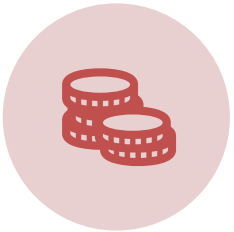
# Combining LCA and IAM

Calculate different environmental impacts through LCA of different technologies.

Integrate them in midpoint and endpoint indicators.

Calculate costs of implementation of the technologies.



**How to minimize the cost and obtain maximum reduction in environmental impact, given constraints in e.g. material availability?**

The broad scope of this research makes it posible to integrate it with any other project looking to LCA, and I would also prefer to work in a group.

# SSP implementation – Step by step description

Assignment: Develop other SSP variants beyond SSP2 by adjusting demand, techno-economic parameters, possibly adding/removing technologies/processes

Steps:

1. Find data on the various other SSPs. Looks like this page is a good starting point: https://tntcat.iiasa.ac.at/SspDb/dsd?Action=htmlpage&page=20
2. Choose one other SSP, for instance SSP1
3. Adjust parameters in MESSAGEix model
   - Map SSP data to MESSAGEix model data and find which parameters should be modified. This applies to both values of parameters and bounds defined in MESSAGEix.
   - Adjustment of the parameters could be done in the South Africa excel file
4. Run the model with various scenarios for both SSP2 and SSP1. Compare results.

# Kamila – interests for the seminar

- Behavioral aspects(“integration of behavioral aspects emergent”)
- Socioeconomic drivers
- Scenario & storyline development
- SSPs

# Explore alternative energy carriers (e.g., hydrogen, ammonia) including supply chains

1. Define new scenario with hydrogen (SMR and FC) and ammonia as alternative fuels and scope supply chain
2. Define data needs and find/assume values
3. Add final demand, technologies, input and output, costs for scenario

# Disaggregation of transportation modes

1. Develop scenarios for long-haul distance transportation (e.g., shipping, aviation)
2. Estimate transport-work increase between South-Africa ↔ Globe
3. Establish technology assumptions in terms of energy efficiency gain, diffusion and cost
4. Embed energy demand estimations for transportation

Run scenario and investigate:

1. Total primary energy production
2. Resulting energy mix (with new alternative carriers)
3. Increase in total fuel cost for transportation
4. Emissions associated with the new fuel mix compared to baseline

# Seminar

## Two topics I would be interested in:

- Biodiversity losses in future societies: land use vs climate change driven impacts on ecosystems (+ modelling approaches for that)
- Coupling of IAMs with supply and use tables (SUTs) and/or input-output tables (IOTs); uni- and/or bidirectional

# Project

Not sure if focus on capital stocks or on linking in general…

## Representation of capital stocks in IO-IAM linkage

0. Conceptualisation: How could IAMs be coupled with IOTs/SUTs?
   → decision if work with IOTs or SUTs
1. Aggregation of IOTs/SUTs to desired country/sector resolution (country aggregation only necessary if multiregional (MR) setting; e.g. 2 region – 10 sector economies)
2. Finding linkages (→ replacement!) of IAM commodities + capital in IOTs/SUTs (only for ZA if MR-case)
3. Representation of IOT/SUT balances (in=out, supply=demand) as constraints in GAMS (perhaps as a rectangular choice model)

# Project (cont'd)

## Representation of capital stocks in IO-IAM linkage

4. Exogenous trajectory definition of extra-IAM flows, i.e. remaining IOT/SUT commodities/industries/final demand (in GAMS)
5. Embedding of above variables/parameters in t0 in spreadsheet
6. Run model for t time periods
7. Analyse results + potentially perform Leontief calculus

# Nelson's Idea for Model Development

- **<u>Option 1 (use of message-ix South Africa)</u>**
- Develop other SSP variants/Scenarios for message-ix South Africa. Three Scenarios will be defined here using message-ix SA as the basic starting point.
    1. What will be the energy system configuration of a net-zero energy system (ES) for South Africa by 2070? The idea is to configure the model parameters, change settings in technology bounds, etc, to test the technology and cost requirements of a net-zero ES for South Africa by 2070. The objective will be to investigate how the energy system should evolve if one were to achieve a net-zero ES by 2070

    2. What will be the ES and cost configuration under an SSP3 or SSP4 (*not settled yet*) scenario

    3. For points 1 and 2, I intend to test the effects of changing technology cost parameters and particularly the effect of carbon tax on the objective solution. Is carbon tax an effective decarbonization strategy?

# Nelson's Idea for Model Development

- **<u>Option 2 (develop message-ix Cameroon following message-ix South Africa, seems quite ambitions)</u>**
- In option 2, develop a message-ix Cameroon to model the evolution of the energy system (ES) under SSP1 scenario. Furthermore, one will test the sensitivity of carbon taxing mechanisms and other techno-economic parameters.
    - I think the way to proceed in this case is to first quantify relevant inputs like energy resource potentials, current capacity of technology, etc. Basically, replacing the message-ix South Africa excel with a message-ix Cameroon excel file and running the model.

# Integrate high volume products (e.g., cement) based on LCA data

- First off
  - I would try and draw/visualize the system that I want to add to South Africa, just to see what I am dealing with.
- Add new (material) commodities and related supply and demand technologies
  - I can add the commodity (cement) manually with python interface or add it in the excel sheet for South Africa.
  - Add one extra technology called “cement_factory” on the secondary level. Output of this technology creates the commodity cement with an input commodity of electricity. I can then play around with the conversation rate of electricity to cement. The demand would be to construct buildings, this could be related to population or GDP – something similar is done in the Westeros baseline example, I don’t know if I can do it like that?
- Possibly modify GAMS code to allow triggering commodity flows by construction/decommissioning
  - I would probably skip this, I have no idea what it would take to do it – I have never used GAMS before.
- Quantify energy consumption and emissions connected to material use
  - Emissions are mostly from the calcination process happening in the cement factory and from energy consumption needed for heating in the calcination process. Therefore, an emission factor is assigned directly to the cement_factory as well in units MtCO2eq/MtCement.
- Analyze substitution of products (via scenario analysis), incl. the impact on decarbonization
  - This I have no idea how to include with MESSAGE. I could put a lower activity bound to a new technology and see how far up it is feasible to take it maybe?
- “Extra”: Compare scenarios of low CO2-eq scenarios (constrains on emissions) by inserting results from the IAM and see how the scenarios look on other impact categories.