Before beginning, we need inventory data and an impact assessment methodology

1. Create a new database
    a. Right click anywhere in Navigation → 'new database'.
    b. Right click on your active database → 'import' → 'other' → Linked database (JSON-LD) → select your zip file and 'finish' (this will take a few minutes!)

The foreground system

The process to be modelled is the encapsulation of ILW solid organic ash in cement.

System boundary: receipt of ash to final disposal in repository. The impacts of the GDF itself are also included based on the percentage of the total GDF volume taken up by the waste.

Functional unit: 1 conditioned 30L stainless steel drum in final repository

Table 1 Inventory data for encapsulation of ILW solid organic ash in cement

Inputs	**Value**	**Unit**
Electricity low voltage	1.5	kWh
Stainless Steel Chromium 18/8	4.8	kg
Portland Cement	29.2	kg
GDF construction – reinforced concrete	0.29	m^3
GDF construction – diesel burned	9.8	MJ
Transport of all inputs	73.5	tkm
Outputs	**Value**	**Unit**
Conditioned 30L stainless Steel Drum in final repository	1	No. of Pieces
Used PPE	0.5	kg
Cement Dust	0.03	kg
Assumptions		
Transport distance	100	km
Radioactive waste mass	5	Kg
Waste loading	12	%
Drum size	30	l

Modelling the system

NB/ remember to save regularly! (Save icon at the top left.)

1. Create new process
    a. Right click on 'Processes' → 'New process'
    b. Give the process a name (e.g. 'encapsulation of ILW ash')
    c. Select 'create a new flow for the process' to act as the reference output of this process, since the database will not already contain drum of ILW
    d. Give the flow a name (e.g. 'Conditioned 30l stainless steel drum in final repository)
    e. Set reference flow to 'number of items', since our FU is 1 drum
2. Add inventory data to your new process, based on Table 1
    a. In 'General information', add a brief description of what the process represents
    b. Under 'Geography', select 'Europe – RER'
    c. At bottom of page, select the tab 'Inputs/Outputs'.
    d. Double click anywhere under 'inputs' and select data to represent the inventory data in Table 1, as shown below in Table 2:

Table 2 Database sourced used to represent the inventory data

Inputs	**Database sources**
Electricity low voltage	Nuclear power → electricity, nuclear, at EPR reactor
Stainless Steel Chromium 18/8	Metals → Steel Stainless 304 → Add SS304 stainless steel SS304 profiles items 47%PCR - AU
Portland Cement	Concrete → Concrete & Cement → Sac Blend & Haul Marine Cement
GDF construction – reinforced concrete	Concrete → Reinforced Concrete → Cast 40MPa Reo Concrete
GDF construction – diesel burned	Utilities → Fuel Use Burn Liquid Fuels → Burn Diesel in Pacific Rim
Transport	Transport systems → road → transport, lorry 32t
Outputs	**Database sources**
Used PPE	Waste management → disposal, hazardous waste, 25% water
Cement dust	Elementary flows → Emission to air → low population density → Particulates, <2.5um

    e. Attach inventory data for all of your input flows by going to the column 'Provider' and selecting the appropriate dataset. (For electricity you will have to select one of several options)
3. Turn your model into a 'product system' to link together all the components
    a. At bottom of page, select the tab 'General Information' and click 'Create product system'
    b. Keep all the default options (auto-link process, prefer default providers) but select 'unit process' instead of 'system process'. This ensures that the impacts of all inputs/outputs will be visible separately rather than aggregated.

4. At bottom of page, select the tab 'model graph' to see a depiction of your model. Check that all 6 inputs are there.

Analyse your results

1. On the 'General information' tab, click 'Calculate'. Select the impact assessment method is ReCiPe 2016 Midpoint (H), and select 'Lazy/On-demand' results calculation.
2. View the results graphically on the first tab, or go to the tab 'Contribution tree' for a numerical breakdown. The 'Sankey diagram' tab will show this graphically (you can select your impact category of choice using the filter symbol on the top left).
    a. What is the hotspot for global warming?
    b. What is the biggest contributing chemical flow for Mineral resource scarcity? (You can use the 'Impact analysis' tab to investigate)

Consider uncertainty using Monte Carlo

The major hotspot should be the concrete used to construct the GDF. This is highly uncertain, since the GDF design and the waste loading (and therefore volume of conditioned drums) are not well quantified. Therefore we will vary the amount of GDF reinforced concrete attributable to this waste, from 0.2 to 0.4 m^3 (baseline = 0.29 m^3).

1. Return to your process and, at the bottom of the page, select the 'Parameters' tab.
2. Double click anywhere under 'input parameters' to create a new parameter, and name it 'GDF_concrete'
3. Set the 'value' to 0.29, then edit the 'uncertainty' value to add a triangular distribution with a minimum of 0.2, mode 0.29 and maximum 0.4.
4. Return to the 'Inputs/Outputs' tab (bottom of page) and change the amount of Cast 40MPa Reo Concrete from 0.29 to 'GDF_concrete' to select your parameterised value.
5. Return to your product system, and on the 'General Information' tab, click calculate (as you did in step 1 of 'Analyse your results'). Set 'Calculation type' to Monte Carlo Simulation, and add 1000 iterations.
6. Under 'Results', select an impact category such as global warming, then under 'progress' click start. The Monte Carlo simulation will begin.
    a. How does the mean result and the total range compare to the original baseline value?
    b. You may note that some impact categories are affected more than others.

Use normalisation to explore the most critical impact categories

1. Return to your product system, and on the 'General Information' tab, click calculate (as you did in step 1 of 'Analyse your results'). Add the normalisation and weighting set 'World (2010) H', and set 'Calculation type' to 'Lazy-On-demand'.
2. At the bottom of the page, select the 'Normalisation and weighting' tab to find the impact category with the highest value.
    a. Which impact category does this suggest is most critical?
    b. Where does most of that impact come from? (You can use the 'Impact analysis' tab to explore it).