

Table 1: Master comparison table about methodologies relating thermodynamics with sustainability/sustainable development: **Thermodynamic Foundation, System Boundaries & Dynamics** . Methods: CED, ExA, CExD, CEENE, ELCA, ECT, ERC, TEC, SPECO, ExEnv, EMG, PBLCA, LExC, ToS.

| Criterion no. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | |
|---------------|-----------------|-----------------------|-------------------------|---------------------|----------|----------|------------------|----|
| Method | Resource metric | Reference environment | Substance scope | Exergy quality | Temporal | Spatial | Scale | |
| CED | Energy | N/A | Energy carriers | N/A | Static | Global | Product | |
| ExA | Exergy | Szargut | Energy carriers | Chem. + phys. | Static | Global | Component | |
| CExD | Exergy | Szargut | All abiotic | Chem. | Static | Global | Product | |
| CEENE | Exergy | Szargut | All abiotic | Chem. | Static | Product | Product | |
| ELCA | Exergy | Szargut | All (incl. land, water) | Chem. + phys. | Static | Product | Product | |
| ECT | Exergy | Szargut | All abiotic | Chem. + phys. | Static | Global | Plant | |
| ERC | Exergy | Thanatia | Minerals + fossils | Chem. + conc. | Static | Global | Mineral reserves | |
| TEC | Exergy | Szargut | All abiotic | Chem. only | Static | National | Product/sector | |
| SPECO | Exergy | Szargut | Energy carriers | Chem. + phys. + kin | Static | Global | Component | |
| ExEnv | Exergy | Szargut | Energy carriers | Chem. + phys. | Static | Global | Component | |
| EEA | Ext. exergy | Szargut | All + labor/capital | Chem. + phys. | Static | Global | Ecosystem | |
| EMG | Energy | GEB | All + ecological | Solar equiv. | Static | Global | Ecosystem | |
| PBLCA | Impact units | Pre-ind. | All (85 flows) | N/A | Static | Regional | Product | |
| LExC | Exergy | Szargut | All abiotic | Chem. + phys. | Dynamic | Global | Fleet/sector | Le |
| ToS | Exergy | Local-varying | All | Full (all) | Dynamic | Local | Fleet + product | D |

Table 2: Master comparison table about methodologies relating thermodynamics with sustainability/sustainable development: **Infrastructure, Impact & Remediation Accounting**. Methods: CED, ExA, CExD, CEENE, ELCA, ECT, ERC, TEC, SPECO, ExEnv, EMG, PBLCA, LExC, ToS.

| Criterion no. | 9 | 10 | 11 | 12 | 13 |
|---------------|-----------------------------------|---------------------|--|-----------------|-------------|
| Method | Material/infrastructure | Env. impact | Remediation cost | Infra. feedback | PB coupling |
| CED | N/A | N/A | N/A | N/A | N/A |
| ExA | N/A | N/A | N/A | N/A | N/A |
| CExD | Static inv. | N/A | N/A | N/A | N/A |
| CEENE | Static inv. | N/A | N/A | N/A | N/A |
| ELCA | Static inv. | Zero-ELCA | Conceptual | N/A | N/A |
| ECT | N/A | N/A | N/A | N/A | N/A |
| ERC | Mineral only | N/A | Minerals only | N/A | N/A |
| TEC | Static | Compensation | Conceptual | N/A | N/A |
| SPECO | N/A | N/A | N/A | N/A | N/A |
| ExEnv | Construction LCA | Component-allocated | N/A | N/A | N/A |
| EEA | N/A | Remediation | Fictitious process | N/A | N/A |
| EMG | N/A | N/A | N/A | N/A | N/A |
| PBLCA | N/A | LCIA CFs | N/A | N/A | Native |
| LExC | Learning + feedback | 25D-emissions | N/A | Partial | N/A |
| ToS | Dynamic fleet and Self-consistent | Exergy-based | Full (scarcity + environmental impact) | Self-consistent | Integrated |

Table 3: Master comparison table about methodologies relating thermodynamics with sustainability/sustainable development: **Implementation, Applicability & Integration Level**. Methods: CED, ExA, CExD, CEENE, ELCA, ECT, ERC, TEC, SPECO, ExEnv, EMG, PBLCA, LExC, ToS..

| Criterion no. | 14 | 15 | 16 | 17 | - |
|---------------|------------------|----------------------------|---------------------|----------|----------------|
| Method | Implementation | Co-products | Ecosystem services | nE class | Dimensions |
| CED | Ecoinvent | N/A | N/A | 1E | E1 |
| ExA | Spreadsheet/code | N/A | N/A | 2E | E1,E2 |
| CExD | Ecoinvent | Ecoinvent default | N/A | 2E | E1,E2 |
| CEENE | Ecoinvent | Ecoinvent default | Land + water | 2E | E1,E2 |
| ELCA | Case-by-base | Single method | N/A | 2-3E | E1,E2 (E3) |
| ECT | Code | Single method | N/A | 3E | E1,E2,E3 |
| ERC | Tables | Single method | N/A | 3E | E1,E2,E3 |
| TEC | Code | Single method | Natural restoration | 3E | E1,E2,E3 |
| SPECO | Comercial (EbS) | SPECO rules | N/A | 3E | E1,E2,E4 |
| ExEnv | Case-by-case | Single method | N/A | 3E | E1,E2,E3 |
| EEA | Code | Single method | N/A | 5E | E1,E2,E3,E4,E6 |
| EMG | Code | Emergy algebra | Full ecological | 3E | E1,E2,E5 |
| PBLCA | Prototype | N/A | Land/biosphere | 2E | E1,E3 |
| LExC | Code | System exp. | N/A | 4E | E1,E2,E3,E7 |
| ToS | Code | Multi-method + sensitivity | NPP-based (planned) | 5-6E | E1,E2,E3,E5,E7 |