energydesign
Shanghai
Office for Sustainable Built Environment Engineering

Energy-efficient, climate-neutral Buildings: Organization and Realization in Germany

节能、气候中和建筑：德国的策略和实践

Sebastian Schulz,
Project Manager

Sino-German Energy Efficiency Day, 05. Dec. 2017

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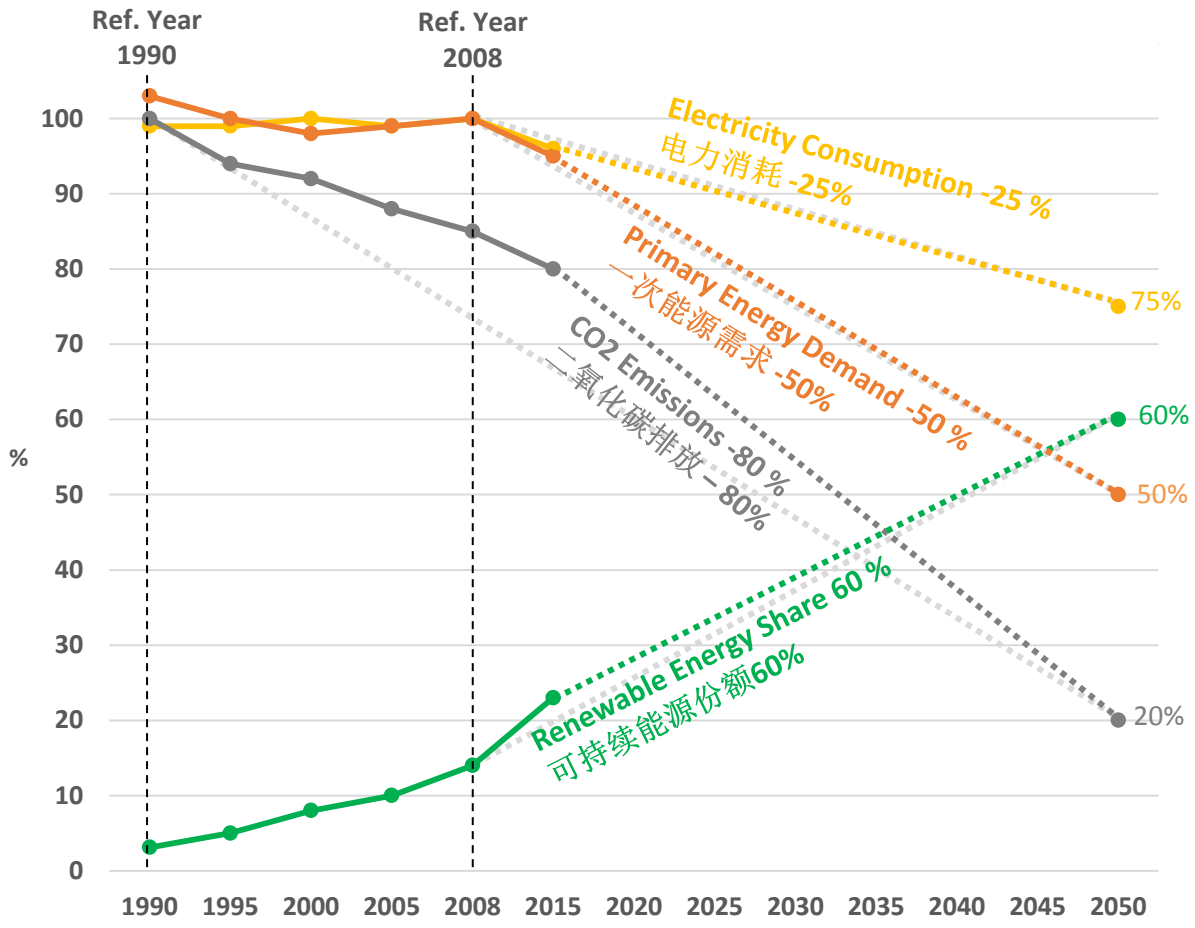
1. **National Goals for the Building Sector**
   - 建筑行业的国内目标
2. **Strategies for Implementation**
   - 实施策略
3. **Technical Challenges**
   - 技术挑战
4. **Implications for China**
   - 对中国的意义

national goals
国内目标

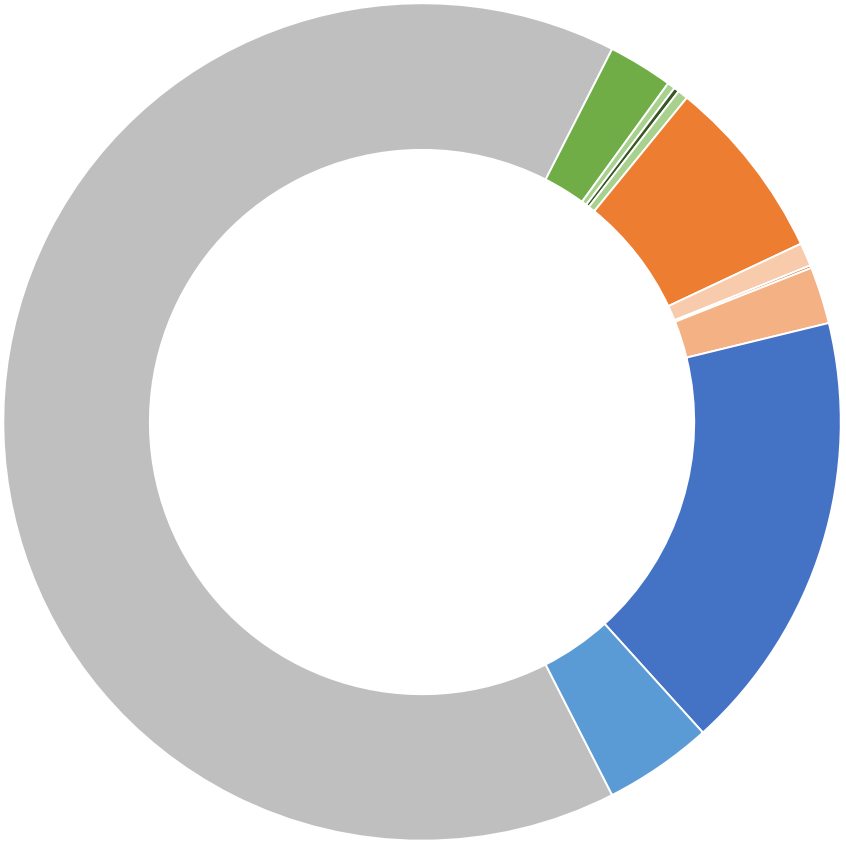
national goals 国内目标



“National Action Plan for Energy Efficiency”

全国能源效率行动计划

End-Energy Use in Germany in 2014
2014年德国终端能源消耗



Industrial Buildings, 3.4%
工业建筑，3.4%
Heating, 2.5%
DHW, 0.3%
Cooling, 0.2%
Lighting, 0.4%

商业建筑10.3%
Commercial Buildings, 10.3%
Heating, 7.1%
DHW, 0.9%
Cooling, 0.1%
Lighting, 2.2%

Other Sectors, 65.0%
其他行业65%

住宅21.3%
Residential Buildings, 21.3%
Heating, 17.1%
DHW, 4.2%

Buildings Total: 35.0%
建筑合计35%

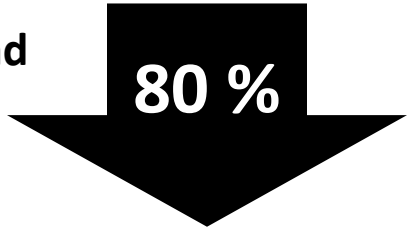
Source: BMWi

Target: a “nearly climate-neutral building stock” until 2050!

目标：2050年完成近气候中和建筑

Primary Energy Demand

一次能源需求



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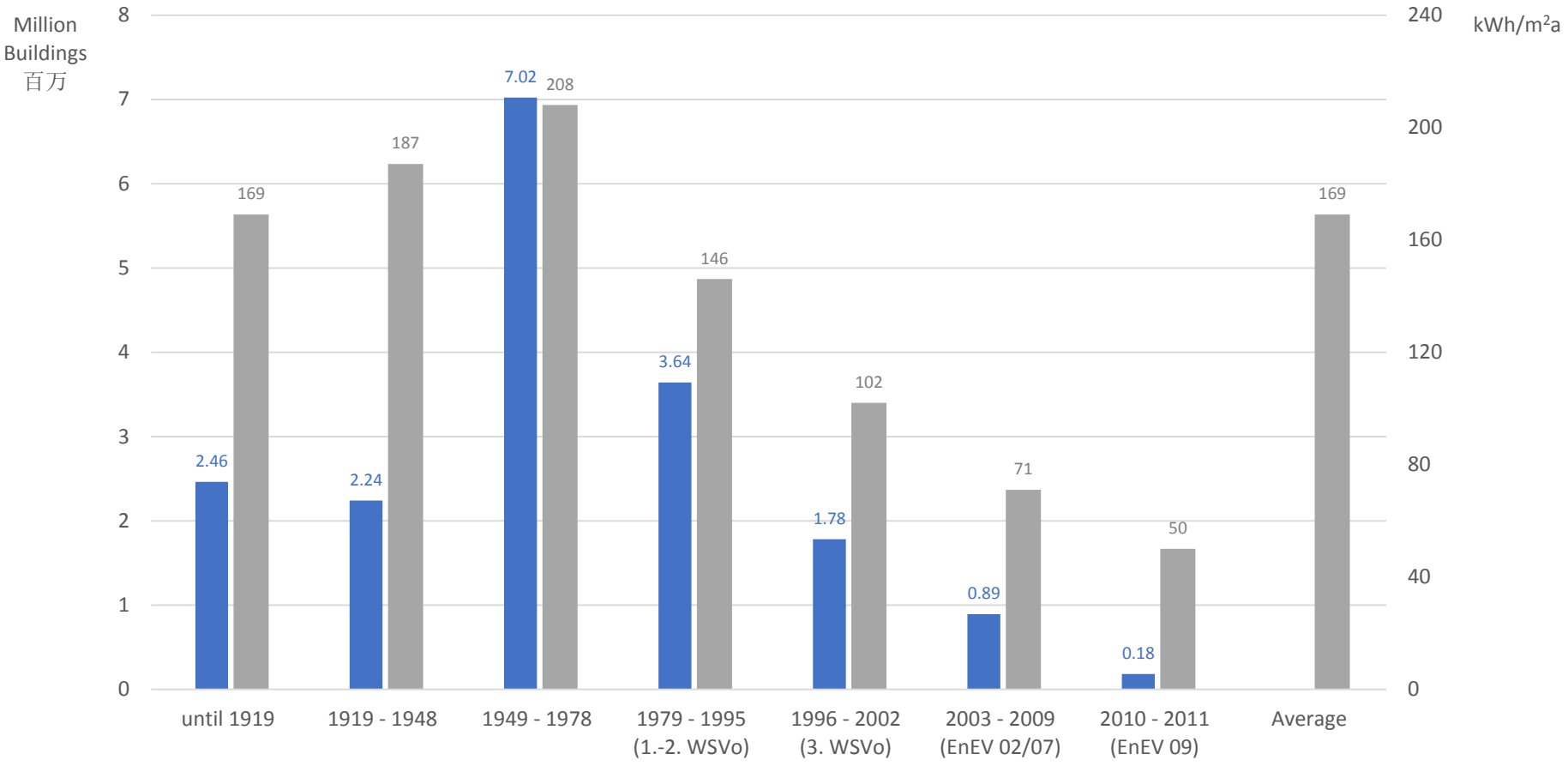
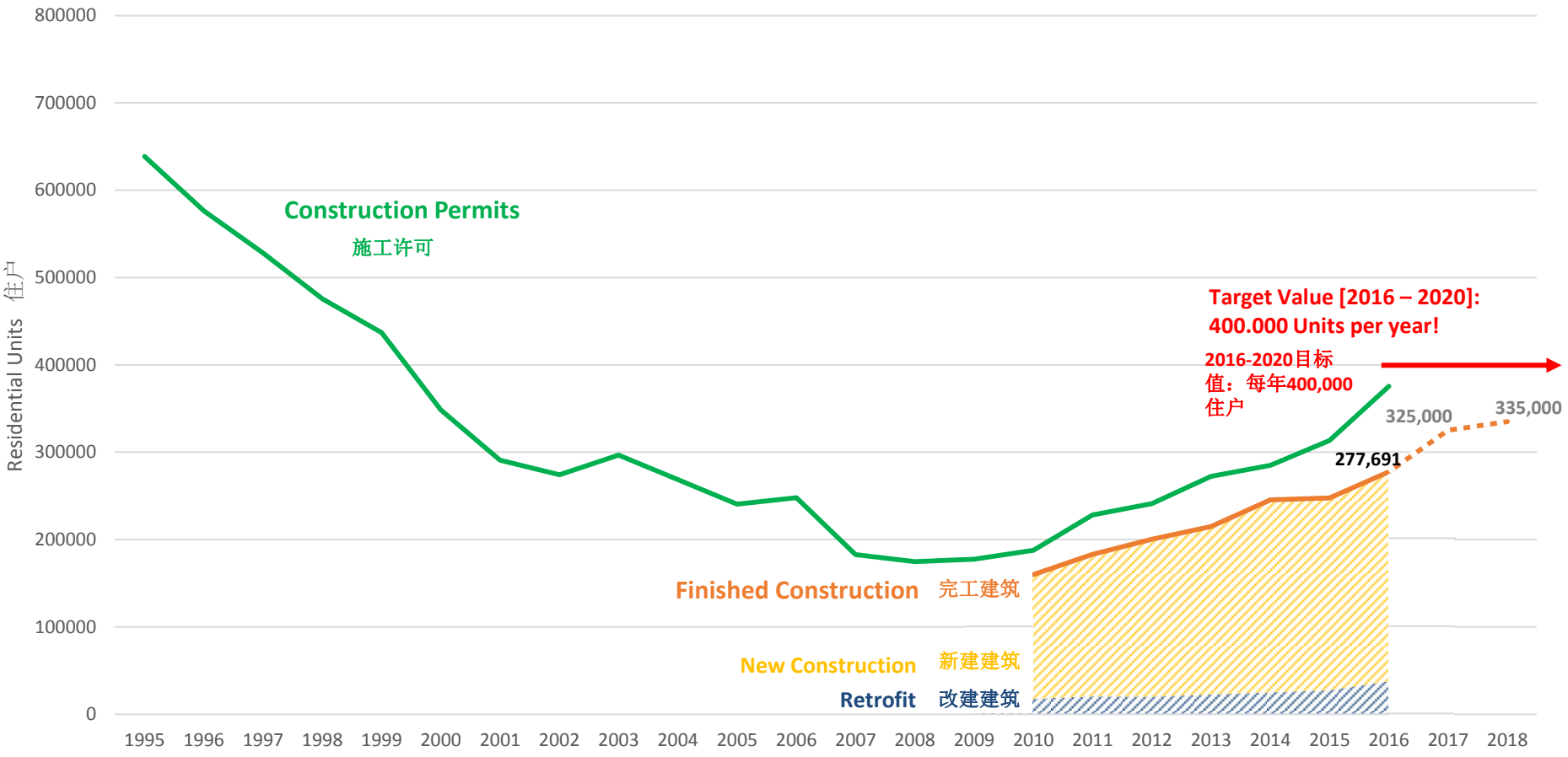
Residential Housing Sector in Germany

德国住宅



Source: BMWi

Residential Housing Sector in Germany
德国住宅



Source: own graphic, after DESTATIS 2017 / ifo

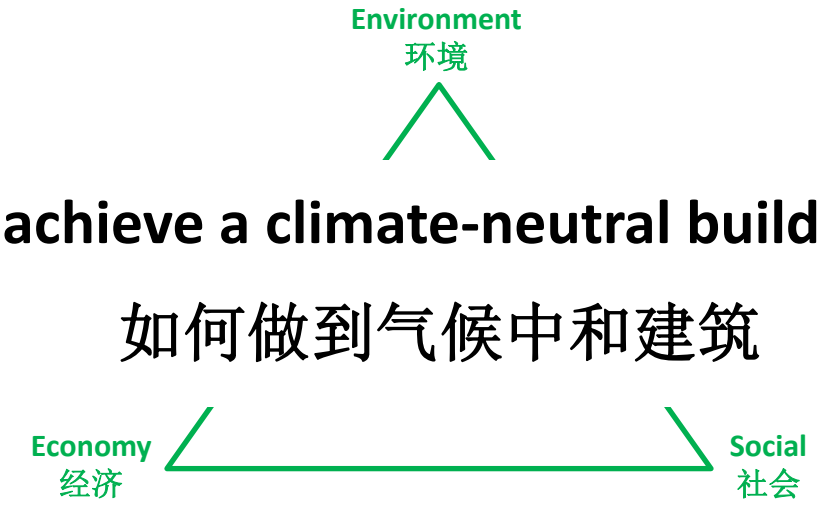
Challenges & Opportunities for a climate-neutral building stock in coming years:
未来几年气候中和建筑面临的挑战和际遇

- **Housing Market**
  > reluctant land use planning over the past years
  > unexpected population growth
  > increase in real estate prices in large cities ("urban housing only for the wealthy?")
  > aging population (and aging property owners)

- **Costs of the Energy Transition ("Energiewende")**
  > Renewable Energy Financial Allocation ("EEG-Umlage")
  > increase of Energy Costs, esp. for private households and SME
  > costs for building retrofitting (e.g. increase of rental prices)

- **住房市场**
  >不愿意改变土地的使用规划
  >人口增长超出预期
  >大城市房地产价格激增（“有钱人的城市住房”？）
  >老龄化人口（和老旧房产业主）

- **能源换代的代价**
  >可再生能源资金分配
  >增加能源费用，尤其是私人住宅和中小型企业
  >改建费用增加（如租金增加）



How to achieve a climate-neutral building stock?

如何做到气候中和建筑

strategic implementation
实施策略

achieving the goals: 4 pillars 如何实现目标：4个支柱

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国内策略

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- Energy Passport
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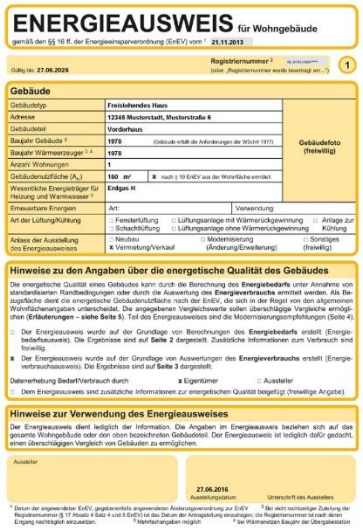
Consulting & Energy Passport:
咨询和能源护照：

- **Information Tool**
  > Energy Passports provide information to building owners, buyers, or tenants about the energy performance of a building.

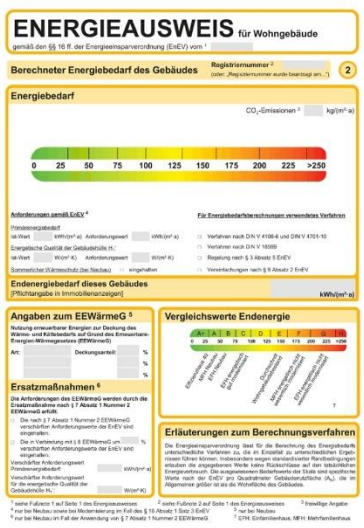
- **Benchmark and Optimization Tool**
  > Energy Passports are based on standardized methods and allow comparison of buildings
  > They contain a list of suggestions for improvement of energy efficiency

- **信息工具**
  >能源护照可以为项目业主、买家、租户提供建筑能源表现的相关信息

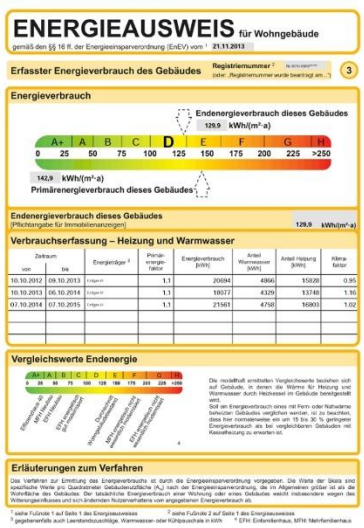
- **参照和优化工具**
  >能源护照是基于标准化研究方法对建筑进行对比
  >包括一系列能效改进建议



1. Building Information
1. 建筑信息



2. Calculated Energy Demand
2. 能源需求计算

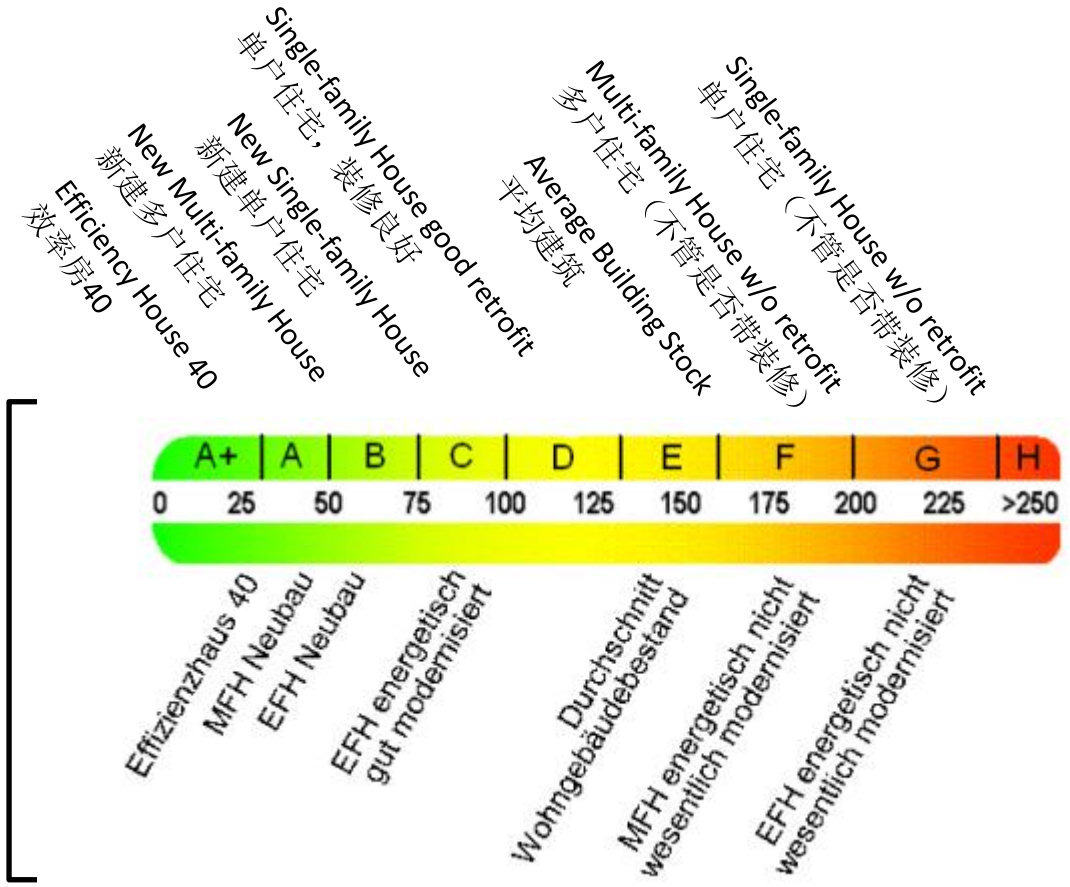


3. Measured Energy Use
3. 能源消耗测量

4. Improvement Suggestions
4. 改进建议

5. Explanations
5. 解释

EnEV Classifications:
德国节能规范分级



Reference Classifications
参考分级

- **Every Building that trades on the market, must have an Energy Passport and must be classified!**
- **市场上交易的任何建筑都必须有能源护照并且分级**

- **but, Energy Passports only serve as an information tool! (e.g., no right to justify higher asked prices)**
- **但是，能源护照仅作为参考信息（例如，不能作为房屋高价出售的依据）**

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Energy Saving Ordinance ("EnEV"):
节能规范 EnEV

- **Standards**
  > minimum standards on energy-efficient buildings
  > Insulation, Air-tightness, Heating System, DHW-system, Cooling, Ventilation,…

- **Definitions & References**
  > calculation methodologies for energy-efficiency assessment (also as reference for Energy Passports)
  > references to further details, such as DIN-norms
  > Energy-efficiency classes (A+ to H)

- **标准**
  >建筑能源效率满足的最低标准
  >保温、气密性、供暖、生活热水、制冷、通风……

- **定义和参考**
  >能效评估的计算方法（也是能源护照的参考）
  >其他的参考,例如DIN
  >能效分级（从A+到H）

Tabelle 1

Ausführung des Referenzgebäudes

Zeile	Bauteile/Systeme	Referenzausführung/Wert (Maßeinheit)	
		Eigenschaft (zu Zeilen 1.1 bis 3)	
1.0	Der nach einem der in Nummer 2.1 angegebenen Verfahren berechnete Jahres-Primärenergiebedarf des Referenzgebäudes nach den Zeilen 1.1 bis 8 ist für Neubauvorhaben ab dem 1. Januar 2016 mit dem Faktor 0,75 zu multiplizieren. § 28 bleibt unberührt.		
1.1	Außenwand (einschließlich Einbauten, wie Rolladenkästen), Geschossdecke gegen Außenluft	Wärmedurchgangskoeffizient	$U = 0{,}28$ W/(m²·K)
1.2	Außenwand gegen Erdreich, Bodenplatte, Wände und Decken zu unbeheizten Räumen	Wärmedurchgangskoeffizient	$U = 0{,}35$ W/(m²·K)
1.3	Dach, oberste Geschossdecke, Wände zu Abseiten	Wärmedurchgangskoeffizient	$U = 0{,}20$ W/(m²·K)
1.4	Fenster, Fenstertüren	Wärmedurchgangskoeffizient	$U_W = 1{,}3$ W/(m²·K)

Tabelle 2

Höchstwerte des spezifischen, auf die wärmeübertragende Umfassungsfläche bezogenen Transmissionswärmeverlusts

Zeile	Gebäudetyp		Höchstwert des spezifischen Transmissionswärmeverlusts
1	Freistehendes Wohngebäude	mit $A_N \leq 350$m²	$H'_T = 0{,}40$ W/(m²·K)
		mit $A_N > 350$m²	$H'_T = 0{,}50$ W/(m²·K)
2	Einseitig angebautes Wohngebäude *		$H'_T = 0{,}45$ W/(m²·K)
3	Alle anderen Wohngebäude		$H'_T = 0{,}65$ W/(m²·K)
4	Erweiterungen und Ausbauten von Wohngebäuden gemäß § 9 Absatz 5		$H'_T = 0{,}65$ W/(m²·K)

* **Einseitig angebaut ist ein Wohngebäude, wenn von den vertikalen Flächen dieses Gebäudes, die nach einer Himmelsrichtung weisen, ein Anteil von 80 Prozent oder mehr an ein anderes Wohngebäude oder an ein Nichtwohngebäude mit einer Raum-Solltemperatur von mindestens 19 Grad Celsius angrenzt.**

stipulation 法规

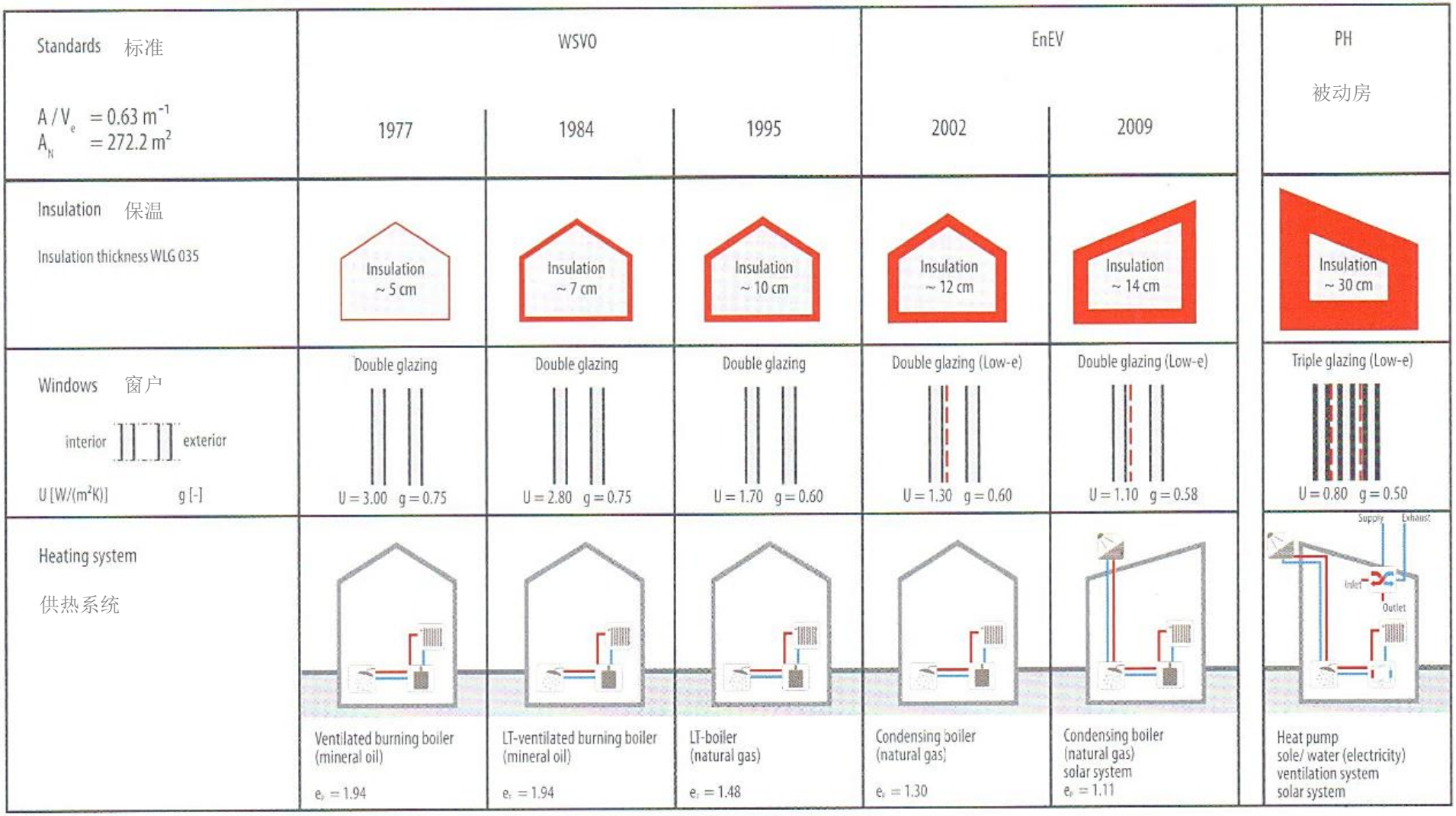

Figure 2.18
Parameter-investigation example of a single-family house

Quelle: MN. Fisch, T. Wilken, C. Stähr; EnergiePlus – Gebäude- und Quartiere als erneuerbare Energiequellen

Energy Saving Law ("EnEG"):
节能规范 EnEG

- **Legally binding law to save energy!**

- **§2a: "Lowest Energy Buildings"**
  (very low energy demand & high share of renewable energies)
  > 2019: all public buildings
  > 2021: all private buildings

- **§3: Energy-Saving Operation**
  > energy-demanding systems should be maintained and operated, so that they do not use more energy than technically required.

- **从法律上要求节能**

- **"最低能耗建筑"（极低能源需求和高度可持续能源利用）**
  >2019：所有公共建筑
  >2021：所有私有建筑

- **节能运行**
  >维护和运行能源需求系统，控制实际使用的能源不超出技术上的要求

Punishment (§ 8):

- neglecting measures for new buildings: **up to 50.000€**
- neglecting measures for existing buildings: **up to 15.000€**
- no energy passport: **up to 5.000€**

惩罚措施

- 新建建筑：最高50.000欧
- 现有建筑：最高15.000欧
- 没有能源护照：最高5.000欧

„Lowest Energy Buildings" (current Definition):

- **Primary Energy Demand max. 40 kWh/m²a**
- **KfW-Efficiency House 55 (EnEV 2009) or better**

Source: dena

"最低能耗建筑"（现行定义）

- **一次能源需求最多40 kWh/m²a**
- **德国复兴银行节能建筑55（2009节能规范）或更高标准**

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KfW Subsidy Program:
德国复兴银行补助项目

KFW

- KfW: government-owned investment bank
- Issuing loans and subsidies to private persons, corporate and public institutions

- 德国复兴银行：政府拥有的投资银行
- 贷款或补贴给私人、公司和公共机构

KfW-40 Plus Effizienzhaus

KfW-40 Effizienzhaus

KfW-55 Effizienzhaus

Efficiency House 40 plus 节能建筑40+	Efficiency House 40 节能建筑40	Efficiency House 55 节能建筑55
Primary Energy Demand: 40 % of $Q_{P\ REF}$ 一次能源需求 **Transmission Heat Loss**: 55 % of $H_{T\ REF}$ 传热损失 ***"Plus Package":*** • *Renewable energy use* • *Power storage* • *Heat recovery* • *BMS* *"额外补助项"* • *可持续能源使用* • *电存储* • *热回收* • *楼宇自控系统*	**Primary Energy Demand**: 40 % of $Q_{P\ REF}$ 一次能源需求 **Transmission Heat Loss**: 55 % of $H_{T\ REF}$ 传热损失	**Primary Energy Demand**: 55 % of $Q_{P\ REF}$ 一次能源需求 **Transmission Heat Loss**: 70 % of $H_{T\ REF}$ 传热损失 *Alternative Proof through reference values (U-values for envelope + technologies)* *或者提供参考数值如外围护的U值和技术方案*

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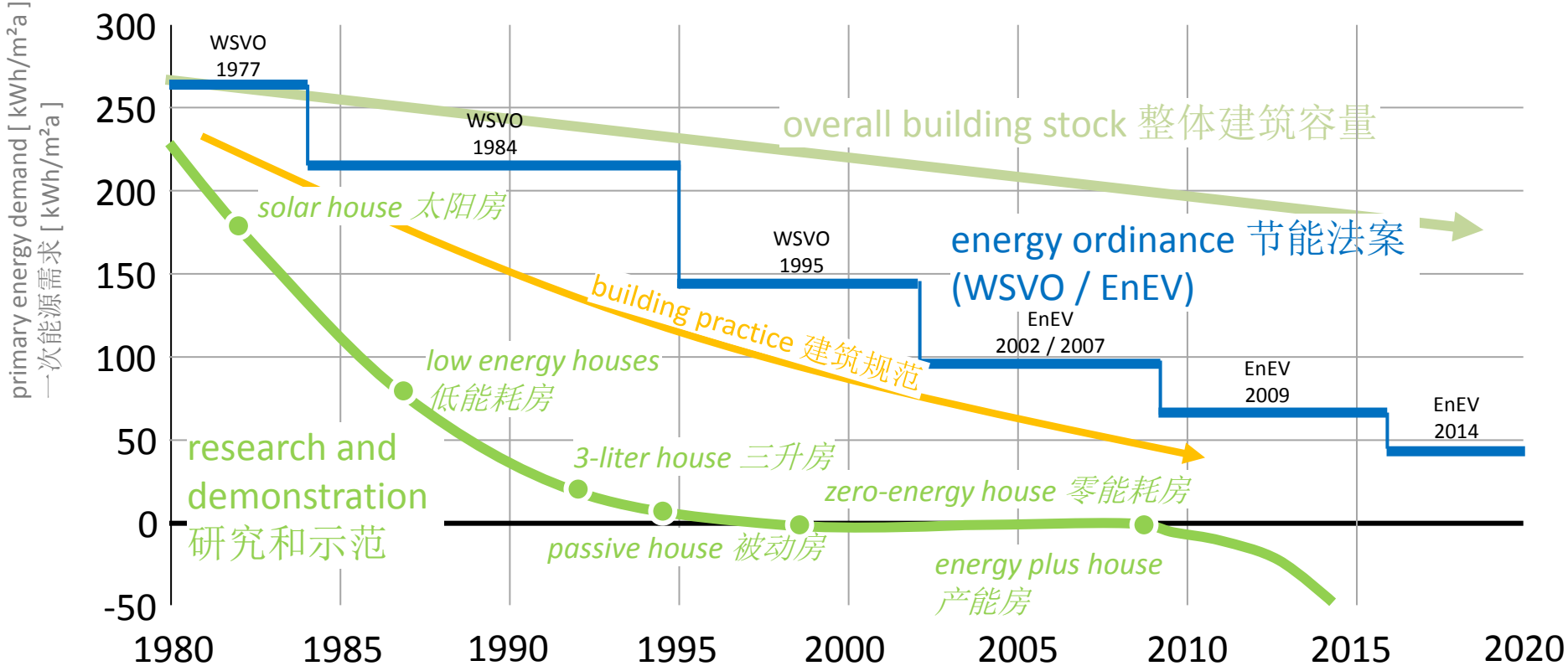
- Pilot Application Programs
  示范申请项目



Source: own graphic, after H. Erhorn-Kluttig et. al. 2015, FH IBP

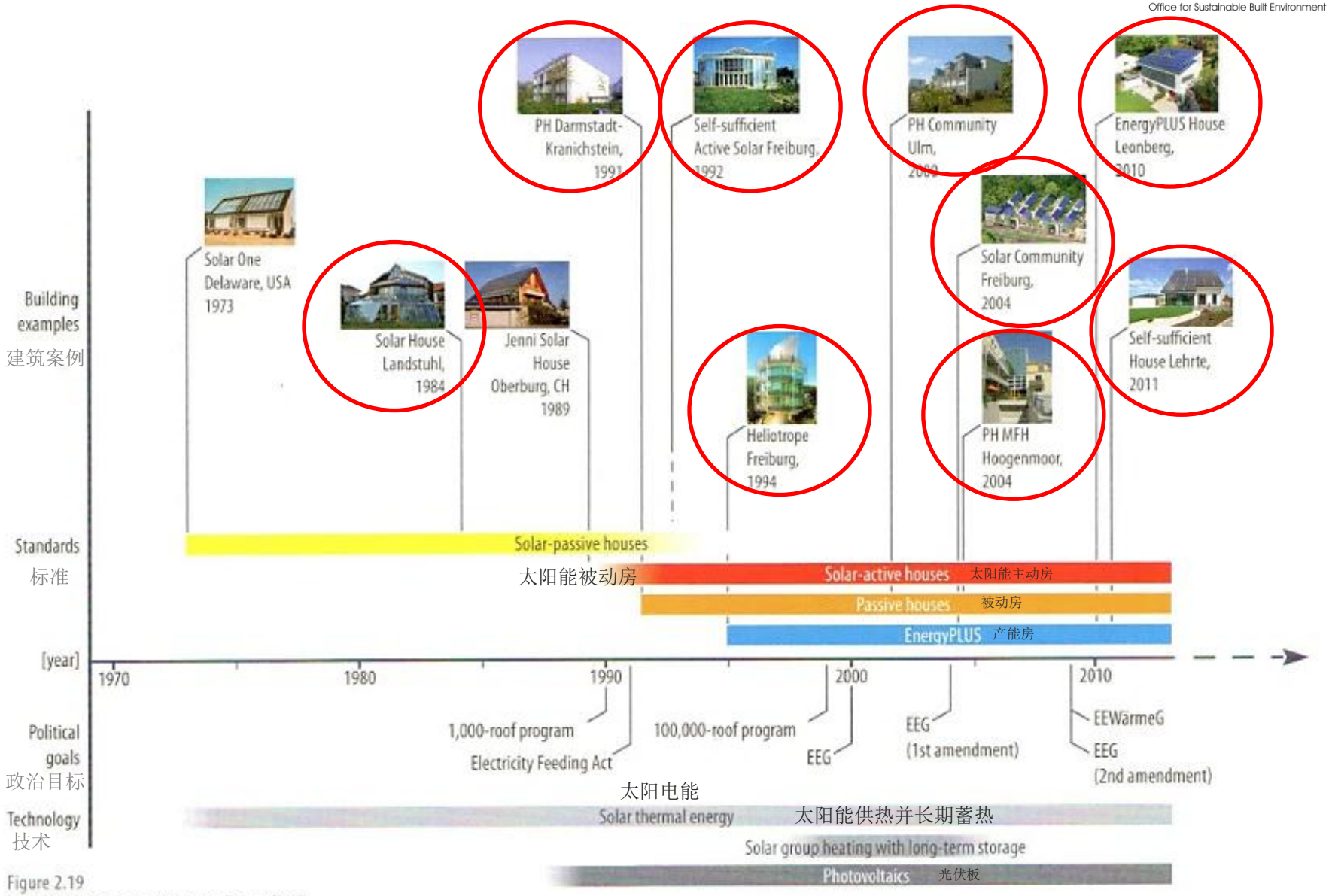


Figure 2.19
Developments along the way to EnergyPLUS

Quelle: MN. Fisch, T. Wilken, C. Stähr; EnergiePlus – Gebäude- und Quartiere als erneuerbare Energiequellen

Research Funding:
研究基金

- Ongoing Pilot Project Funding by the Government
- Sustainable impacts on material costs and building practice

- 政府资助建设中的示范项目
- 对材料费和建筑规范可持续方面的影响

Latest Trends: "EnergyPLUS"

- Buildings with positive annual energy balance
- Energy generation instead of energy saving!
- Better cost-balancing of demand reduction measures

最新趋势：产能房

- 实现年能源平衡并有盈余的建筑
- 生产能源取代节约能源
- 降低能源需求措施的经济性更优化




achieving the goals: 4 pillars 如何实现目标：4个支柱

energydesign Shanghai
Office for Sustainable Built Environment Engineering

Information 信息

CONSULTING 咨询

- Local On-Site Consulting Services
  现场顾问服务
- Energy Consulting for SME
  中小企业能源顾问
- Energy Consulting for Municipalities
  政府的能源顾问
- Energy Efficient Networks
  能效网络

BENCHMARKS 参照基准

- Energy Passport
  能源护照
- National Heating Label
  国家供暖标签

Stipulation 法规

LEGAL REQ. 法规要求

- Energy Savings Law (EnEG)
  节能法案
- Renewable Energy Heating Law (EEWärmeG)
  可持续能源供暖法
- Housing and Tenancy Law
  住房和租房法

TECHNICAL REQ. 技术要求

- Energy Savings Ordinance (EnEV)
  节能规范
- Heating Cost Ordinance
  供暖费用条例
- Eco-Design Labels for Products
  产品节能设计标识

Stimulation 激励

SUBSIDIES 补贴

- CO2 Building Retrofit Program
  建筑二氧化碳改建项目
- Market Stimulation Program (MAP) Renewable Energies
  可持续能源市场激励项目
- Stimulation Program Energy Efficiency
  能效激励项目
- Nat. Climate Protection Initiative
  国家气候保护倡议
- KfW Subsidy Program
  德国复兴银行补助项目

TAX REGULATION 税务制度

- Energy Tax & Electricity Tax
  能源税和电力税
- Tax Refunding for Retrofit Services
  改建服务的退税政策

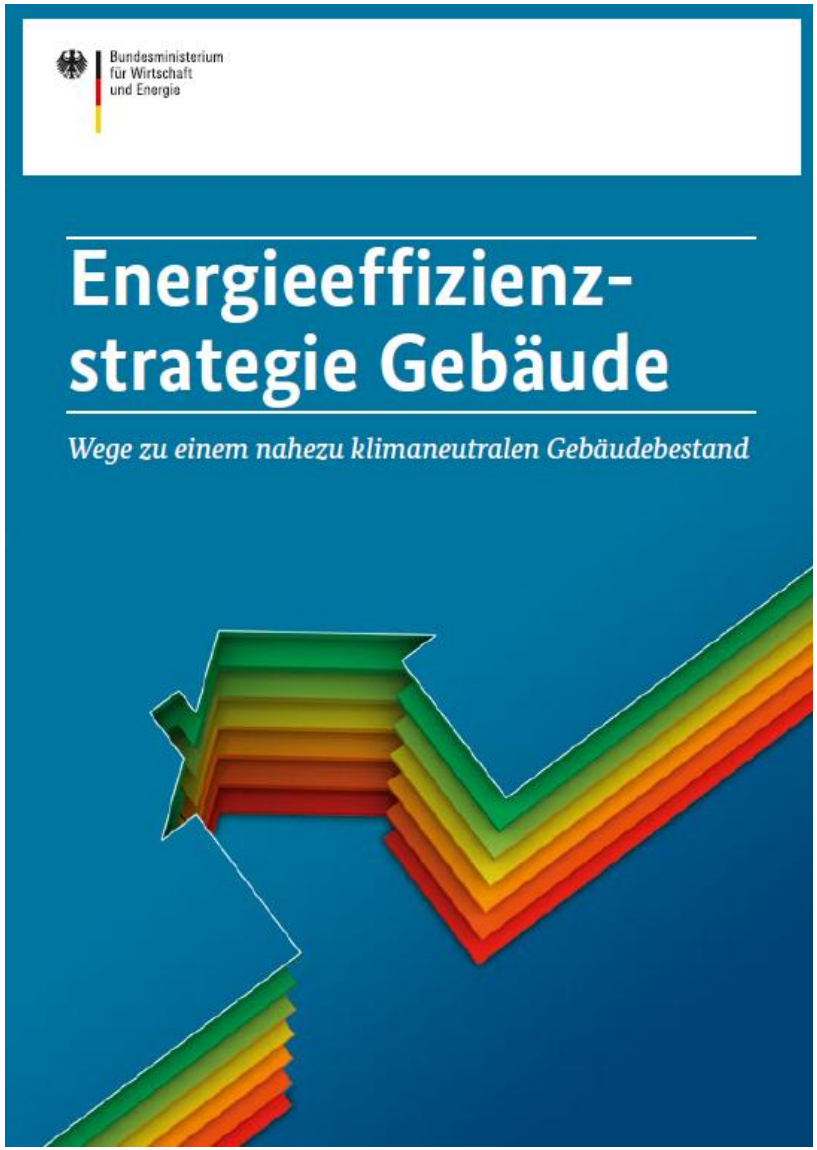
Innovation 创新

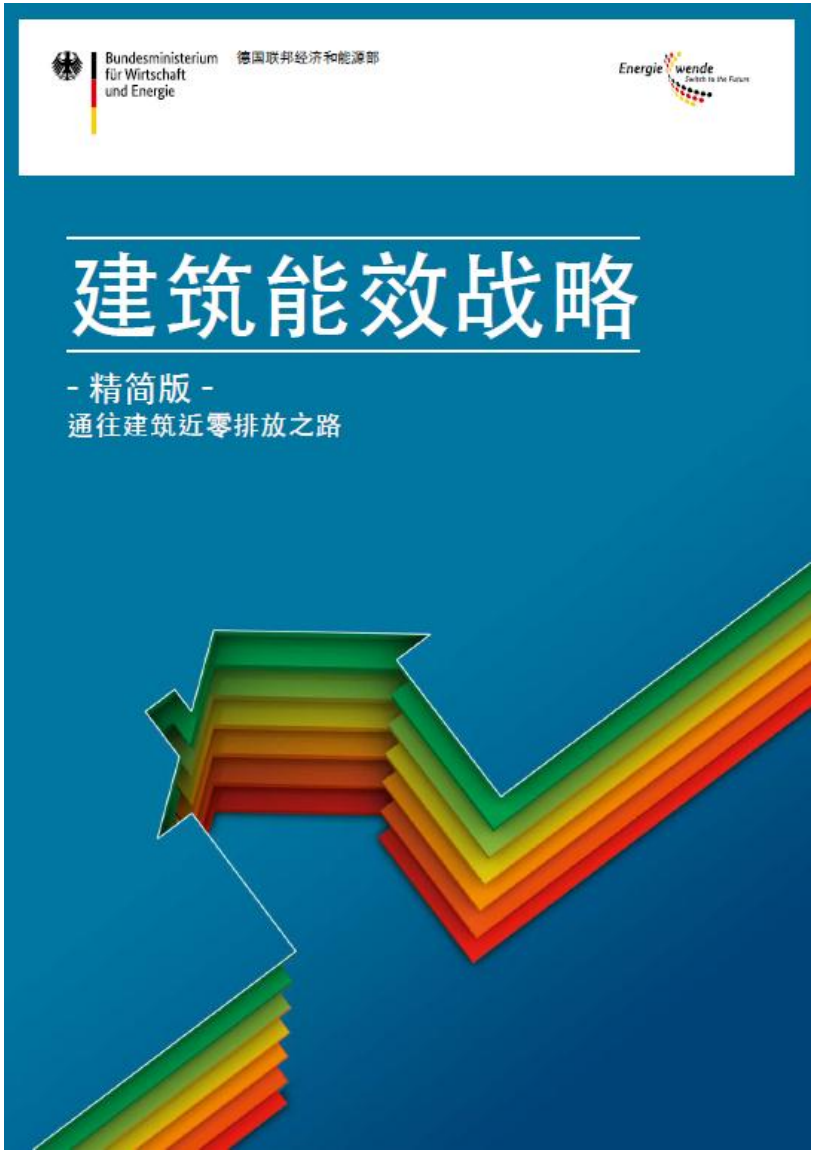
IMPROVEMENT 改进

- Research Networks
  ("Energy in Buildings and Districts")
  研究网络
- Research Initiatives
  ("EnOB", EnEff:Stadt/Wärme)
  研究项目补助
- Research Funds
  研究项目基金
- Pilot Application Programs
  示范申请项目

technical challenges

技术挑战

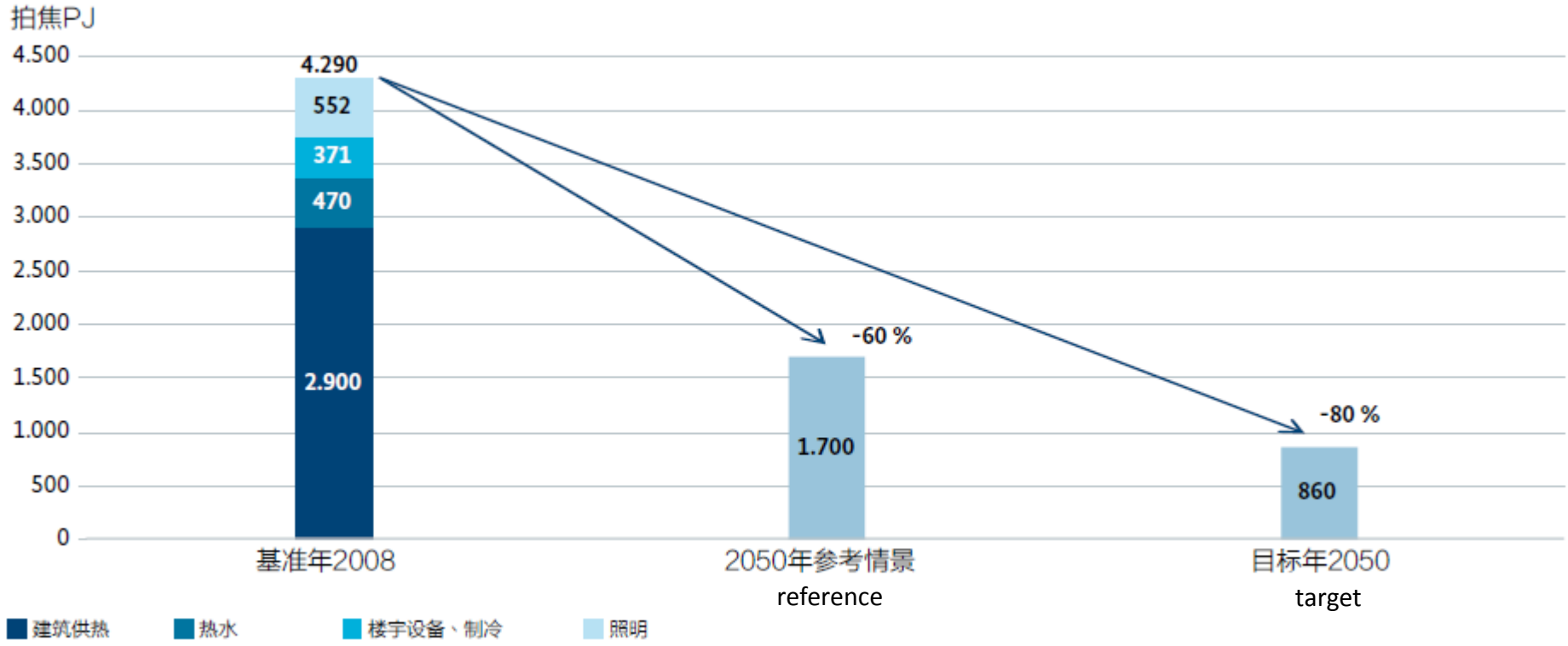

Bundesministerium
für Wirtschaft
und Energie
Energieeffizienz-
strategie Gebäude
Wege zu einem nahezu klimaneutralen Gebäudebestand


Bundesministerium
für Wirtschaft
und Energie
德国联邦经济和能源部
Energie wende
建筑能效战略
- 精简版 -
通往建筑近零排放之路

Target Scenarios 不同目标

Reference Scenario for resulting primary energy demand towards 2050

图表：根据参考情景得出的一次能源需求量（2008年，根据参考情景所作的预测及2050目标年，单位：拍焦）



2 Target Scenarios
2个目标

Energy Efficiency (reducing energy demand)
能源效率（降低能源需求）

Renewable Energies (increasing energy generation)
可持续能源（提高能源生产）

Technical Limitations 技术局限

Limitations for Energy Efficiency
能源效率的局限

- Insulation Boundary Value: ~ **0.1 W/m²K**
  保温临界值
- Windows Boundary Value: **~ 0.5 W/m²K**
  窗户临界值
- **In practical conditions, further limitations:**
  > building physics
  > heritage protection
  > financial constraints
- **实际情况中还有更多的限制:**
  >建筑物理结构
  >遗产保护
  >费用限制

Demand Reduction Potential until 2050:
到2050年，潜在能源需求降低达

-36 – -54 %

Abbildung 7: Einfluss der Dicke eines Dämmstoffs auf den U-Wert eines Wandbauteils; Grenz-U-Wert rund 0,1 W/m²K
U-Wert in Abhängigkeit des Baustoffs (Wärmeleitgruppe WLG)

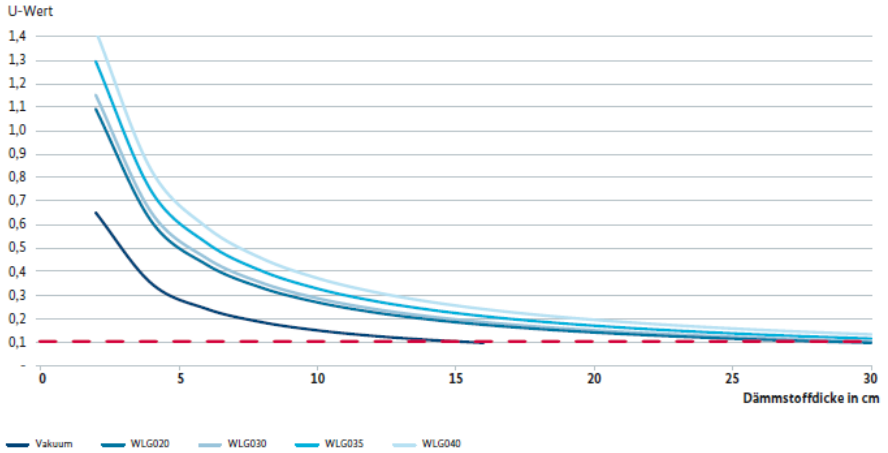
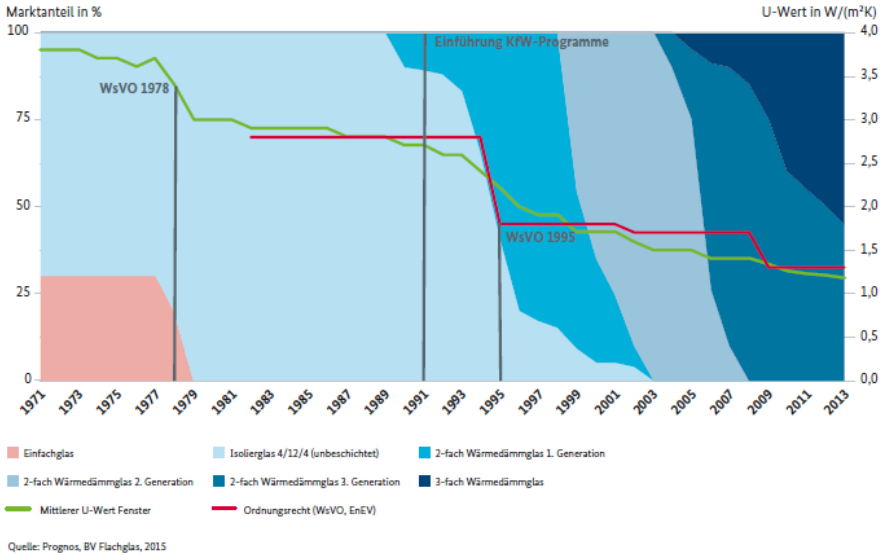


Abbildung 8: Entwicklung der energetischen Qualität der Fenster (mittlerer U-Wert)



Quelle: Prognos, BV Flachglas, 2015

Technical Limitations 技术局限

Limitations for Renewable Energies
可持续能源的局限

Space Conflicts
空间冲突

Roof for Solar PV 太阳能光伏屋顶 ⟷ Roof for Solar Thermal 太阳热能屋顶

Wind Turbines 风力涡轮 ⟷ Residential Areas 住宅区

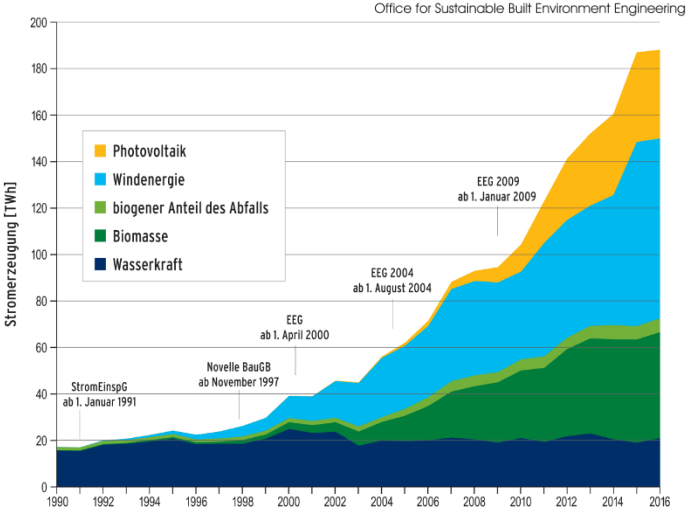
Demand Conflicts
需求冲突

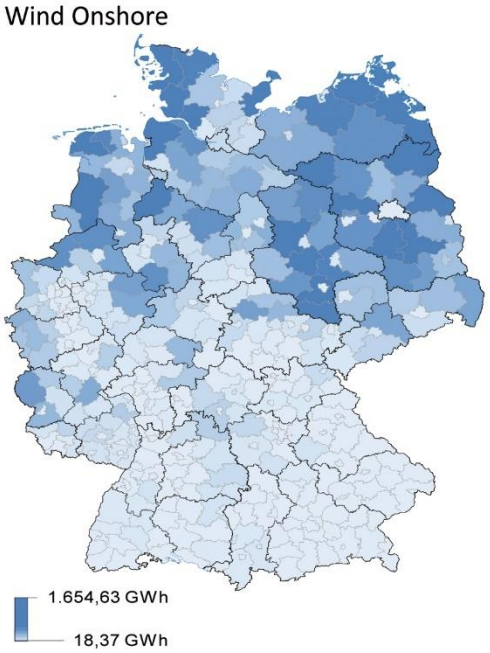
Biomass for Energy 生物质能 ⟷ Biomass for Fuel 生物质燃料

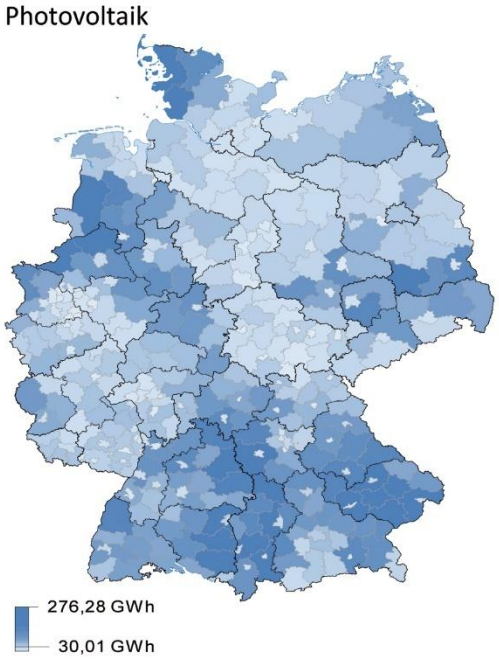
Direct Use 直接使用 ⟷ Transport & Storage 运输和储存

Demand Cover Potential until 2050:
到2050年，潜在能源需求满足达

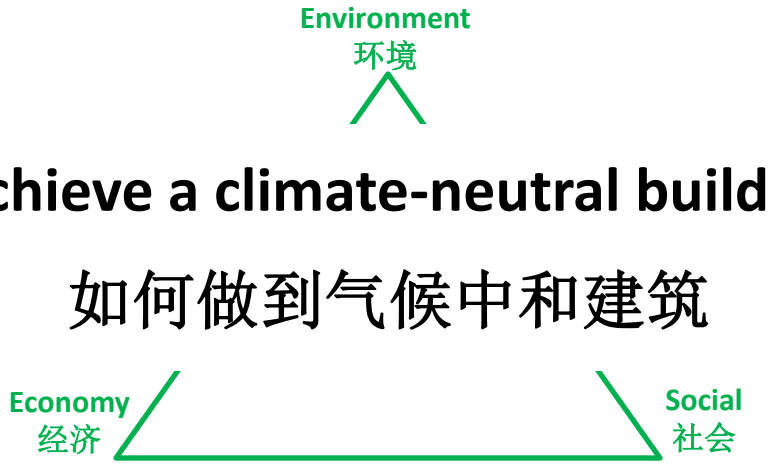
57 – 69 %







Maps Source: Growitsch, Meier, Schleich – Regionale Verteilungswirkung des Erneuerbare-Energien-Gesetzes, 2015



How to achieve a climate-neutral building stock?

如何做到气候中和建筑

Sustainable Solutions for the coming decades:
未来几十年的可持续发展方案：

- Individual Step-by-Step Retrofit Programs
- Regional Expert Networks and increased consulting activity
- Public Funding for CHP (combined heat-power) & heat storage
- Public Investment in energy-retrofit of entire urban districts
- Using potentials of Digitalization (Smart Grids, Smart Metering)
- Further backing of social cohesion (tenancy law, social law)
- Further research (in all aspects of sustainable development)

- 个人房产逐步改造项目
- 建立区域专家网络，增加咨询服务的机会
- 热电联产和热能储存的公共基金
- 整个城区能源改造的公共投资
- 运用数字化潜力（智能电网、智能测量）
- 支撑社会凝聚力（房屋租赁法、社会法）
- 进一步研究（可持续发展的方方面面）

implications for china
对中国的意义

Knowledge Transfer from Germany? 传递德国经验？

Differences compared to Germany
与德国的不同点

- urban layouts and building typology
  区域规划和建筑类型
- property ownership structure
  物业所有权结构
- ownership/rental distribution
  所有权/租赁分布
- market value of building qualities
  建筑质量和市场价值
- availability of materials & technology
  材料和技术的可获得性

Similarities compared to Germany
与德国的相似点

- large proportion of housing stock in demand for retrofit
  住房改建的需求很大
- Climate Protection Targets
  气候保护目标
- Increasing use of renewable energy sources
  提高可持续能源利用
- economic & urban growth meeting energy transition & carbon reduction
  经济和城市发展匹配能源过渡和碳排放降低

Knowledge Transfer from Germany? 传递德国经验？

energydesign Shanghai
Office for Sustainable Built Environment Engineering

GERMAN PRACTICE & INNOVATION

CHINESE SCALE

?

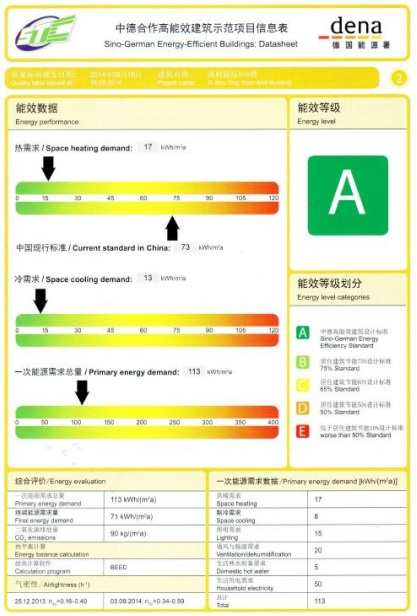
德国工艺和创新

中国规模

Sino-German Energy-Efficiency Standard – Pilot Project "Energy Passport" for China (2014)
中德合作高能效示范项目“能源护照”（2014）

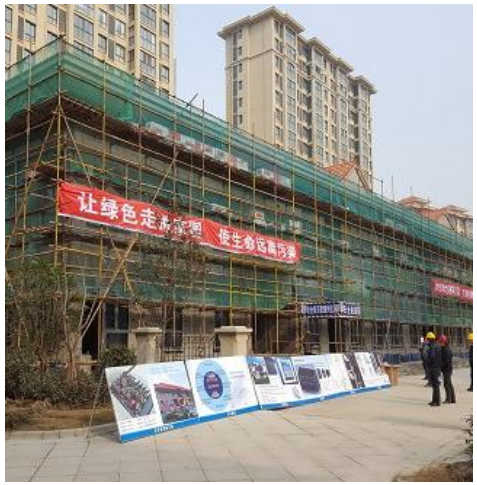
Joint project of dena, CSTC, and energydesign (auditor)
德国能源署、 CSTC和设能公司（能源审计）合作的项目

- Adaptation to Chinese Standards
  转化成适用中国的标准
- Climate adaptation (esp. humidity factors)
  气候区转化（尤其是湿度因素）



Passive House – in China since 2009
被动房 – 2009年来到中国

- dena Passive House Standard adapted to China
  将德国能源署被动房标准转化成适用中国的标准
- PHI Passive House Standard adapted to China
  德国被动房研究所被动房标准转化成适用中国的标准

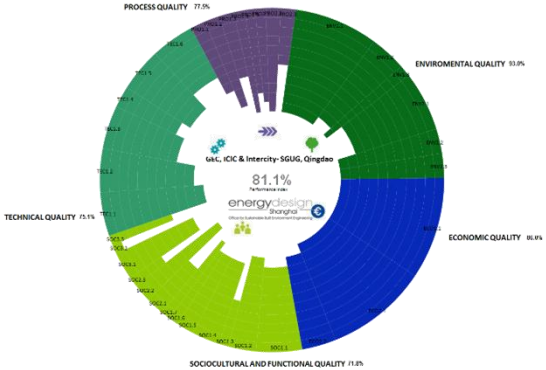


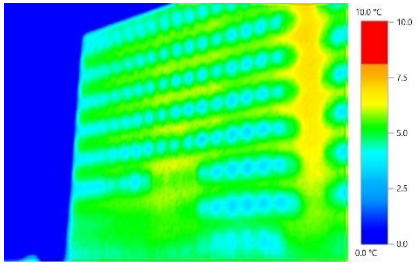
German Sustainable Building Label (DGNB) since 2012 in China
德国可持续建筑标识（DGNB）- 2012年来到中国

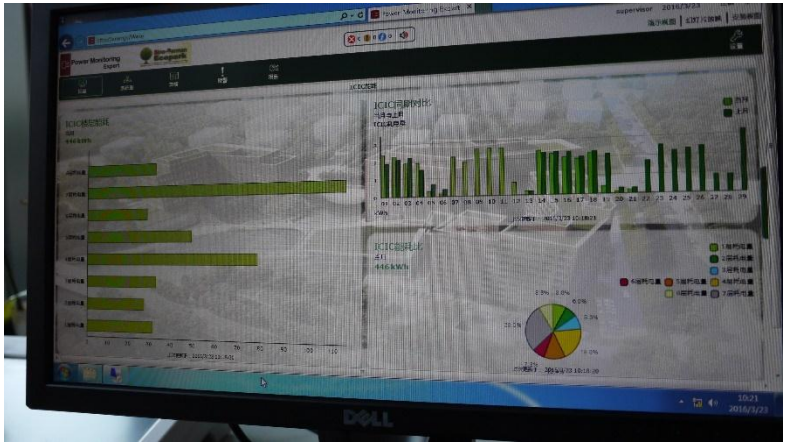
Sino-German Eco-Park Qingdao (2016)
青岛中德生态园（2016年）

Largest DGNB mixed-use complex outside Germany
德国本土之外面积最大的DGNB认证的多用途综合体

DGNB Platinum Certification
DGNB白金认证







THANK YOU!
谢谢！
VIELEN DANK!

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