easy to capture end-use technologies, power sector performance and rural-urban divide
MESSAGE	• MESSAGE is a dynamic linear programming model which calculates cost-minimal supply options under different constraints given by the user. • It is used for developing medium to long term energy systems plan, also used for analysing climate change policies and scenario analysis • The model can be used for simulating renewable energy, thermal generation, transport technologies among others. The inputs of the model are well detailed on the side of supply but more aggregated on the demand side.	• Most suitable when policy, financial and technological constraints are involved

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The next chapter is Setting targets for GHG emissions in cities

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Thank you

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