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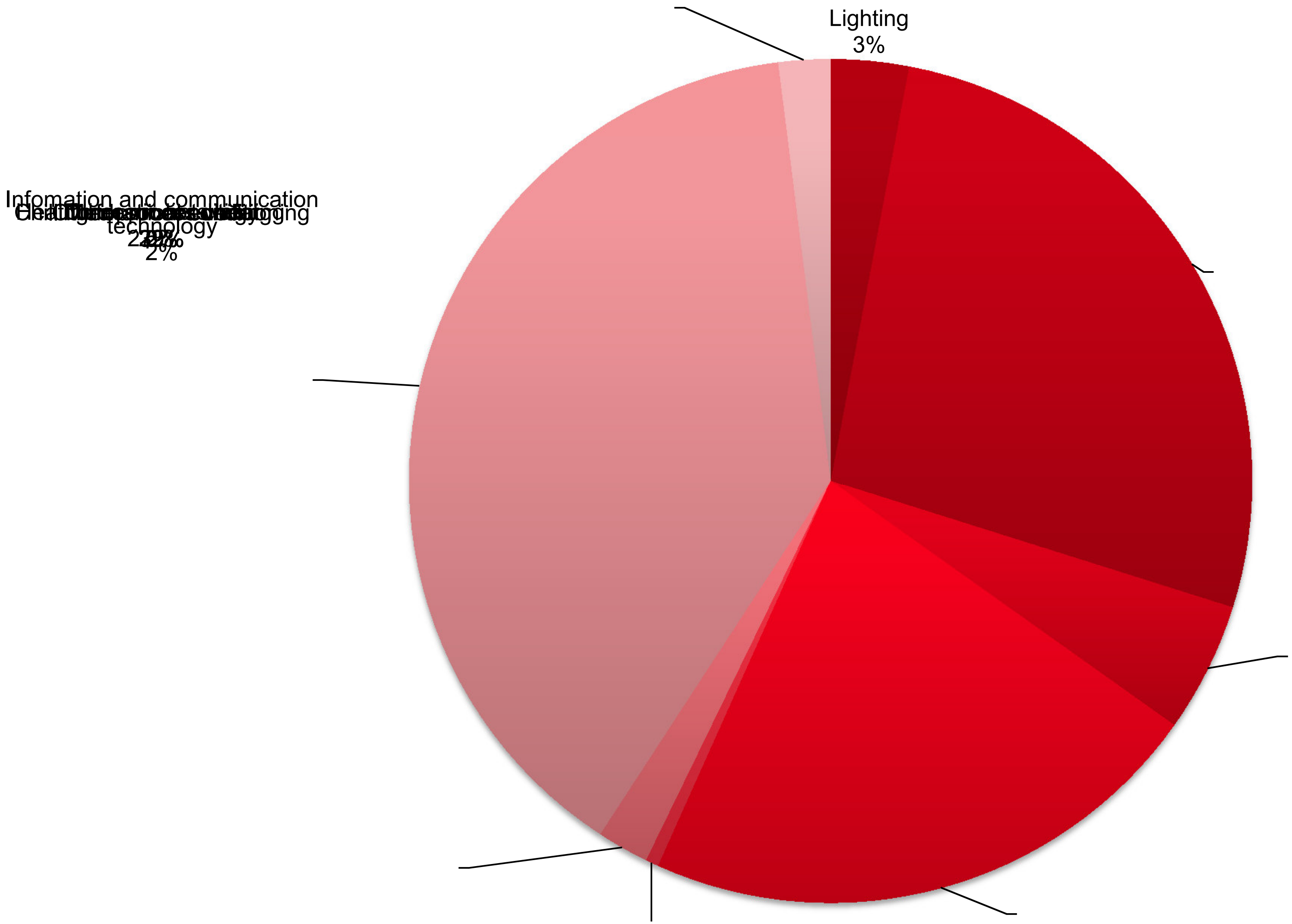
05. September 2016 | Berlin

Sustainable building design, in Germany

Christopher Moore

Energy consumption according to field of application

Germany 2014 (total 8648 PJ)



(total 8648 PJ)

Source: Arbeitsgemeinschaft Energiebilanzen (AGEB), Bundesverband der Energie- und Wasserwirtschaft (BDEW)

Things people worry about

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- It is too technical and complicated
- It will not work form a thermal comfort perspective
- It will use a lot of energy (at least more than calculated)
- They cannot open windows and cannot breathe
- There will be mould
- The design will be lacking
- Costs will explode
- It will not be cost effective
- I will not make any money for the extra work

Development of the German Energy Saving Ordinance

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German Energy Savings Act (EnEG) 1976

Building requirements

WSchV 1977, 1984 und 1995

K-Value Guidelines (U-Value)
Balance Method
Indicators for heating demand

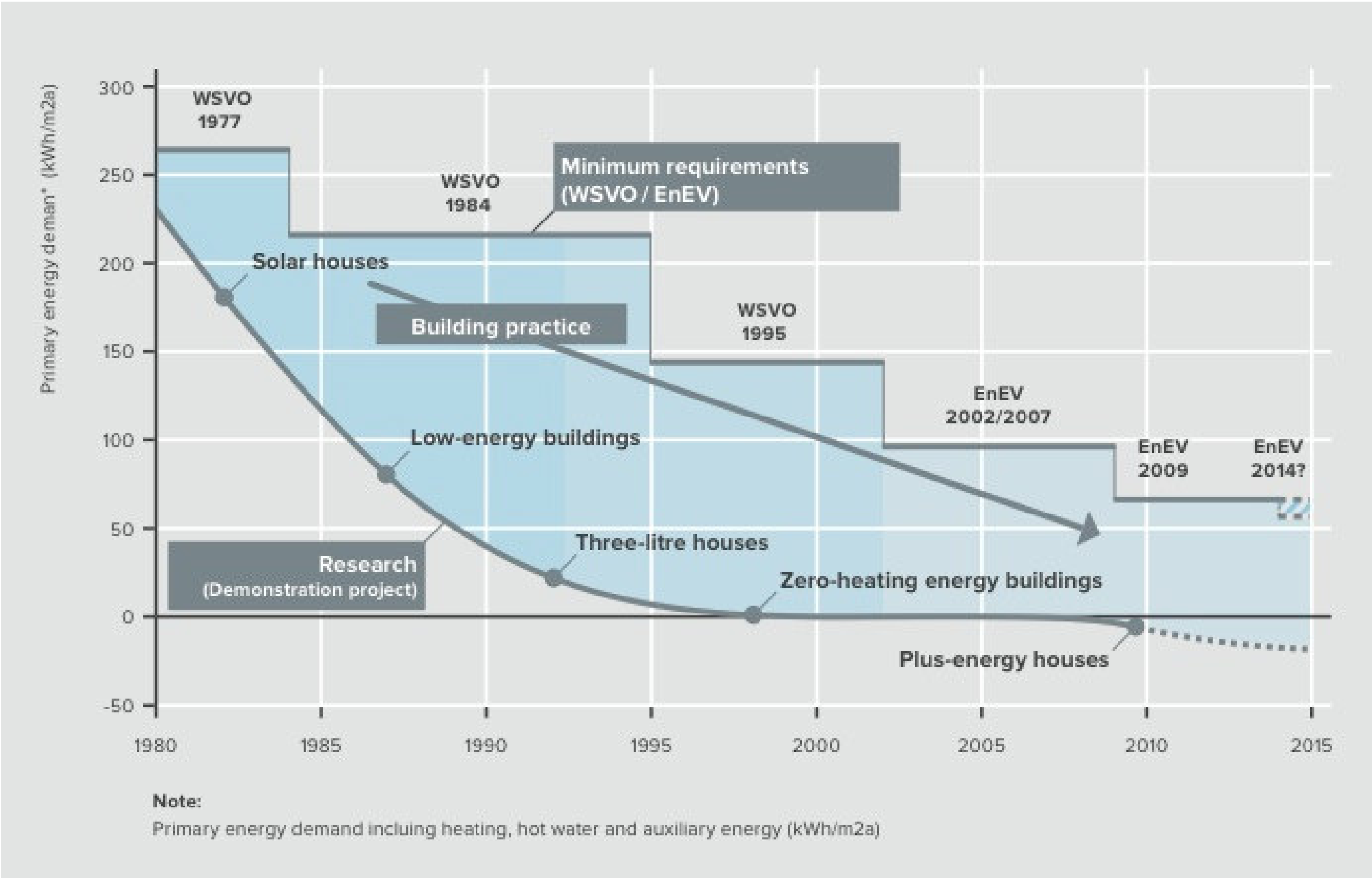
Technical requirements

HeizAnlV 1978, 1989, 1994, 1998

Regulation and Maintenance
Requirements for boilers
Insulation of pipes

EnEV 2002 - EnEV 2007	Tightening of general requirements in stages and continual adjustments of the calculation base; Introduction of an ‚Energy Passport' for existing buildings
EnEV 2009	Approx. 30% reduction of threshold values; Introduction of monitoring; Tightening of retrofitting obligation
EnEV 2014	Implementation of the revised EU building directive; Lowering of the threshold of primary energy demand by 25% in 2016; Tightening requirements regarding the building envelope by 20% in 2016; Amendments regarding the 'Energy Pass'.

Minimum energy performance standards
Case study: new buildings in Germany



Source: bigEE, Frauenhofer IBP

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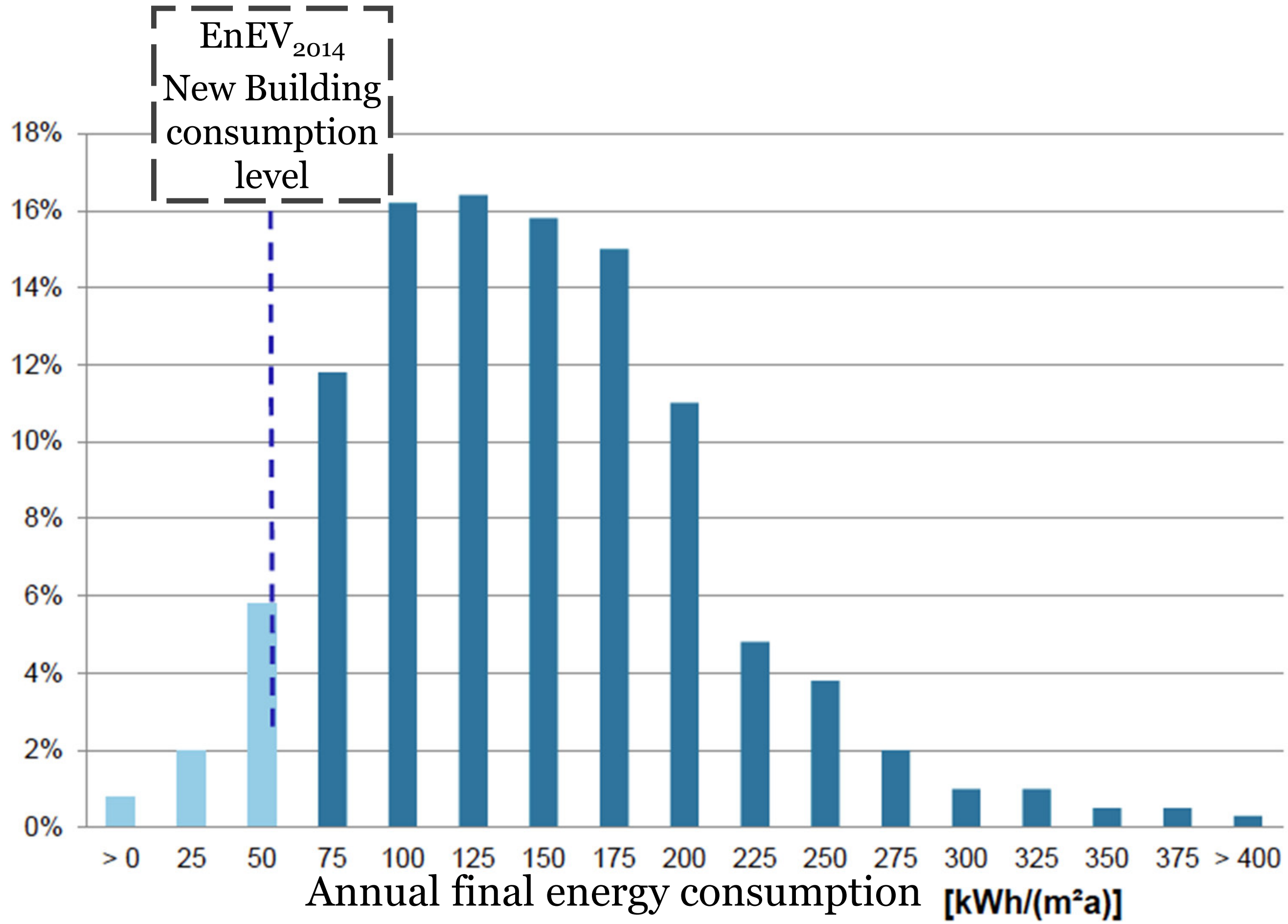
Germany

Plusenergiehaus (Plus Energy House)	Disch	1994
PassivHaus (Passive House)	PHI	1996
Nullenergiehaus (Zero-Energy House)	BUW	2008
Niedrigstenergiehaus (Low-Energy House)	EPBD	2010
Effizienzhaus Plus (Energy Efficient House Plus)	DENA	2011

Source: Passive House Institute, BMBVS

Energy Consumption in the Building Stock



Source: DENA 2012

Building Energy Certificates
Comparing consumption

	Primary energy consumption	Primary Energy	Transmission losses
EnEV 2014	ca. 75 kWh/(m²•a)	100 %	100 %
KfW 70	ca 53 kWh/(m²•a)	70 %	85 %
KfW 55	ca 40 kWh/(m²•a)	55 %	70 %
KfW 40	ca 30 kWh/(m²•a)	40 %	55 %
Passive House	ca. 40 kWh/(m²•a)	ca. 55 %	ca. 70 %

Energy Efficient Exhibition Centres

Source: Fertighauswelt

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Most used technologies

- Superinsulation
- Triple glazed windows U = 0.8 W/m2K
- Heat Recovery Systems > 90%
- Hybrid Ventilation
- Demand Ventilation
- Heat pumps (w/w)
- Floor heating
- LED Lighting
- PV (+ Battery)
- Class A+++ Appliances

Source: Frauenhofer IBP

Comparison of U-Values

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	EnEV 2014	Efficient House 70	Efficient House 55	Passive House
U-Value Roof (W/m^2K)	≤ 0.20	≤ 0.18	≤ 0.15	≤ 0.12
U-Value Window (W/m^2K)	≤ 1.1	≤ 0.90	≤ 0.90	≤ 0.80
U-Value Wall (W/m^2K)	≤ 0.28	≤ 0.24	≤ 0.21	≤ 0.15
Example System	Condensing boiler + solar HW	Heat pump + Solar HW	Heat pump / Pellets + Solar HW	Heat pump / Pellets + Solar HW
Ventilation	Air tightness test with window ventilation	Air tightness test with mechanical ventilation	Air tightness test with mechanical HR-Ventilation	Air tightness test with mechanical HR-Ventilation

Cost effectivness and priority

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	Cost Effectiveness	Niche Market	R & D
Cold Climate			
Passive Design			
Optimise passive design	✔		
Passive Heating gain	✔		
Advanced Envelopes			
Optimised insulation	✔		
Super Insulation		✔	
No Thermal Bridges	✔		
Air Sealing	✔		
Double Glazed, Low-e windows	✔		
Window FIlms	✔		
Highly insulated Windows		✔	
Advanced Technologies			
Heat Pumps	✔		
Solar Thermal (water)	✔		
Passive house equivalent performance		✔	

Cost effectivness and priority

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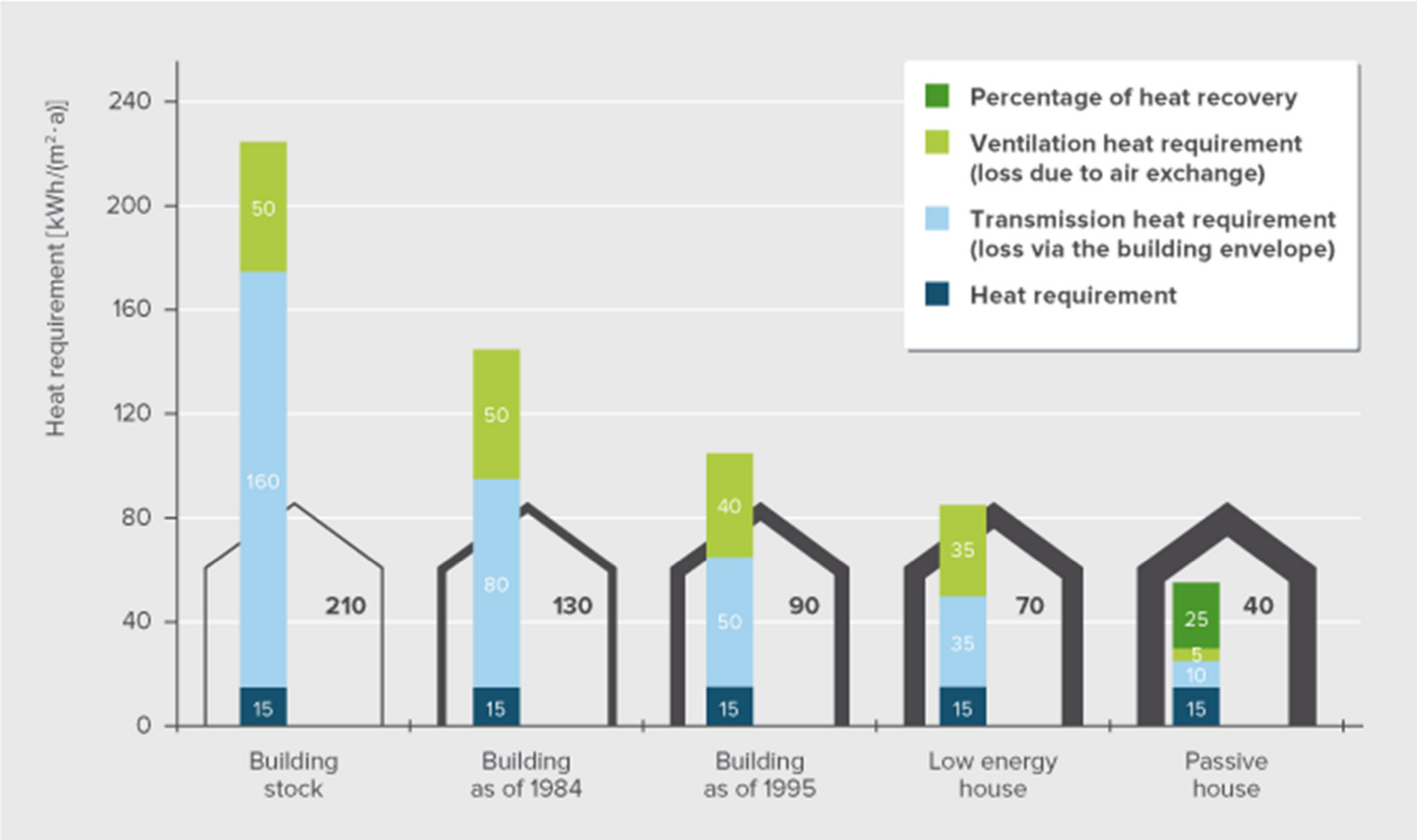
	Cost Effectiveness	Niche Market	R & D
Hot Climate			
Passive Design			
Optimise passive design	✔		
Reduce cooling loads	✔		
Exterior Shading and Architectural Shading	✔		
Reflective Walls	✔		
Advanced technologies			
Insulation in conditioned buildings	✔		
Phase Change Materials			✔
Advanced roofs (integrated design/BIPV)		✔	
Very low SHGC (or dynamic windows)	✔		
Optimised natural / mechanical ventilation	✔		

Where can energy be saved?



Source: Händel, 2011

Energy Costs

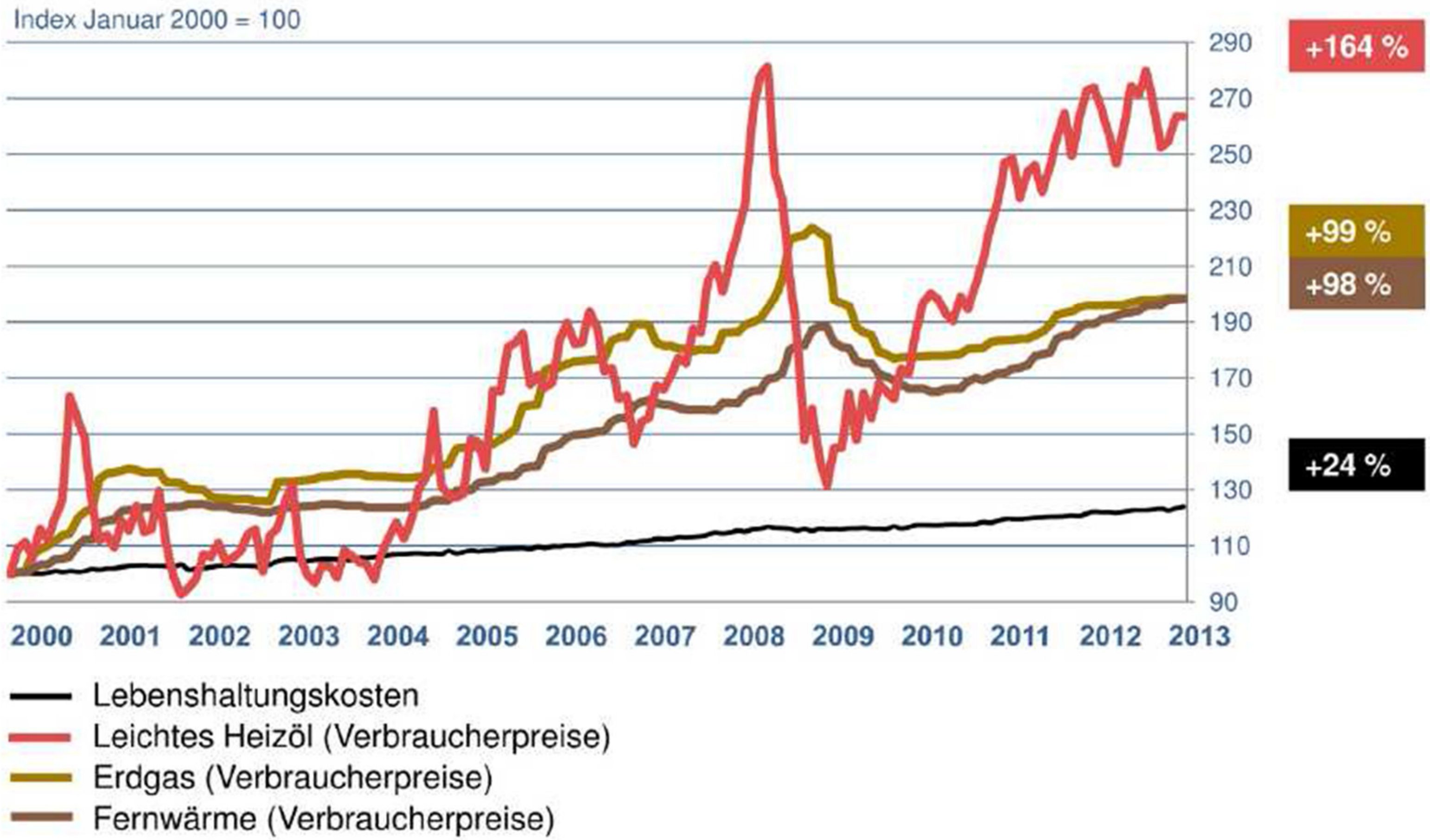


Diagramm 6: Entwicklung der Energiepreise für leichtes Heizöl, Erdgas und Fernwärme (Verbraucherpreise) im Vergleich zu den allgemeinen Lebenshaltungskosten

Material and Labour Expenses

Diagramm 4: Entwicklung der Material-, Arbeits- und Planungskosten im Wohnungsbau im Vergleich zu den allgemeinen Lebenshaltungskosten

Total building costs

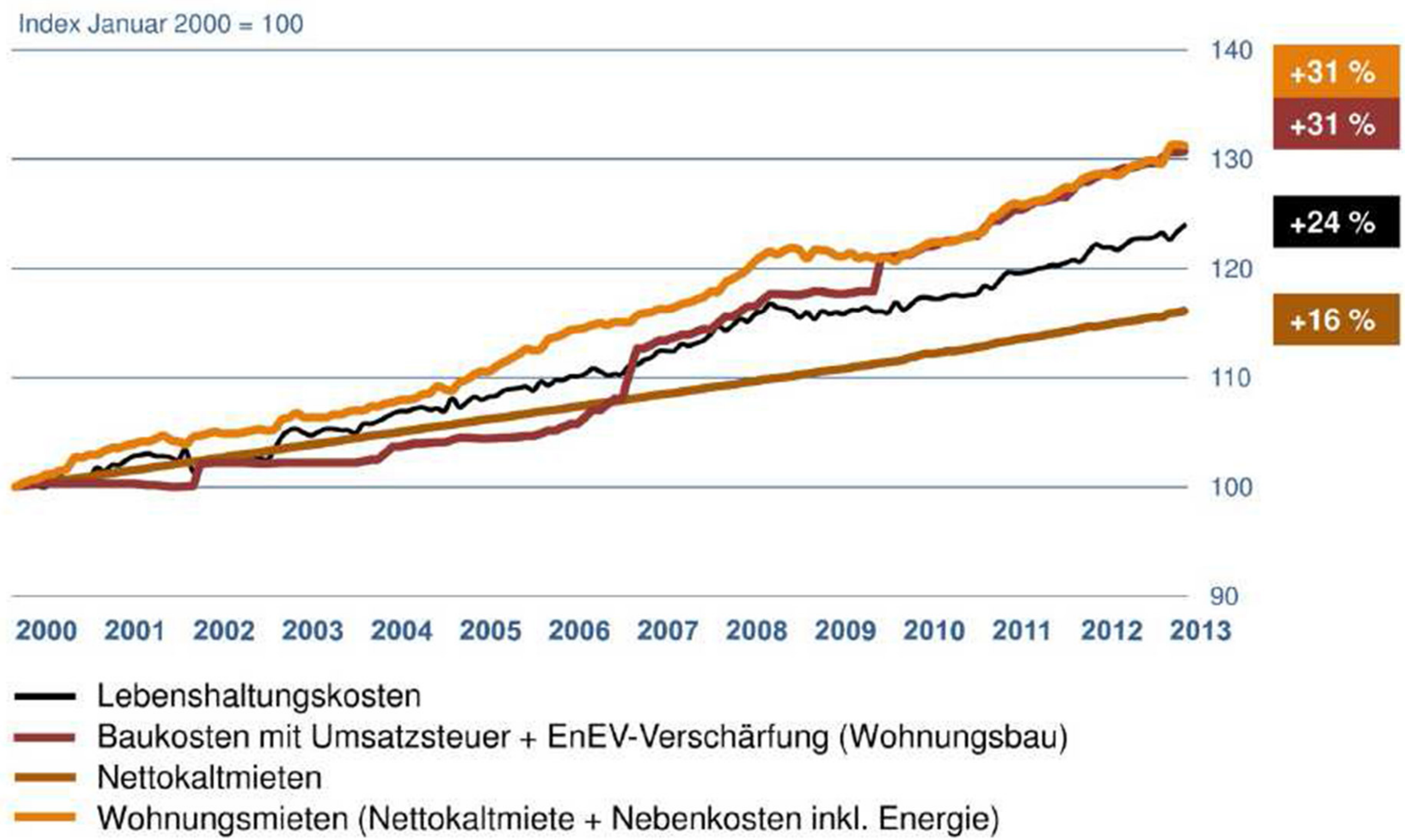


Diagramm 5: Entwicklung der Wohnungsmieten im Vergleich zu den Baukosten im Wohnungsbau (mit Umsatzsteuer + EnEV-Verschärfung) und den allgemeinen Lebenshaltungskosten

Construction Prices in Europe

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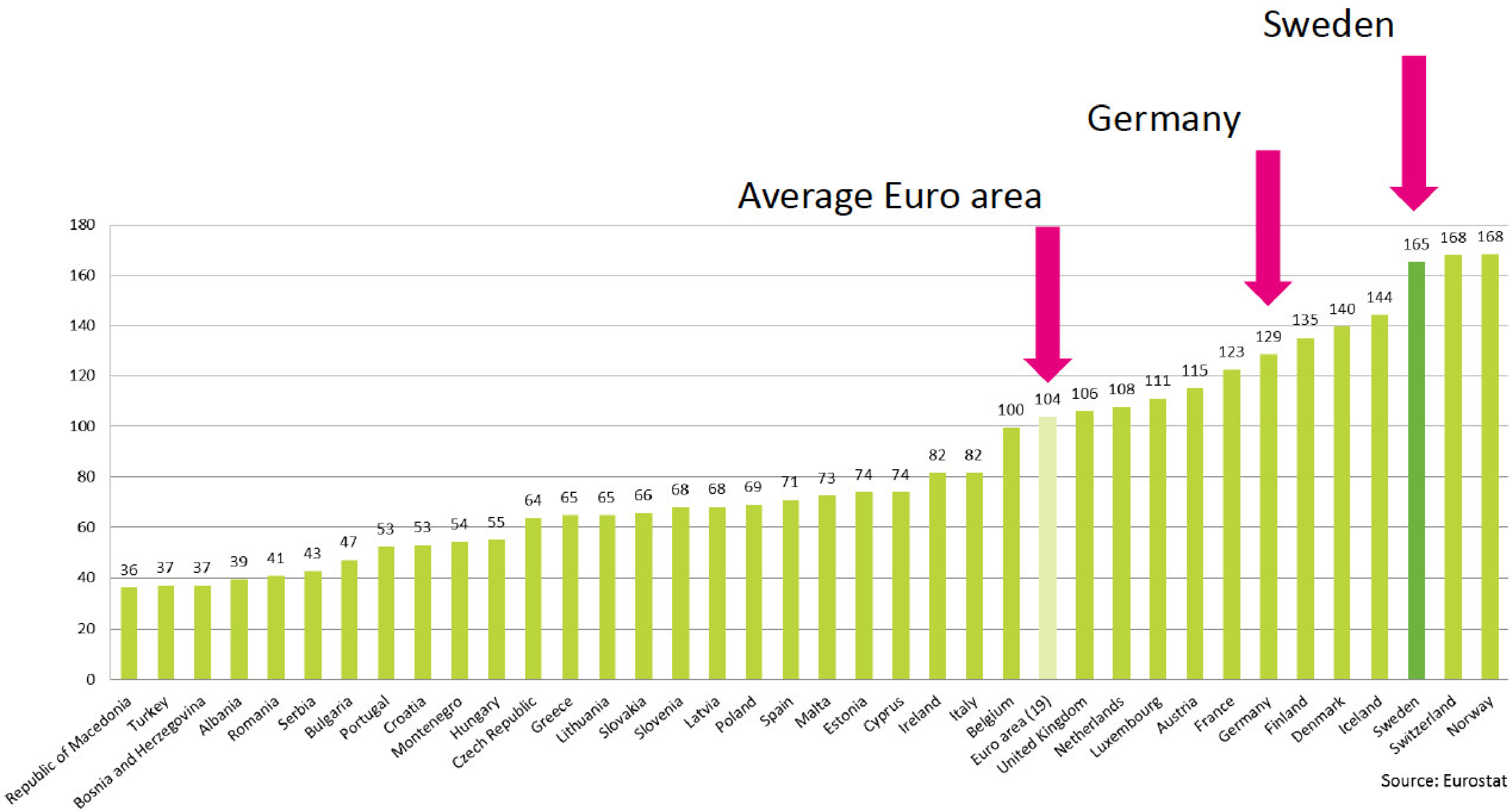

Where can costs be saved?

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Cost of a project

- Land costs
- Financing
- Planning and expert fees
- Construction costs
- Running costs
- Returns
- Planning and building deadlines

Reductions of the project costs

- Subsidies

Benefits of Pre-Fabricated Buildings

Benefits:

- Reduction of building costs
- Reducing the probability of error
- Reducing the diversity (system solutions)

Share of Pre-Fabricated Buildings Germany

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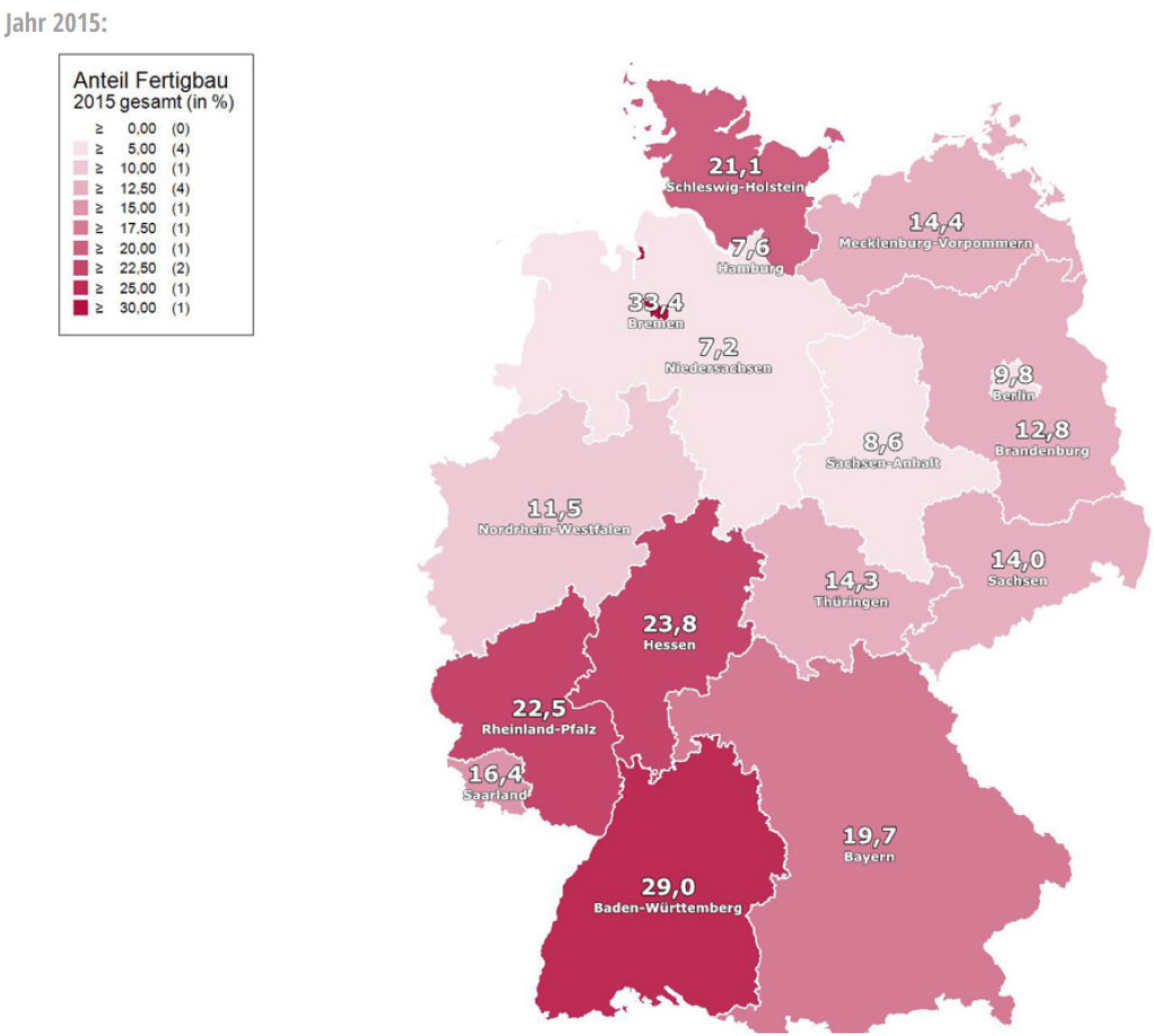


Source:Bundesverband Deutscher Fertigbau e.V.

Types of Pre-Fabricated Production

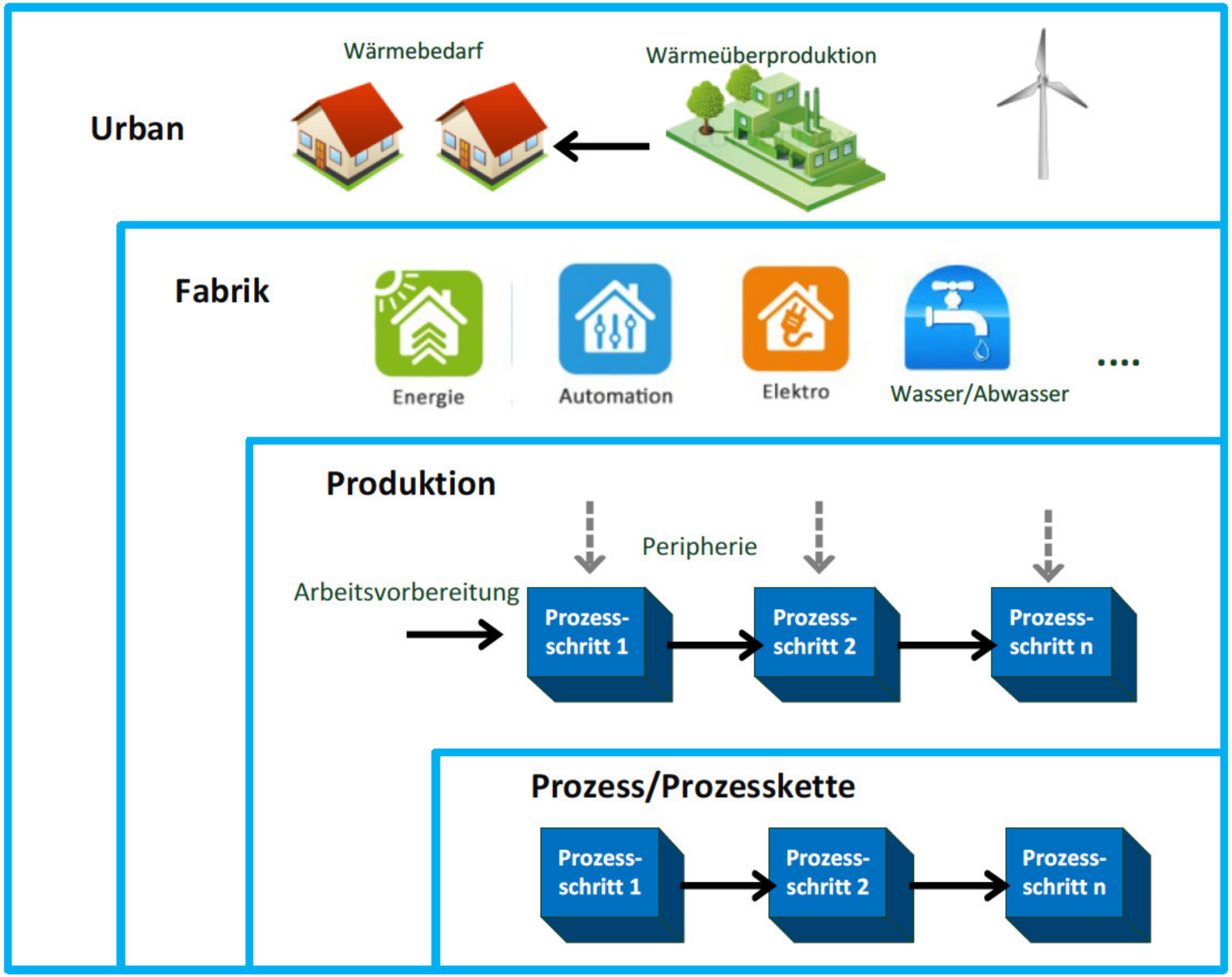
Modular – System

Used in school buildings, kindergartens , Office buildings etc. (steel and timber framework)

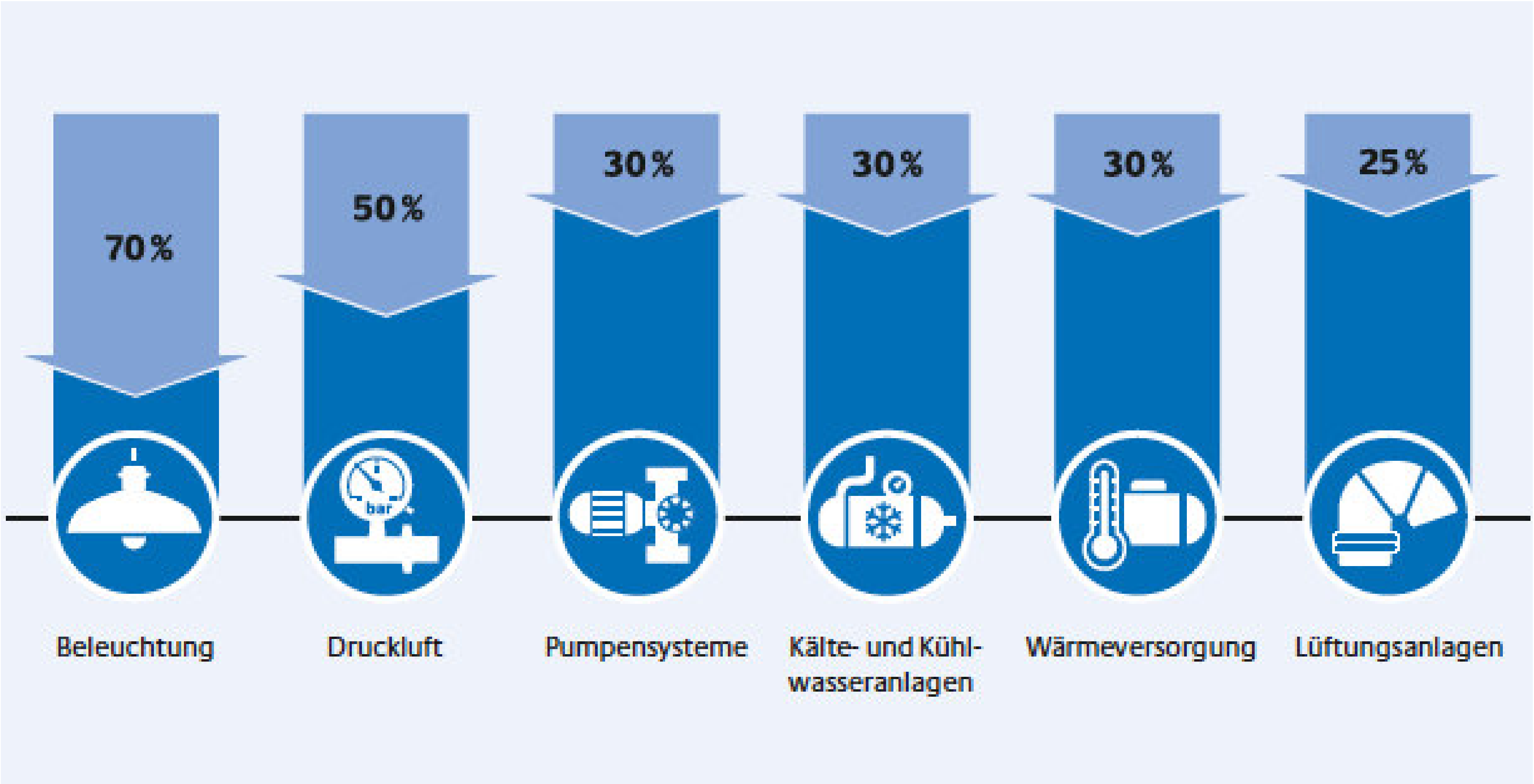
Panel – System

Application in residential construction in the area of Prefab providers (wooden framework). Precast concrete products in traditional building construction

Where can costs be saved?



Savings Potential in different industrial sectors



Driving Forces for Industrial Energy Efficiency in Germany

- Introduction of Energy Management Standard ISO 50001
- Interconnection with other instruments:
  - Tax reductions/exemptions
  - Exemptions from renewables charge
- Regulation for large energy-intensive companies
- Incentives for companies not concerned by such exemptions
- Voluntary schemes (Learning Networks for Energy Efficiency) for medium-sized companies, as well as small companies (more simplified approaches)
- EMS as new business fields for energy suppliers

German energy efficiency measures (Federal level)
Industry and business

A balance of incentives and regulations, consultation and information.

- Grants for cross-cutting technologies
- On-site consultations
- European emissions trading
- Efficiency classification (Ecodesign Directive)

Source: BMWi 2015

Discussion

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- Buildings (responsible for 30-40% energy consumption and 40-50% material consumption) should be eco-efficient
- In high energy efficient buildings / plus energy buildings, in the operational phase with low energy cost, the decrease in embodied energy plays an important role
- Green buildings (e.g. LEED & 3 Star) do not address energy efficiency effectively whereas Passive House does not address ecological aspects directly
- Green buildings reinforced through ULEB/ PH can be a stepping stone in reaching higher energy efficiency (complement each other)
- Barriers - higher upfront cost- removed through learning effects and cost digression fostered by effective policy package (e.g. BigEE project)

LCT One
Passive House Wood-Hybrid Pre-Fab Building System

Voralberg, Austria

Location	Austria
Type of building	Office
Treated floor area (TFA)	ca. 1765 m^2
Building volume	ca. 8074 m^3
Year of completion	2012

Source: Photo: Norman Müller, Hermann Kaufmann ZT GmbH

Building 2226
Passive House Wood-Hybrid Pre-Fab Building System

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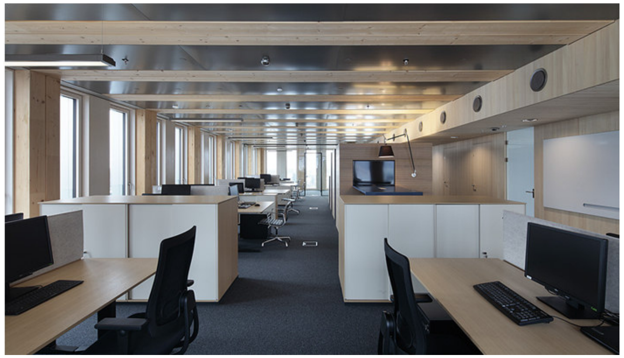

Building Services

Primary Energy consumption 117 kWh/m2/a

Heating Consumption 11 kWh/m²/a.

Ventilation system with heat recovery

Building Construction

U-Value Wall 0.11 W/m²K

U-Value Window 0.76 W/m²K

Costs and Energy Consumption

Costs 1417 m²

The total project costs amounts to 2,5 million Euros.

Source: Photo: Norman Müller, Hermann Kaufmann ZT GmbH

Boyen Street Zero-Emission Building Berlin

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Source: Deimel Oelschläger Architekten Partnerschaft

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Making Utopia possible

Low Energy Building (LEB)
Easy approach to reach energy efficiency

- Compact building form and adequate orientation
- East-West orientation of building
- Usage of passive solar gains
- Avoidance of thermal bridges
- Effective external shading elements to avoid summer overheating
- Highly energy-efficient building envelope
  - including high performance windows,
  - insulation and
  - air tightness
- Highly energy-efficient heating and/or cooling technologies
- Highly energy-efficient units for ventilation and domestic hot water production
- Highly energy-efficient lighting and appliances
  (the users are responsible for this but the developer should provide guidance to them)
- Quality surveillance of construction work and

40 - 60 % savings

Ultra low Energy Building (ULEB)
Advanced approach to reach energy efficiency

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Further improvement from the LEB concept:

- Extraordinarily good thermal insulation (e.g. 10 to 40 cm insulation thickness for roof and outer walls, depending on climate zone)
- Windows:
  Triple (UWindow-values less than 0.8 W/m2K for cold and temperate climate zones) respectively double (UWindow < 1.3 W/m2K for hot climate zones) low-e-glazing
- Energy efficient heating / cooling backup system for covering the residual heating / cooling energy demand if necessary
- In addition to energy efficiency actions: Use of local renewable heat sources to the best extent possible (solar radiation, ambient and geothermal energy, sustainable biomass)

60 % to 80 % Savings

Zero / Plus Energy Building (ZPEB)
Advanced approach to reach energy efficiency

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Based on the Ultra-low Energy Building concept

- In addition to the highly energy-efficient building performance, on-site power or heat generation from renewable energy sources or from combined heat and power (CHP)
- “Zero Energy Building” if amount of produced energy (converted in primary energy equivalent!) is roughly identical with annual primary energy demand
- “Plus Energy Building” if it exceeds the demand

80 % and beyond