Integration of Energy and Material Performance of Buildings: I=E+M

S.M. van Hulten, E.A. Alsema, D. Anink, G. Donze, A. Meijer, A. Straub

W/E Consultants Sustainable Building
OTB Research Institute, Delft University of Technology
The Netherlands

WORLD Sustainable Built Environment Conference 2017 HONG KONG

Organisers: CONSTRUCTION INDUSTRY COUNCIL 建造業議會 HKGBC 香港綠色建築議會

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Why an integration of methods?

- **2020**: Net Zero Energy Buildings

Increasing impact of materials and embodied energy

- **2013**: Material performance introduced in Dutch building regulations

Energy: improvement by factor 10-100 since 1970's

- **1995**: Energy performance introduced in Dutch building legislation

Material vs Energy performance

For example: effect of solar panels + extra insulation:

Positive effect on energy performance

Negative effect on material performance

How to balance materials and energy performance?

Material Performance of Buildings (MPG)

FME CWM · BNA · WE adviseurs · MRPI milieu relevante product informatie · Rijksoverheid · Dutch Green Building Council · koninklijke metaalunie

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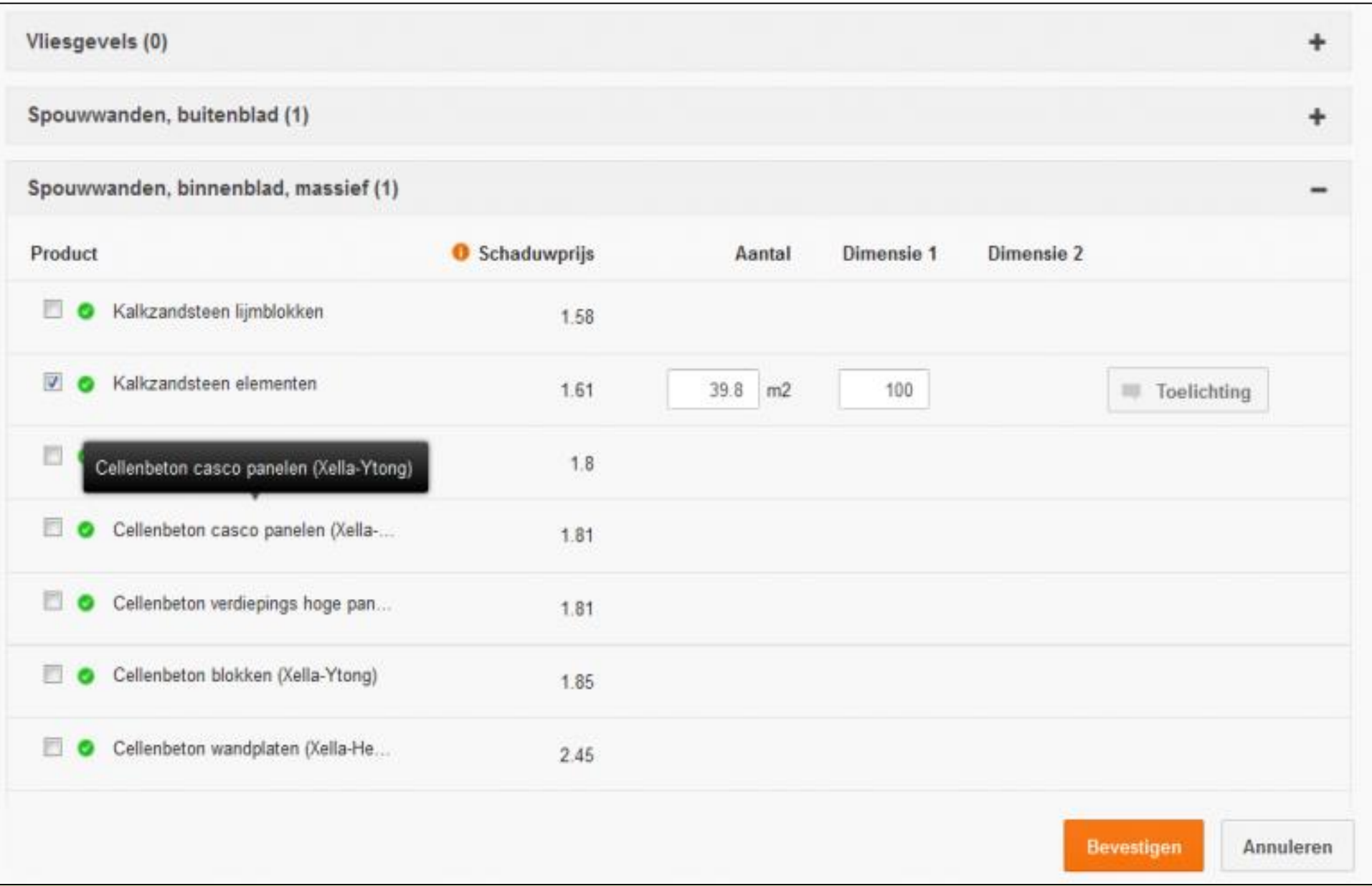
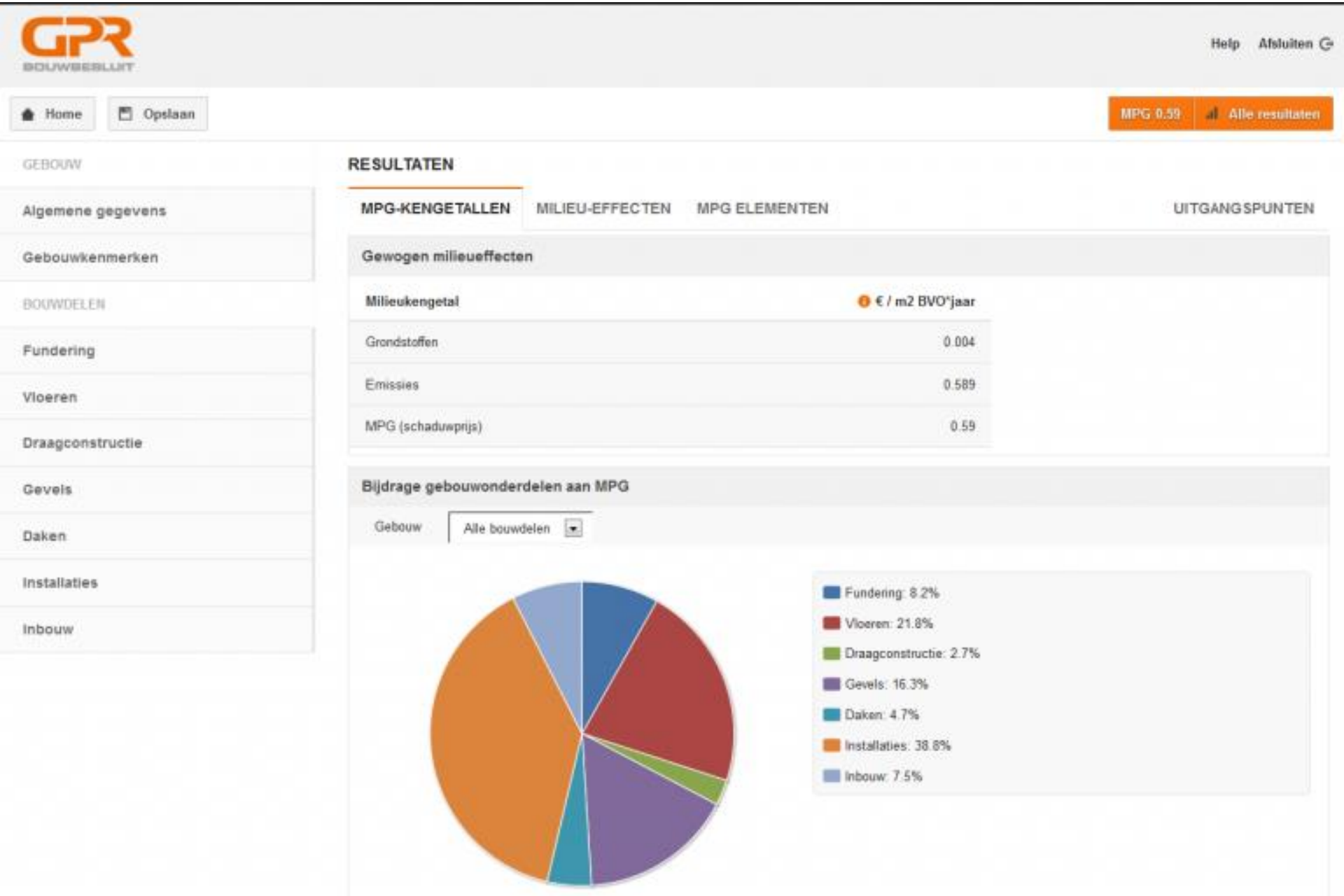
MPG: legislaton and certification

- MPG methodology in National Building Legislation
- National, LCA based product database
- ‘Shadowprice’ in €/m^2/year
- Tools / certification

MPG: generic/specific LCA product database



MPG: material and embodied energy impact



Integration: framework

MPG

Material performance indicator
National standard **Dutch** building **legislation**
Considers **whole life cycle** (LCA)
System boundary **= global economy**.

EPG

Energy performance indicator
Based on **EPBD** standard (**legislation**)
Considers building **use phase**
Materials' embodied energy **not** included
System boundary ≈ **building perimeter**

LCA

EPG*

Environmental impact score operational energy consumption - **LCA** based
System boundary = **global economy**

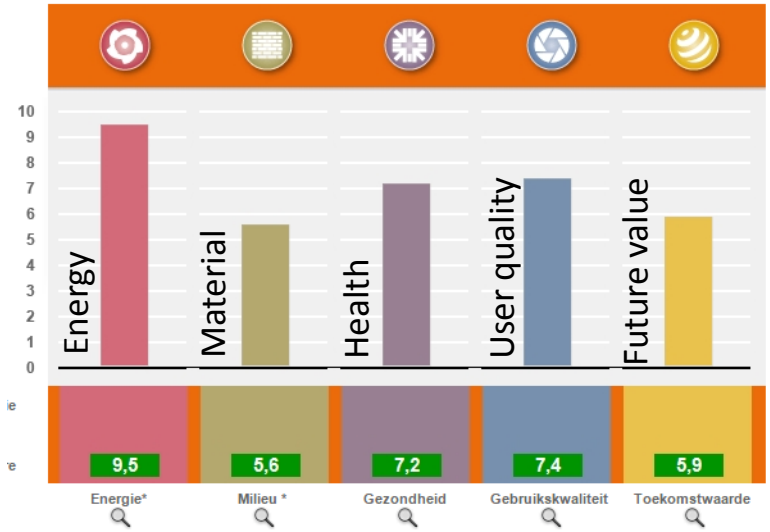
MPG+EPG*

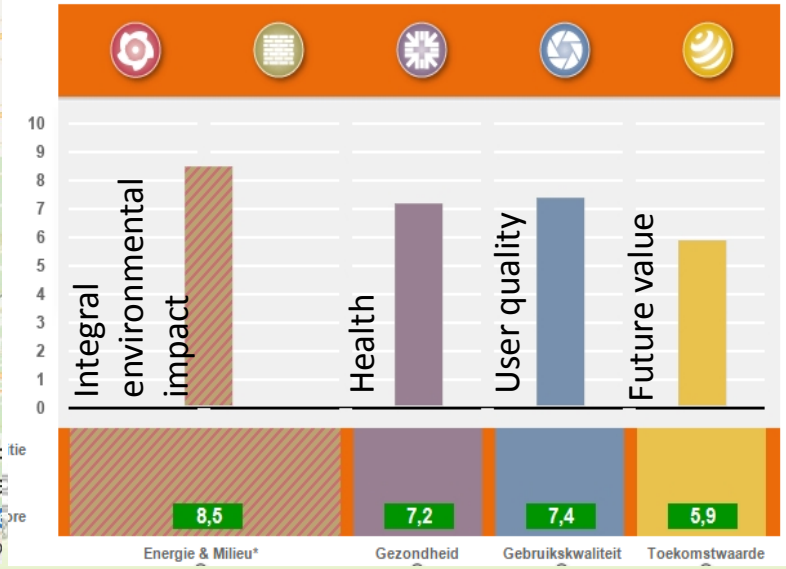
=

IPG

integral environmental impact from operational **energy** consumption and **materials** use expressed in **€/m²/year**

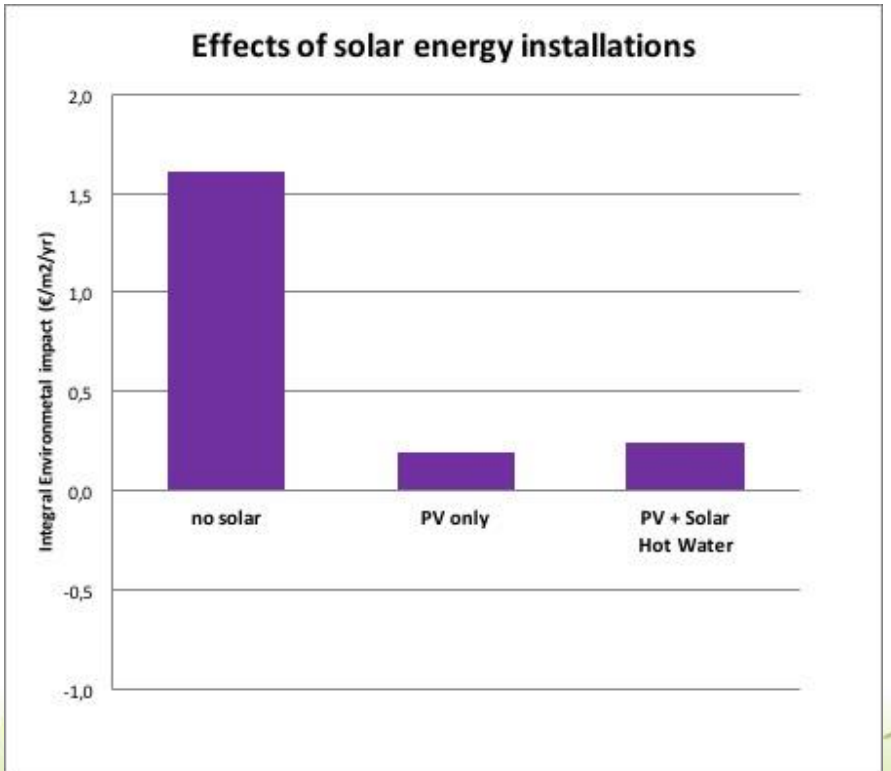
GPR Building: assessment tool

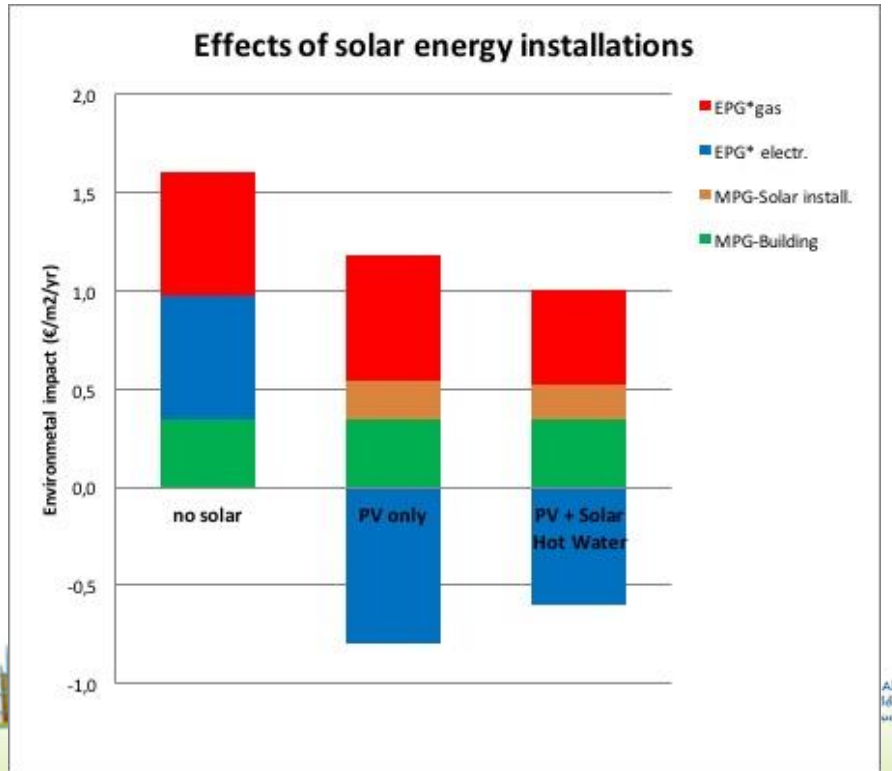




Case: Net Zero Energy Building

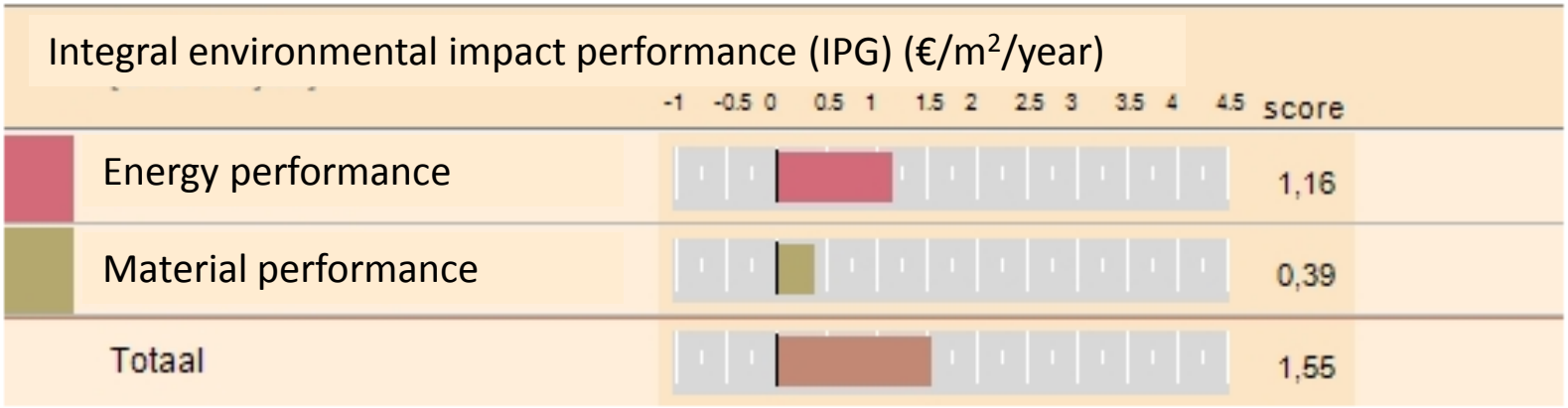
- 3 variants in solar energy installation
- effects on total environmental impact of building



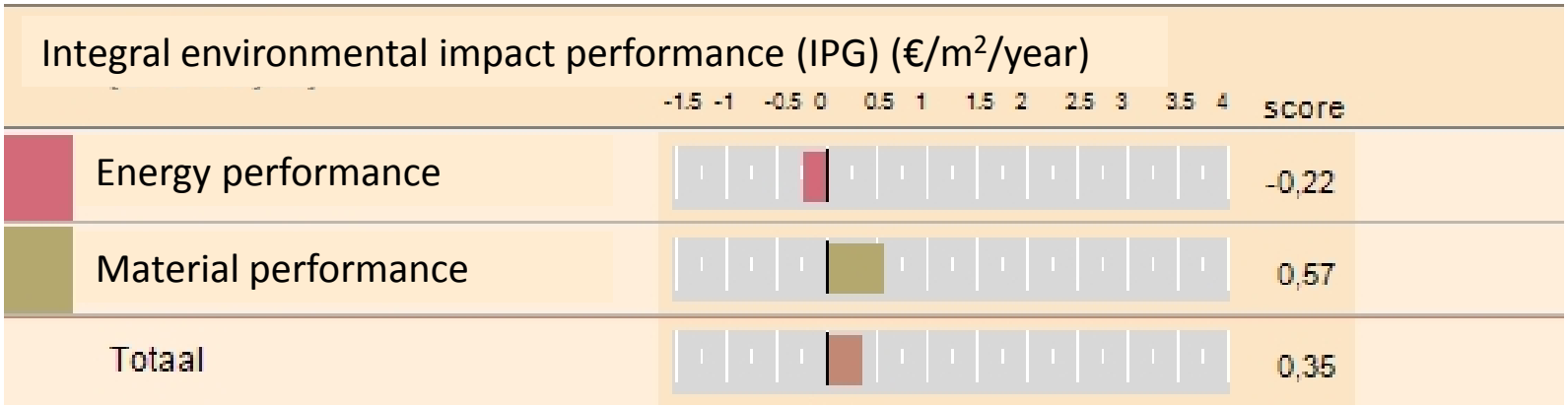


IPG: Integral environmental impact

Residential building, **present** standard: **EPC=0,40**



NZEB Residential building: **EPC= -0,04**



Conclusions

- IPG gives an **integrated** assessment of environmental performance
- For **entire building life cycle**, from resource winning to use phase and final decommissioning
- Based on **existing**, standardized calculation methods, familiar to building community
- Level playing field

Discussion and outlook

- Extension to other countries requires:
  - reassess **system boundaries** (energy)
  - establish national **LCA database** (materials)
- EU level:
  - **eco-efficiency program** and **energy directive**
  - product specific **European LCA database** would be a great advantage for producers of building materials

Thank you for your attention

More information:

www.tki-kiem.nl (in Dutch)

or in the paper (in English)

We gratefully acknowledge the financial support from the research program TKI ENERGO of the Dutch Ministry of Economic Affairs

MPG method (2)

	Environmental impact categories	Equivalent unit	Weighing factors [€ / kg equivalent]	
1.	Depletion of abiotic resources (excluding fossil fuels) – ADP	Sb eq	€ 0.16	Raw materials
2.	Depletion fossil fuels – ADP	Sb eq[6]	€ 0.16	Raw materials
3.	Global warming – GWP 100 j.	CO_2 eq	€ 0.05	Emissions
4.	Depletion ozone layer – ODP	CFK-11 eq	€ 30	Emissions
5.	Photochemical oxidant creation – POCP	C_2H_4 eq	€ 2	Emissions
6.	Acidification – AP	SO_2 eq	€ 4	Emissions
7.	Eutrophication – EP	PO_4 eq	€ 9	Emissions
8.	Human toxicity – HTP	1,4-DCB eq	€ 0.09	Emissions
9.	Fresh water aquatic eco toxicity – FAETP	1,4-DCB eq	€ 0.03	Emissions
10.	Marine aquatic eco toxicity - MAETP	1,4-DCB eq	€ 0.0001	Emissions
11.	Terrestrial eco toxicity – TETP	1,4-DCB eq	€ 0.06	Emissions

1-points score

GPR Building: Sustainable building assessment tool

GPR Building v.4

Energy
- Energy performance
- complementary energy measures

Environment
- Water
- Environmental care
- Materials

Health
- Noice
- Air quality
- Thermal comfort
- Light and visual comfort

User Quality
- Accessibility
- Functionality
- Technical Quality
- Safety

Long term value
- Adaptability and future amenities
- Flexibility
- Perceived value

System boundaries for EPG and MPG