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"MESSAGE in an hour" - a simple hands on example

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"MESSAGE in an hour" – a simple hands-on example

Objective

This training session aims to provide a brief overview of how the energy component of an integrated CLEW model could be set up with MESSAGE. A simple energy system will be modelled and run under different scenarios, assuming different supply constraints and an emission limit. Simplified assumptions will be made to keep the systems at minimum complexity.

The Energy System

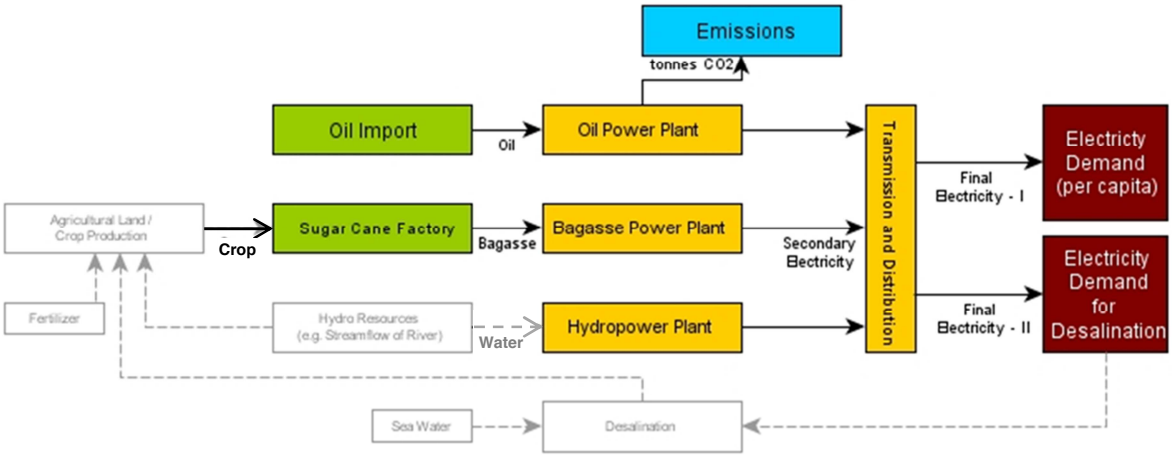
We will consider a basic energy system where demand in electricity is met by an oil-fired power plant and hydro power. Additionally, sugar cane is cultivated and its by-product bagasse is used as well to generate electricity.

The tonnes of sugar cane harvested are assumed to be an input value derived from the land-use model, which is itself dependent on the water model to ensure the irrigation water demand is satisfied.

Further, the energy model is dependent on the water model: In case of a water deficit, desalination is considered and the hydro power production reduced. The energy model also provides an input to the water model, as it will have to ensure that the cooling water demand for the oil and bagasse fired power plants can be met.

The energy related component of the climate model will be reflected through CO_2 emissions, which are assigned to the oil fired power plant. (All sugar cane is assumed to be produced in a sustainable manner.)

The schematic representation below gives an overview of the energy system:



Only the coloured parts of the illustration will be modelled in our exercise. The grey parts of the model demonstrate elements which are modeled outside of our energy model. They constitute „feedback loops" with the water or land-use model.

The different colours represent:

- GREEN: Energy Input Data (Imported oil, energy crops provided)
- YELLOW: Energy production Technologies used in our system. The three main technologies used in our example are:
    a) A conventional coal power plant using imported oil
    b) A bioenergy plant which uses Bagasse (from a sugar factory) to produce electricity, and
    c) A hydropower plant.
- BLUE: Emissions produced (in our case only CO2 is assumed)
- RED: Electricity demand data.

The Scenarios:

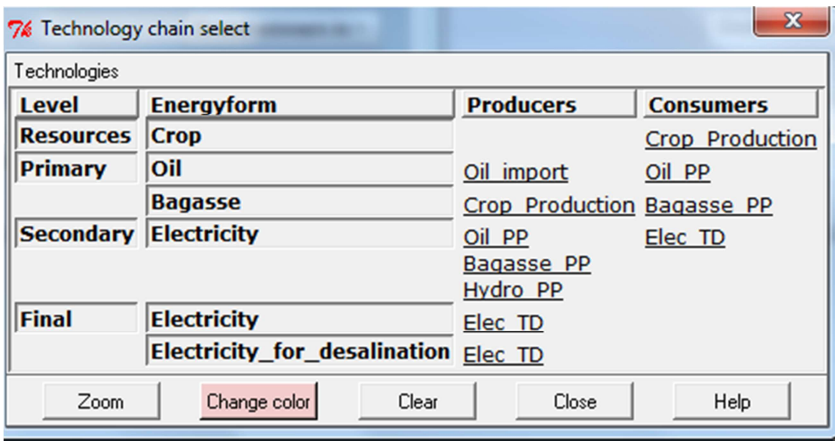
In this exercise you will enter all the necessary input data to set up this simple energy system and will model 3 different scenarios:

a) Scenario A (Business as Usual Scenario): No constrains – water is available indefinitely, as well as oil. There are no restrictions on the CO_2 emissions.
b) Scenario B: A limit on annual CO_2 emissions is introduced.
c) Scenario C: From 2015 onwards, rainfall is expected to be reduced. The limited water availability has influence on both hydropower and sugar cane production.

The Input Data:

The following data will be required for setting up the model:

Global Input Data	
Modelling Period:	2005 – 2030 in 5 year time steps
Global Discount Rate:	10%
Energy Demand:	220 MWyr in 2005 with an annual growth rate of 3.5%



Input Data for the Technologies:

	MESSAGE Technology ACTIVITY window				MESSAGE Technology CAPACITY window				con1a
Technology	**Input**	**Output**	**Efficiency**	**Variable Cost**	**Plant Factor**	**Investment costs**	**Fixed cost**	**Capacity in 2005**	**Emissions**
	-	-	*MWyr/MWyr*	*US$/kWyr*	-	*US$/kW*	*US$/kW/yr*	*MW*	*kton CO2/MWyr*
Energy Crop Production at the Sugar Factory	Sugar cane	Bagasse	0.015 MWyr/kton	-	-	-	-	-	-
Oil Import	-	Oil	-	250					-
Oil Power Plant	Oil	Second. Electricity	0.38	20	0.85	600	10	350	5.25
Hydro Power Plant	-	Second. Electricity	1	1	0.25	3000	20	55	-
Bio Energy Plant	Bagasse	Second. Electricity	0.25	20	0.7	2250	35	100	-
Transmission and Distribution	Second. Electricity	Final Electricity (Desalination & other uses)	0.85	-	-	-	-	-	-

Lifetime of all power plants: 30 years

Restrictions / Constraints:	
Scenario A, B, C: Limit of Crop Production per Year (due to limited agricultural area/production	10,000 kton/yr (bagasse)
Scenario B: Limit of CO2 emissions in scenario b)	1,500 kton of CO2 per year
Scenario C: Limit of water availability (due to decreased rainfall)	13 MWyr for 2010, 10 MWyr for 2015 and 5 MWyr for 2020 onwards
Scenario C: Desalination	Additional Demand: 50 from 2015 onwards

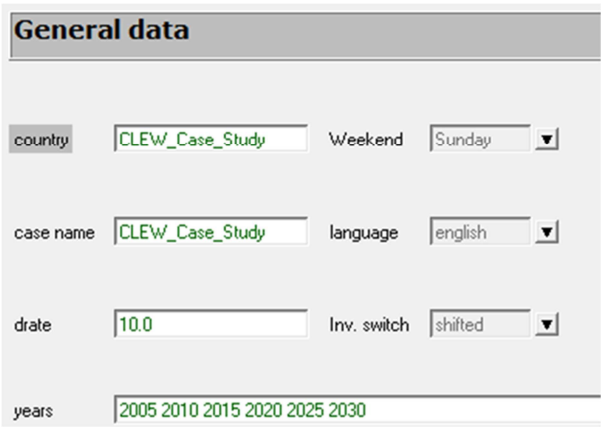
Selected Screenshots for Data Entry

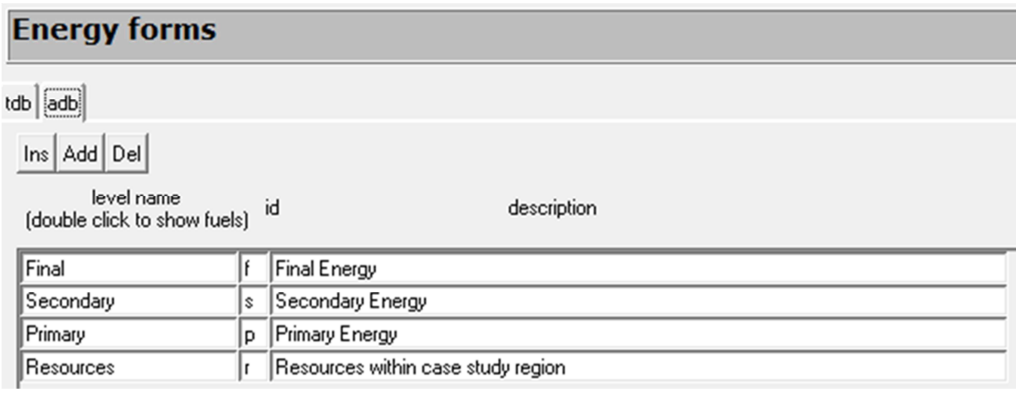
Start Message and go to:

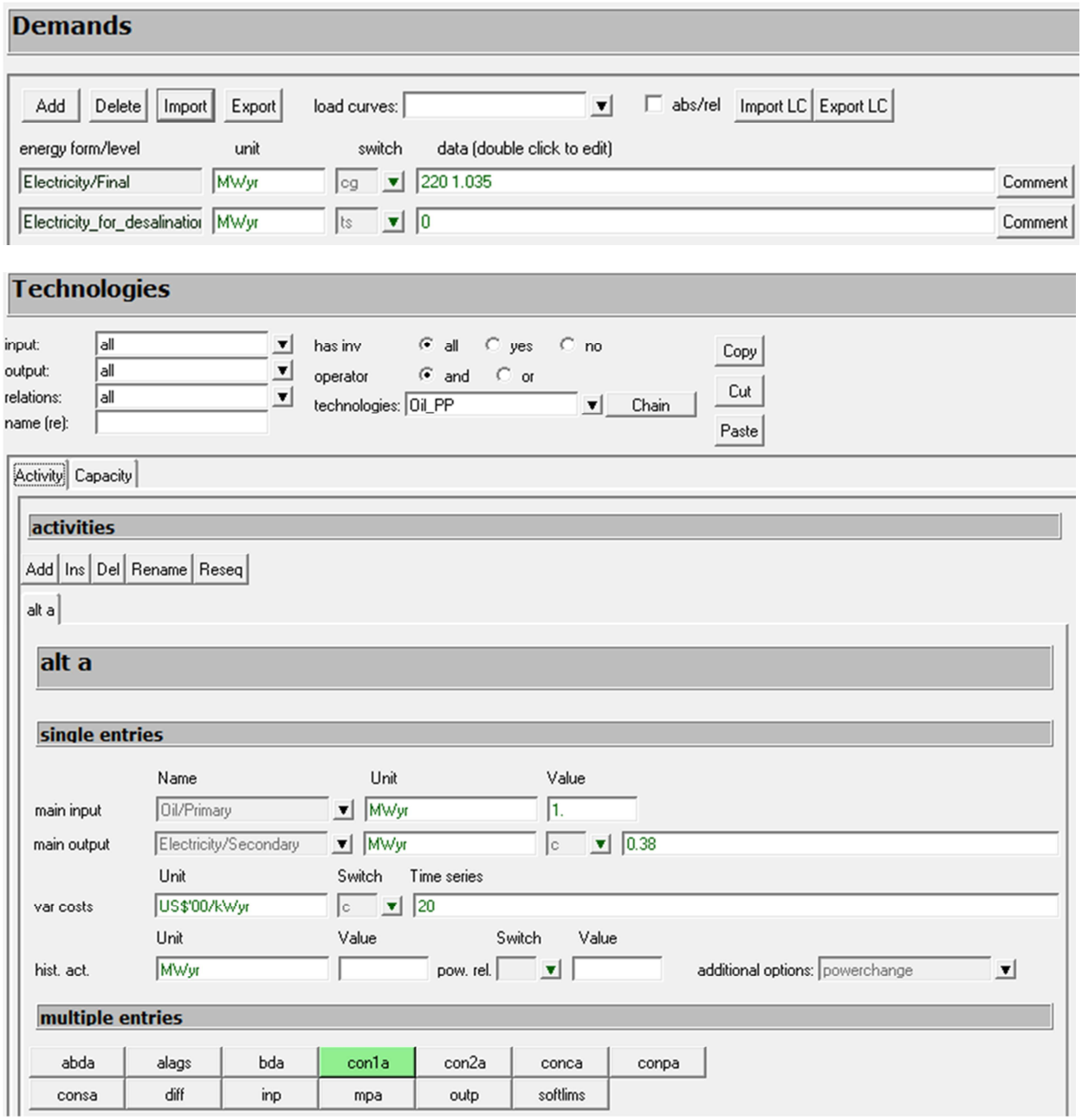
- Cases/New/Create single region case
- Cases/Open: select new case
- Edit/application db

Always press save in every screen possible. Especially when leaving the application db by pressing save and close, do not forget to click on Cases/Save in the blue Message screen, otherwise all previous changes will be lost!

Scenario A – Business as Usual



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pow. rel.
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multiple entries
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con1a
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mpa
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softlims


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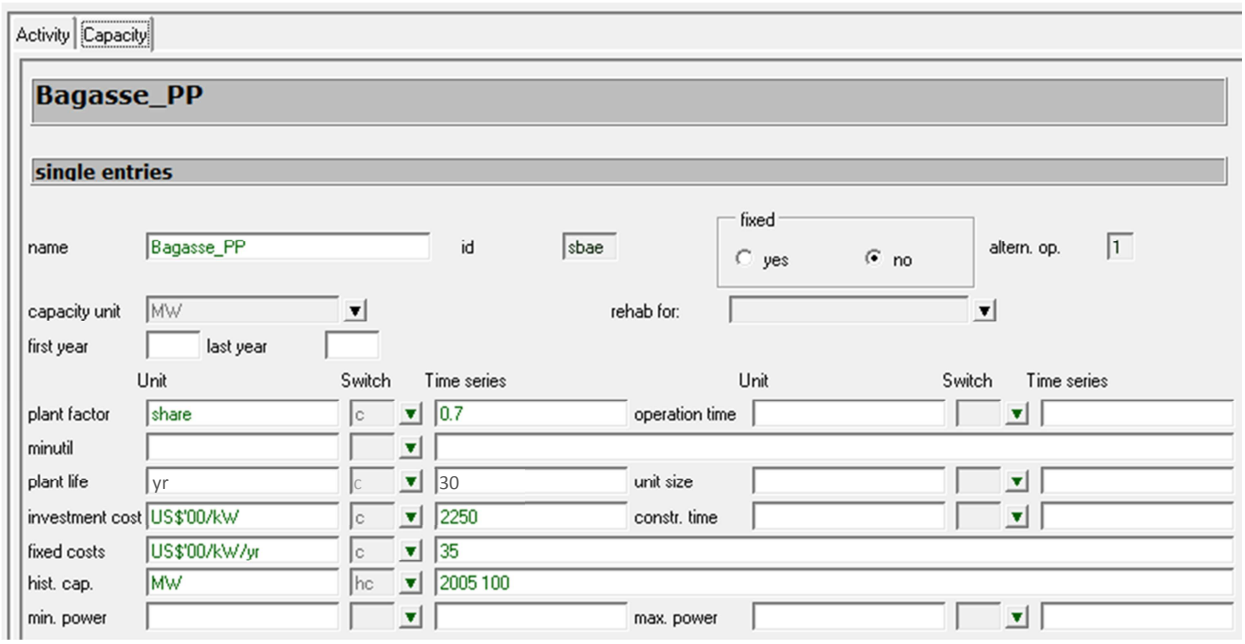
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Bagasse_PP
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rehab for:
first year
last year
Unit
Switch
Time series
plant factor
share
c
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operation time
minutil
plant life
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US$'00/kW
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US$'00/kW/yr
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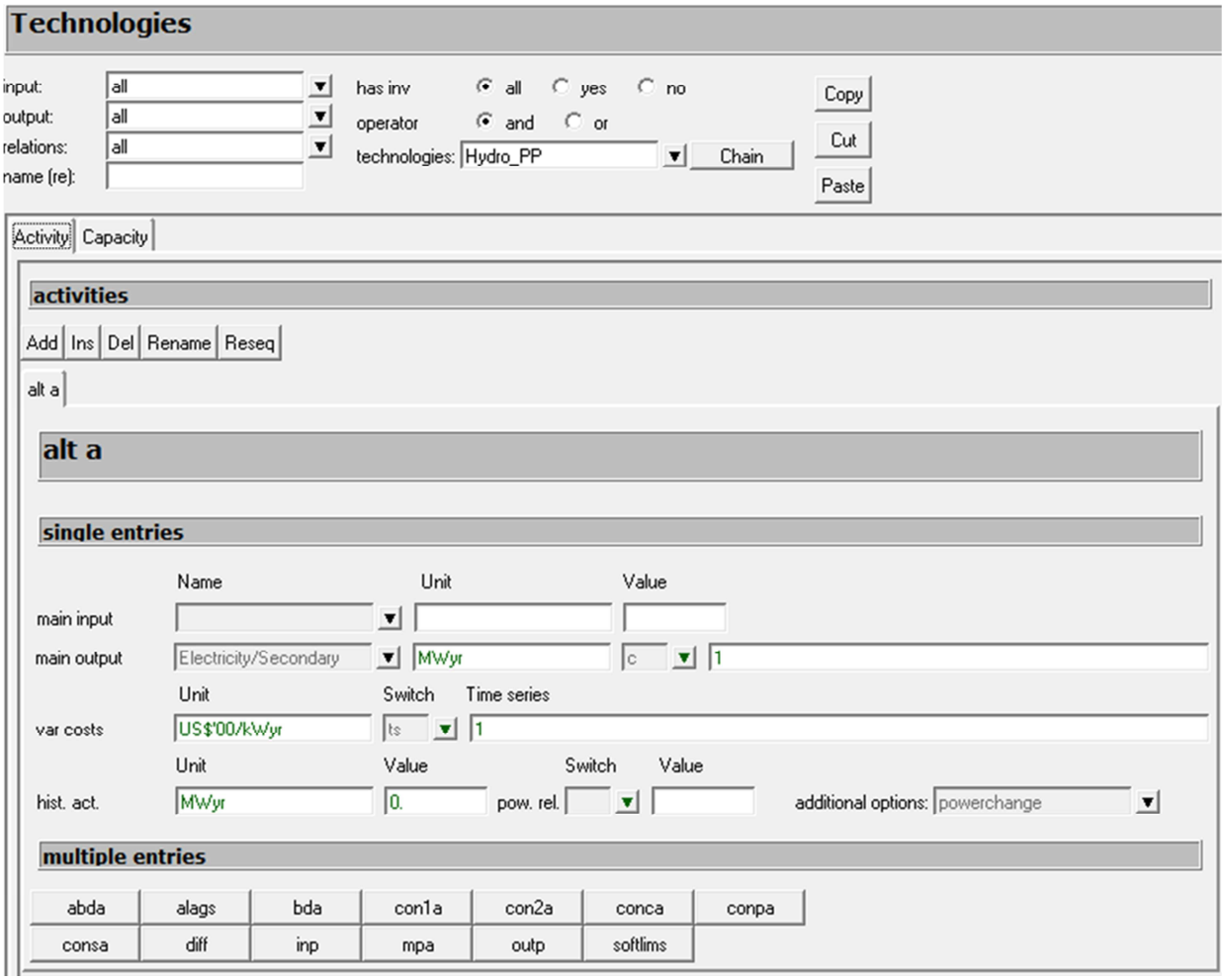
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single entries
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main output
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Time series
var costs
US$'00/kWyr
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additional options:
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multiple entries
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alags
bda
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con2a
conca
conpa
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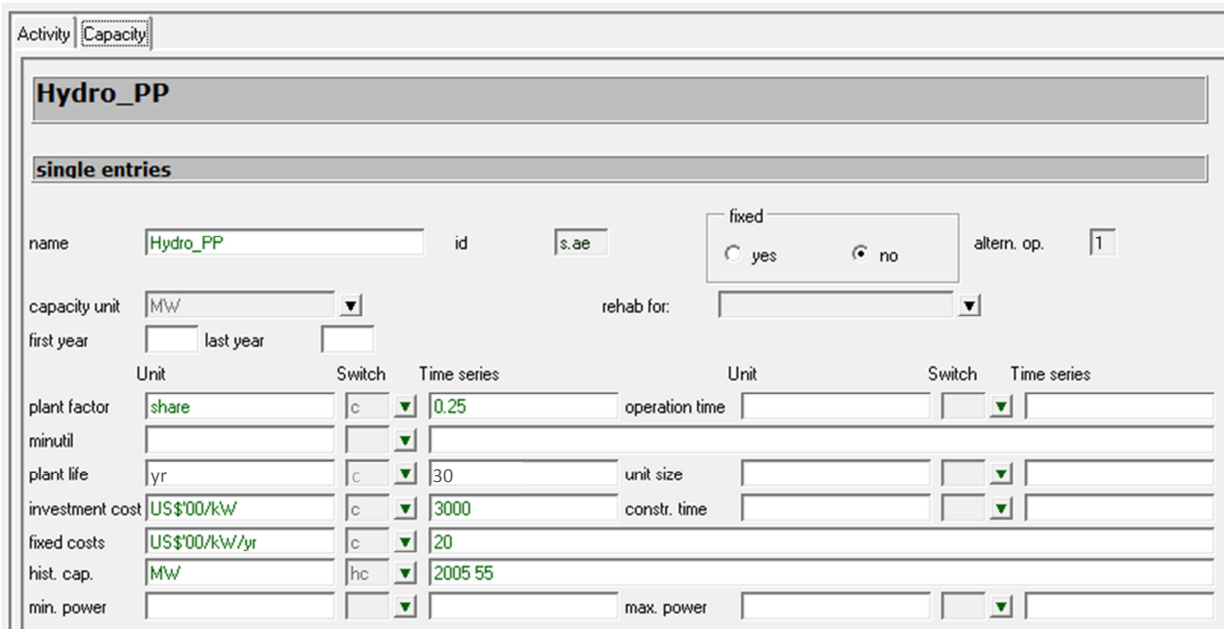
inp
mpa
outp
softlims


Activity
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Unit
Switch
Time series
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operation time
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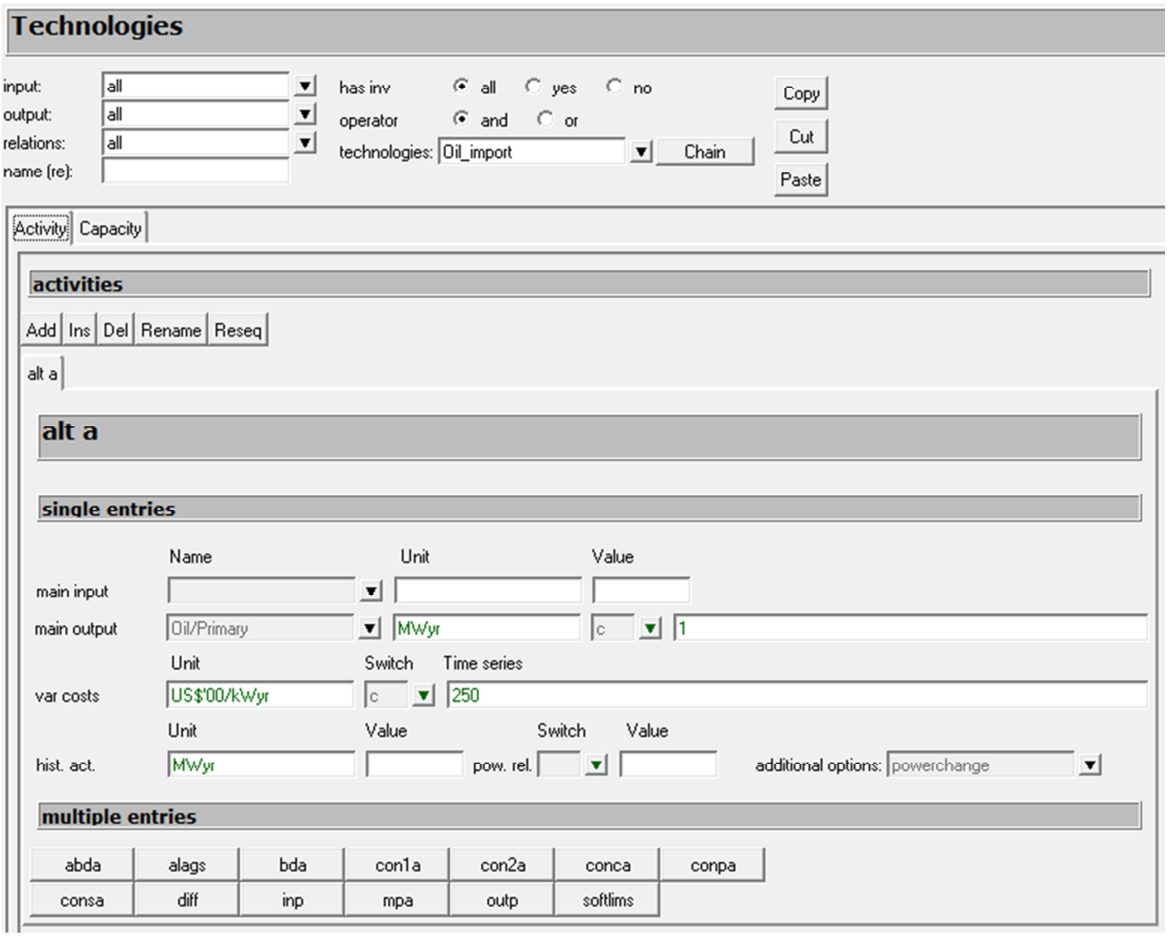
max. power


Technologies
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operator
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Rename
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single entries
Name
Unit
Value
main input
main output
Oil/Primary
MWyr
c
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Unit
Switch
Time series
var costs
US$'00/kWyr
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MWyr
pow. rel.
additional options:
powerchange
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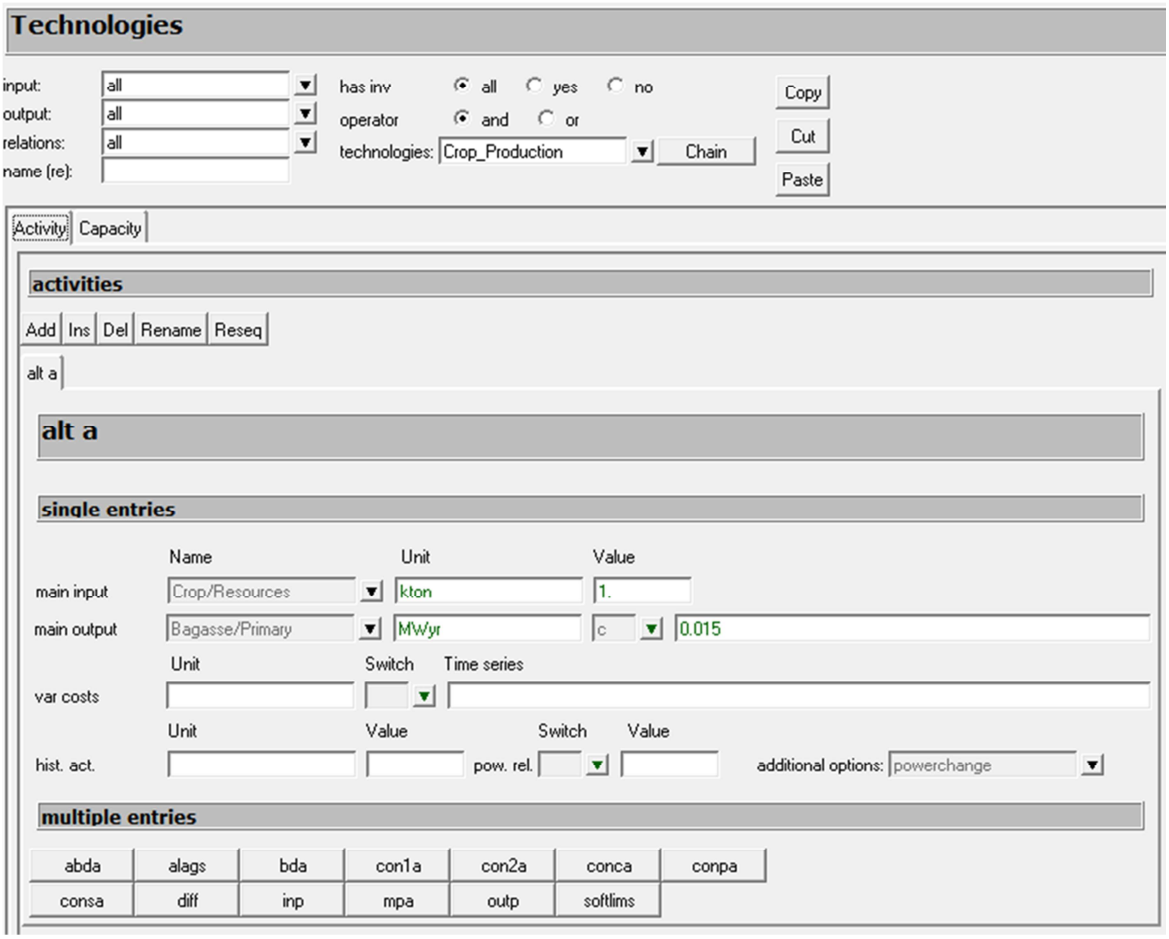
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main output Bagasse/Primary MWyr c 0.015
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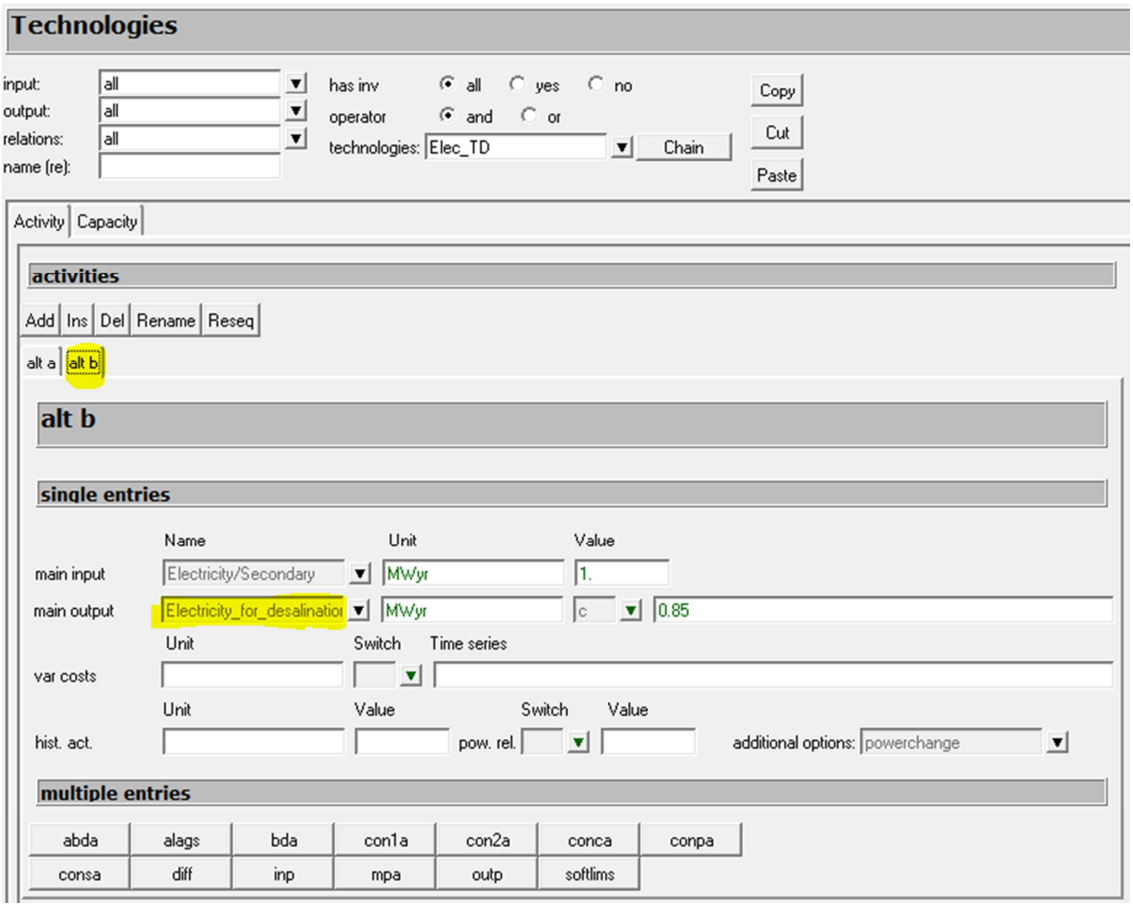
Technologies
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output: all
relations: all
name (re):
has inv all yes no
operator and or
technologies: Elec_TD
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Activity Capacity
activities
Add Ins Del Rename Reseq
alt a alt b
alt b
single entries
Name Unit Value
main input Electricity/Secondary MWyr 1.
main output Electricity_for_desalinatio MWyr c 0.85
Unit Switch Time series
var costs
Unit Value Switch Value
hist. act. pow. rel. additional options: powerchange
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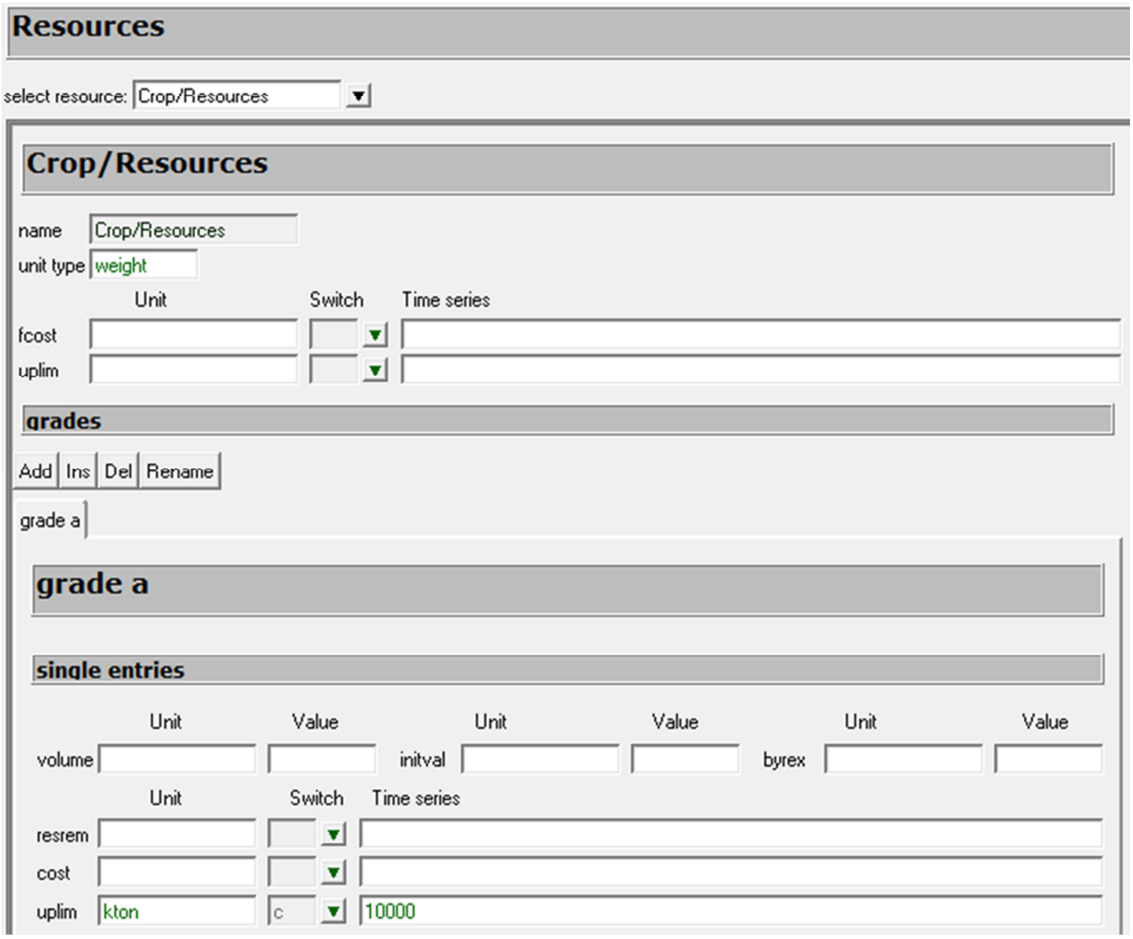
consa diff inp mpa outp softlims


Resources
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Crop/Resources
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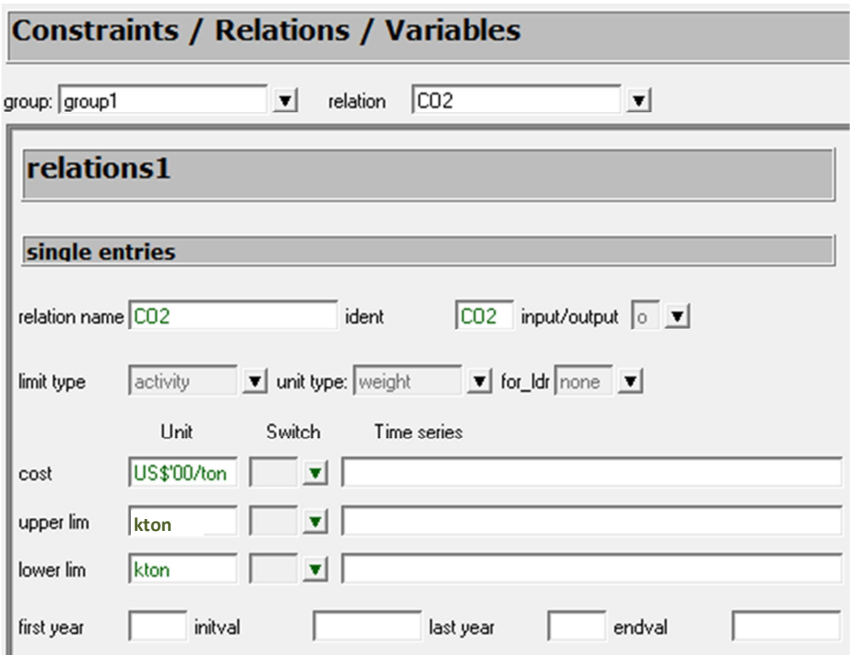
Constraints / Relations / Variables
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single entries
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lower lim kton
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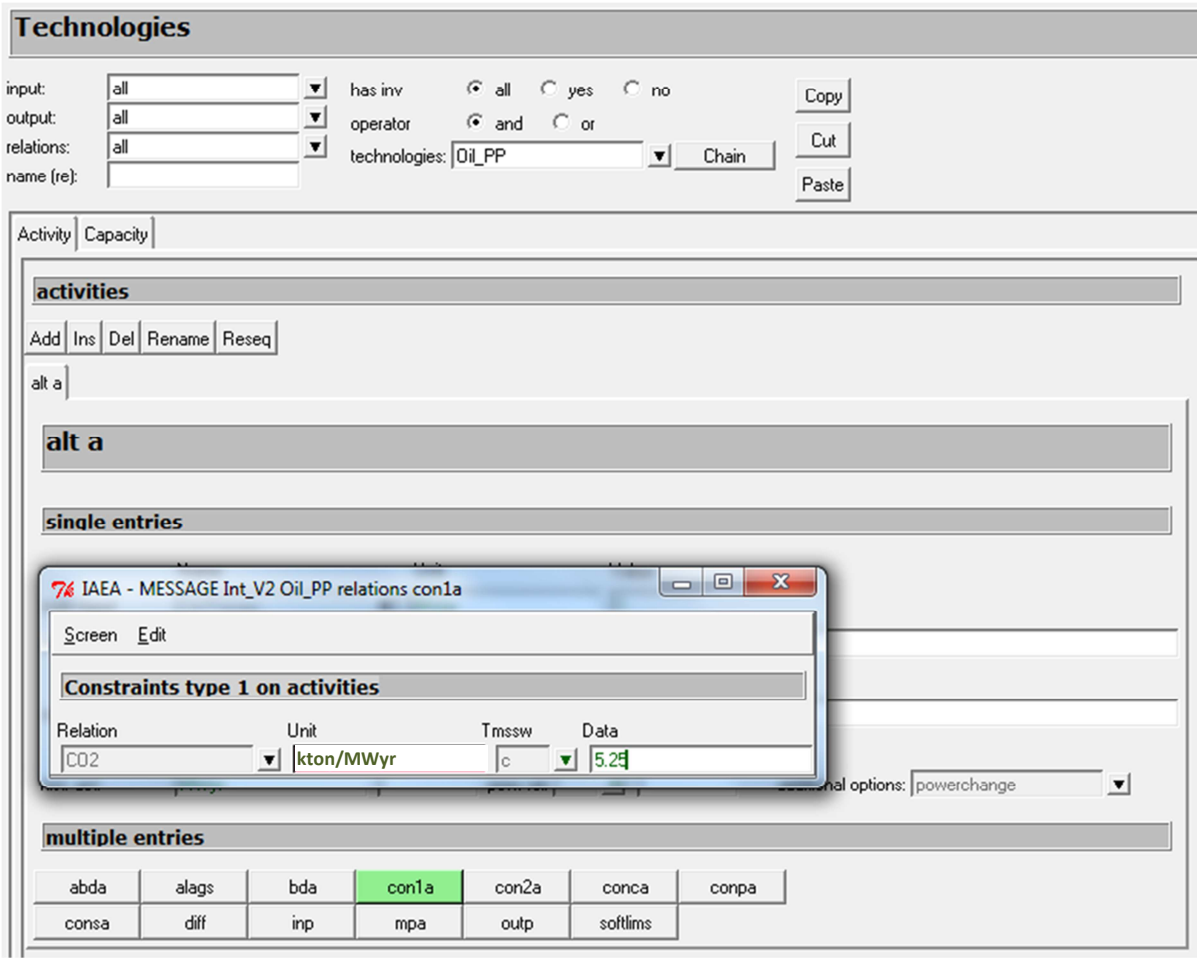
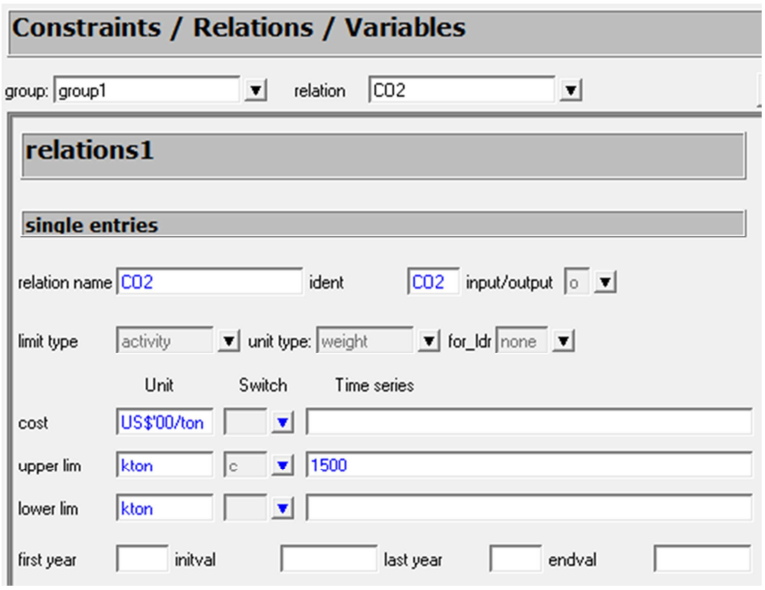


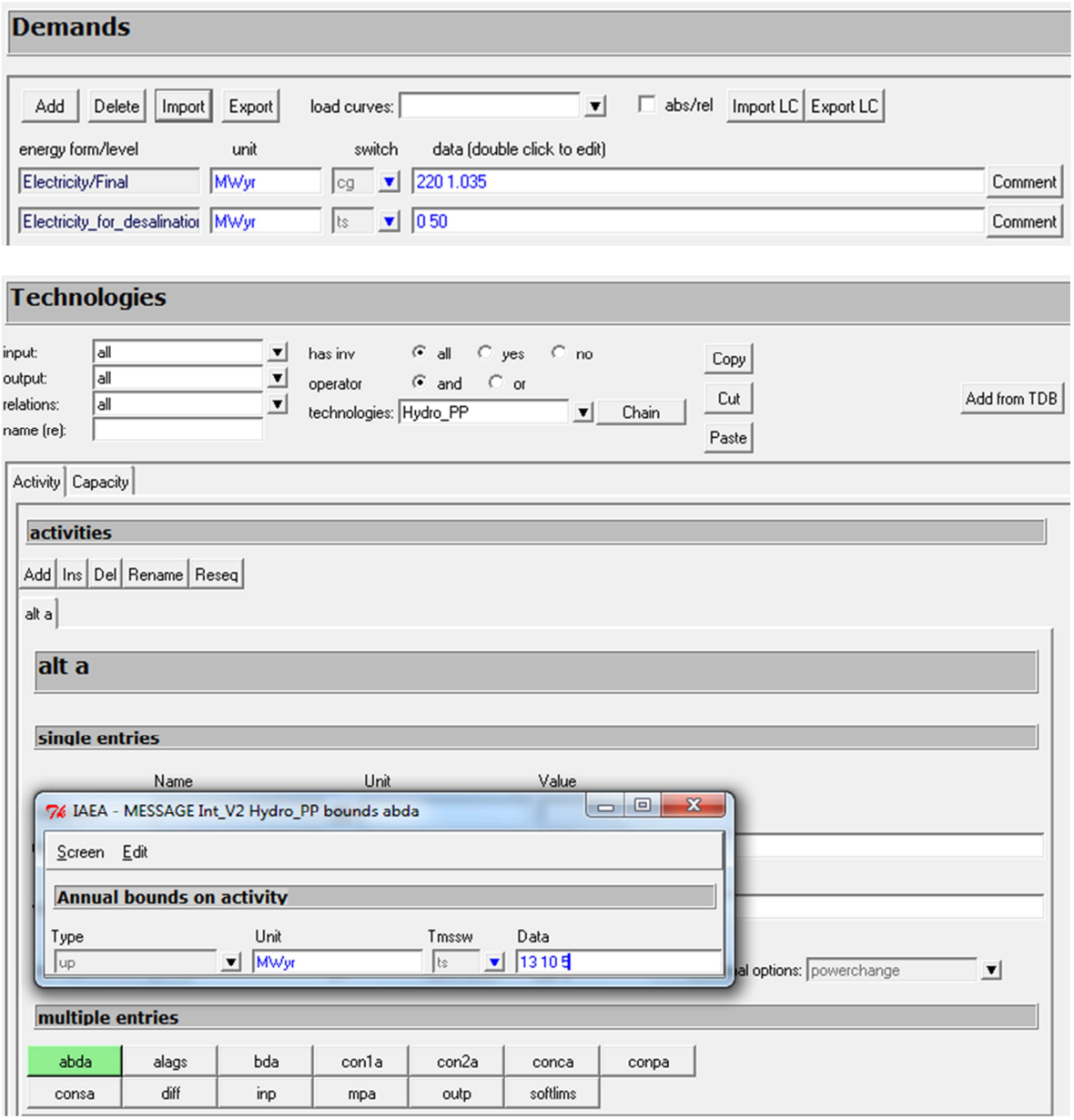
Scenario B – CO_2 emissions limit

- Cases/Copy Scenario: select adb
- Cases/Edit: select new scenario



Scenario C – Reduced rainfall

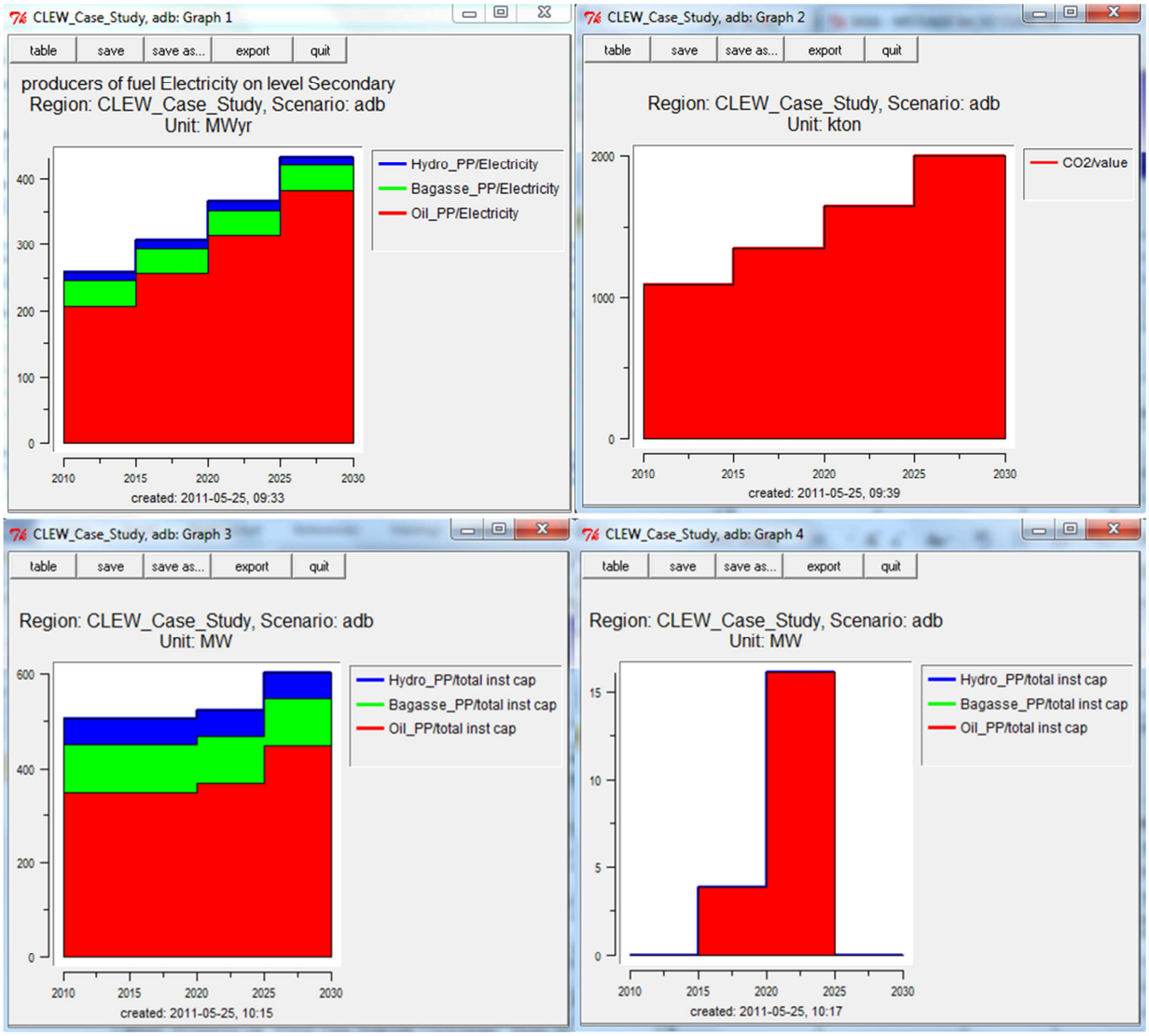
- Cases/Copy Scenario: select adb
- Cases/Edit: select new scenario



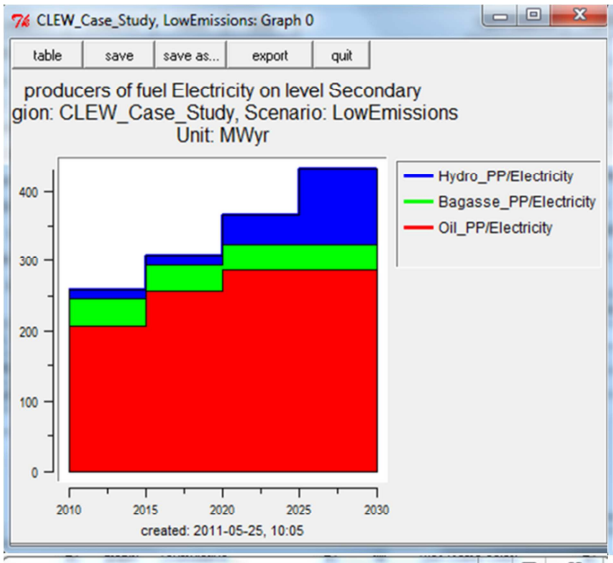
Selected Results

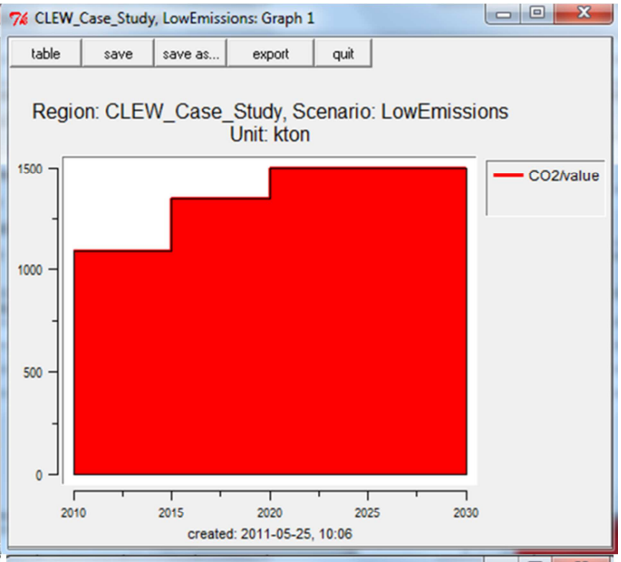
Scenario A – Business as Usual

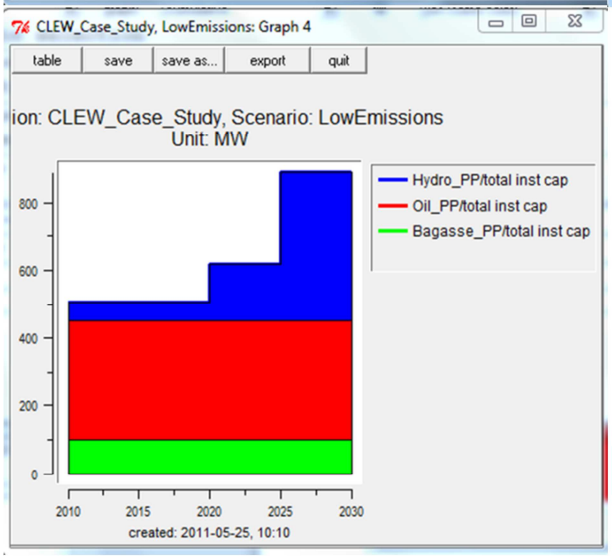
- Select/Scenario: select adb
- Run/All
- Results/Interactive: e.g., in Balance selection, choose secondary level, click take balance and click on graph; quit graph, press clear and go to curve selection, choose a power plant technology, press take curve, choose other technologies and press take curve again, click on graph;

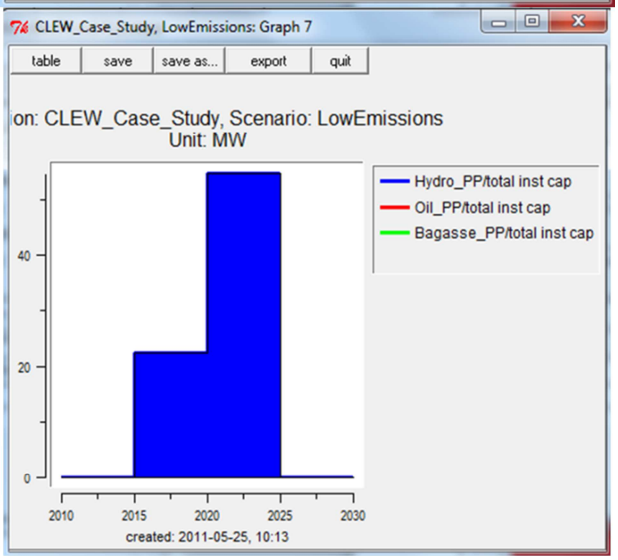


Scenario B – CO_2 emissions limit









Scenario C – Reduced rainfall