

## Passivehousing in Denmark! Isn't it about time?



Passive House Institute Darmstadt  
Dr. Jürgen Schnieders



Innovationszentrum Fensterbau  
DI (FH) Franz Freundorfer  
Lohbachstraße 3 D-83080 Oberaudorf  
Tel.: (0049) 0170 / 34 66 0 99



### **1 - Litre - Car: April 2002**

**80% less energy than normal cars**



### **1991: Passivhaus = 1- Litre-House**

- **Uses 90% less energy than normal houses**
- **Verifiable**
- **Comfortable**
- **Affordable**

24.04.200  
6



Passive Houses: How and why in Denmark?



Seite 2

## ***What is a Passive House?***



*A passive house is a building with such a low heating load that it can be heated by the anyway existing ventilation system.*

Criteria 1: anual heat requirement. Energy used for space heating is 15 kWh/(m<sup>2</sup> a) (normally 180!)

Criteria 2: heat load of the building is less than 10 W/m<sup>2</sup> (normally 100!)

So the building is comfortable in the worst weather possible. The ventilation system must be able to heat the house. (max. 52 °C)

24.04.200  
6



Passive Houses: How and why in Denmark?



Seite 3

## ***What is a Passive House?***



Criteria 3: primary energie requirement less than 120 kWh/(m<sup>2</sup> a). (heating,warm water,electricity)

Criteria 4: Summer comfort. Overheating (inside temperature over 25 °C) appears in less than 10% of the year (Lothar Rouvel )

Criteria 5: Excellent airtightness. Result of Blower Door Test below 0,6/h.

24.04.200  
6



Passive Houses: How and why in Denmark?



Seite 4

## ***How to achieve a passive house?***

- Very good walls (U-value  $0.1 - 0.15 \text{ W}/(\text{m}^2 \text{ K})$ ).
- Compact building form (surface to area volume)
- Very low thermal bridging
- Excellent air-tightness
- Thermally efficient glass and frames.
- Very good heat recovery with ventilation system
- A good facing to the sun

24.04.200  
6

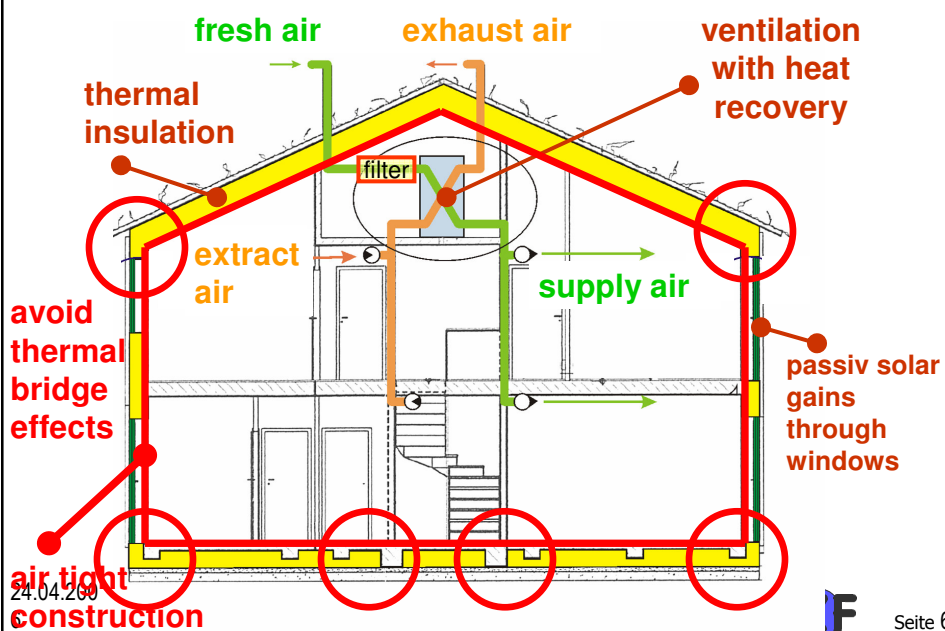


Passive Houses: How and why in Denmark?



Seite 5

### passiv house – schematic composition



24.04.200



Seite 6

Out of Nansens diary:  
Ventilation, insulation,  
aer tight layer,  
tripple glazed windows  
„I think about leave out  
the stove. It only bars  
the way.“

entdeckt von Rainer Pfluger, Passivhaus Institut



Passivehouse in the year 1893

und Eis. Die norwegische Polarexpedition", Leipzig 1898

24.04.200  
6

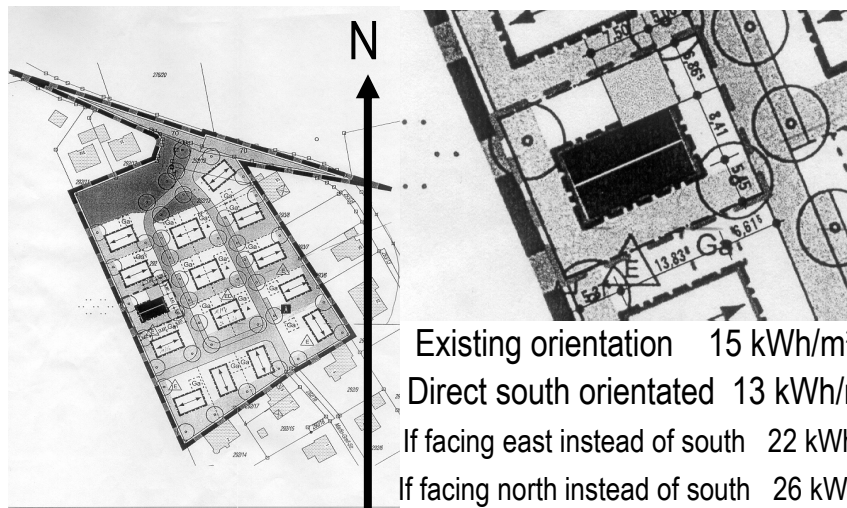


Passive Houses: How and why in Denmark?



Seite 7

## The importance of facing the sun!



Existing orientation 15 kWh/m<sup>2</sup>a

Direct south orientated 13 kWh/m<sup>2</sup>a

If facing east instead of south 22 kWh/m<sup>2</sup>a

If facing north instead of south 26 kWh/m<sup>2</sup>a

24.04.200  
6



Passive Houses: How and why in Denmark?



Seite 8

## Building without thermal bridges



24.04.200  
6

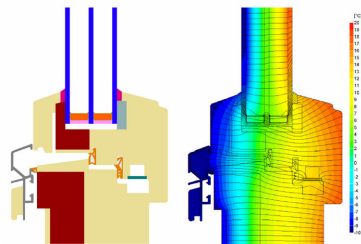


Passive Houses: How and why in Denmark?



Seite 9

## The windows ... From the biggest energy hole ... To passive solar heating



Freisinger „DreiHolz“			
Rahmenmaterial: Holz und Holzwerkstoffe, Flügelrahmendämmung aus Kork, abnehmbare Vorsatzschale aus Lärchenholz Verglasung 44 mm mit $U_g \geq 0,7 \text{ W/(m}^2\text{K)}$ (4/16/4/16/4) Mitteldichtung im Flügelrahmen, Entwässerung im Falz hinter Vorsatzschale			
		Laibung	Brüstung
Rahmenkennwerte	$U_{f,R} [\text{W/(m}^2\text{K)}]$	0,73	0,80
	Ansichtsbreite [mm]	131	131
Randverbund: Edelstahl Ø 2 mm	$\Psi_{f,R} [\text{W/(mK)}]$	0,037	
Glaseinstand	d [mm]	30	
$U_{f,R}$ -Wert (1,23 m x 1,48 m)	$U_{f,R} [\text{W/(m}^2\text{K)}]$	0,80	
Hersteller:	Freisinger GmbH & Co. KG, Wildbacherstr. 1, A-6341 Ebbs, Tel. 0043 (0)5373/460-46		
Berechnung:	PHI		



24.04.200  
6

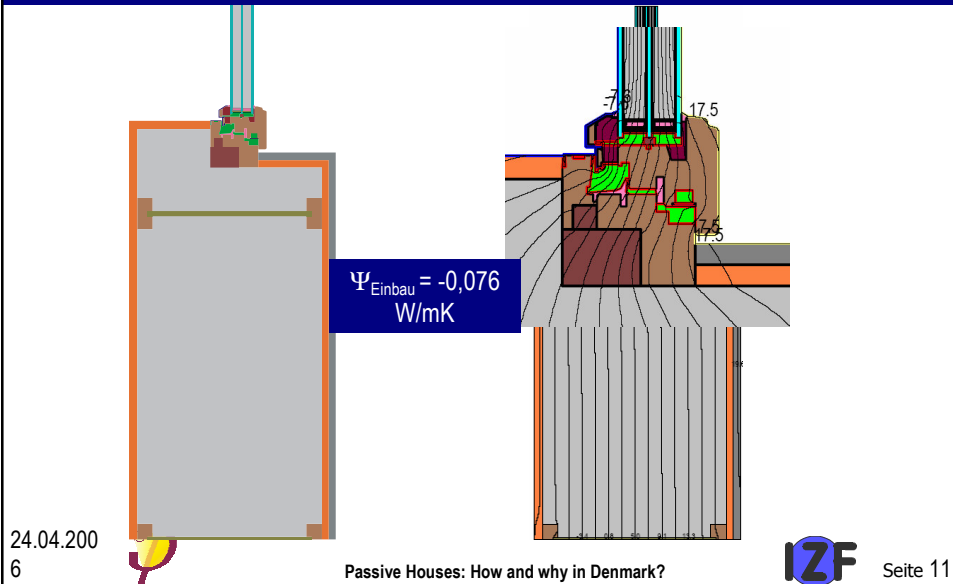


Passive Houses: How and why in Denmark?

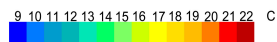


Seite 10

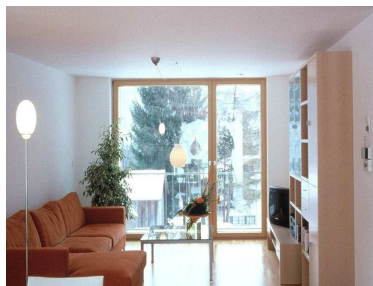
## The certified window connection ... Cost efficient or ... Dangerous?



## Cosines: Radiation temperature - Asymmetric



### Living room



- 10°C  
outside air

22°C  
inside

### Living room:

In a new building?

In a rehabilitated old building?

Quelle: Helmut Krapmeier

24.04.200  
6



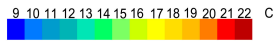
Passive Houses: How and why in Denmark?



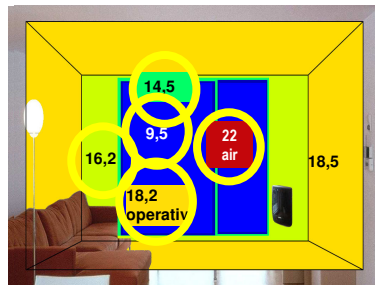
Seite 12



## Cosines: Radiation temperature - Asymmetric



Old building



- 10°C  
outside  
air

Cold surfaces on components by old buildings belong to a big temperature asymmetric.

Quelle: Helmut Krapmeier

24.04.200  
6



Passive Houses: How and why in Denmark?

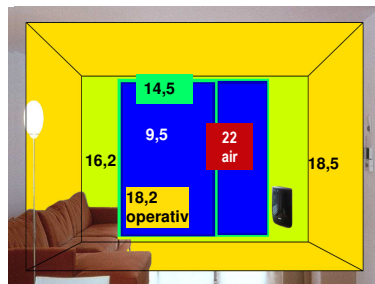
IZF

Seite 13

## Cosines: Radiation temperature - Asymmetric



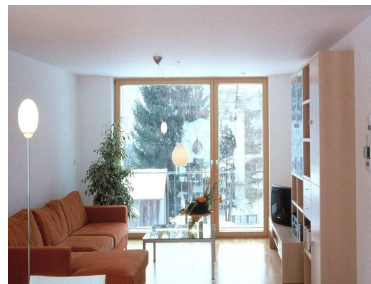
Old building



- 10°C  
outside  
air

Cold surfaces on components by old buildings belong to a big temperature asymmetric.

Passive House



Quelle: Helmut Krapmeier

24.04.200  
6

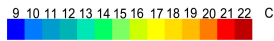


Passive Houses: How and why in Denmark?

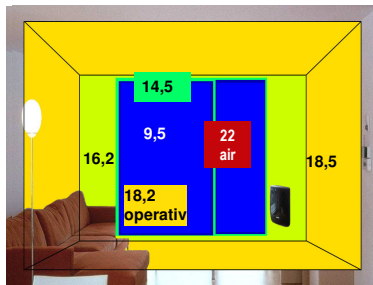
IZF

Seite 14

## Cosines: Radiation temperature - Asymmetric

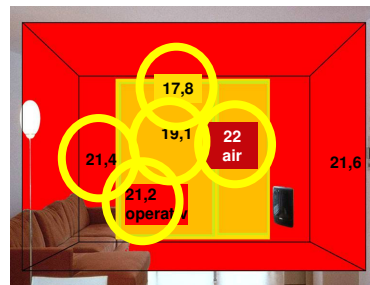


Old building



Cold surfaces on components by old buildings belong to a big temperature asymmetric.

Passive House



Different in Passive Houses: All walls and also the windows have nearly the same temperature. An excellent radiation climate.

- 10°C  
Outside  
-air

24.04.200  
6



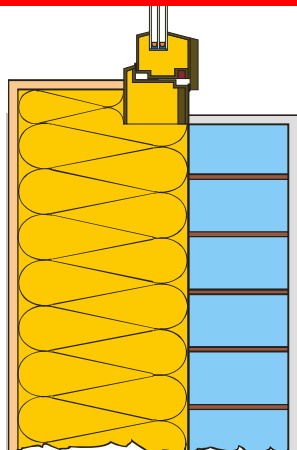
Quelle: Helmut Krapmeier

Passive Houses: How and why in Denmark?



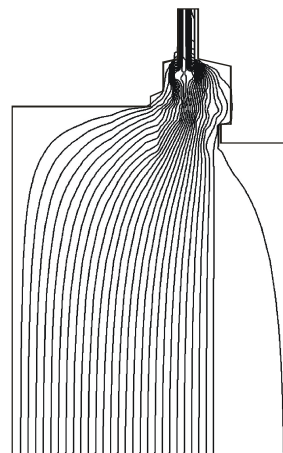
Seite 15

## Recommended fitting



$$\Psi_{\text{Einbau}} = 0,005 \text{ W/(mK)}$$

$$U_{\text{w, eff}} = 0,78 \text{ W/(mK)}$$



24.04.200  
6



Passive Houses: How and why in Denmark?



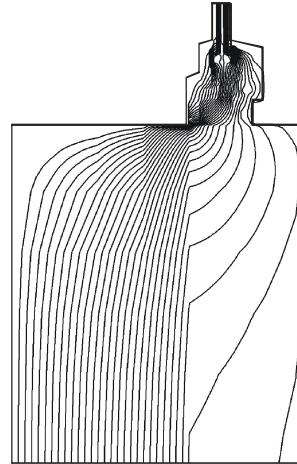
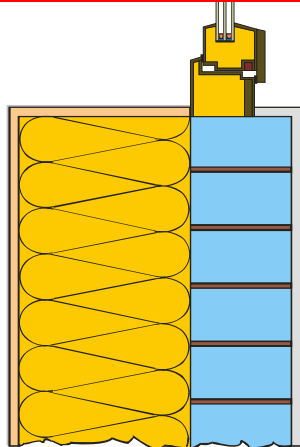
Seite 16



## Poor (normal) fitting

$$\Psi_{\text{Einbau}} = 0,15 \text{ W/(mK)}$$

$$U_{\text{w, eff}} = 1,19 \text{ W/(mK)}$$



24.04.200  
6



Passive Houses: How and why in Denmark?



Seite 17



Passivhaus Dienstleistung GmbH  
[www.passivhaus-info.de](http://www.passivhaus-info.de)



### Example of window on wood support

- Frame completely covered by insulation
- Fixed external to blocks with brackets
- Tape for air-tightness
- Timber support for weight

Quelle: [PHD]

24.04.200

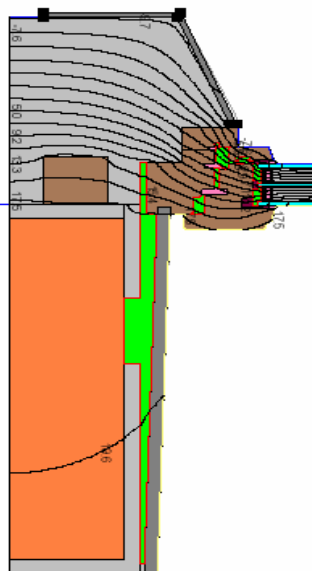
6



Passive Houses: How and why in Denmark?



Seite 18



## An example for integral planning

More easy

More cheap

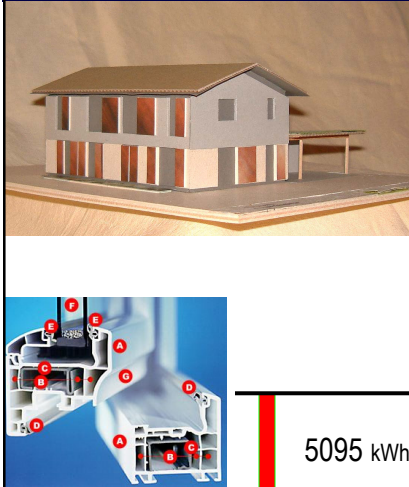
More good

More nice

!!More passiv!!

24.04.200  
6
Passive Houses: How and why in Denmark?
IZF Seite 19

## This house with normal PVC-windows



Heat requirement  
42kWh/m²a

Credit for energie consumption of the windows over 30 years:	Costs of the fitted windows:	Defacto costs with energy
8.818,- €	9.676,- €	18494,- €
Assumption: 15 kWh/m²a incl. auxiliary and real interest rate of 4%	48.38m² windows 200,- € pro m²	

5095 kWh/Jahr

153.000 kWh

in 30 years

24.04.200  
6
Passive Houses: How and why in Denmark?
IZF Seite 20

## The same house with normal wood windows



Heat requirement  
36kWh/m²a

Credit for energie  
consumption of the  
windows over 30  
years:

**6.844,- €**

Assumption: 13 cent/kWh  
first auxiliary and real interest rate  
of 4%

Costs of the  
fitted  
windows:

**12.095,- €**

48.38m² windows  
250,- € pro m²

Defacto costs  
with energy

**18.939,- €**



3958 kWh/Jahr

119.000 kWh

in 30 years

24.04.200  
6



Passive Houses: How and why in Denmark?

**IZF**

Seite 21

## The house with classic PH-windows



Heat requirement  
14kWh/m²a

Credit for energie

**-425,- €**

Assumption: 13 cent/kWh  
first auxiliary and real interest rate  
of 4%

Costs of the  
fitted  
windows:

**19.352,- €**

48.38m² windows  
400,- € pro m²

Defacto costs  
with energy

**18927,- €**



+245 kWh/Jahr

7.350 kWh

in 30 years

24.04.200  
6



Passive Houses: How and why in Denmark?

**IZF**

Seite 22

## The house with certified fitting connection



Heat requirement  
15kWh/m<sup>2</sup>a

Credit for energie  
**171,- €**

Assumption 15 kWh/m<sup>2</sup>a  
and auxiliary and heat interest  
related 4%

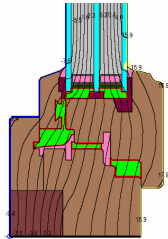
Costs of the  
fitted  
windows:

**14.030,- €**

48.38m<sup>2</sup> windows  
290,- € pro m<sup>2</sup>

Defacto costs  
with energy

**14201,- €**



99 kWh/Jahr

2.970 kWh

in 30 years

24.04.200  
6



Passive Houses: How and why in Denmark?



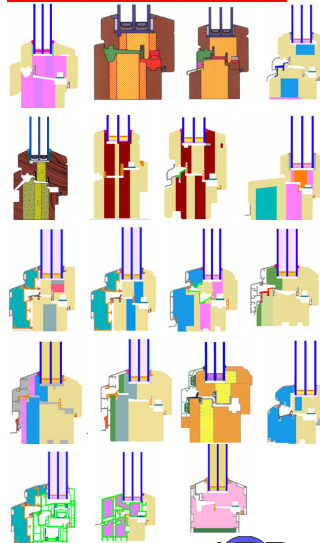
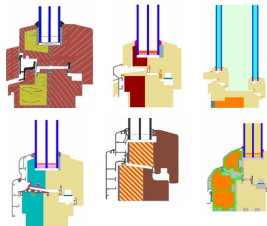
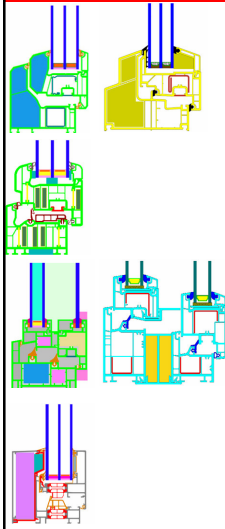
Seite 23

## There are three groups of certified windows

The synthetic

Coming from nature

The agglutinated



24.04.200  
6



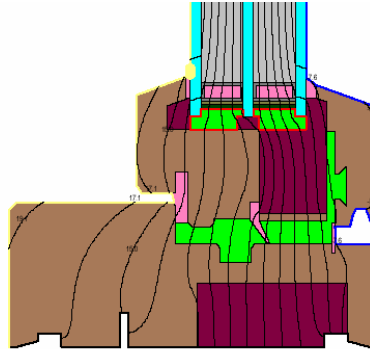
Passive Houses: How and why in Denmark?



Seite 24

..and what's going on with wiking passive house windows??

Alphawin exterior designed by Tonny Skjernø



24.04.200  
6



Passive Houses: How and why in Denmark?



Seite 25

Fresh Air for Comfort – Look to nature



24.04.200  
6

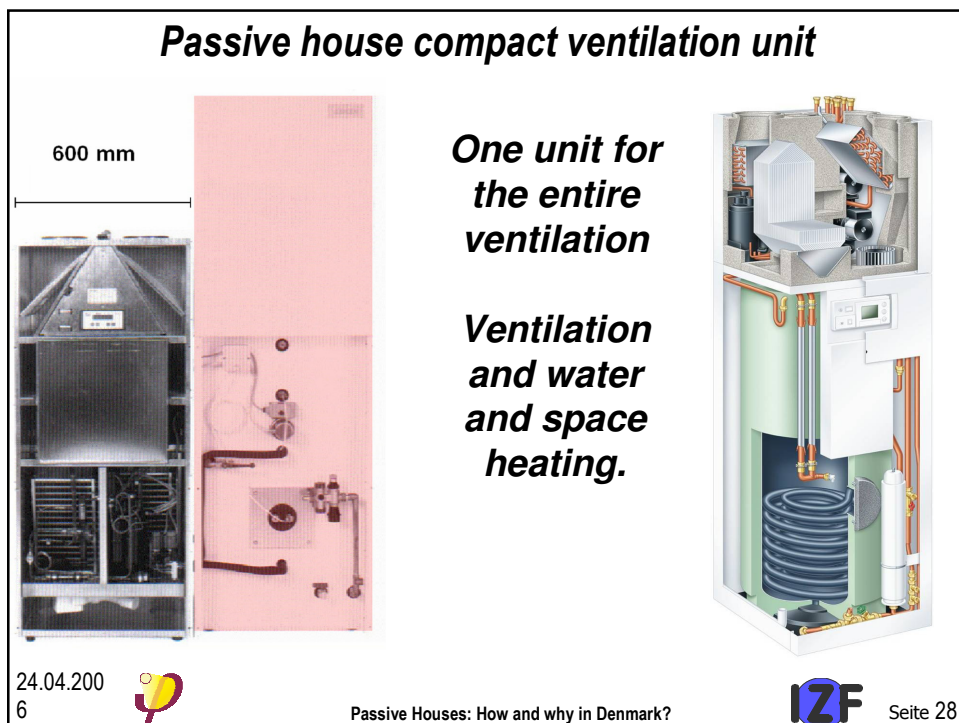
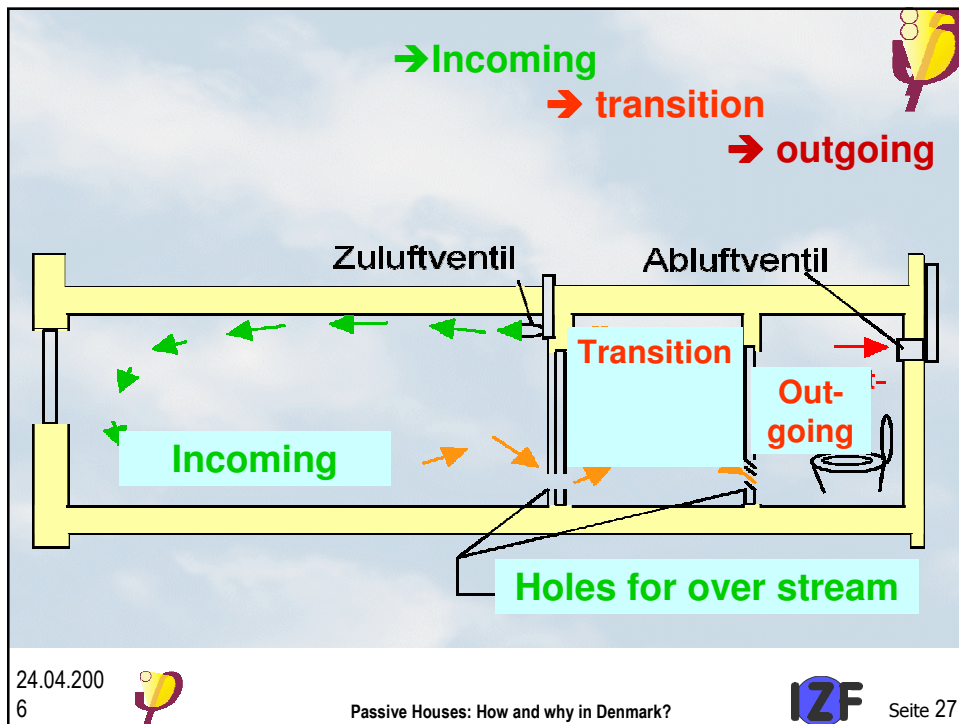


Passive Houses: How and why in Denmark?



Seite 26





# passive house prototype construction Darmstadt 1991



Location	Number of Units
Hannover	32 Reihenhaus
Kassel	40 Wohnungen
Nebikon/Luzern	17 Reihenhaus
Rennes	40 Wohnungen
Hofbranz	3 Reihenhaus
Wolfratshausen	11 Wohnungen
Darmstadt	3 Reihenhaus (Haus)
Legg	32 Wohnungen
Kochel	23 Wohnungen
Göteborg	20 Reihenhaus
Salzburg-Gallg	6 Wohnungen
Steyr	3 Reihenhaus
Horn	1 Reihenhaus (Haus)
Hallein	31 Wohnungen

**CEPHEUS**  
cost efficient passive  
houses as european  
standards

**CEPHEUS**   
cost efficient passive houses as european standards

**IZF** Seite 30

24.04.200  
6

Passive Houses: How and why in Denmark?



### Solar energy only for crazy one??

The most think, that only 5% of our energie can be sustaible.


A terrible lie.

0 C



S  
O  
L  
A  
R  
E  
N  
E  
R  
G  
I  
E

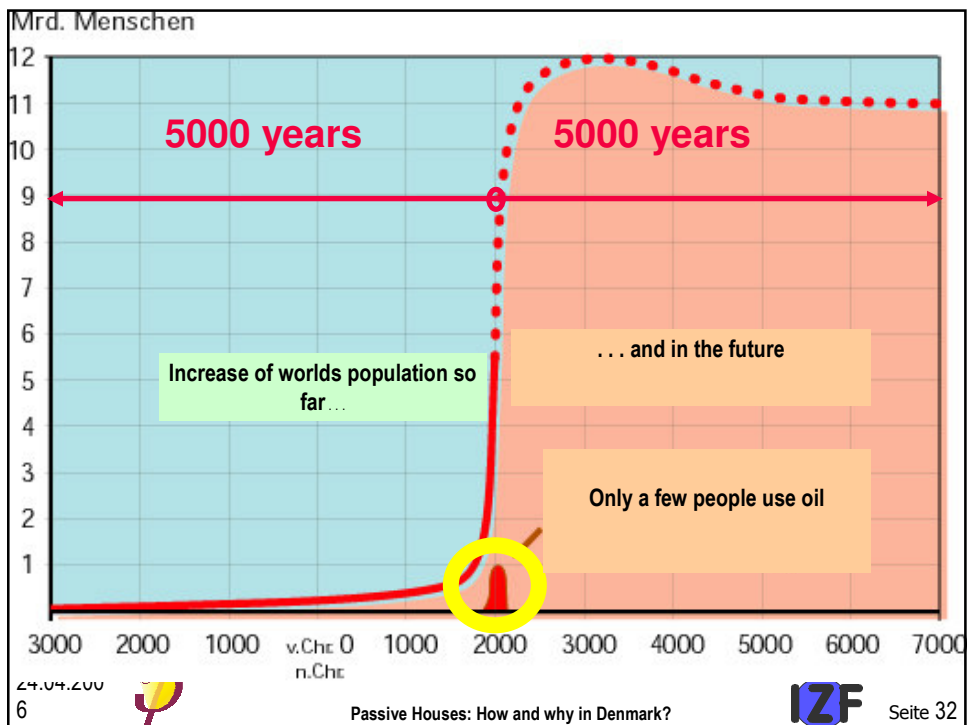
-273 C  
= 0 K

atomar/fossile energie  
Less than 1%



homo politicus contra  
homo idiotus

24.04.2006

Passive Houses: How and why in Denmark?
 Seite 31



## **Passivehousing in Denmark! Isn´t it about time?**



**Passive House Institute Darmstadt**  
Dr. Jürgen Schnieders



**Innovationszentrum Fensterbau**  
Di (FH) Franz Freundorfer  
Lohbachstraße 3 D-83080 Oberaudorf  
Tel.: (0049) 0170 / 34 66 0 99