



Low-ex houses: the next step in energy efficiency?

Supply and demand in quality, not quantity

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Consultant / researcher



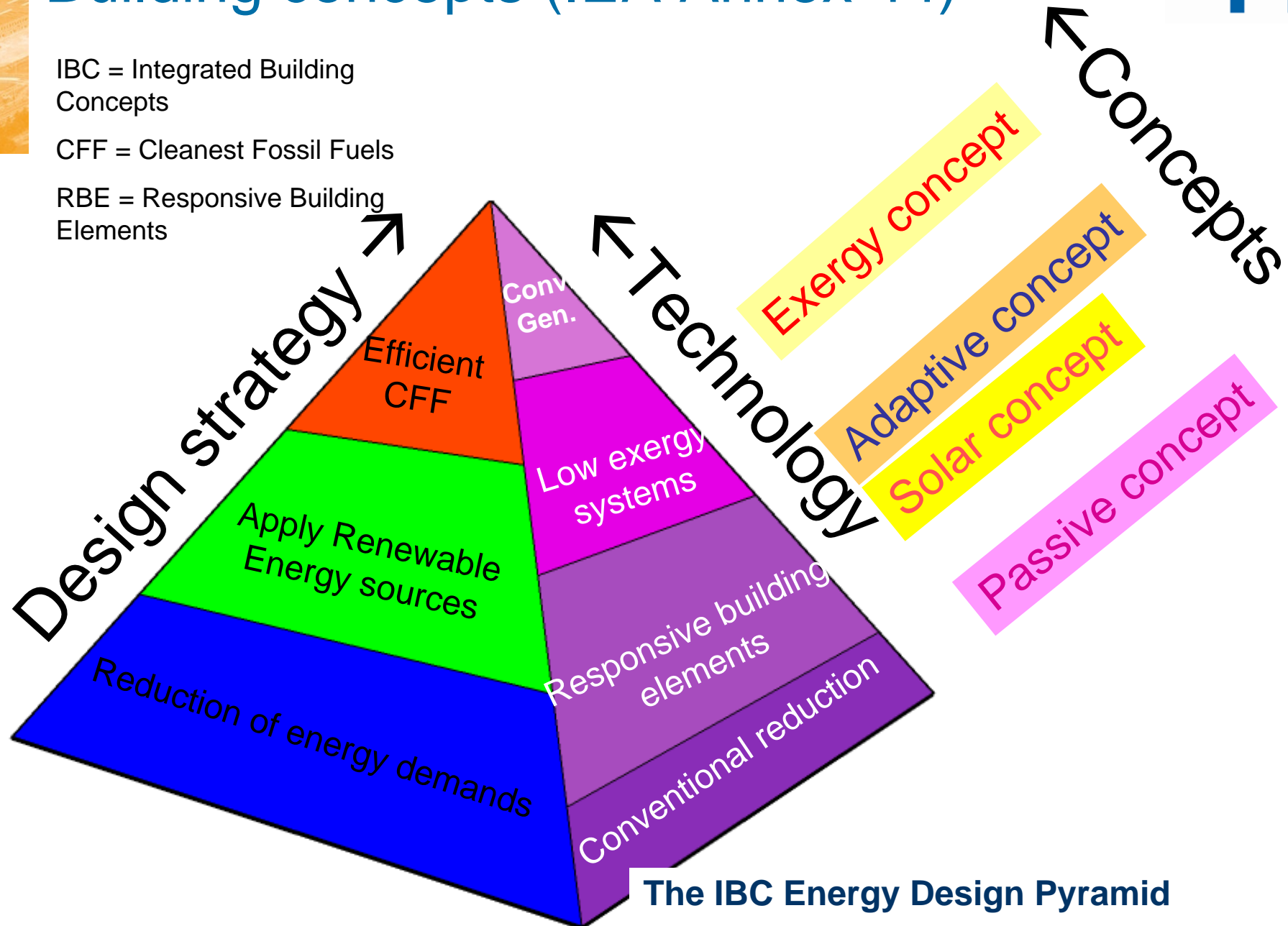
Building concepts (IEA Annex 44)



IBC = Integrated Building Concepts

CFF = Cleanest Fossil Fuels

RBE = Responsive Building Elements



The IBC Energy Design Pyramid

Passive house concept



Concept characteristics:

- Maximum energy use heating 15 kWh/m²y
- Maximum primary energy demand 120 kWh/m²y
- Compact building shapes and U values < 0.15 W/m²K
- Extreme air tightness
- Passive solar energy
- MVHR
- E-saving appliances and PV

Passive = measures in building physics, not depending on energy source

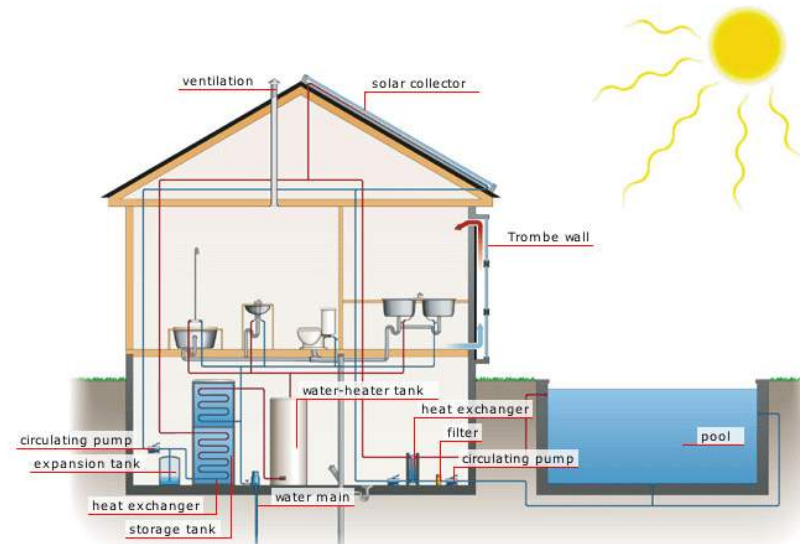


Solar concept



Concept characteristics:

- South orientated design
- Large solar boiler of Heating and DHW
- PV
- Heat storage
- Attention for summer comfort!

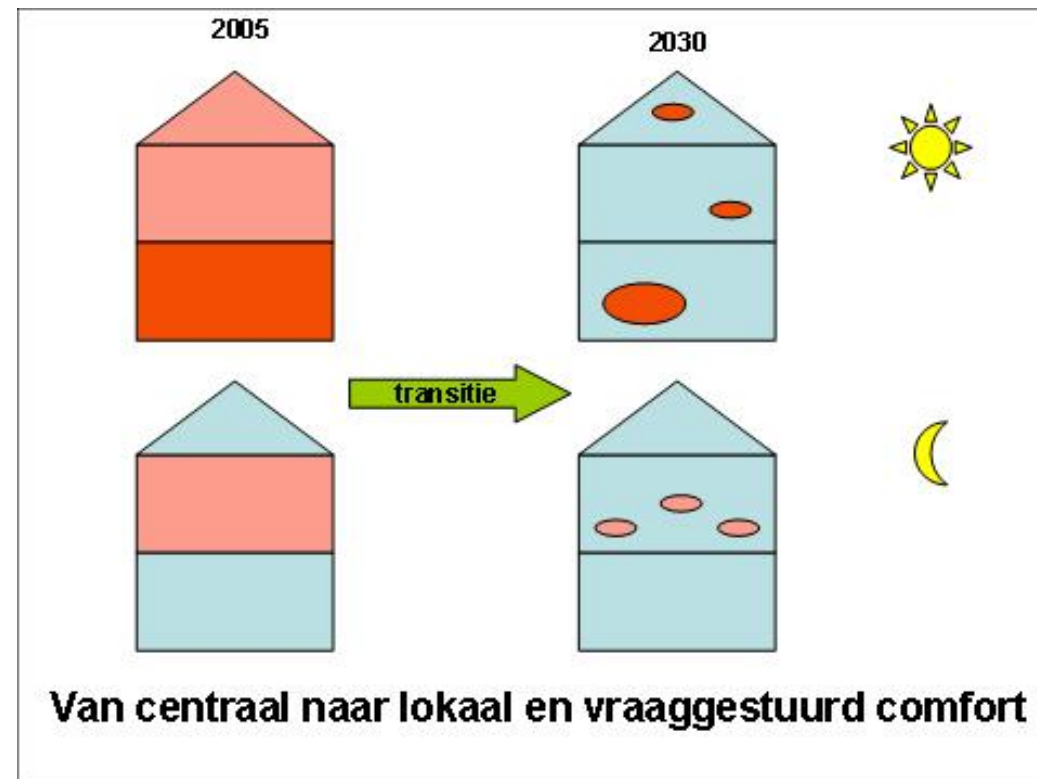


Adaptive dwelling concept



Concept characteristics:

- Demand control
- Climate active building components
- Integration of installation with building components

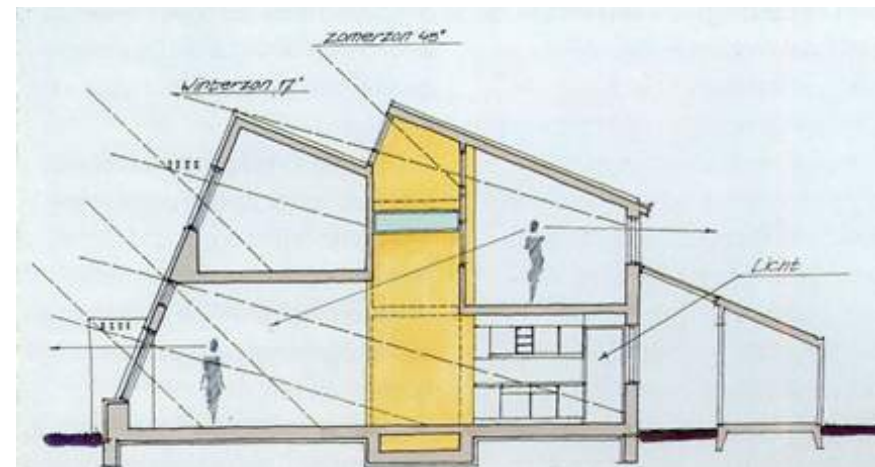


Exergy dwelling concept IEA Annex 49

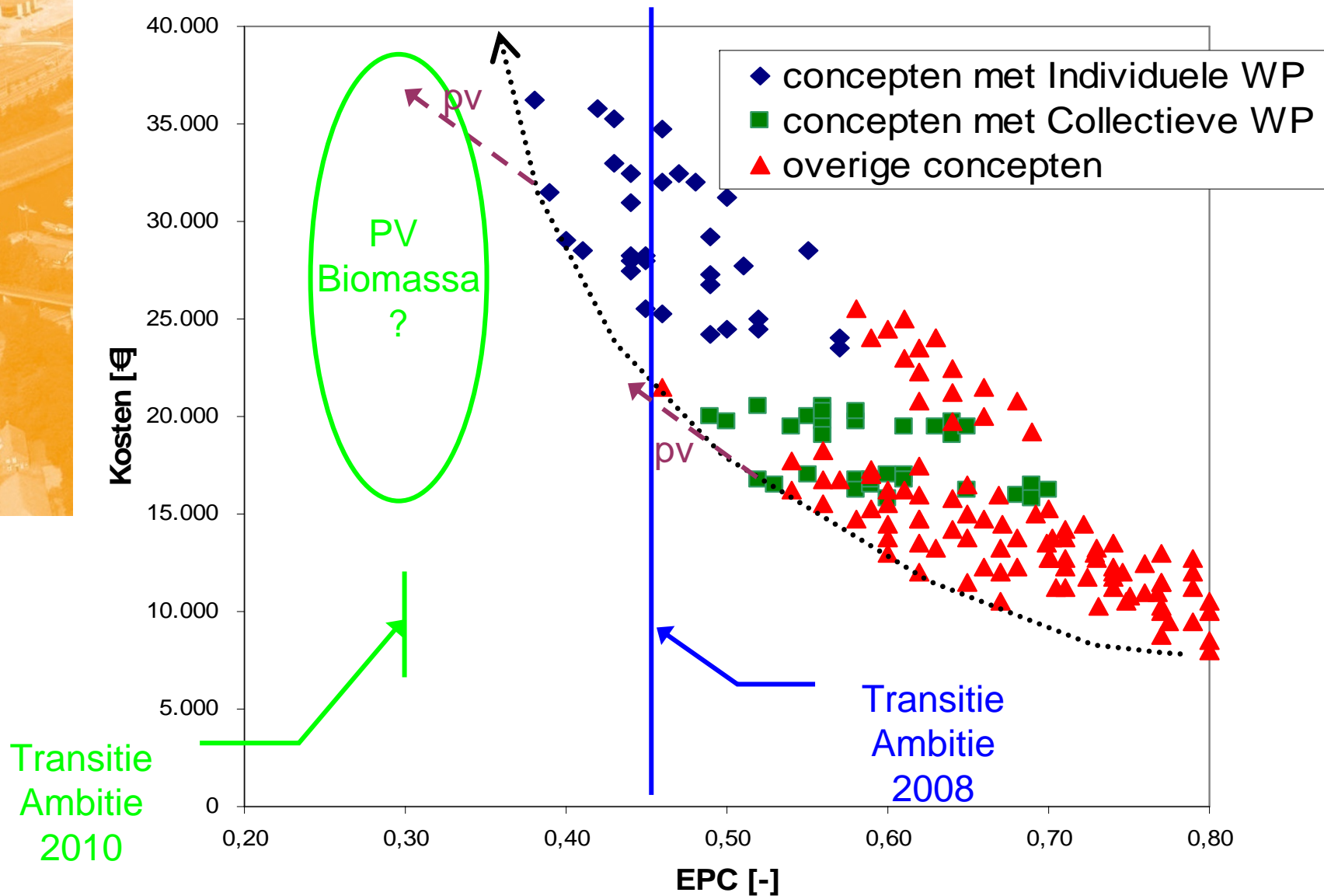


Concept characteristics:

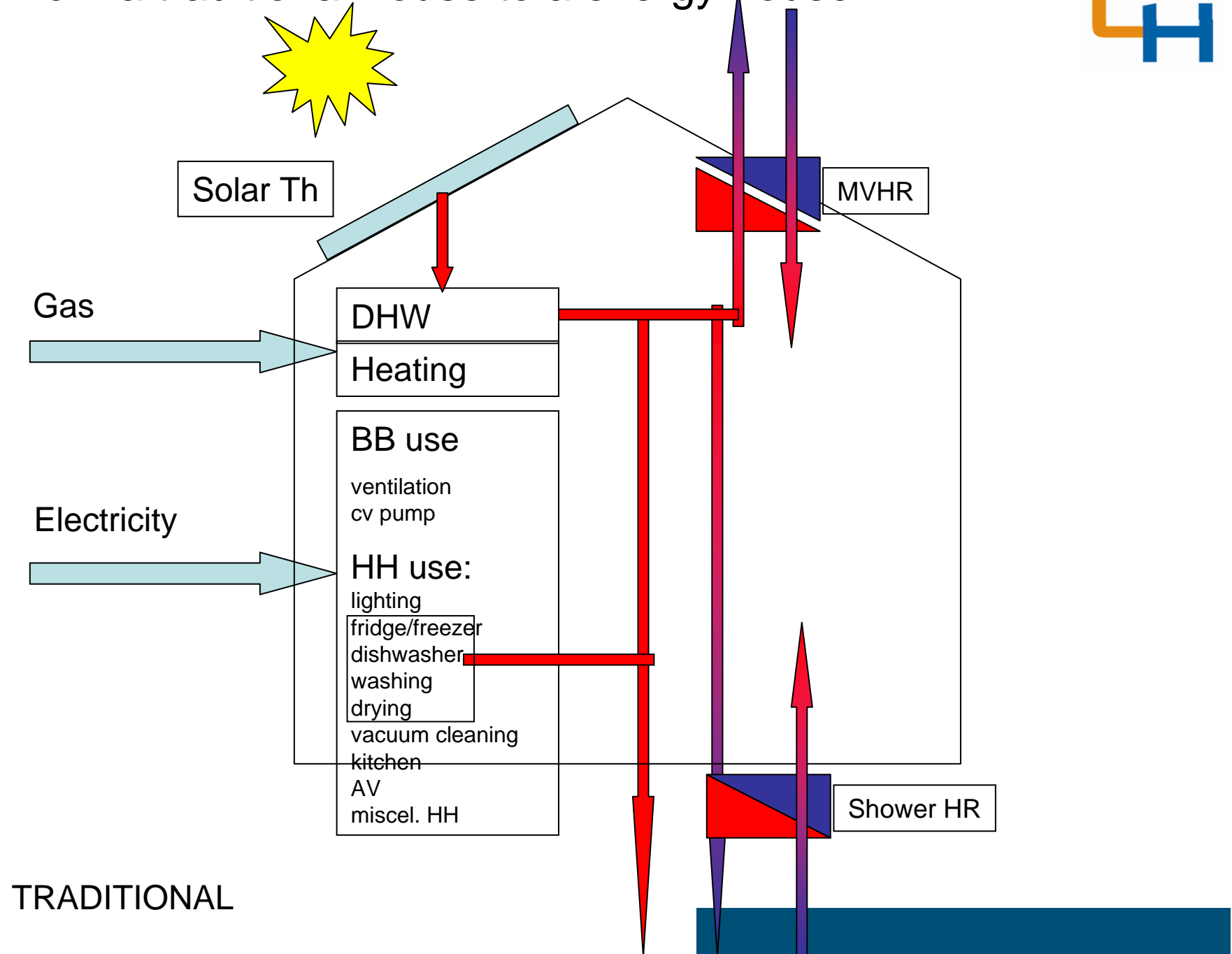
- (Very)Low supply temperatures (close to room T)
- (Very)LTH emission systems combined heating and cooling
- Routing and management for optimal utilisation of energy flows
- Focus on efficient application of renewable energy and efficient fossil fuel conversion
- Building Bound appliances instead of Household appliances (hotfill, coldfill)
- H/C storage



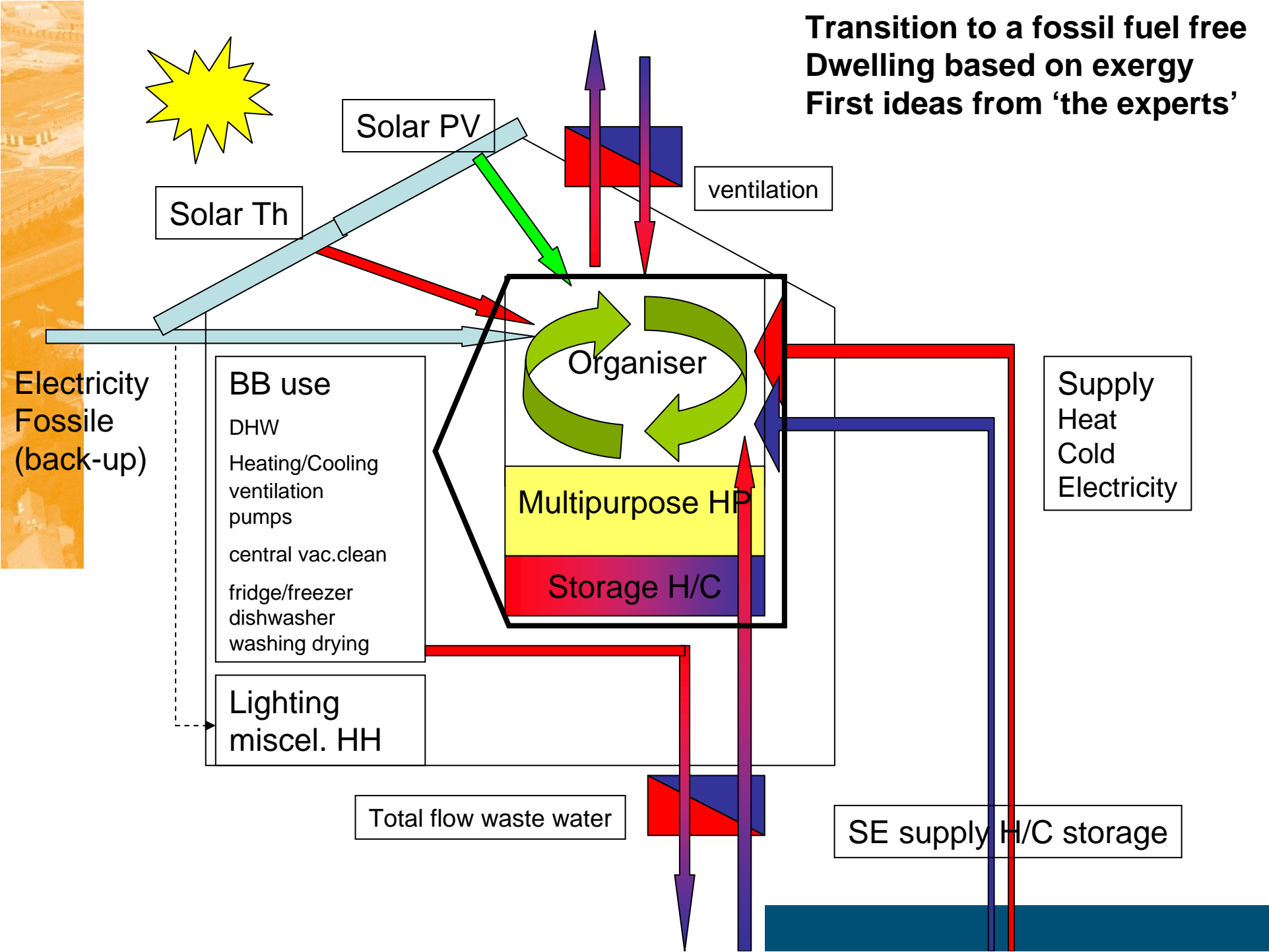
Energy concepts, performance and costs



From a traditional house to a exergy house



Transition to a fossil fuel free Dwelling based on exergy
First ideas from 'the experts'

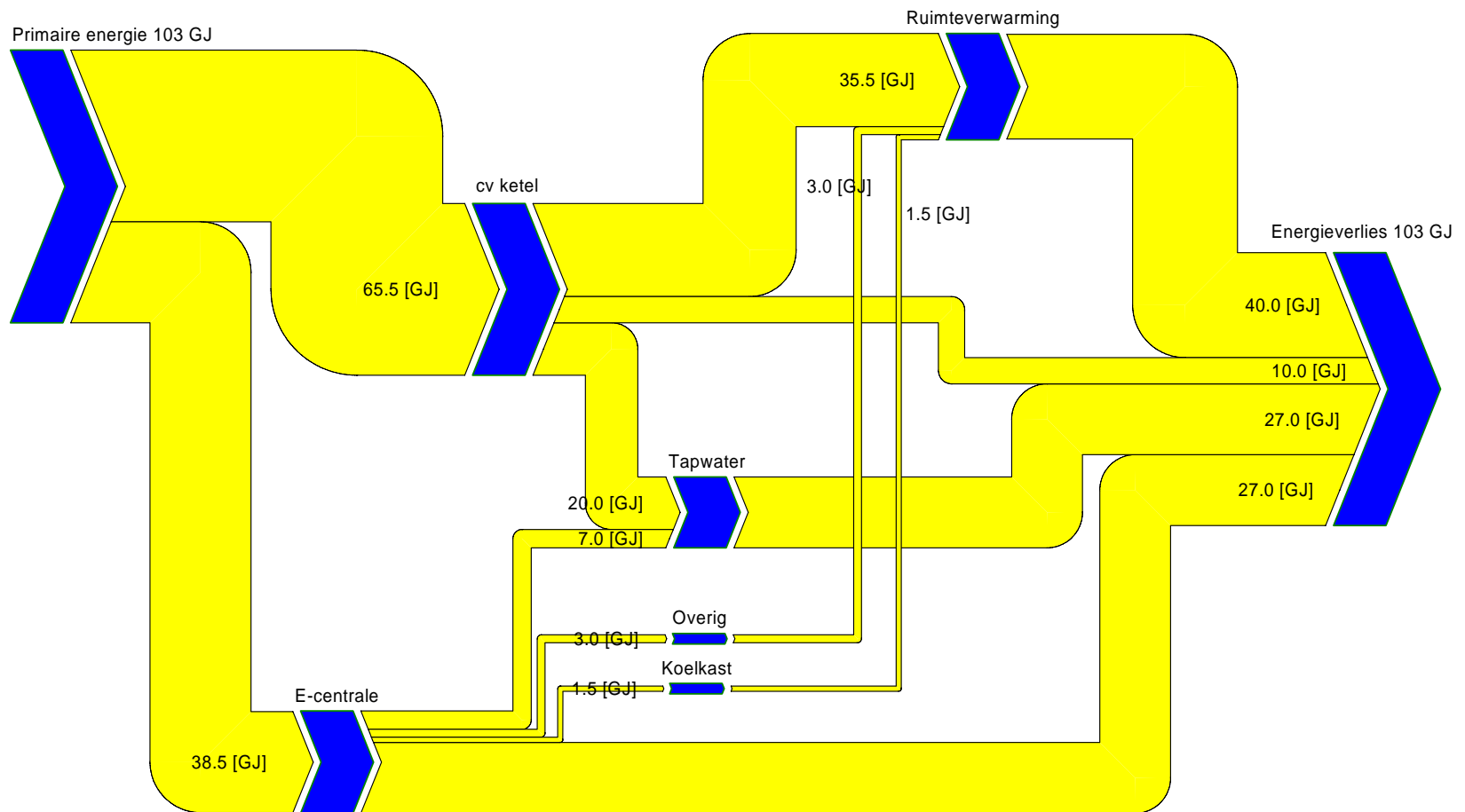


Analyses of CO₂ reduction/primary energy by exergy approach

Traditional situation, reference dwelling



Referentiesituatie

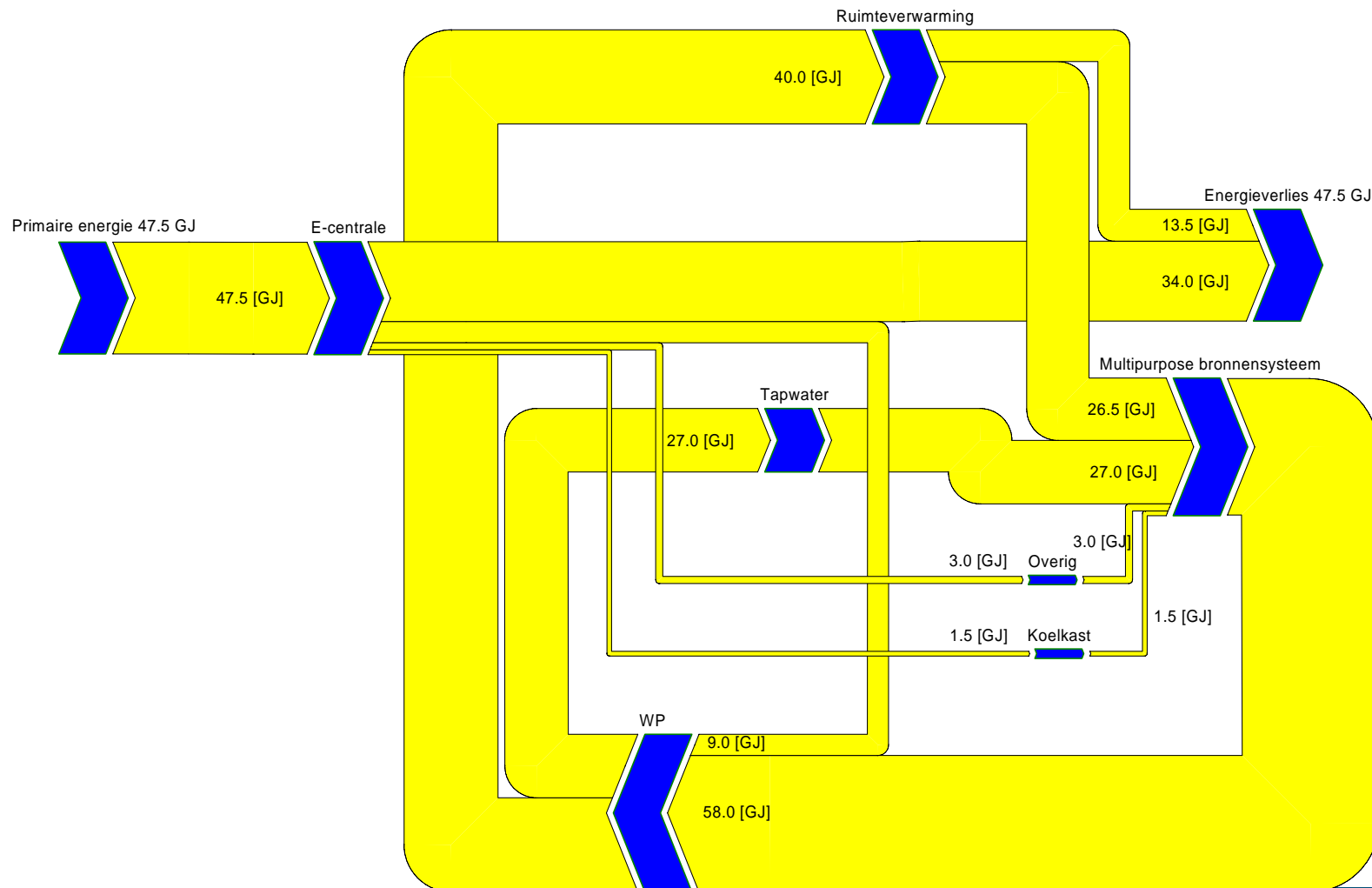


Analyses of CO₂ reduction/primary energy by exergy approach

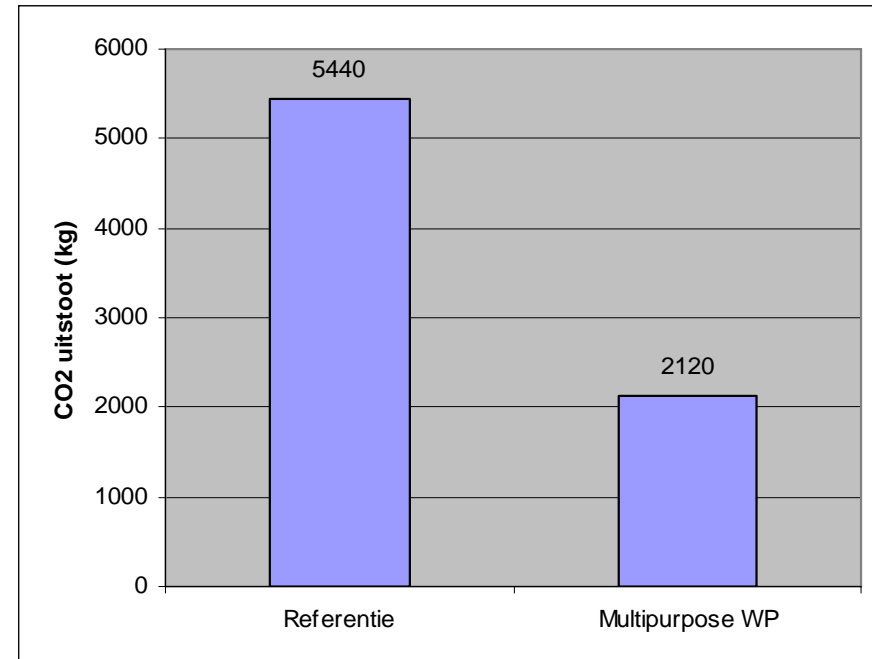
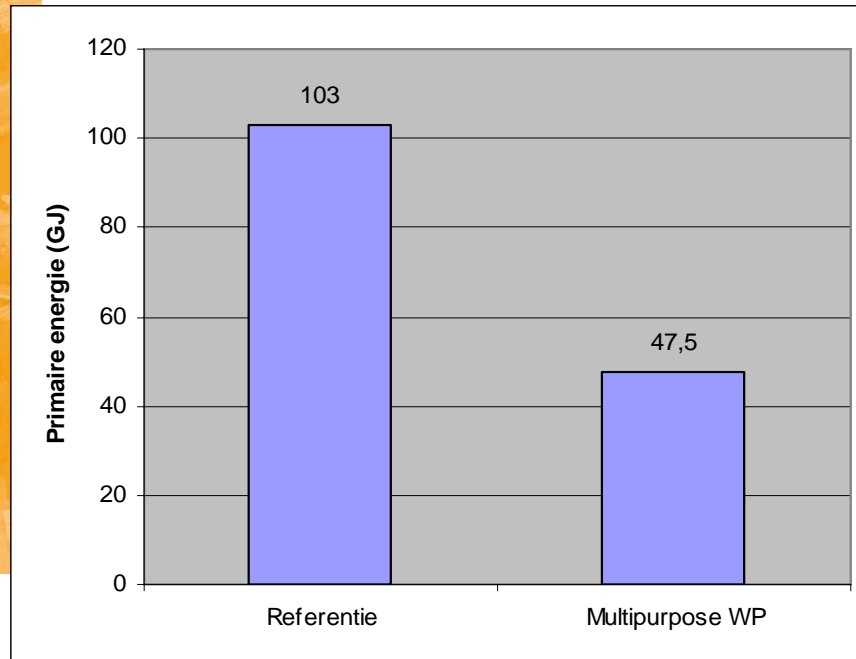
Exergy approach, only effects of exergy – no further optimisation of building envelope



Geoptimaliseerd volgens Exergiebenadering



Reduction by exergy principles (in combination with a multi purpose HP and storage)



Saving potential pure exergy approach (i.e. no other measures):

CO₂ reduction 61%

Primary Energy reduction: 54%

With additional measures 80% CO₂ reduction is possible

- Optimisation building envelope
- Solar PV and thermal
- 12V DC grid in dwelling??



Dutch policy agreement



- 2008 – 2012 large scale demonstration projects in 5 sectors (residential new and existing, non-residential new and existing, community level) with 3 levels of CO₂ reduction:
 - ➔ 45%
 - ➔ 60%
 - ➔ 80%
- Energy neutral newly built buildings from 2020
- A number of concept lines have been discriminated:
 - ➔ Passive House
 - ➔ Solar House
 - ➔ Adaptive House
 - ➔ Exergy House
- Towards energy neutral district development: which concept is suitable?



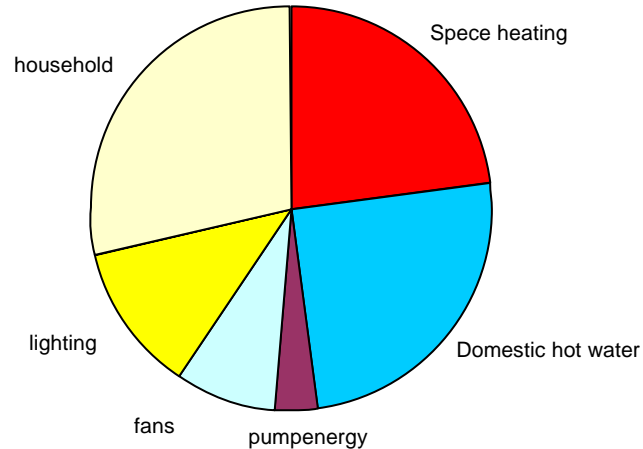
Exergy house concept	Passive house concept
Measures for 45% CO2 reduction (possible with existing technologies)	
<p>Improved thermal insulation; ($U_{env} < 0,24 \text{ W/m}^2\text{K}$) MVHR HP with H/C storage Heat Recovery shower Solar boiler 2,8 m2 Reduction E use by 400 kWh/y E saving HH appliances (or 4 m2 PV)</p>	<p>Improved thermal insulation; ($U_{env} < 0,12 \text{ W/m}^2\text{K}$, Uglazing $< 0,8 \text{ W/m}^2\text{K}$) MVHR + Extreme air tightness Condensing boiler Solar boiler 2,8 m2 Reduction E use by 500 kWh/y E saving HH appliances</p>
Measures for 60% CO2 reduction	
<p>Improved thermal insulation; ($U_{env} < 0,20 \text{ W/m}^2\text{K}$) Multipurpose heat pump in combination with heat recovery from air and all waste water Thermal storage Reduction E use by 800 kWh/y E saving HH appliances (or 6 m2 PV) Thermal active building components</p>	<p>Improved thermal insulation; ($U_{env} < 0,10 \text{ W/m}^2\text{K}$, Uglazing $< 0,8 \text{ W/m}^2\text{K}$) MVHR + Extreme air tightness Solar boiler 5.6 m2 Reduction E use by 500 kWh/y E saving HH appliances Reduction E use by 300 kWh/yr E saving BB energy 6 m2 PV</p>
Measures for 80% CO2 reduction	
<p>Improved thermal insulation; ($U_{env} < 0,16 \text{ W/m}^2\text{K}$) Multipurpose heat pump in combination with heat recovery from air and all waste water Intelligent controlled thermal storage Reduction E use by 2000 kWh/y E saving HH appliances (transition to building bound appliances) (or 15 m2 PV) Thermal active building components</p>	<p>Improved thermal insulation; ($U_{env} < 0,10 \text{ W/m}^2\text{K}$, Uglazing $< 0,8 \text{ W/m}^2\text{K}$) MVHR + Extreme air tightness Heat Recovery shower Solar boiler 5.6 m2 Reduction E use by 1250 kWh/y E saving HH appliances Reduction E use by 300 kWh/y E saving BB energy 15 m2 PV</p>



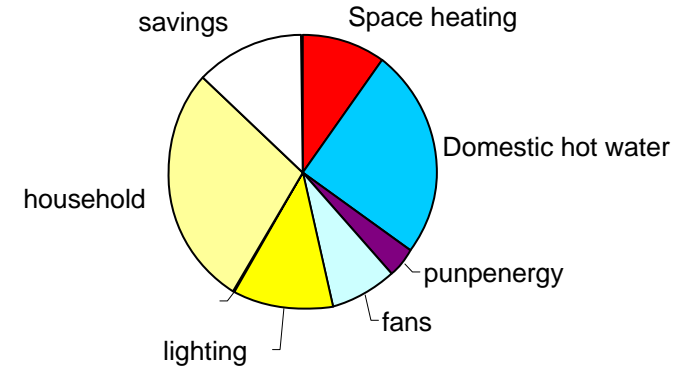
Comparison of energy carriers



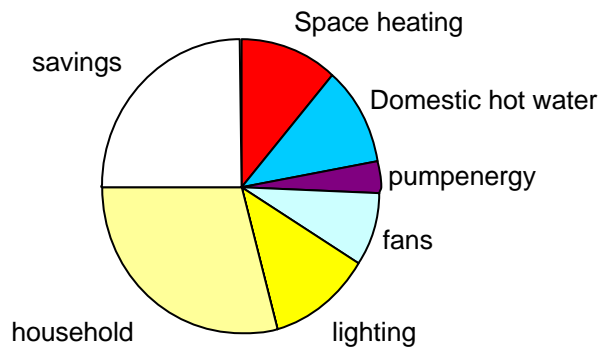
Reference 2009



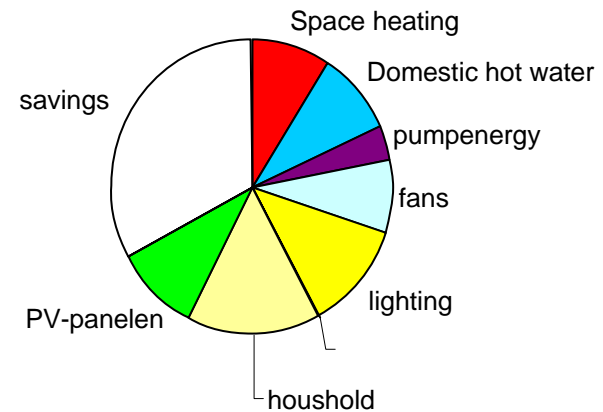
Passive house



Passive house plus



Exergy house





Tomorrow's Neighborhood: training and demonstration houses designed and constructed by students



A test and show case for the Dutch National Energy Transition Programme
(PEGO)



PHOTOVOLTAÏSCHE CELLEN

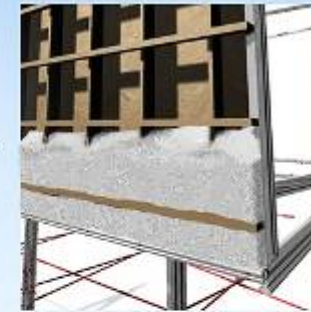
als elektriciteitsbron. Op het Zuiden gericht, onder een hoek van 20 graden voor afspoelen regenwater en vuil

ENERGY-DAK

ontrekt warmte aan PV-cellen voor warm tapwater en regeneratie bodem; rendement PV-cellen wordt verhoogd

WANDOPBOUW

houten wand- en vloerpanelen met stijl- en regelwerk; buiten en binnenzijde afgedicht met OSB plaat; geheel volgespoten met ISOFLOC cellulose isolatie, $R_c = 6,5$ Stramien voor constante en handelbare afmetingen panelen



CONSTRUCTIE

opgebouwd uit staatskelet wand- en vloerpanelen voor stabiliteit

GESLOTEN GEVEL

op het Noorden voor weinig warmteverlies

LICHTSTRAAT

voor afvoer oververwarmde lucht en extra daglichttoetreding

LAMELLEN OVERSTEK

houdt hoogstaande zomerzon buiten; diffuus daglicht treedt wel binnen

KANTOORBLOK

aan de Noordzijde (koudevraag > warmtevraag)

GROOT GLASOPPERVLAK

op het Zuiden voor maximale licht- en warmte toetreding

SCREEN

weert direct zonlicht en houdt warmte buiten; verstelbare bovenrand om diffuus daglicht binnen te laten treden

VIJVER

I.b.v. opvang HWA onder overstek

WOONBLOK

aan de Zuidzijde (koudevraag < warmtevraag)

TERRAS

aan de Zuidzijde

VERBINDINGSGANG

verbinding met andere gebouwen op het perceel

VENTILATIE

Mechanische afzuiging per ruimte afzonderlijk

Afvoerleidingen

Centrale Ventilatie-Unit

Aanvoer buitenlucht via afsluitbare roosters

VERWARMING
Warmtepomp

Wateropslagvat

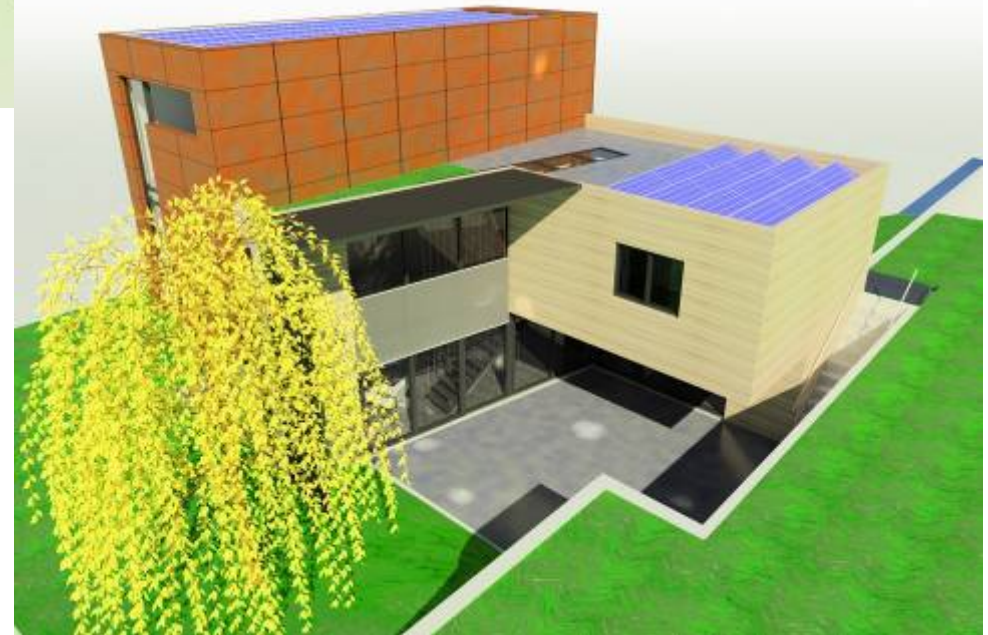
Vloerverwarming



Transition to a fossile fuel free dwelling: first ideas from students
Daring design with space to live in and eXergy to experiment with



Ontwerp: Exergiehuis concept





Exergy next step?



- Exergy approach is part of energy neutral building environment
- Future concepts are combination of techniques
- District heating – all electric: complementary concepts





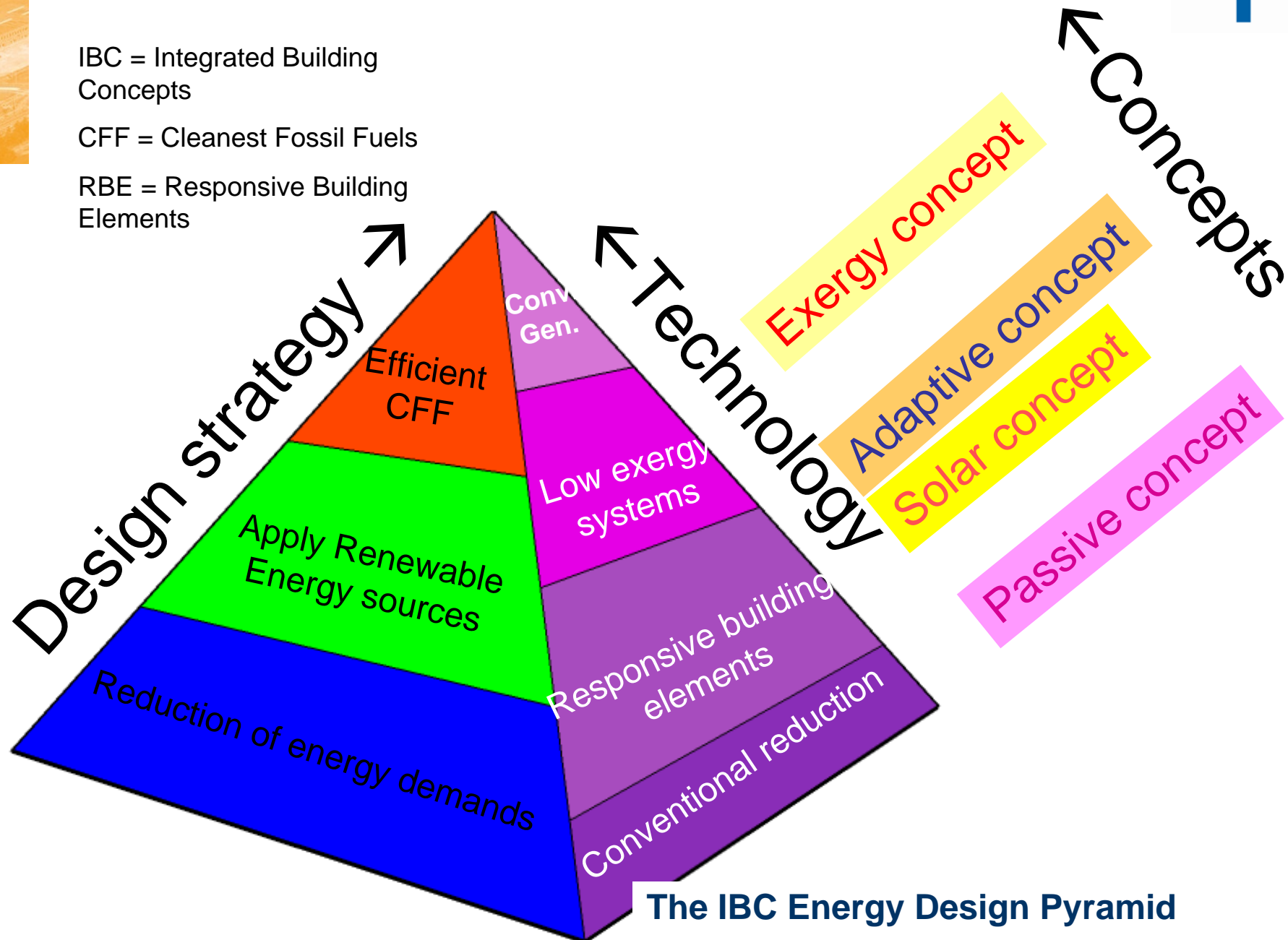
Ranking of concepts? Which is better?



IBC = Integrated Building Concepts

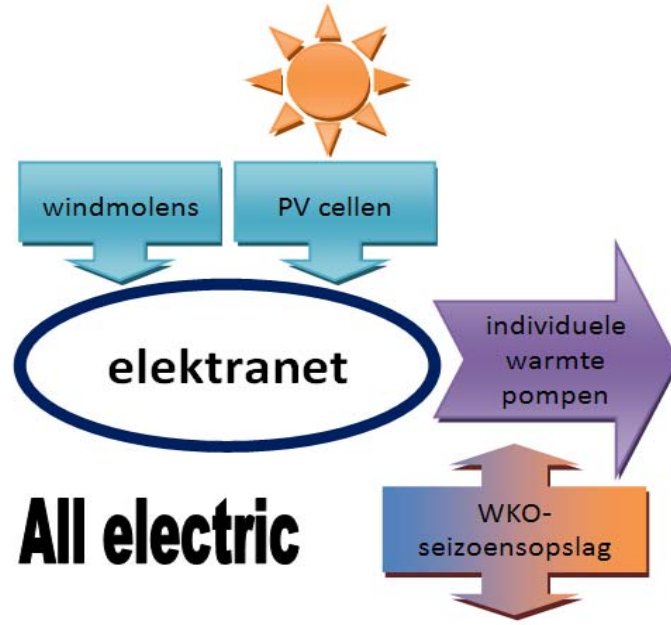
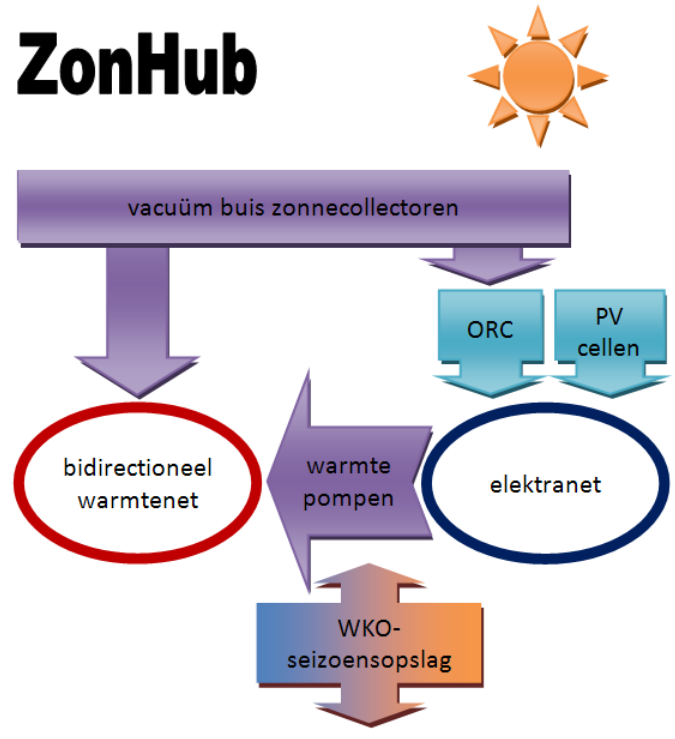
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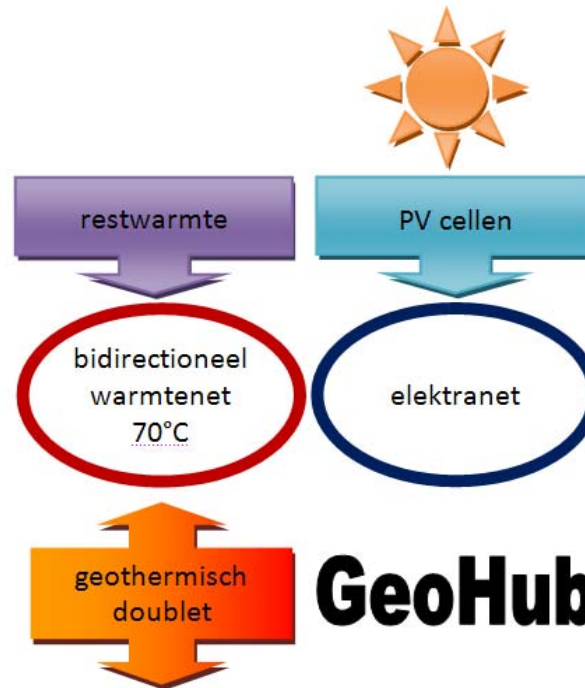
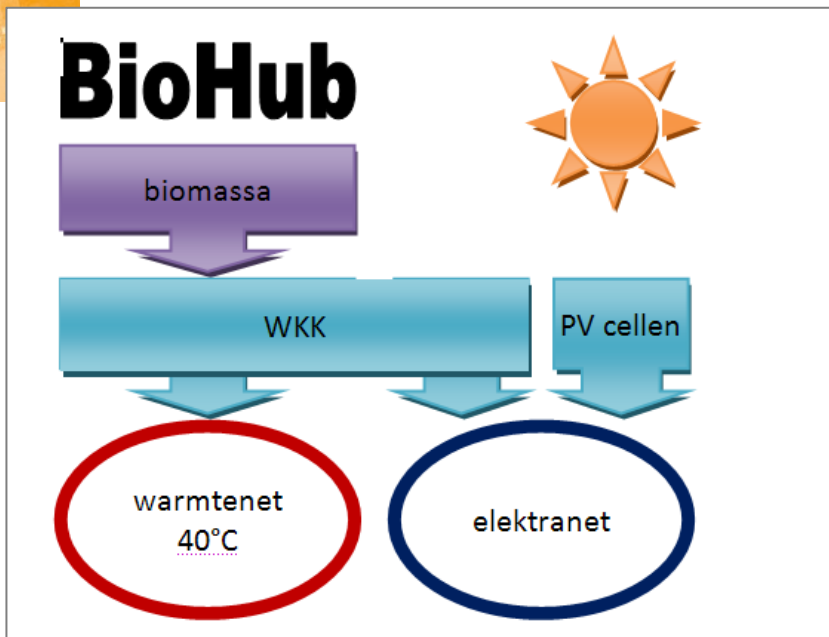


The IBC Energy Design Pyramid

ZonHub

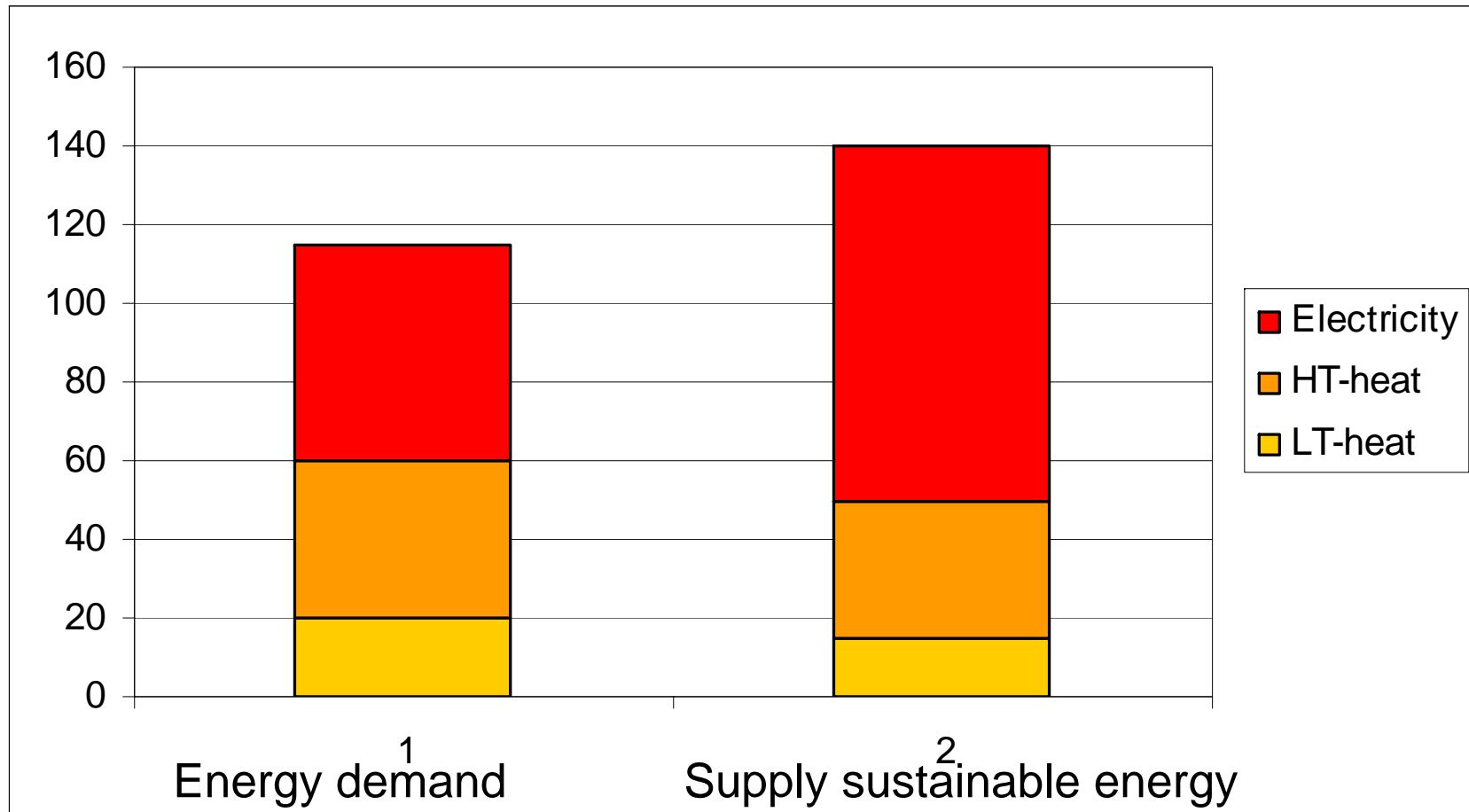


BioHub



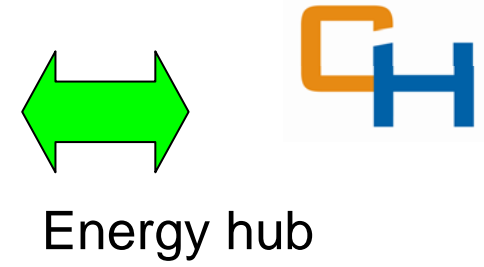
GeoHub

Exergy and availability of energy neutral district

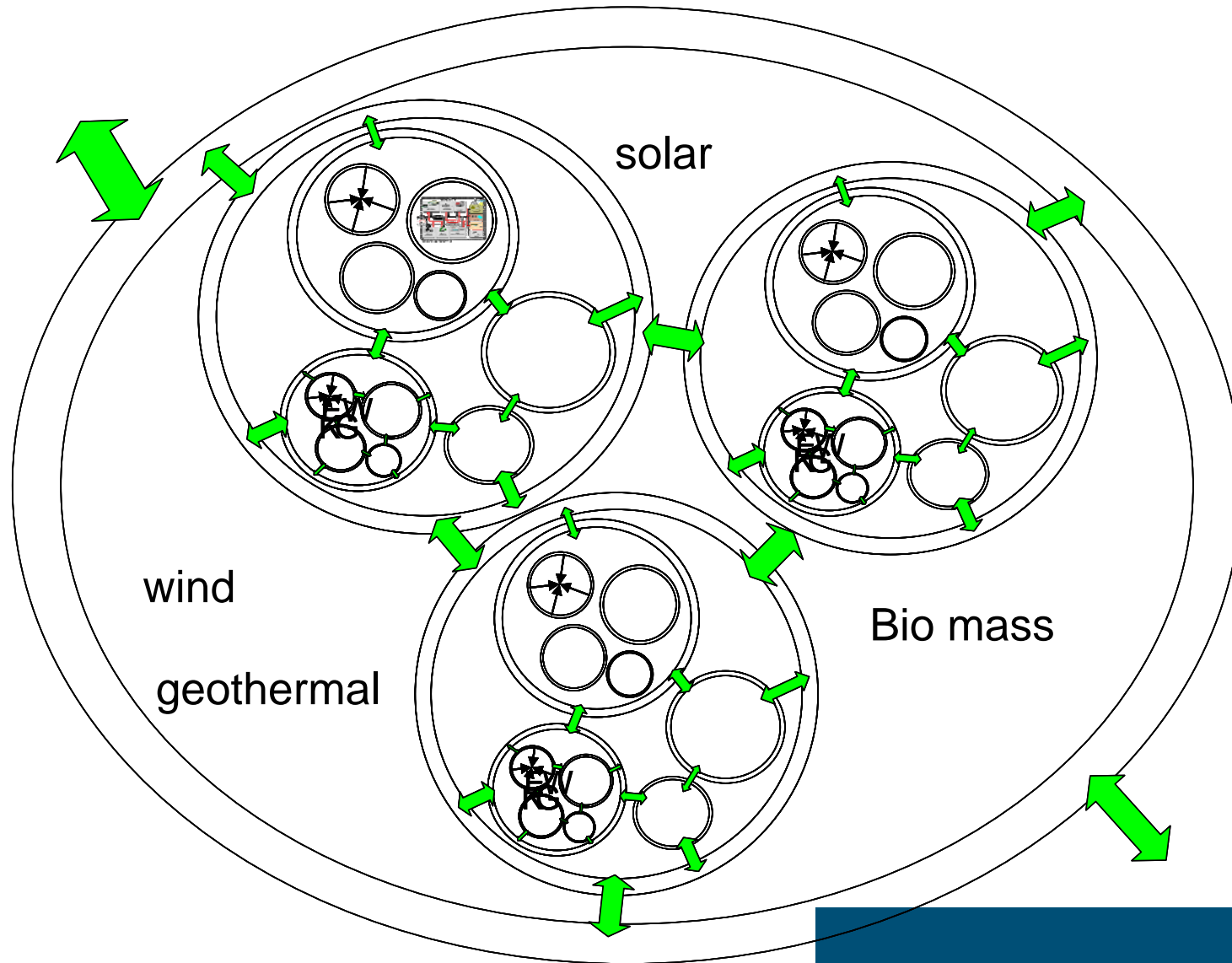




Abstraction of districts



Energy hub






Exergy in energy neutral districts



- JIT of energy quality
 - Different districts, different concepts
 - Complementary overshoot

 - Low-ex may not be an exclusive aim, but a necessary boundary towards energy neutral building environment

 - Design paradox: availability sustainable
 energy versus exergy
- 



Thank you for your attention



- Discussion and questions

