

Rebound effects in heating energy demand after thermal refurbishment of apartment buildings









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Main Research

-  Sustainable Buildings
-  Environm. Technologies & Renewable Energies
-  Food Quality & Safety
-  Products, Processes, Materials
-  Innovation & Competitive Capability

Services

-  Applied R&D
-  Technological Transfer
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Content

1. Introduction

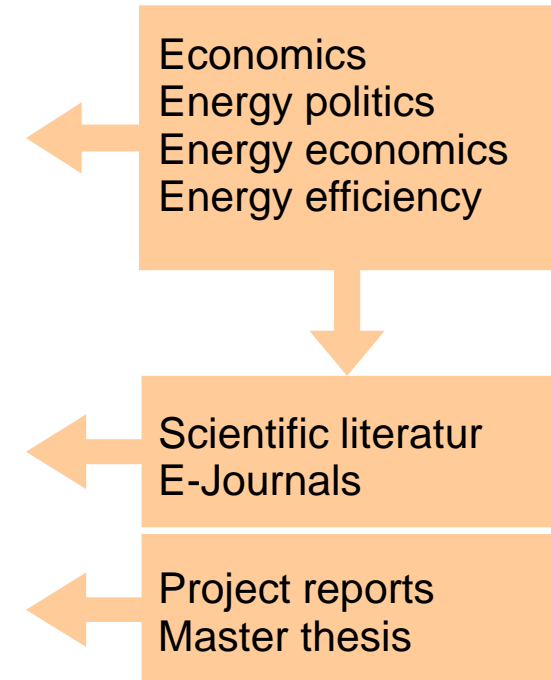
- Energy Efficiency - Why?
- The Building Sector
- Definition of Rebound Effect (RE)
- Direct Rebound Effect

2. Results

- Analysis of 27 Projects
- Extent of RE

4. Important Factors to limit the Extent of RE

5. Summary



Energy Efficiency in the Building Sector

High **dependency on imports of energy** (esp. fossile fuels)

→ 70 % in EU (2020–2030); 62 % in AT (2010)

Global warming

Energy policy: demand control → consumer behavior and energy efficiency

Building sector

→ 36 % of CO₂ emissions

→ 40 % of final energy consumption

→ 68–79 % final energy consumption of private households for space heating (AT)

Efficiency potentials: buildings up to construction year 1960 → 60 – 90 %

buildings up to construction year 1970 → 30 – 40 %

Dependent on

→ Type of building

→ Status before retrofit

→ Level of thermal retrofit

The Rebound Effect

A rebound effect is the cushioning of desired, introduced processes and the diminishing of their effects by different mechanisms.

(Translation from Langenscheidt)

Example: **Increasing energy efficiency**

- Single measure
- Politically initiated efficiency programmes

Expected energy savings [kWh/a] ... 100 %

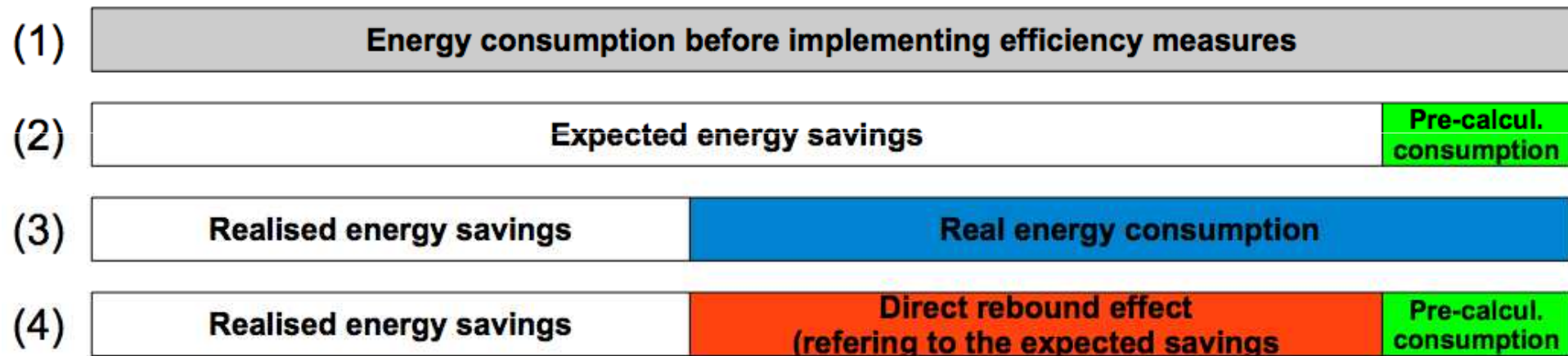
Realised energy savings ... 70 %

Not realised savings = Rebound effect ... **30 %**

Direct Rebound Effect I

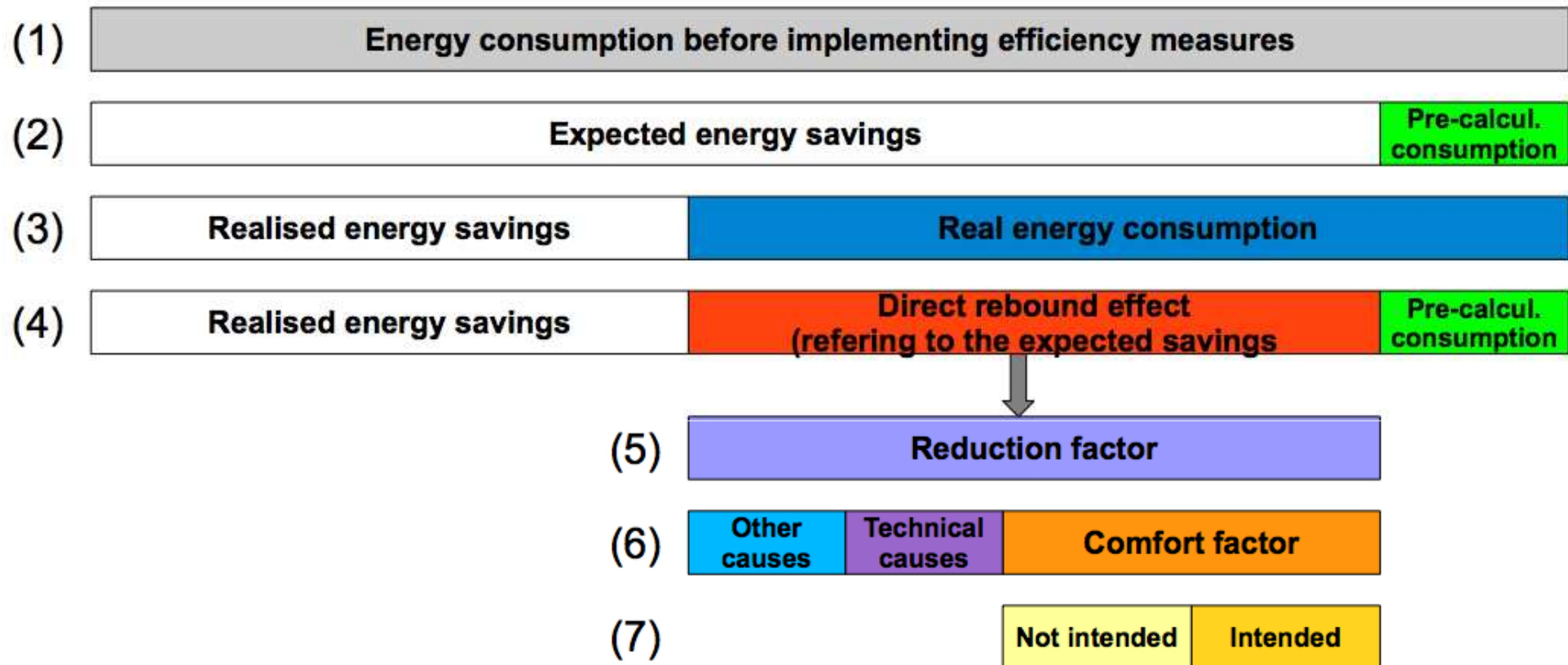
Direct Rebound Effect \Rightarrow **Primary Effect**

- regarding final energy demand (energy services, e.g. space heating)
- occurs immediately, primarily, directly



Direct Rebound Effect II

Reduction factor & Comfort factor (Hamilton et al. 2011)



Results of Project Analysis I

Rebound effects

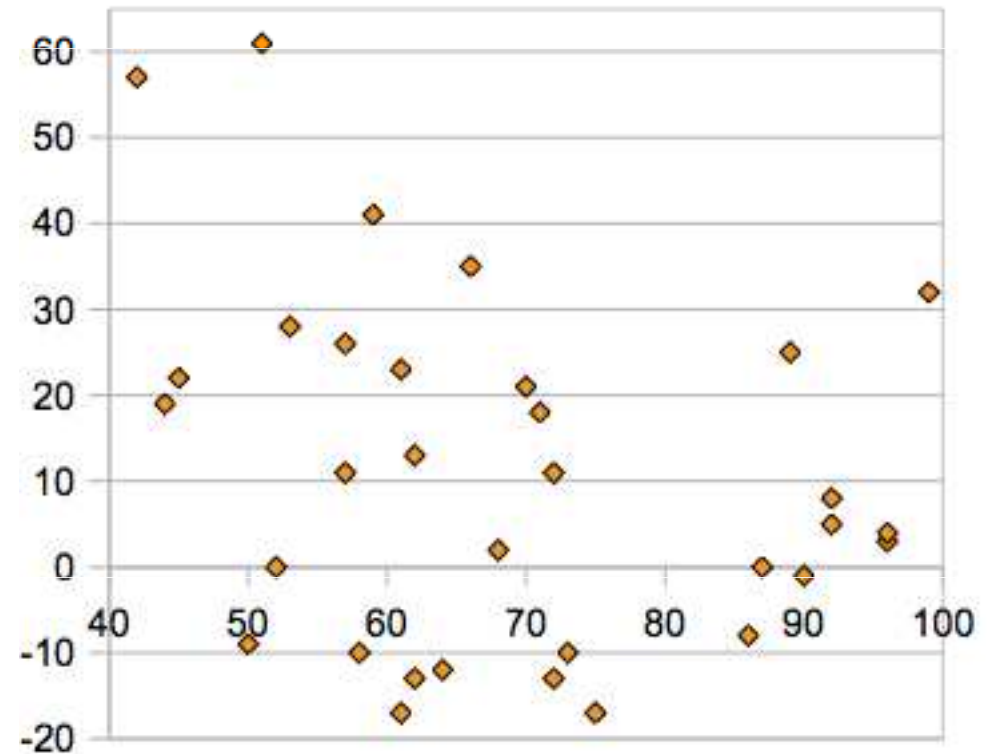
Project reports

-17 % to +25 %

Master thesis Scheer P. (1996)

0 % to +61 %

Rebound
effect in
[%]

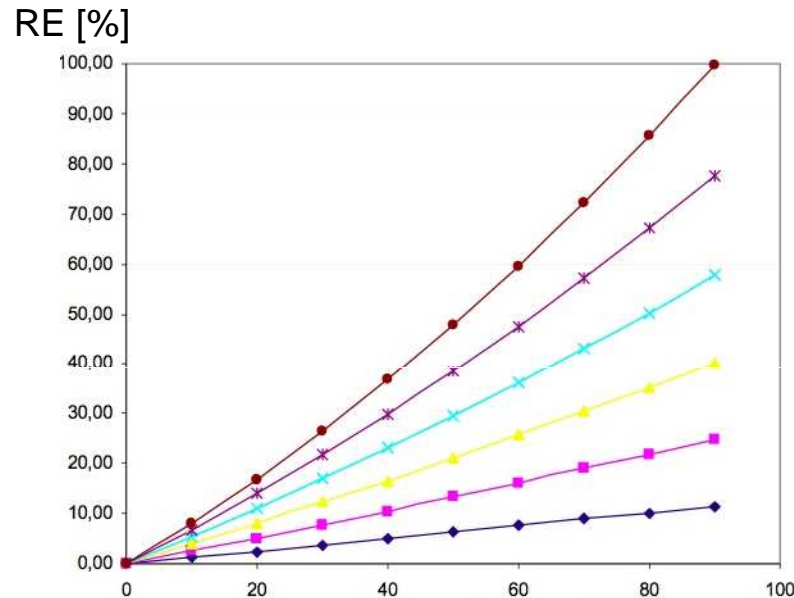


Planned savings in heating energy demand in [%]
according to basic value before thermal retrofit

Results of Project Analysis II

Rebound effects in dependency of heating energy consumption before thermal retrofit

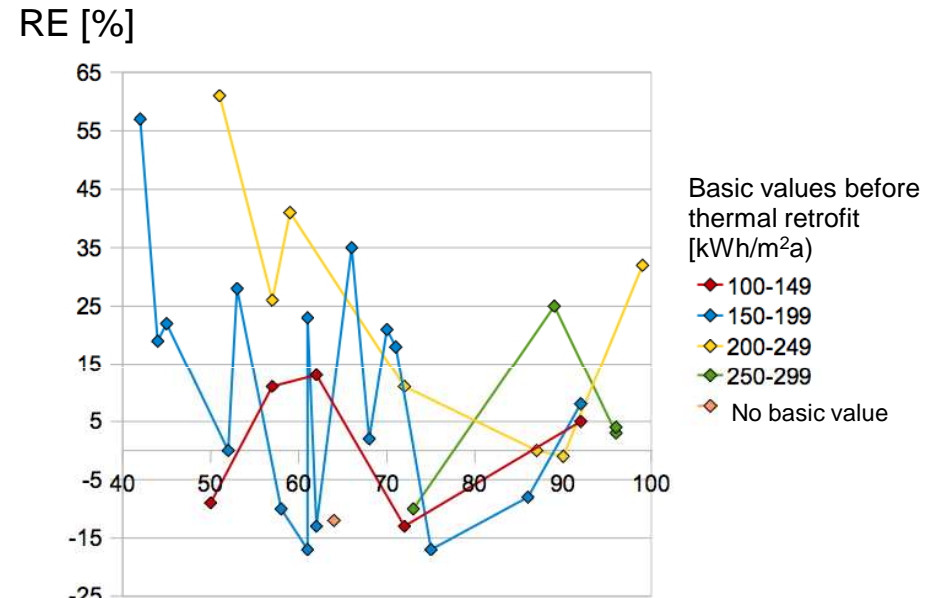
MARESI study



Theoretical savings in heating energy relating to basic value before thermal retrofit [%]

(Biermayer et al. 2005)

Project analysis



Theoretical savings in heating energy relating to basic value before thermal retrofit [%]

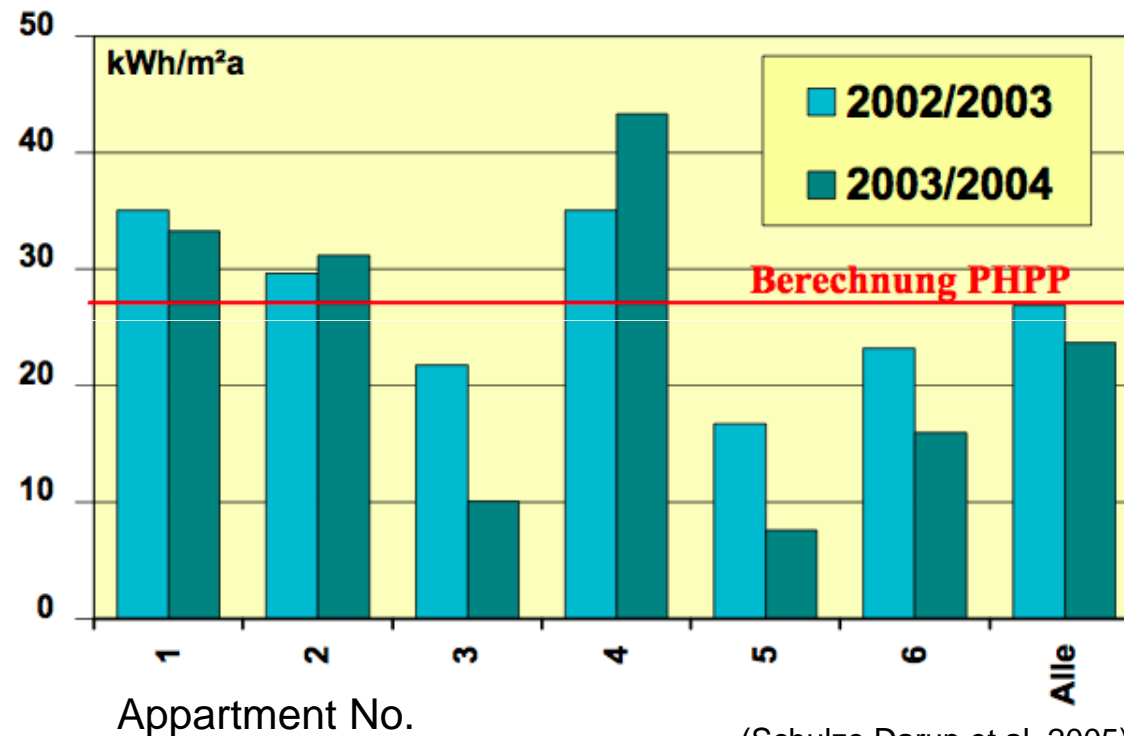
Results of Project Analysis III

Drastically varying specific heating energy consumption of different households in the same building.

Example: Energetic building refurbishment by factor 10

Multy storey building, Jean-Paul-Platz, Nürnberg (GER)

Specific heating energy consumption after thermal retrofit [kWh/m²a]

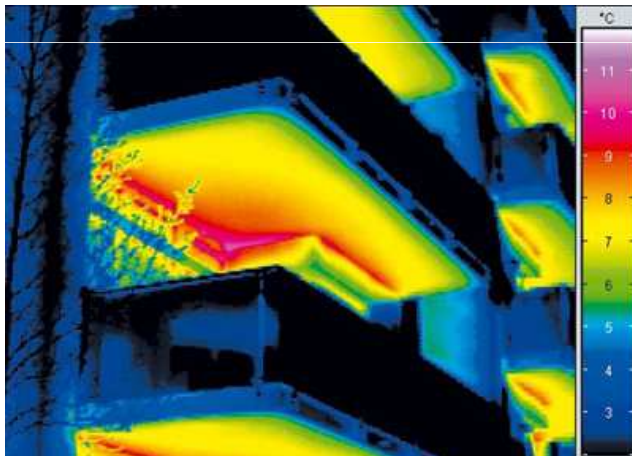


(Schulze Darup et al. 2005)

Important Aspects for Retrofit I

Building

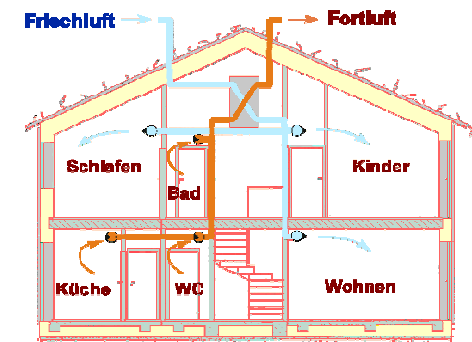
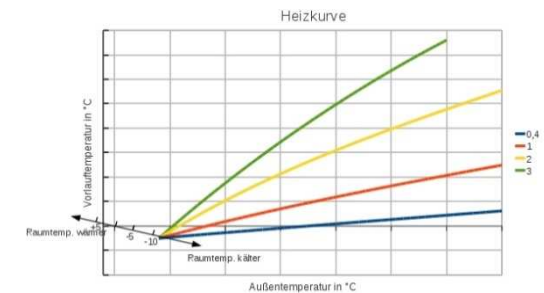
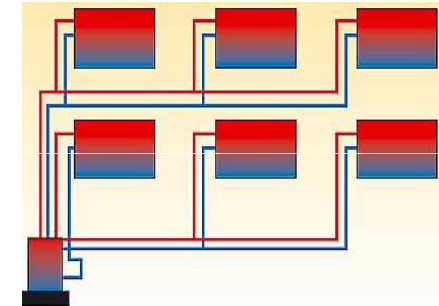
- **Maximum** level of retrofit
 - thermal bridges minimised
 - air & wind tightness
 - insulation of heat distribution pipes
- **Avoiding** lock-in effects on energy efficiency potentials



Important Aspects for Retrofit II

HVAC systems

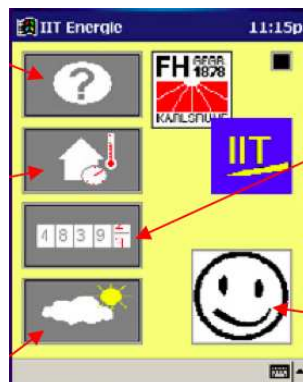
- **Avoid** complex systems
- **Optimised** planning of HVAC system
- **Adopted** building equipment
 - quality assurance of the systems
 - hydraulic balance
 - optimised heating curve
 - heating system driven by ambient temperature
- **Combined** fresh/exhaust air ventilation system
 - heat recovery system
 - minimum (hygienic) air change rate



Important Aspects for Retrofit III

Control systems

- Coupling heating & ventilation system by window contacts
- Limiting permitted indoor temperature
- Control system
 - indoor temperatur, air change rate
 - easily operated
 - energy consumption control in real-time



Important Aspects for Retrofit IV

Users

- **Involve** dwellers into the retrofitting process
- **Explanation** about the new situation
- **User training**
 - control elements
 - adequate ventilation habits
 - continuous & long-term
 - individual & direct
- **Energy billing**
 - direct, clear, in-time
 - no lump-sum!!



Summary

Energy saving potentials for single object between **30 – 90 %**
⇒ should be put into effect!

Direct rebound effects arise mainly from:

User habits

- chosen temperature
- ventilation behavior

Technical aspects

- building
- HVAC system

Summary

Three pillars for restricting rebound effects:

1. Increasing energy efficiency

Optimised and adopted HVAC

2. Demand control / restriction of energy consumption

Maximised quality of retrofitting

Minimised potentials for dissipation of energy

Higher prices for energy

3. Awareness raising

Information and training of the users/habitants/dwellers

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Thank you for your attention!

