CLEWs: an open source tool for building capacity in integrated resource planning’

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UNDESA
The Abdus Salam International Centre for Theoretical Physics
KTH VETENSKAP OCH KONST
OpTIMUS.community
Climate, Land, Energy & Water systems:
https://un-desa-modelling.github.io/

Rationale

Agriculture and energy sectors are responsible for 90% of freshwater withdrawals

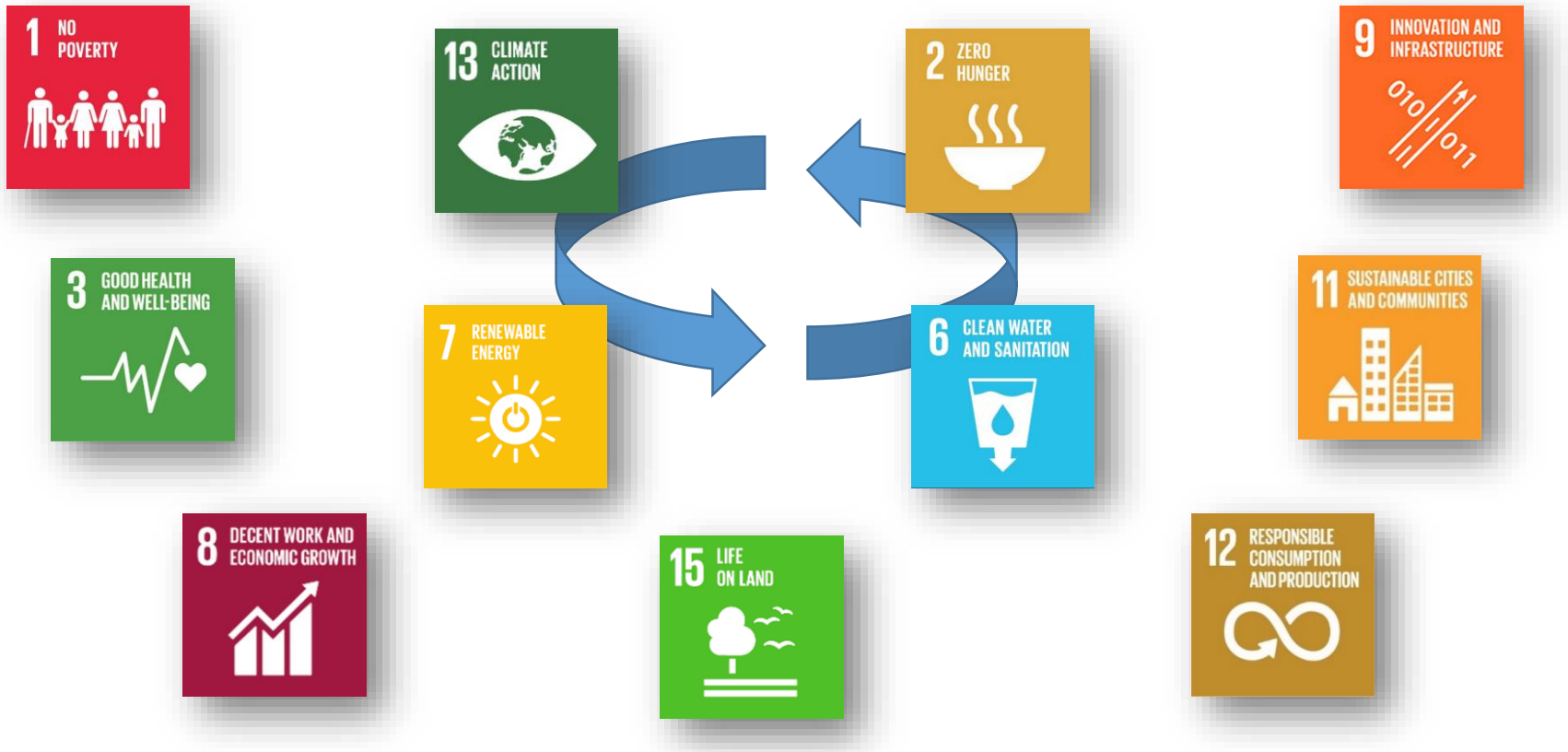
Supply and treatment of water consumes approximately 7% of electricity produced

3-4% of final energy consumption is used in agriculture

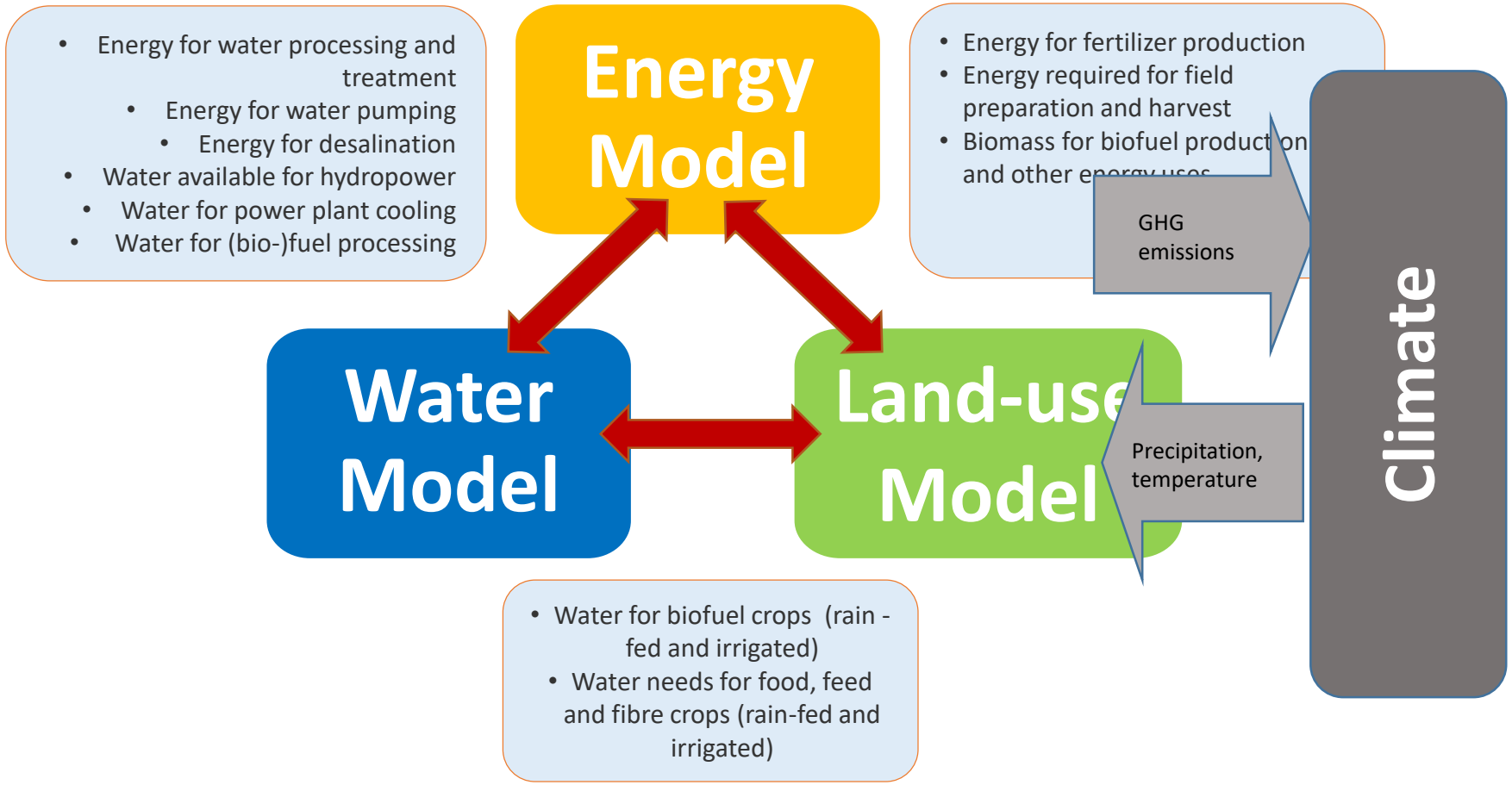
A growing share of cropland is used to provide biofuel feedstocks

Energy, agriculture and land-use change contribute more than 90% of GHG emissions

SDGs and CLEWs



CLEWS framework



Open **S**ource **e**nergy **MO**delling **SYS**tem (OSeMOSYS)

- OSeMOSYS is a tool to inform the development of medium- to long-term energy strategies
- Fully-fledged, deterministic, linear optimisation model
- Open source -> no associated upfront financial requirements
- Comparable to MESSAGE and TIMES
- Well-documented, flexible, modular, easy to modify (relatively)

Structure and formulation

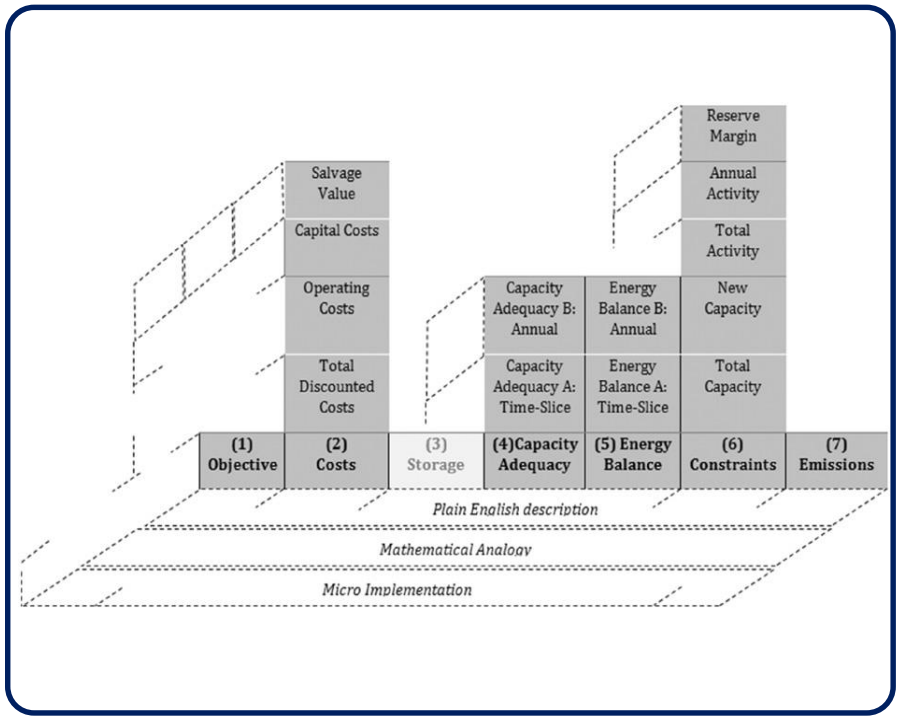
Structured in **blocks of functionality**

Several **levels of abstraction**:

- A plain English description
- An algebraic formulation of the plain English description
- The model's implementation in a programming language
- The application of the model

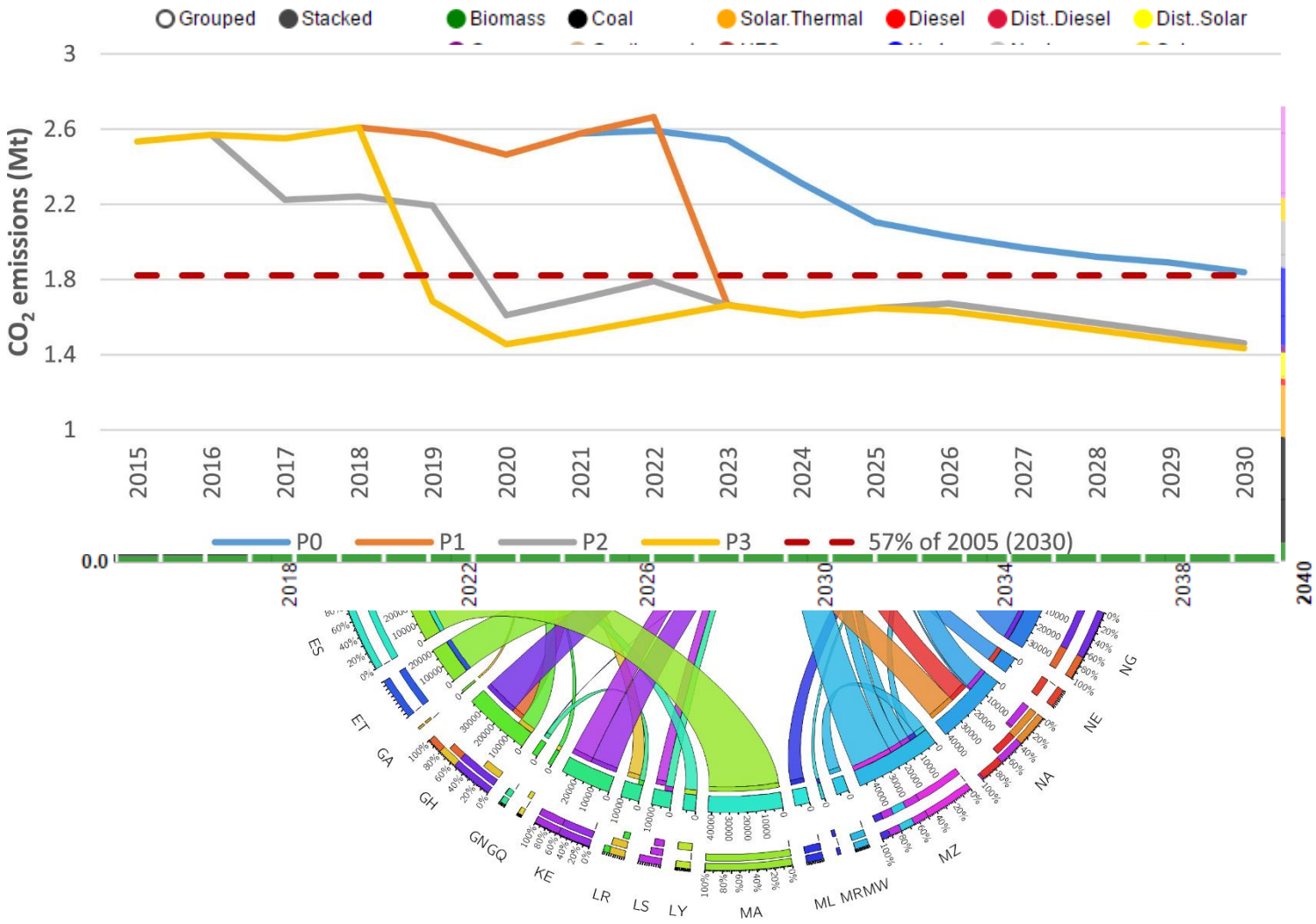
Mathematical language(s): GNU MathProg, Python, GAMS

Solvers: glpsol (free and open source), CPLEX (proprietary and industry standard)

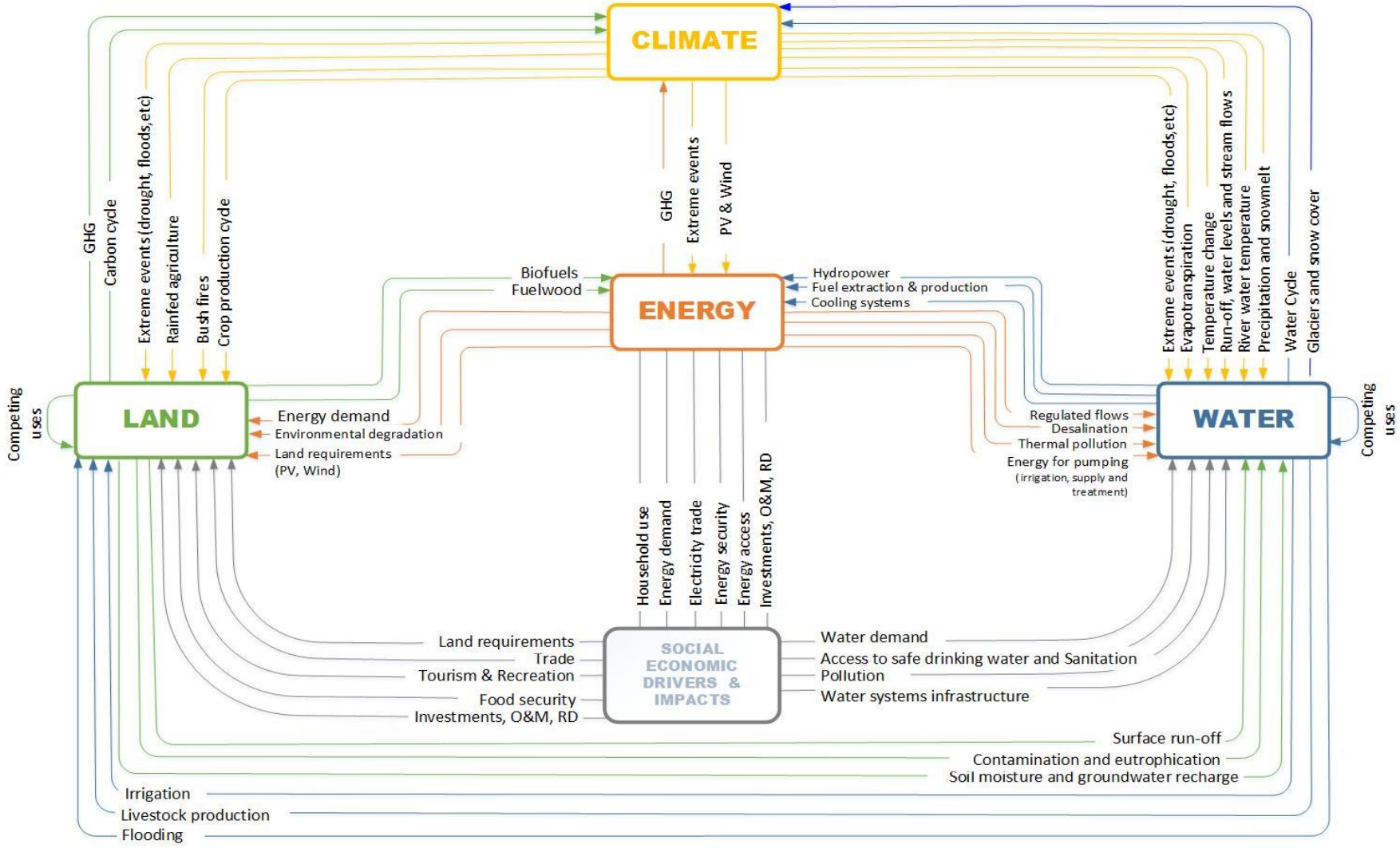


Information provided by OSeMOSYS

- Investment in new capacity of each technology
- Generation profiles of each technology
- Emissions of different pollutants
- Trade balances between regions

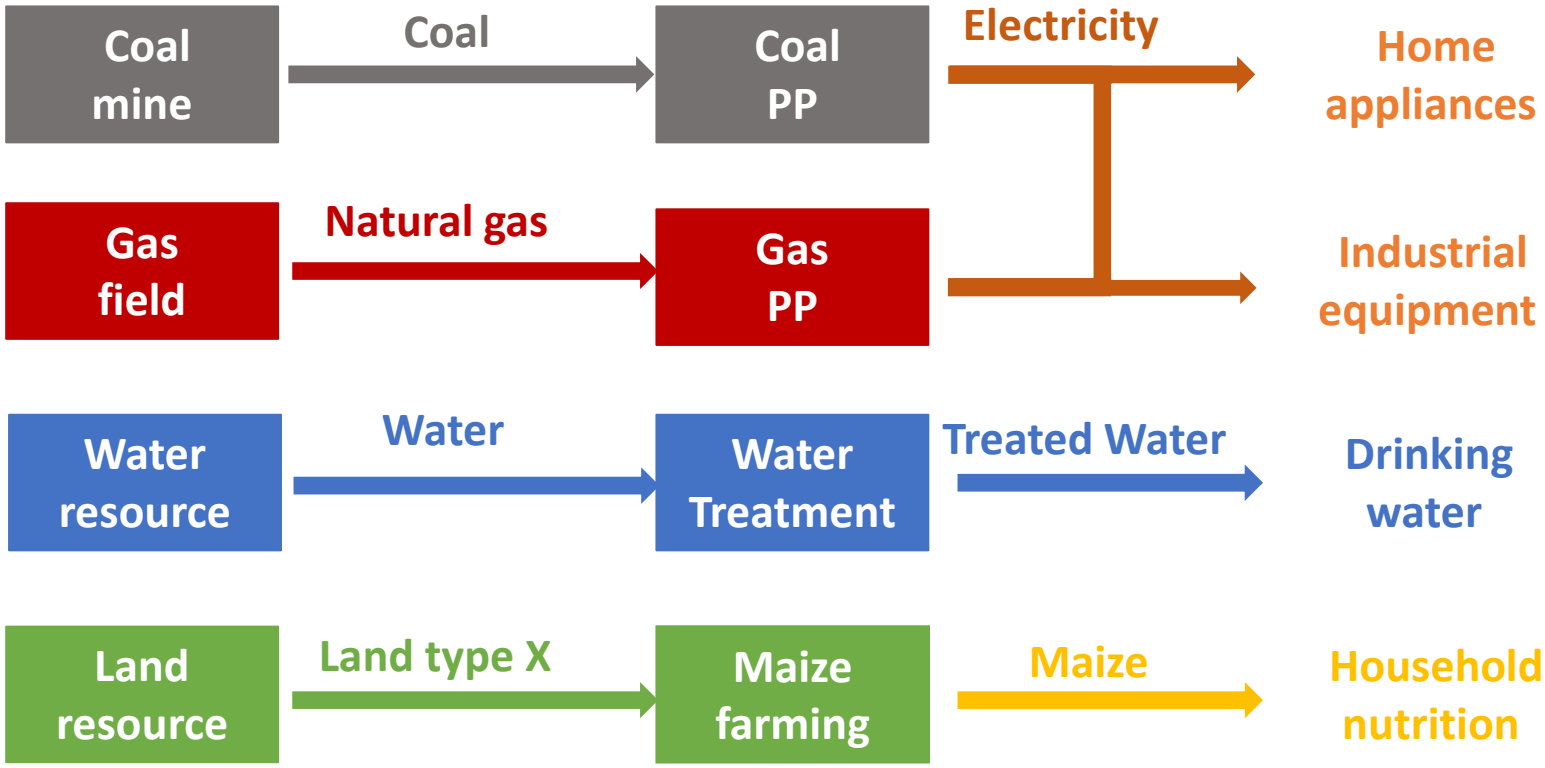


CLEWs framework and interlinkages



Technology definition in CLEWs

- Terminology inherited from energy systems analysis
- An asset, stock or process that produces, converts or consumes one or more commodities.



Technology example #1

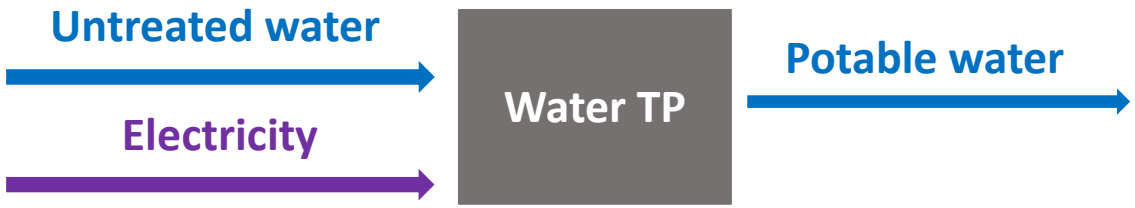
Power station

A physical asset that turns an input fuel (e.g. coal) and perhaps other resources (e.g. water for cooling) and produces an output - electricity

Technology example #2

Water treatment plant

Facilities and equipment that turn untreated water into potable water, consuming energy (electricity) to do so



Technology example #3

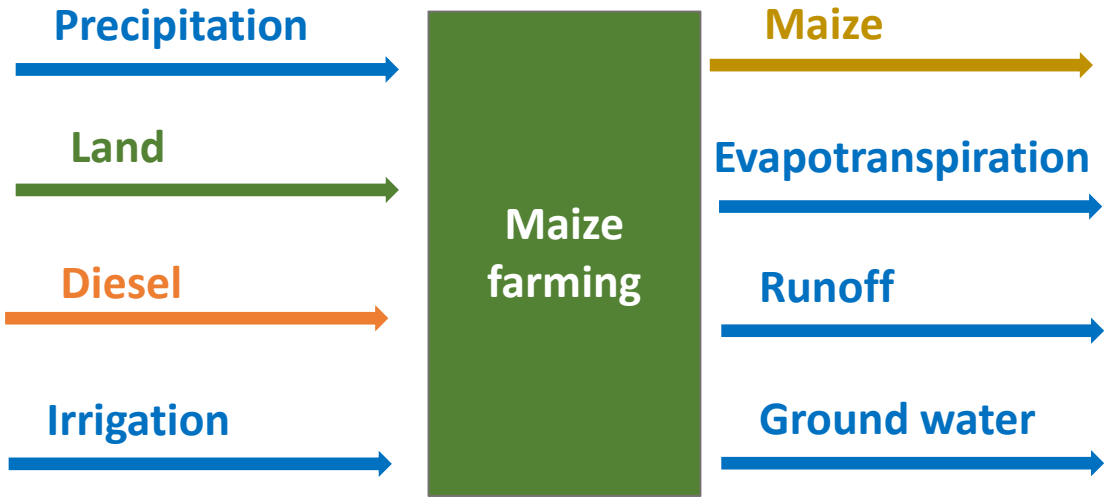
Coal mine

Equipment and facilities that extract a commodity (coal) from a natural stock (resource) – coal deposit

Technology example #4

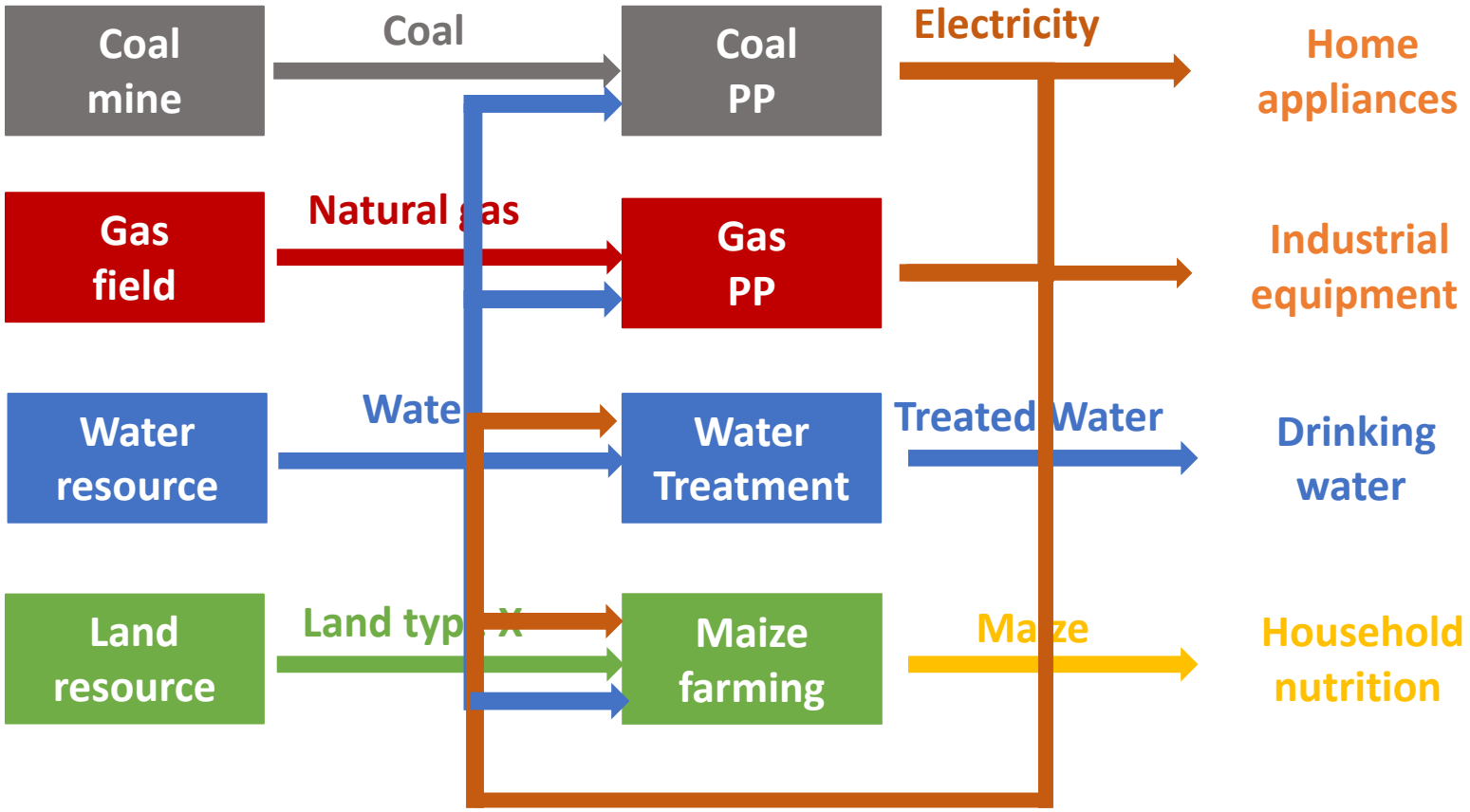
Maize farming

Application of physical equipment and management practices to transform takes a range of inputs (e.g. a land resource, water, energy, fertilizer etc.) into an output – maize.

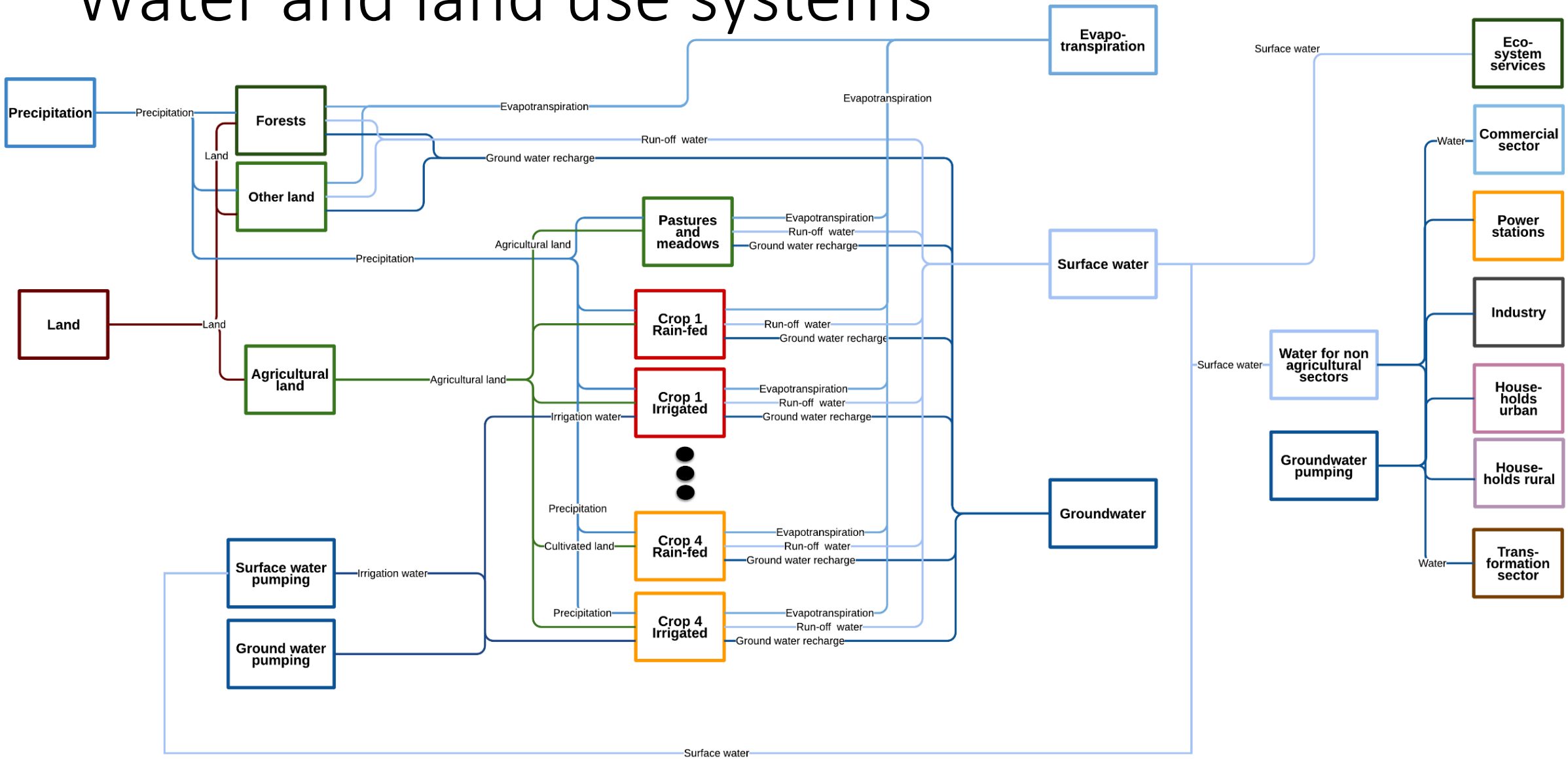


Bottom-up analysis using CLEWs framework: Simplified illustration

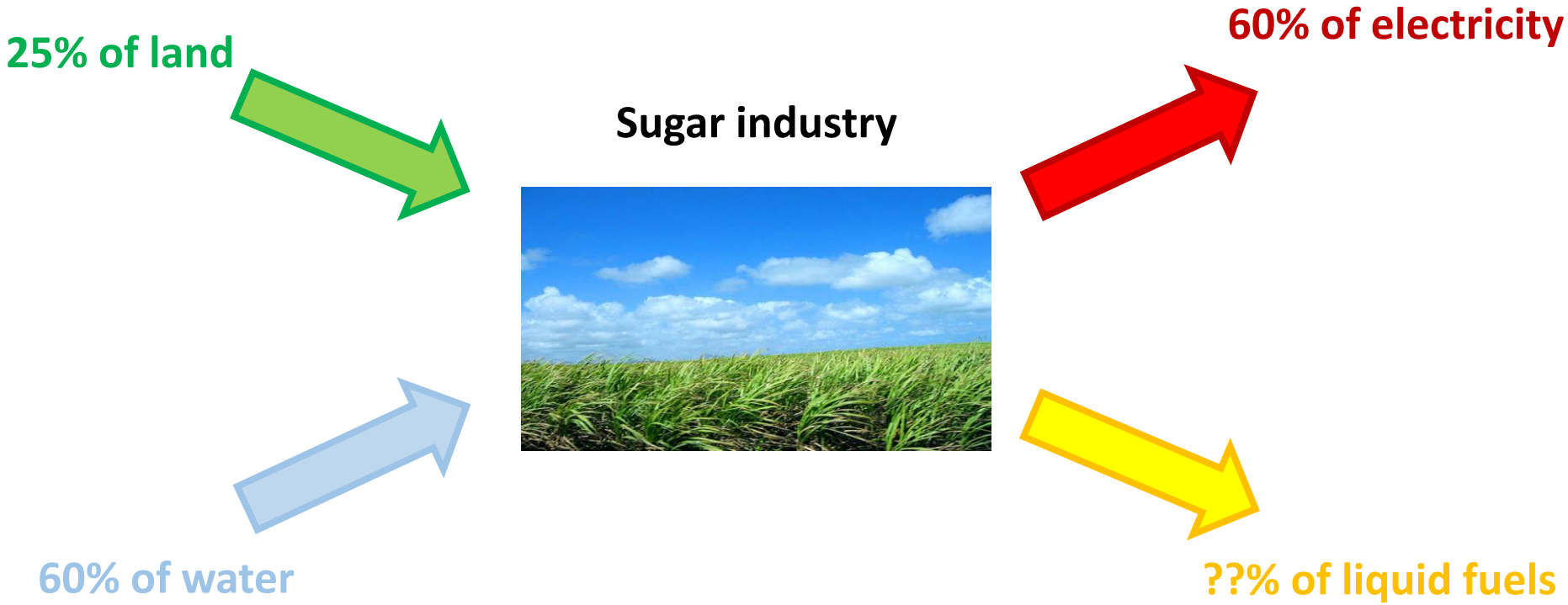
- The components are linked together in a flow network, representing a web of interconnected value chains



Water and land use systems

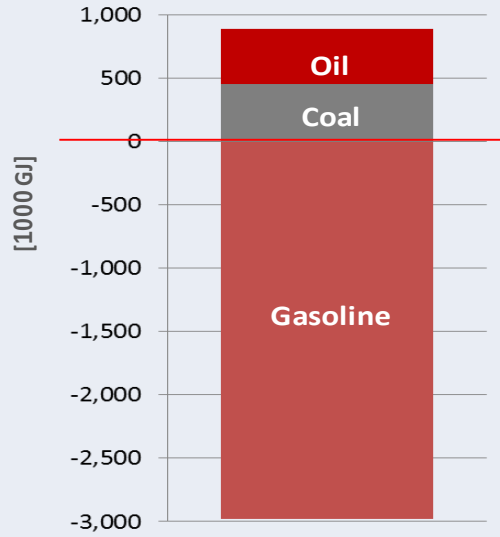


Mauritius sugar sector



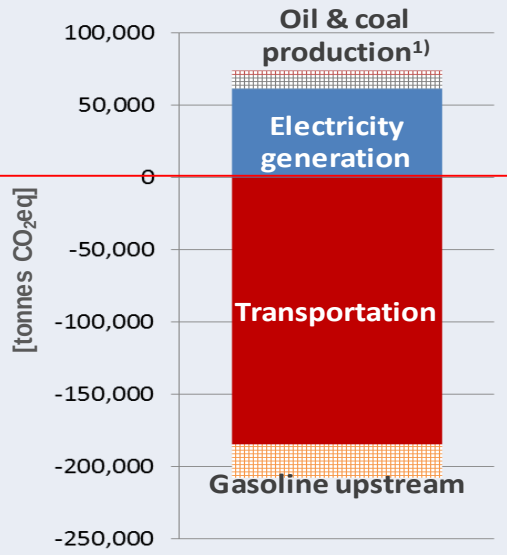
Impact of shifting two major sugar refineries to produce 2nd generation ethanol

Reduced fuel imports



Overall energy import dependence decreases: Gasoline imports are reduced as ethanol replaces gasoline as a motor fuel. Some bagasse is diverted from electricity generation to ethanol production and needs to be substituted by higher imports of coal and distillate oil.

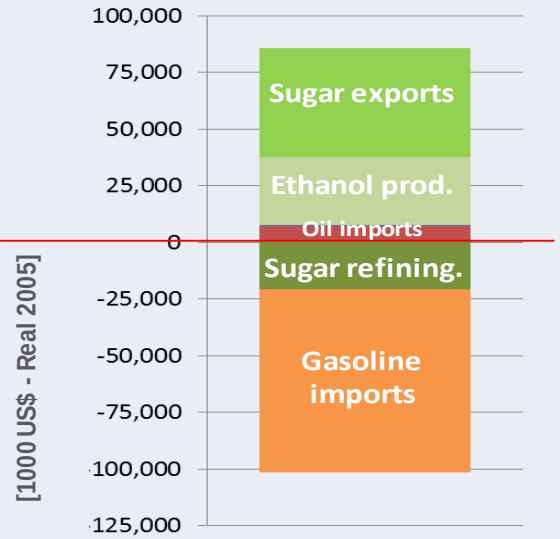
Reduced greenhouse gas emissions



Total greenhouse gas emissions are reduced: Tailpipe and upstream emissions are reduced as gasoline is replaced by ethanol. The increased use of coal and distillate oil (in place of bagasse) for electricity generation results in smaller additional emissions.

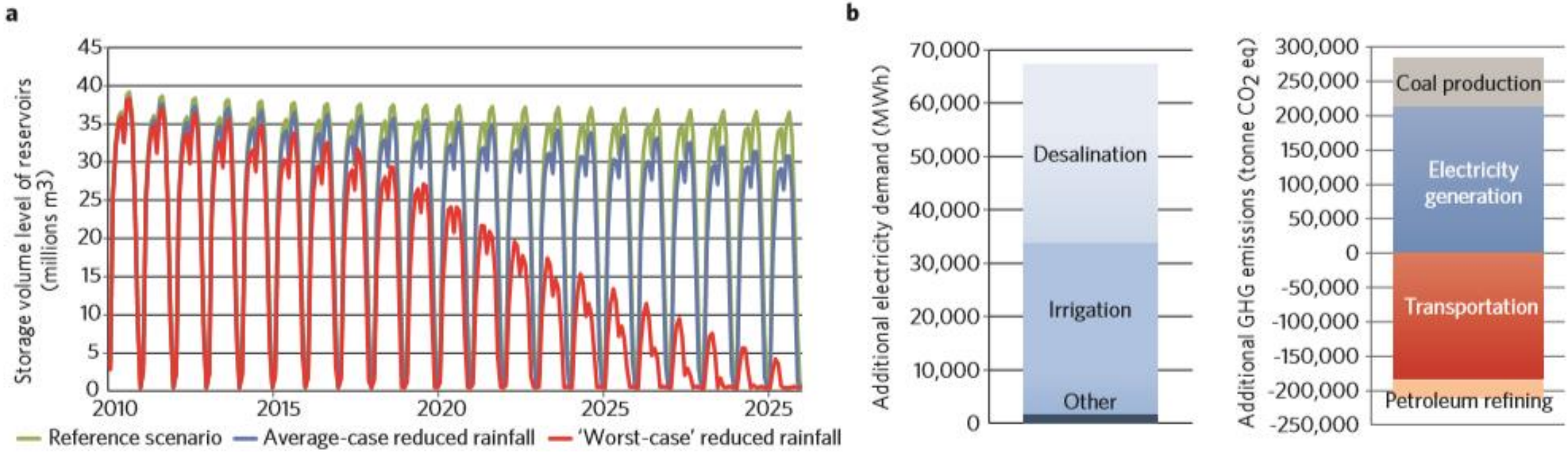
1) Indirect emissions

Reduced expenditures

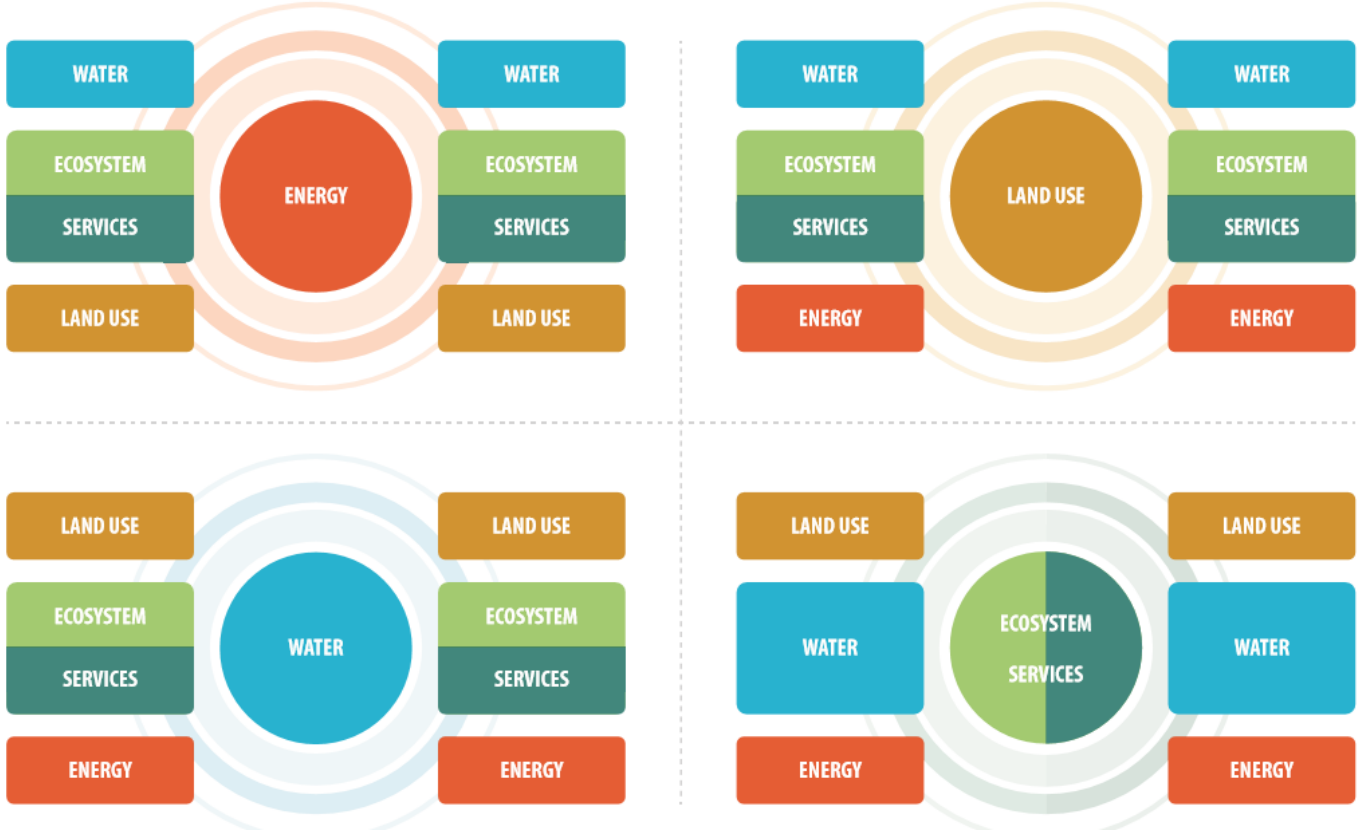


Domestic ethanol production has economic benefits: As some of the sugar is converted to ethanol, the expenditures for sugar refining and gasoline imports are reduced. This outweighs the reduced sugar export earnings and the costs associated with ethanol production and the increases in oil and coal imports.

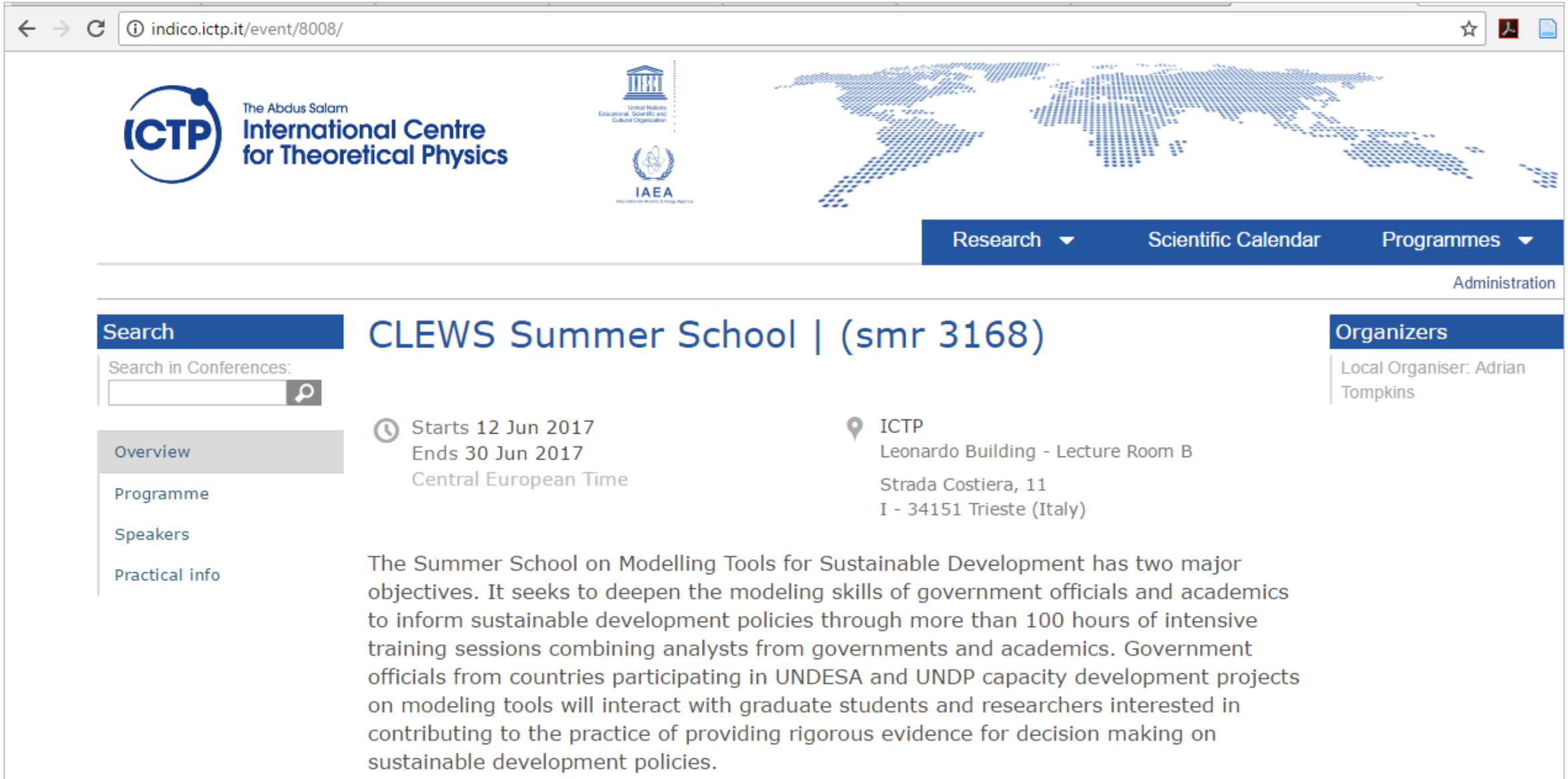
Impact of climate change in a CLEWs framework



Capacity building and communication



ICTP CLEWs training workshop



Contact and links to OSeMOSYS

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- OSeMOSYS website: www.osemosys.org
- FAQ and help: www.reddit.com/r/optimuscommunity/comments/5qb0hm/osemosys_qa/
- Code development: www.github.com/KTH-dESA/OSeMOSYS
- Visualisation of Mauritius case study results: http://un-desa-modelling.github.io/clews-mauritius-visualisation/dist/