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Hi-BITS

LCIC 2026 by FSLCI

Product Category Templates (PCTs)

Conformance layers for upscaling life cycle models of the same product group

(Photovoltaic systems as an example)

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LCIC 2026, Berlin

Motivation

- Horizon Europe project Hi-BITS
  “High-efficiency bifacial thin-film chalcogenide solar cells“

- There is many ways on modelling photovoltaic systems or solar panels according to a given standard/guideline
  - Is the solar inverter and mounting included?
  - Is infrastructure (machinery, factory lighting and air conditioning …) included?
  - Functional unit of 1 kWh of AC electricity delivered to the grid
  - Declared unit of 1 W_p of nominal power for the solar panel only
  - Which installation location during the use phase? (solar irradiation varies)

- We also want to check or use result from different compliances, e.g. from already existing, verified EPDs

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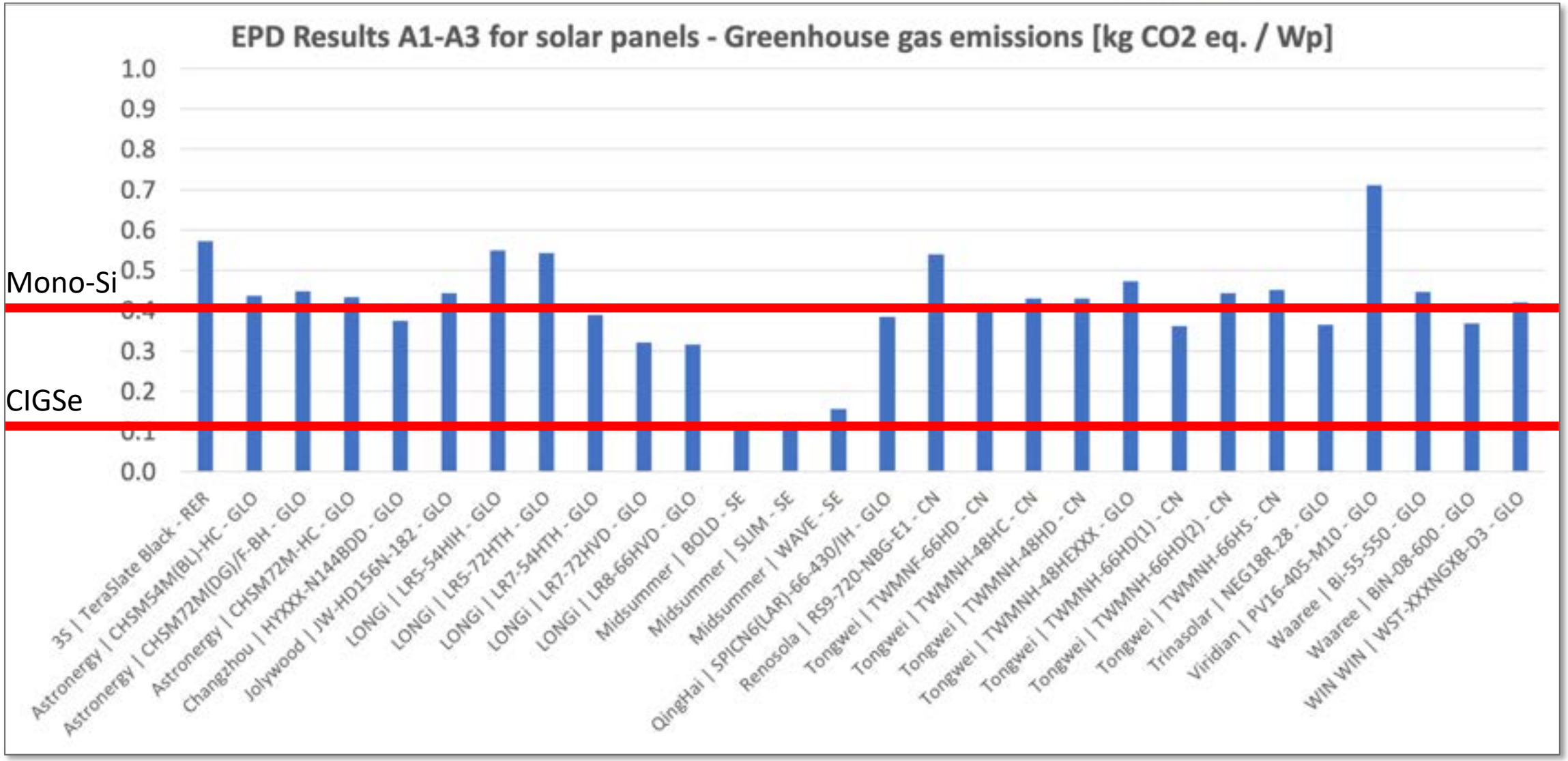
Motivation



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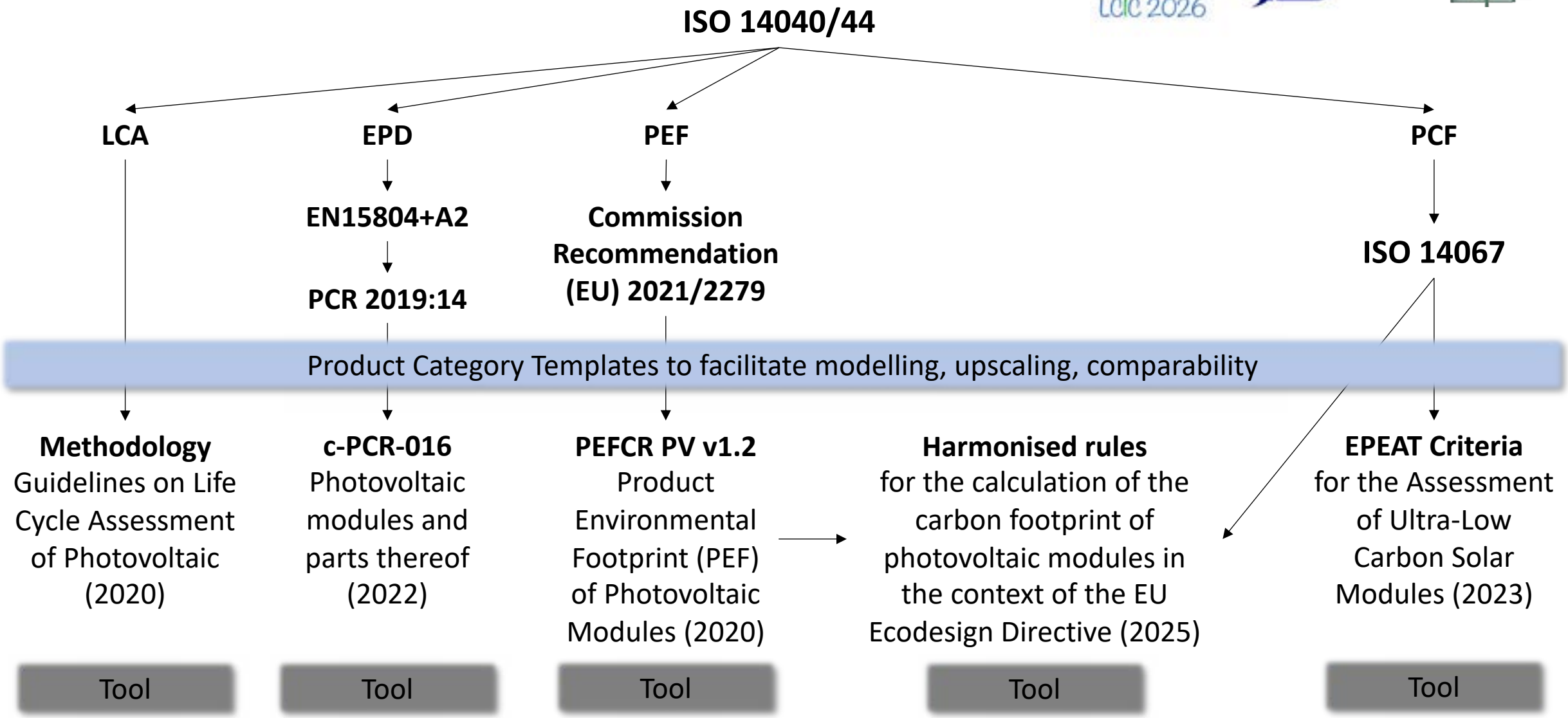
Possible Standards & Guidelines



Specific tools for one “end-point”, similar to e.g. GCCA tool, PEFCR tools, PCF tools for certain chemicals

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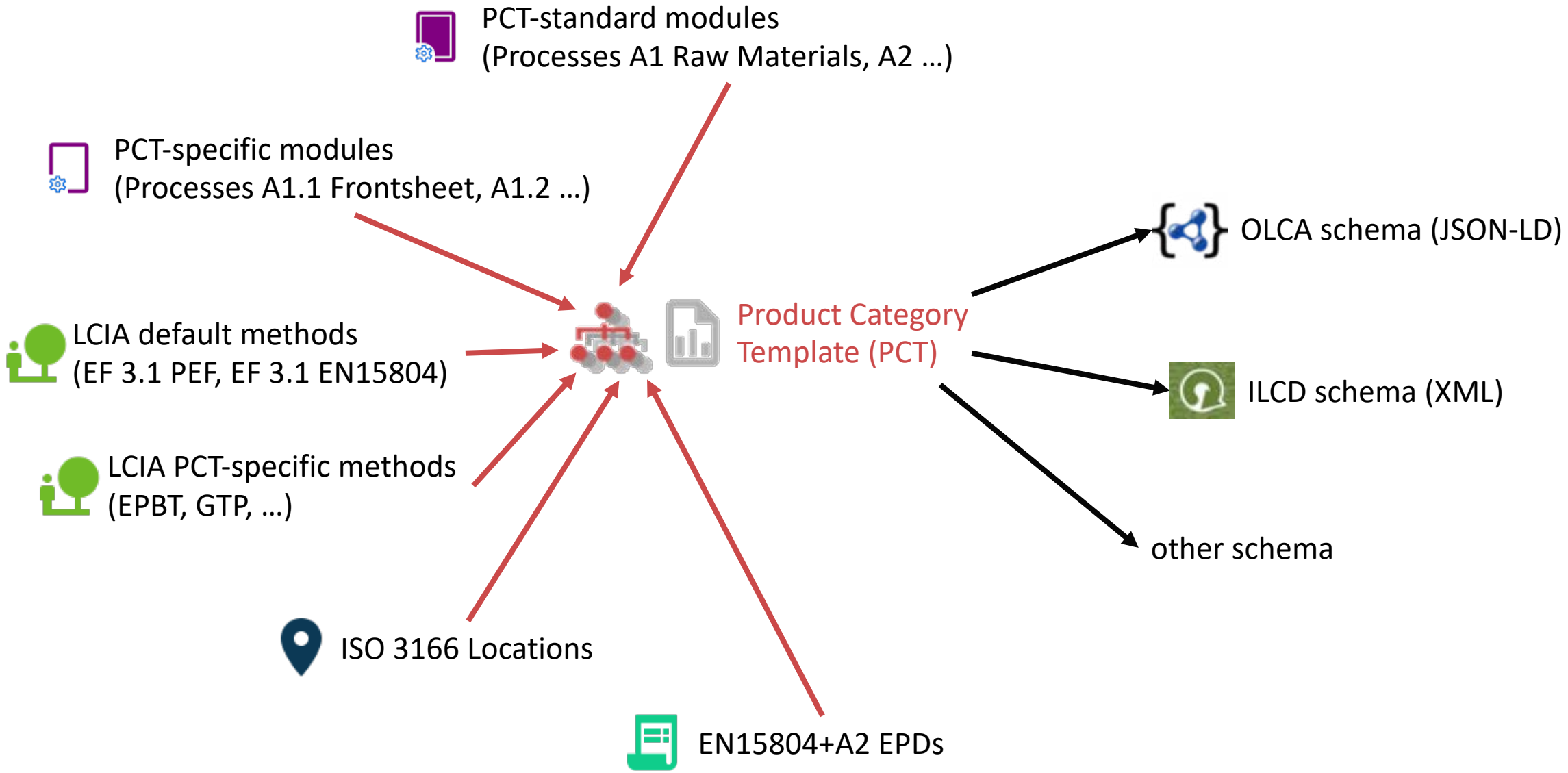
Concept



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How would a normal workflow with PCTs look like?

1. Download the latest PCT in the right format (OLCA or ILCD) and the right reference system (BAFU 2026, ecoinvent 3.12, etc.)

   Example: “PCT Photovoltaics v1.0 – Nexus ecoinvent 3.12 (OLCA).zip”

2. Import the PCT into the background database

3. Set values for the minimum necessary parameters

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How would a normal workflow with PCTs look like?

4. If needed, calculate parameters with the integrated calculators (e.g. the average annual specific yield can be automatically calculated from solar irradiation, bifacial gain, first and subsequent yearly degradation rates)

5. Fill the template with your primary or secondary data with a fixed reference flow

6. Set the additional / optional parameters if needed

7. Calculate the product system with the correct method, depending on your compliance needs

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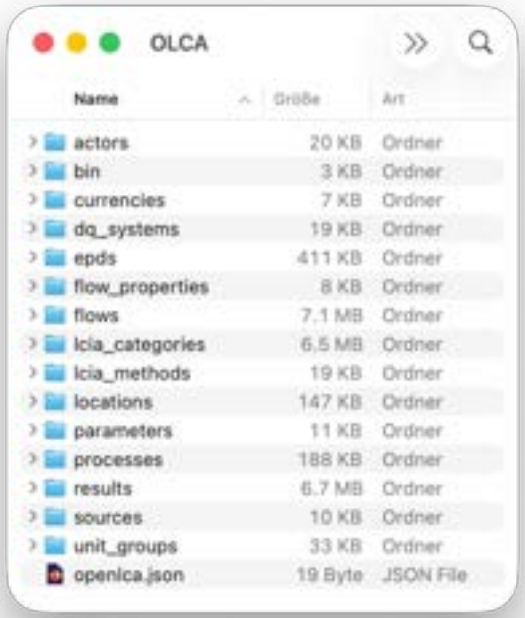
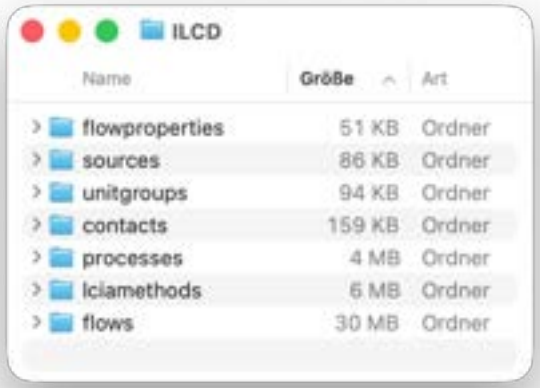
What is inside a PCT?

Approximately 10MB zip-file with data elements in ILCD or OLCA format (background database is not included on purpose)





PCT Photovoltaics v0.7 – Nexus ecoinvent 3.12 Nexus (ILCD).zip
PCT Photovoltaics v0.7 – Nexus ecoinvent 3.12 Nexus (OLCA).zip
PCT Photovoltaics v0.7 – Nexus BAFU 2025 (ILCD).zip
PCT Photovoltaics v0.7 – Nexus BAFU 2025 (OLCA).zip

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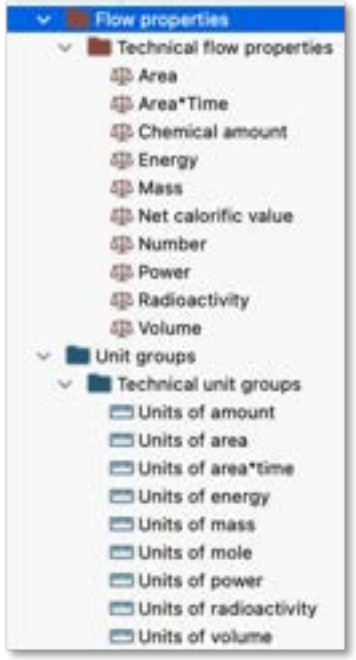
What is inside a PCT?

Minimum for flow properties and unit groups needed



- Can be taken e.g. from ILCD units
- More units and flow properties can come from background databases
- Necessary to keep compliance between results from the same PCT

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Locations from ISO 3166-1, ISO 3166-2 and UN M49

- Background database like ecoinvent typically add more locations for background data (aluminium industry, etc.)
- For the PCT foreground, only a “compliant” minimum of countries, global regions and its subdivisions needed

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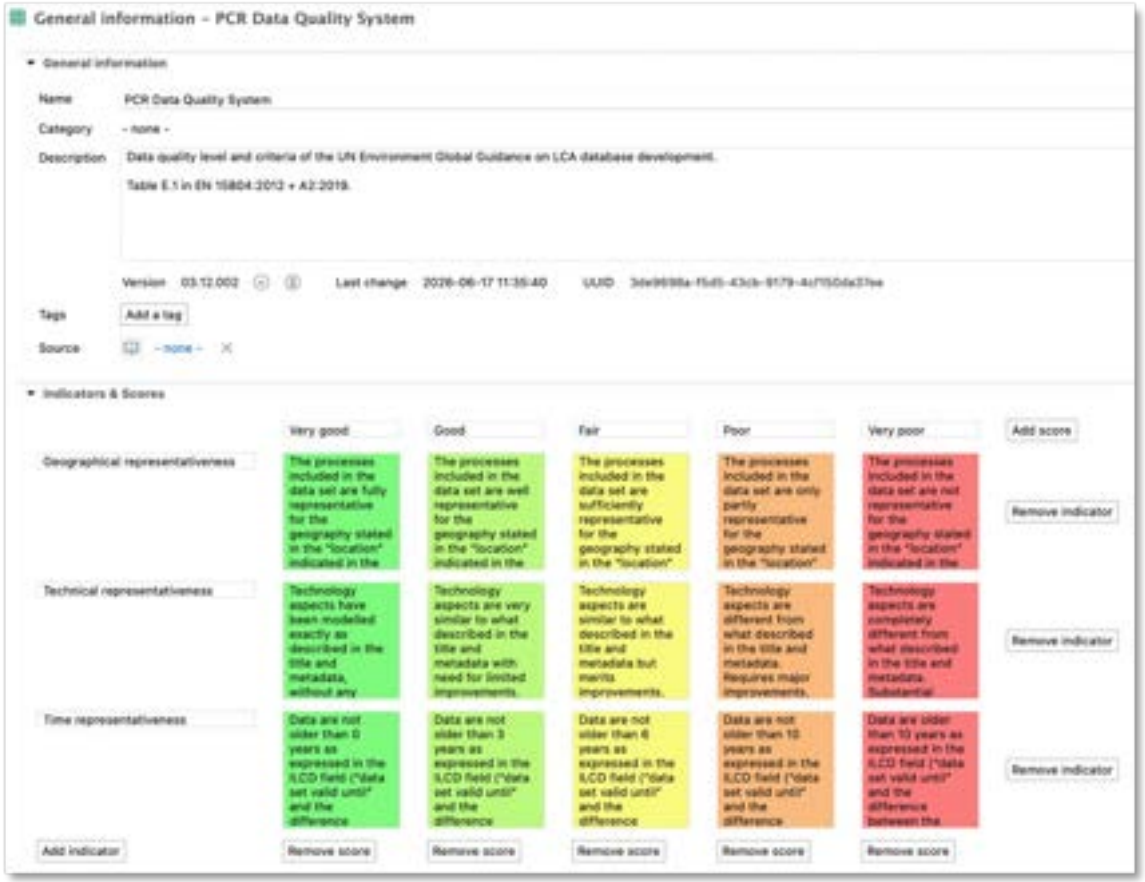
What is inside a PCT?

Data quality systems for the standards/guidelines used



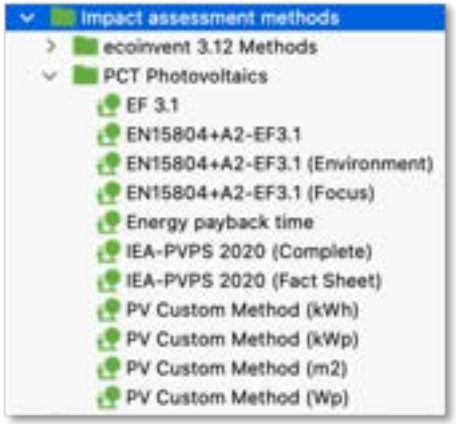
LCIA methods for the different standards/guidelines

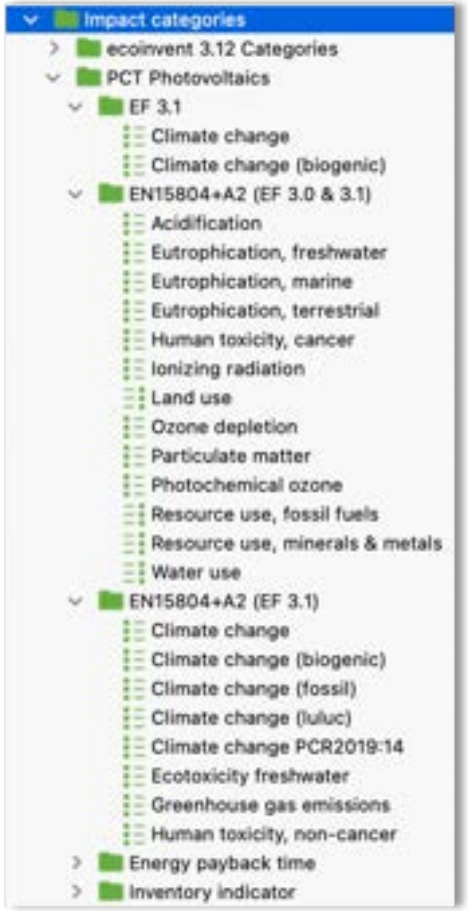
- LCIA methods compatible to specific reference system

→ PCTs available for different background databases

→ Availability for different background database allows to also set some default product/waste flows

- Different LCIA methods for different standards
  - EN15804+A2 (EF 3.1) for EPDs
  - EF 3.1 for PEF and standards LCA
  - IEA-PVPS 2020 is EF 3.1 plus NR-EPBT
  - IPCC 2021 (incl. biogenic CO2) for PCF, ISO 14067
  - Custom methods to focus on few relevant indicators





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What is inside a PCT?

PCT specific impact method to e.g. automatically calculate the PV energy payback time

$$EPBT = \frac{CED_{mat} + CED_{manuf}\ CED_{trans} + CED_{inst} + CED_{EOL}}{\left(\frac{E_{year}}{\eta_{grid}}\right) - CED_{use}} \approx CED_{tot}\frac{\eta_{grid}}{E_{year}}$$

Characterization factors – Energy payback time

Characterization factors

Flow	Category	Factor	Unit	Uncertainty
Coal, brown	Elementary flows/Resource/in ground	9.9 / 3.6 * Grid_Efficiency / (Annual_Specific_Yield / 1000)	year/kg	none
Coal, hard	Elementary flows/Resource/in ground	19.1 / 3.6 * Grid_Efficiency / (Annual_Specific_Yield / 1000)	year/kg	none
Energy, geothermal, converted	Elementary flows/Resource/in ground	1.0 / 3.6 * Grid_Efficiency / (Annual_Specific_Yield / 1000)	year/MJ	none
Energy, gross calorific value, in biomass	Elementary flows/Resource/biotic	1.0 / 3.6 * Grid_Efficiency / (Annual_Specific_Yield / 1000)	year/MJ	none
Energy, gross calorific value, in biomass, primary forest	Elementary flows/Resource/biotic	1.0 / 3.6 * Grid_Efficiency / (Annual_Specific_Yield / 1000)	year/MJ	none
Energy, kinetic (in wind), converted	Elementary flows/Resource/in air	1.0 / 3.6 * Grid_Efficiency / (Annual_Specific_Yield / 1000)	year/MJ	none
Energy, potential (in hydropower reservoir), converted	Elementary flows/Resource/in water	1.0 / 3.6 * Grid_Efficiency / (Annual_Specific_Yield / 1000)	year/MJ	none
Energy, solar, converted	Elementary flows/Resource/in air	1.0 / 3.6 * Grid_Efficiency / (Annual_Specific_Yield / 1000)	year/MJ	none
Gas, mine, off-gas, process, coal mining	Elementary flows/Resource/in ground	40.0 / 3.6 * Grid_Efficiency / (Annual_Specific_Yield / 1000)	year/m3	none
Gas, natural	Elementary flows/Resource/in ground	40.0 / 3.6 * Grid_Efficiency / (Annual_Specific_Yield / 1000)	year/m3	none
Oil, crude	Elementary flows/Resource/in ground	46.0 / 3.6 * Grid_Efficiency / (Annual_Specific_Yield / 1000)	year/kg	none
Peat	Elementary flows/Resource/biotic	9.9 / 3.6 * Grid_Efficiency / (Annual_Specific_Yield / 1000)	year/kg	none
Uranium	Elementary flows/Resource/in ground	560000.0 / 3.6 * Grid_Efficiency / (Annual_Specific_Yield / 1000)	year/kg	none

Example here for declared unit of 1 Wp and an annual specific yield given in kWh/kWp/year

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Parameterized calculation of PV energy yield to fulfil different standards

$$E_{RSL} = \eta_M A_M I_{STC} P_R Y_{rad} (1 - r_1) \left(1 + \sum_{n=1}^{L-1} (1 - r_x)^n \right) = \eta_M A_M I_{STC} E_{PV} L_{RSL}$$

E_{RSL}	Total energy yield in the reference service life [kWh]
E_{PV}	Specific average annual PV system energy yield [kWh/kW$_p$/year]
Y_{rad}	Specific annual solar energy yield [kWh/kW$_p$]
η_M	Module efficiency [relative]
A_M	Module area [m^2]
I_{STC}	Irradiance at standard test conditions, usually AM1.5 with 1000 W/m^2 [kW/m2]
P_R	Performance ratio [relative]
r_1	Degradation rate first year [relative]
r_x	Degradation rate subsequent years [relative]
L_{RSL}	Reference service life [year]

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What is inside a PCT?

All existing digital EPDs for photovoltaics can be used (modules, inverters, solar glass)

Unfortunately most digital EPDs not allowed to be freely distributed

→ direct import of EPDs into openLCA over the soda4LCA API

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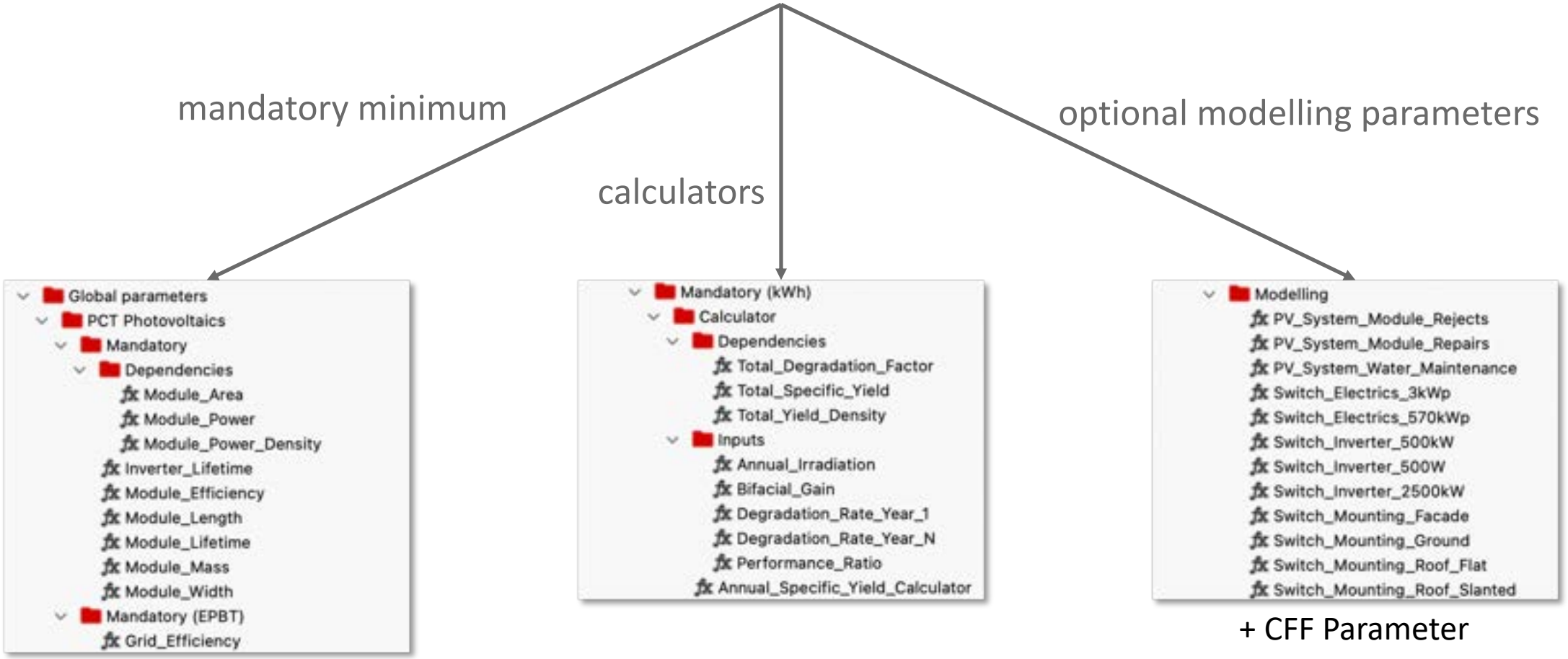
What is inside a PCT?

Global parameters for automatic calculations (the less the merrier)



+ CFF Parameter

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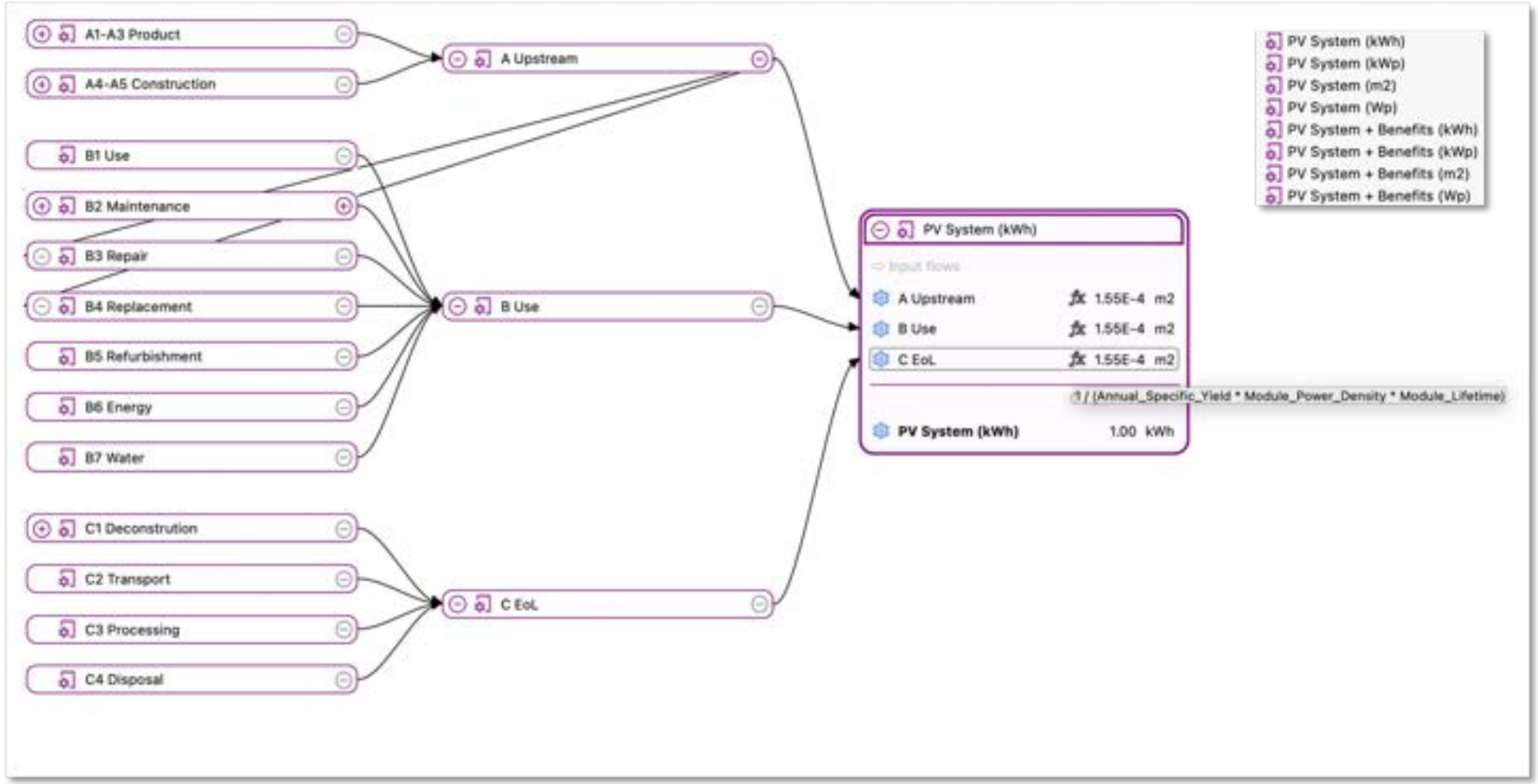
What is inside a PCT?

Base modules (taken from EPDs) and conversions for declared or functional unit



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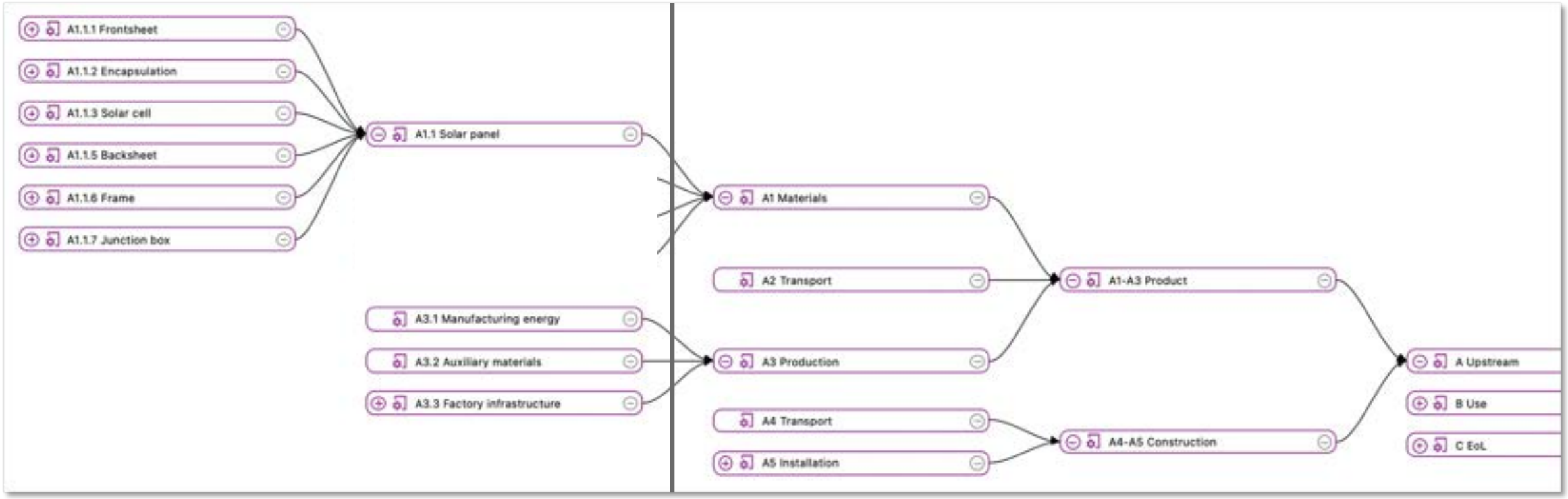
What is inside a PCT?

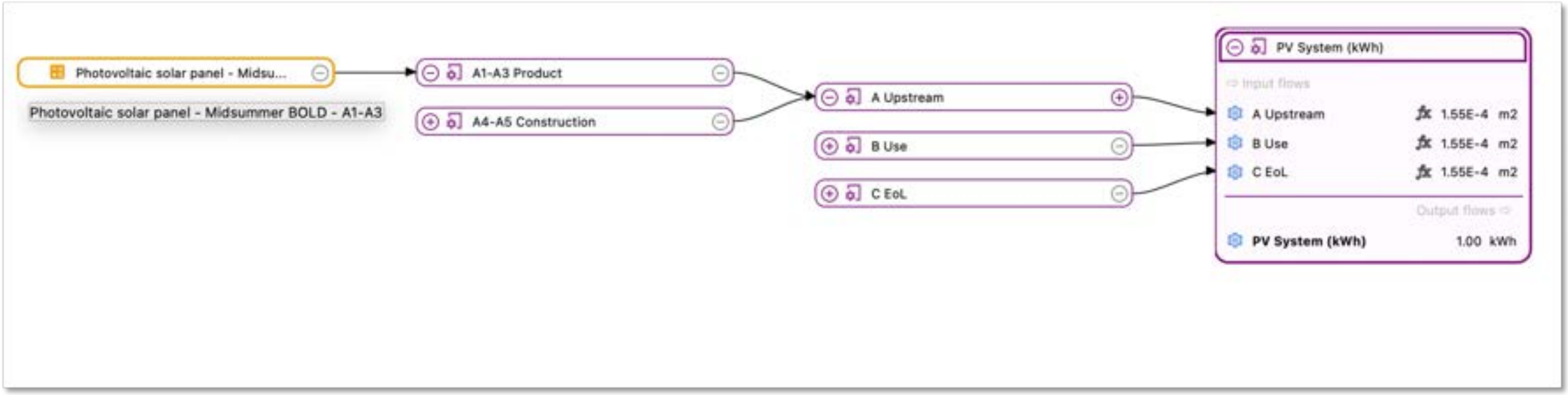
PCT specific modules (left) to guide the modeller and to simplify analysis groups

Modules can be easily removed depending on the system boundaries of the needed standard/compliance



What is inside a PCT?

Depending on the goal & scope or the supplier data, user can also connect EPDs



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How does it differ from already existing, more specific tools?

- Open-source templates that can be verified/improved/corrected by the community (not proprietary, since all modules included are simply unit processes)
- Open data formats like OLCA (JSON-LD) or ILCD (XML) format
- All needed database elements are included in one package, except background data
- Wish of ongoing and dynamic system for updating and distributing PCTs (Product Category Templates) that is similar to e.g. the ongoing and dynamic developments of PCRs (Product Category Rules) for EPDs

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Thank you for your attention!

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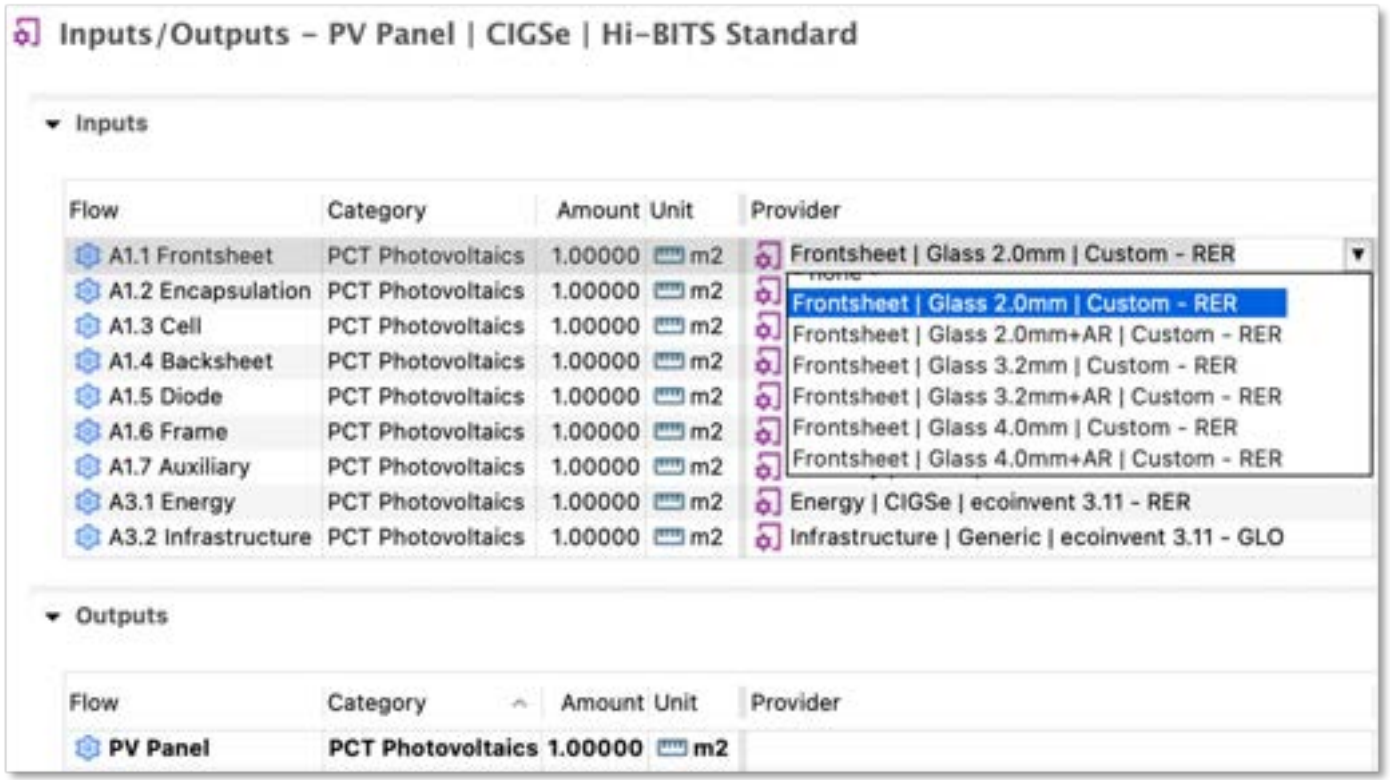
How does it differ from already existing tools or compliance packs?



- Specific tools usually limit already the possible providers
  - → less freedom to model
  - → usually only 1 compliance
- PCTs are step before this, so that different compliances can be modelled
  - → more modelling tasks
- PCTs could also be limited further to create a specific tool if wanted

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