Day-ahead impacts of European electricity consumption

Motivation

1. Consider dynamic aspects of LCA → real-time LC assessment of the electricity consumption from the grid
2. LC assessment tool that is usable as integral part or in connection with the CoPro integration framework
3. New tool that is flexible, agile and suited to CoPro’s goals
4. Impact of electricity consumption in a location- and time-dependent approach (dynamic behavior)

Methodology

Tool architecture

- ENTSOE database
- ECOINVENT database
- Frontend (user inputs)
- Data fetcher
- Query builder
- Responsive parser
- DB offline loader
- CO2 eq. emissions
- CO2 network builder
- Solver
- Data writer
- Predictors
- Database mode
- Running mode
- Single state
- JSON file
- LCA database
- Query response
- Load data

Application

Rolling-horizon optimal scheduling of a batch process in Germany (April 2018)

- 5 production lines
- 2 final products (A and B)
- 2 raw materials and 5 intermediates

MPC algorithm:

- LCA tool for predicting day-ahead CO2 eq. emissions
- Rolling horizon optimal scheduling problem (MILP)

For each EU country:

- Near-real-time electricity generation mixes
- Power exchanges across borders
- LC impacts of generation technologies
- Price of electricity consumption
- Calculates:
  - CO2 eq. emissions forecast profiles (day-ahead)
  - Current/year CO2 eq. emissions profile
- Enables:
  - Optimal operation scheduling with environmental objectives
  - LCA of past/current operating conditions

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Method selection criteria:

- data (features) analysis (standardized correlation matrix)
- performance evaluation (MSE and R² evaluation)
  - e.g. covariance matrix DE

Results

- Total operating cost: -17.3% (24.2%)
  - Grid: 473.5
  - Process: 418.4
  - Grid: 508.2
  - Process: 468.5

- CO2 emissions: -11.6% (33.4%)
  - Grid: 473.5
  - Process: 418.4
  - Grid: 508.2
  - Process: 468.5

- Minimum emissions

- Grid vs process CO2 eq. emissions

Conclusions

- New LC assessment tool able to provide background data to compute LC impact of grid-connected processes.
- Calculates the grid GWP and provides the real-time RE share.
- Industry application: generate predictions for optimal operation scheduling with environmental targets.

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