71st LCA Discussion Forum
Environmental Benchmarks for buildings: Needs, challenges and solutions

The French benchmark system for buildings: its goals and its effects

MINES ParisTech – CES

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Goals of benchmarks

- **Preparation of the next environmental regulation**
  - Integration of 2 environmental criteria: primary energy and CO_2 emissions
  - E+C- label being tested, progress towards plus energy buildings with low carbon emisions
  - Required performance level to obtain a building permit
- **Design aid, new or existing buildings**
  - My project emits 30 kg CO_2 per m^2 and per year, is it good enough ?
  - Need of reference values for LCA indicators
- **Information to owners or occupants, environmental certificate (label from A to G)**

Main choices and methods, regulation

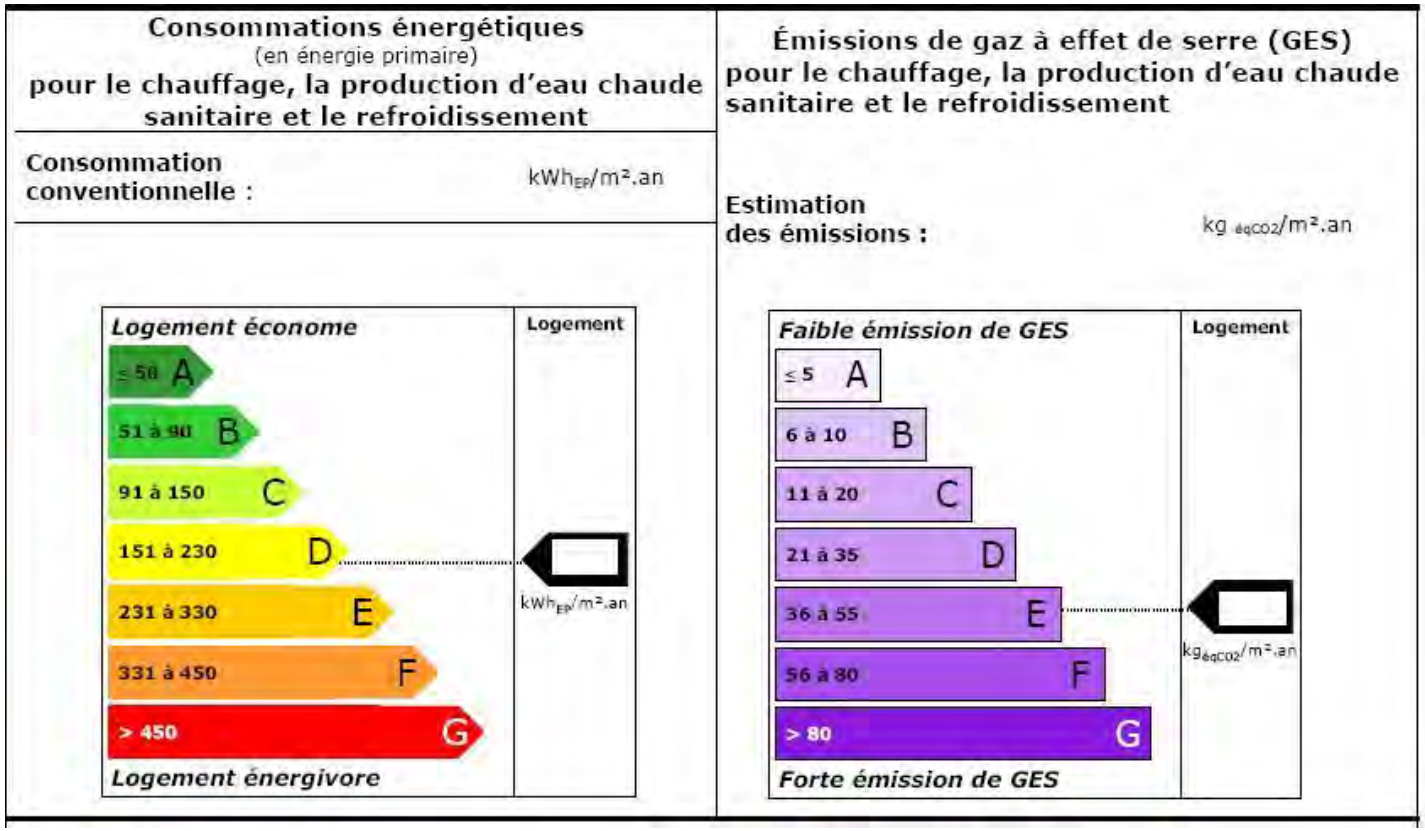
- **E+C- label**
  - Primary energy (operation only) and CO_2 emissions (life cycle)
  - Separating Operation (energy and water use) and Products (fabrication, transport, construction, maintenance, replacement and end of life)
  - 3 required thresholds : operation primary energy, total life cycle and products only CO_2 emissions
  - Houses, apartments, offices or other buildings, modulation according to climate zone, altitude, area, + for CO_2 number of parking slots
  - Exported energy accounted for until 10 kWh/m^2/year
  - 1/3 of module D is accounted for
  - 50 years reference study period

Main choices and methods, design

- **Design tool, EQUER method**
  - 12 LCA indicators (3 endpoints, mid points, energy and water use, wastes)
  - 4 main steps: Fabrication+transport+construction, Operation, Renovation and End of life (including transport and possible recycling)
  - 2 levels: worst and best performance
  - Houses, apartments, offices
  - Exported energy accounted for
  - Module D is accounted for (PEF 50/50 method)
  - Reference study period as realistic as possible (e.g. 200 years for an hausmannian building in Paris)

Main choices and methods, certificates

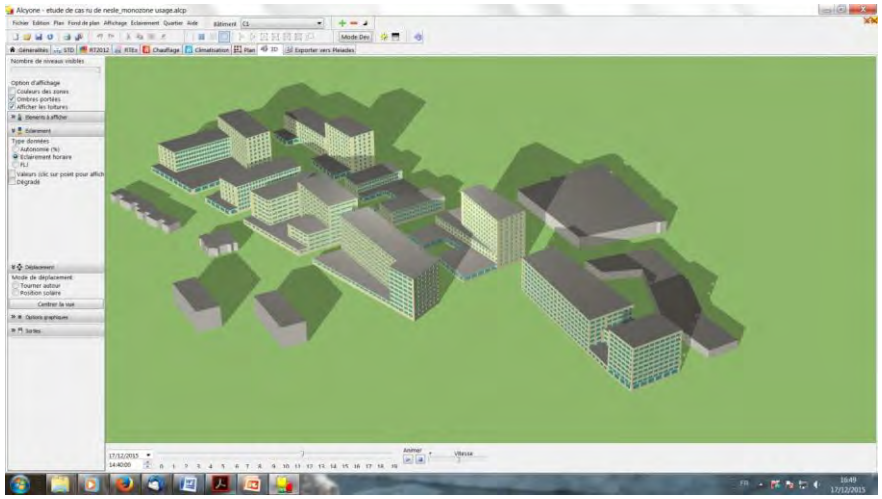
- **Energy and CO_2 label, 3CL method**
  - At the moment primary energy and CO_2 for heating+cooling+hot water
  - 7 levels from A to G



Evaluation of benchmark references, samples

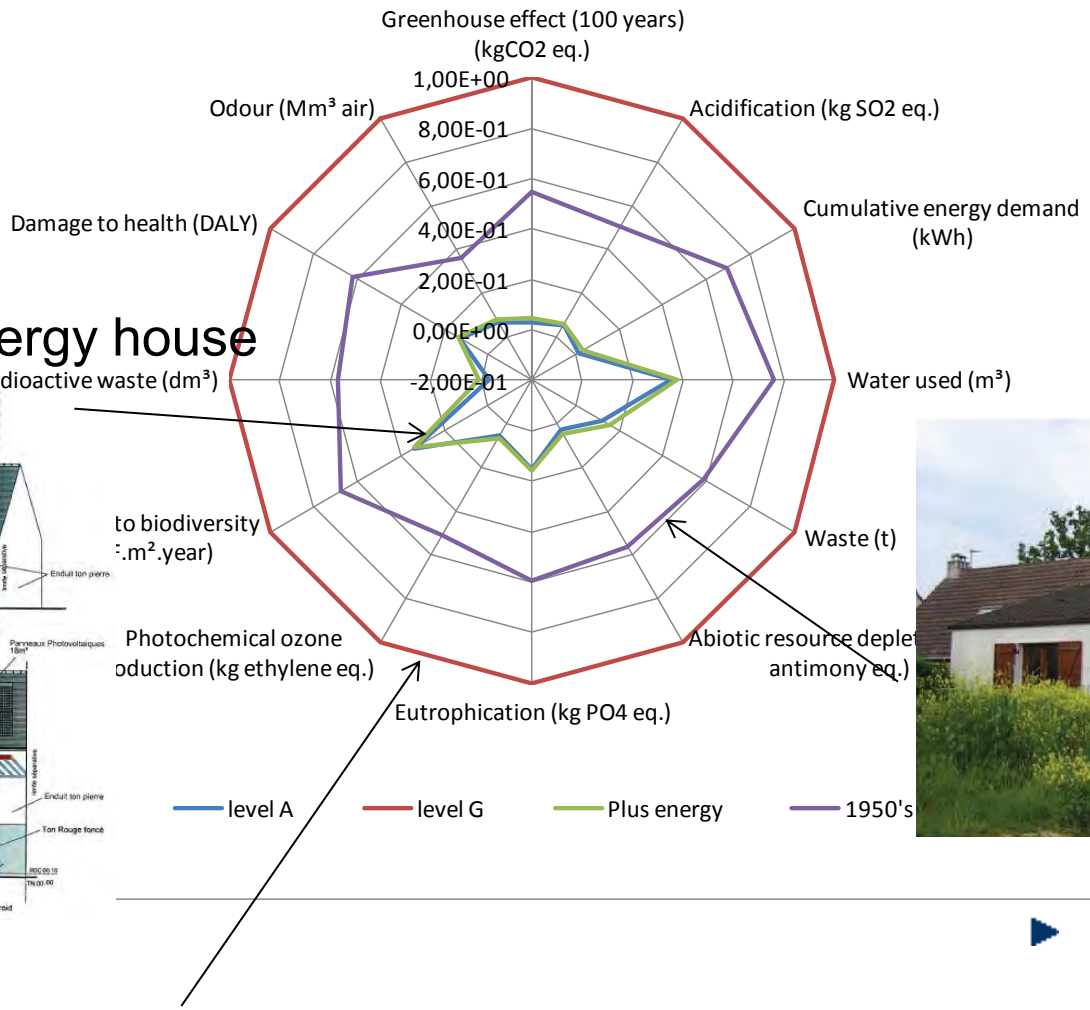
- Single family houses, apartments, offices, highschools, urban projects
- New or existing (no, low or high insulation, 1 to 3 glazings etc.)
- Several hundred cases

wood or concrete



gas versus electricity and wood heating -> lowest and highest impacts

Example results on houses

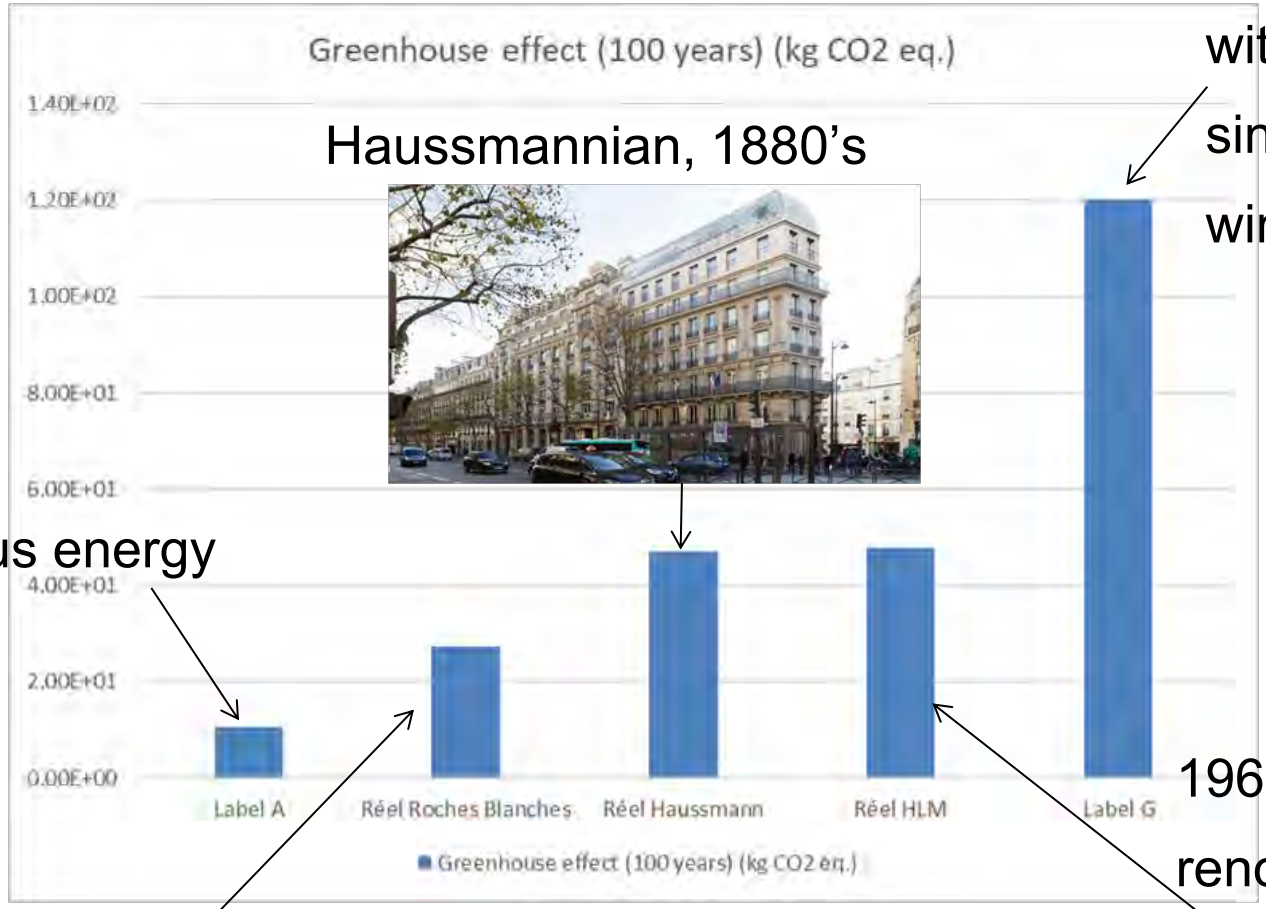


- Plus energy house

- 1950's house, renovated

- House without insulation, single glazed windows, worst alternative on each indicator

Example results on apartment buildings



Haussmannian, 1880's

without insulation,

single glazed

windows, gas boiler

Plus energy

1960's social housing

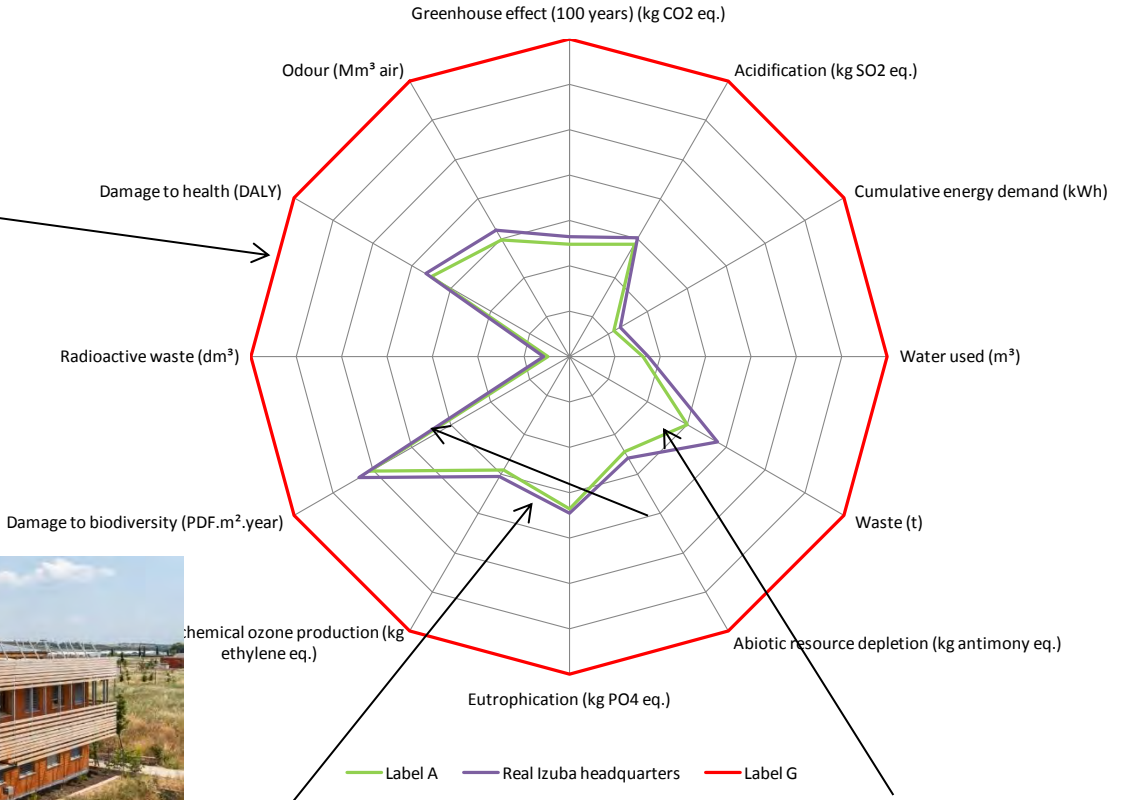
renovated

New residential

Example results on offices

Office building category
Comparison of real building cases to theoretical national benchmarks
Radar chart with Label G as reference (100%), the results representing a percentage of the reference
Based on results per m² and per year

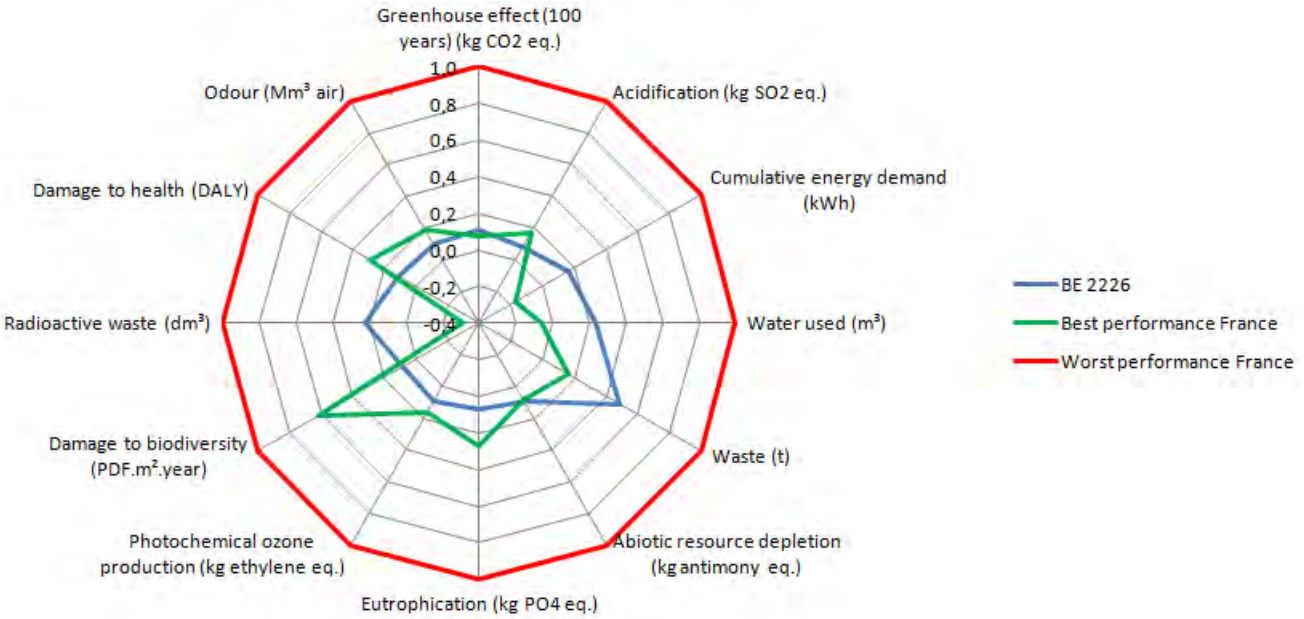
- Building without insulation, single glazed windows, boiler/electric



- Real building
- Best alternative on each indicator

Example results on be2226

- using the same functional unit and use scenario as in the benchmark
- 50 years study period



- Near the best performance of the French benchmark

- Better on e.g. biodiversity and health because no PV modules
- Not as good on primary energy, radioactive waste and water (no PV), waste (insulating bricks instead of wood and straw)

E+C- results

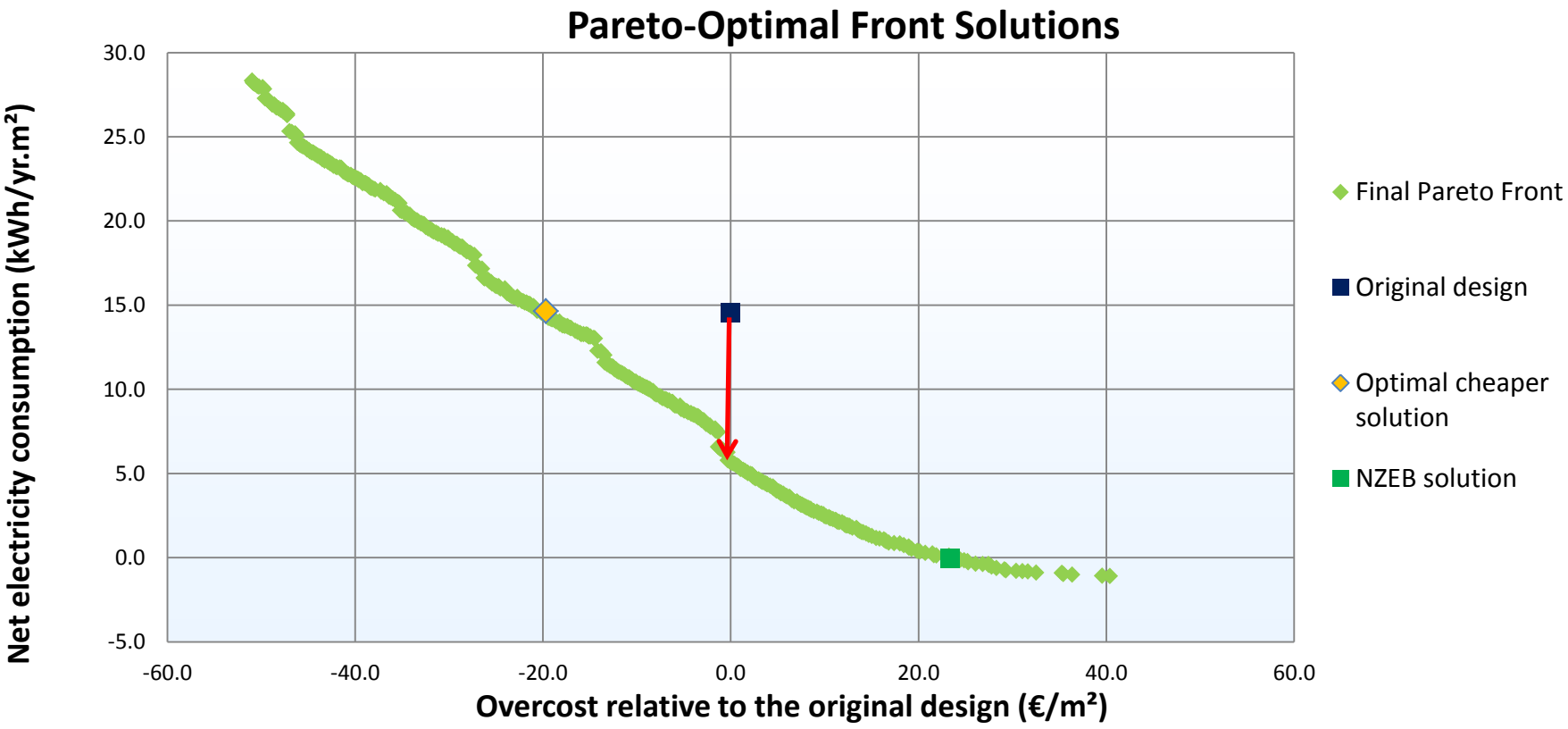
- **Discussions with professional associations tend to lower the required performances (cost argument)**
- **Various lobbies influence the method (e.g. 10 kWh/m^2/year limit for PV production) and the data (e.g. dioxins not separated from other COVs in the inventories)**
- **CO_2 threshold on products does not allow high performance buildings because high PV area and triple glazing induce too much emission**

Technico-economic evaluation, regulation

- **Regulation thresholds are fixed according to costs that are acceptable by the market**
- **Group of consultants testing the E+C- method on projects**
- **Evaluate the cost corresponding to different performance levels**
- **Concertation with professional associations (e.g. social housing organisations, project developers) in progress in order to choose accceptable thresholds**

Interest of multi-criteria optimisation

Improve performance for a given cost



EQUER LCA complemented with a genetic algorithm

Effects of benchmarks

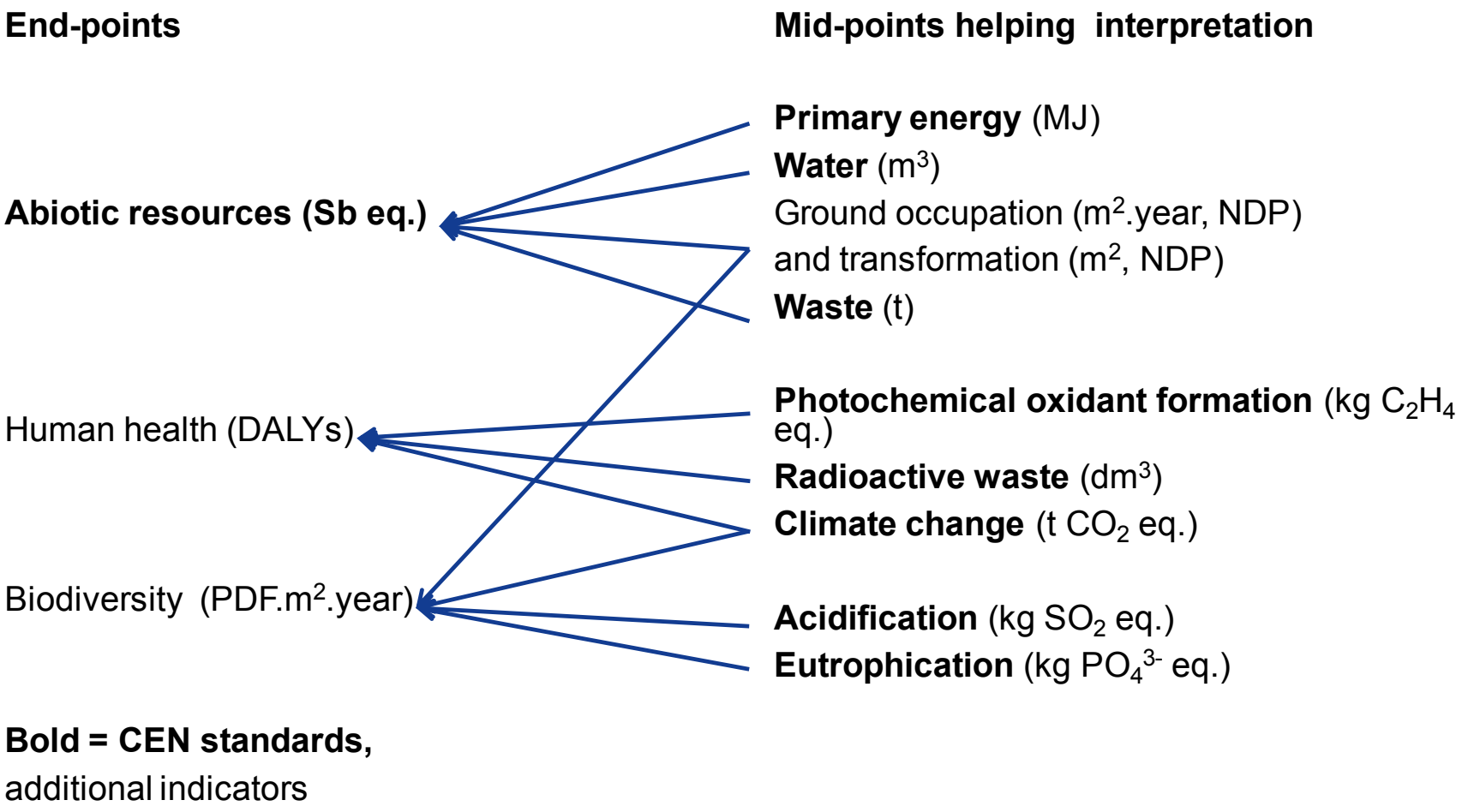
- **Benchmarks enable designers knowing how their projects perform compared to best and worst practice**
- **Regulation benchmarks on products limit the use of energy efficient and renewable energy technologies**
- **No direct effect of benchmarks if they are not rigorous**
- **Indirect effect to promote LCA among designers, but also clients and manufacturers**

Conclusions and perspectives

- **It is possible and essential to define benchmarks for different purposes (regulation, design, certificates)**
- **Integration of LCA in a regulation may be counterproductive if the chosen indicators are inappropriate (e.g. separated threshold on products)**
- **Benchmarks may be refined according to the type of building (housing, tertiary…), the climate and the functional unit (e.g. parking slots), clustering ?**
- **Optimisation may help to improve performance**

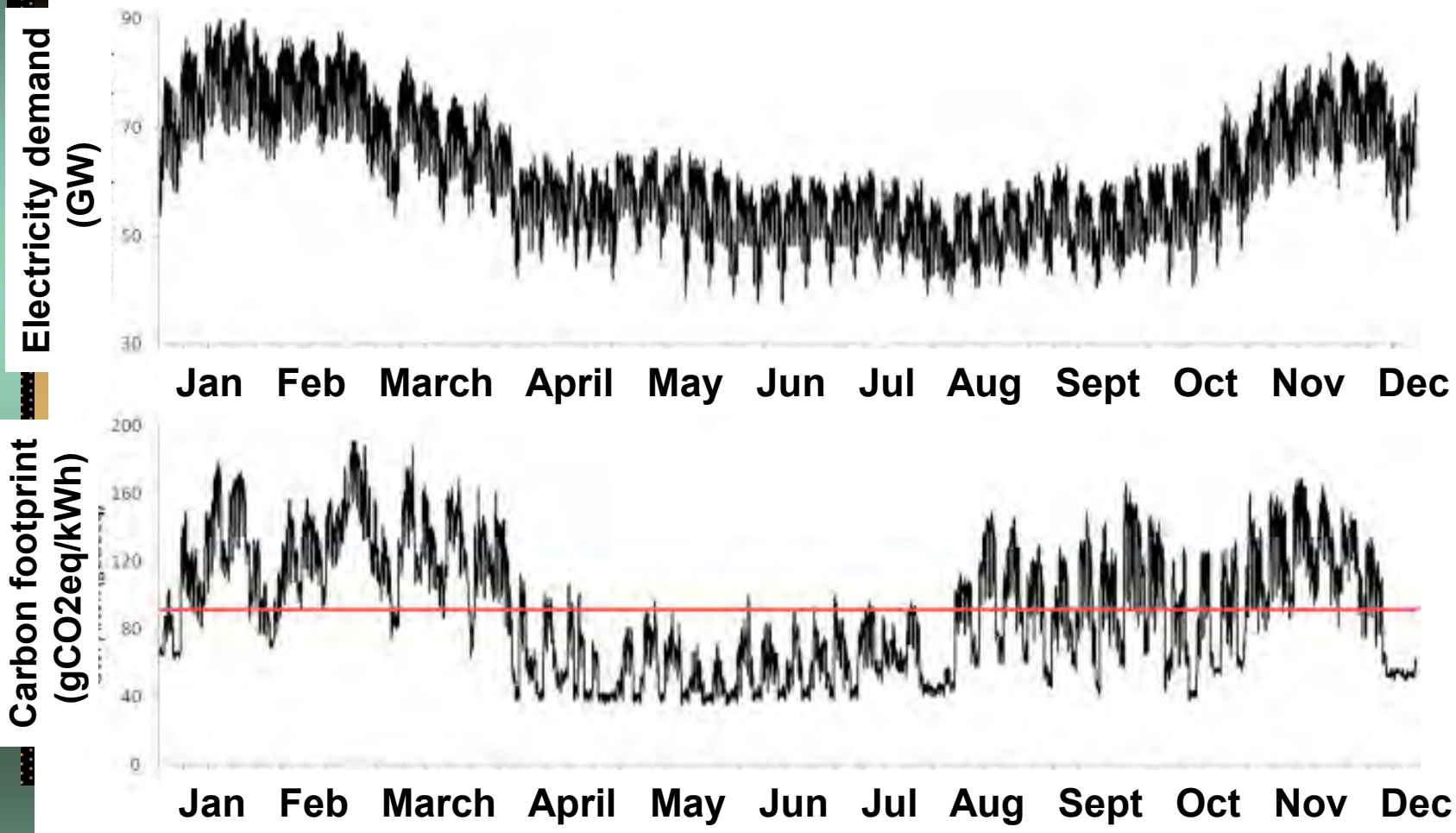
Thank you for your attention !

Environmental indicators, not only energy and CO_2



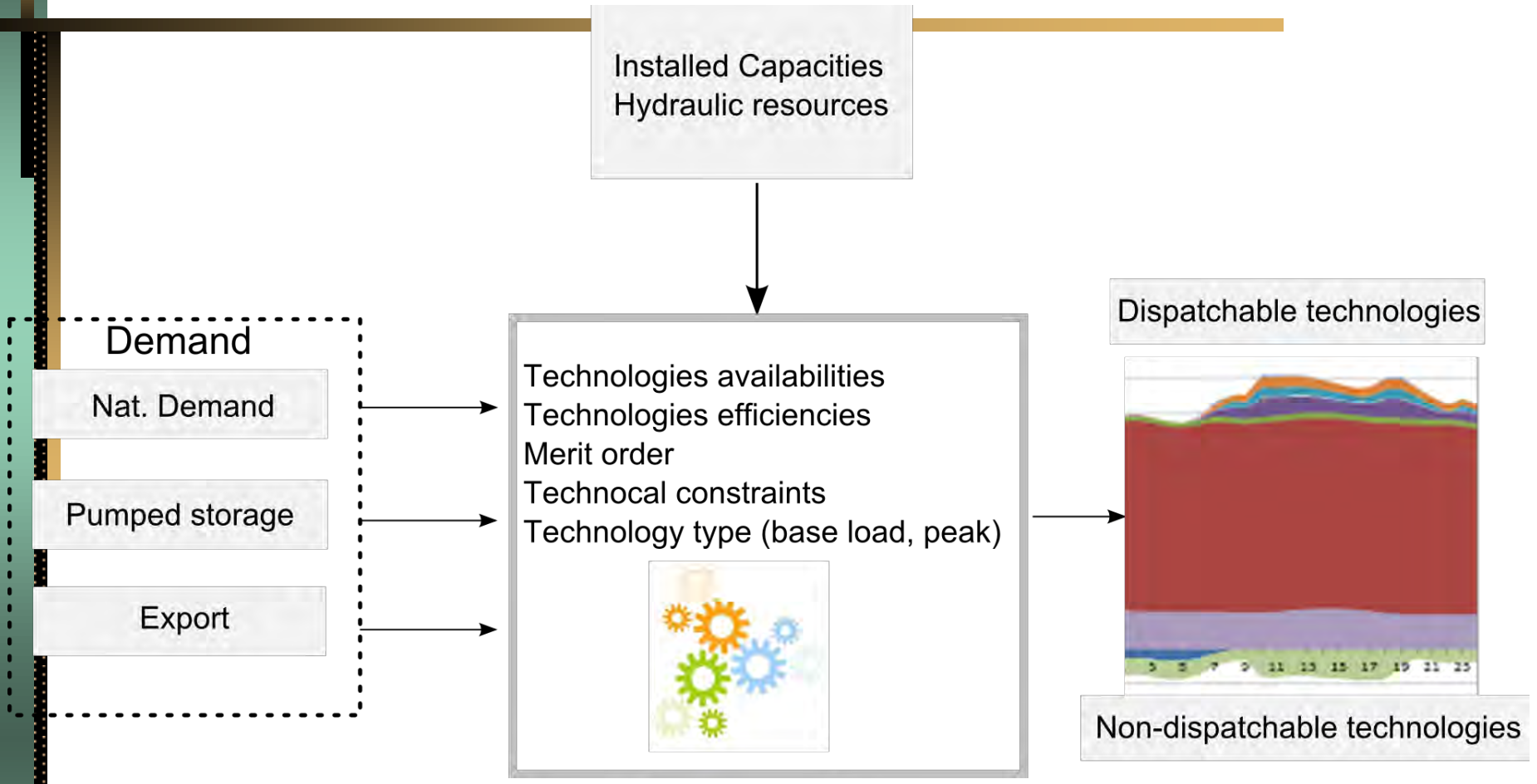
Bold = CEN standards,
additional indicators

Electrical system, dynamic LCA



Total electricity consumption in France in 2013 (top) and carbon footprint per kWh (bottom) - Roux et al. 2016

Electrical system simulation model



- **Same typical meteorological year building/grid**
- **Averaging climatic and economic hazards of real years**
- **Technology explicit : easy update to follow e.g. renewable energy capacity evolution (prospective model or scenarios)**