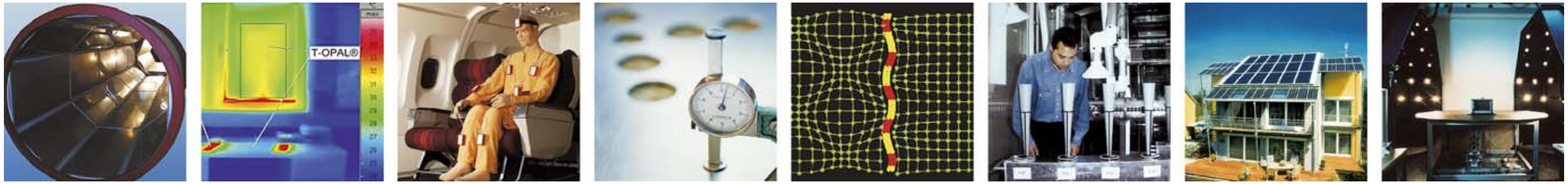
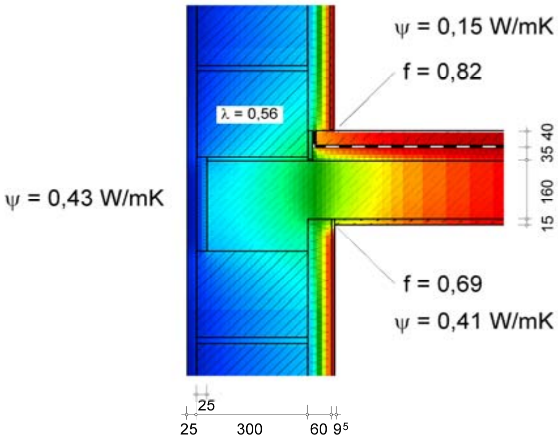


*ASIEPI* - Assessment and improvement of the EPBD Impact (for new buildings and building renovation)




# WP4: An effective handling of thermal bridges in the EPBD context

## Task 2: Impact of thermal bridges on the energy performance of buildings


Heike Erhorn-Kluttig
Fraunhofer Institute for Building Physics


ASIEPI
Intelligent Energy Europe

IBP
Fraunhofer Institut Bauphysik

# ASIEPI WP4:

## „An effective handling of thermal bridges in the EPBD context"

| MS approaches in regulation | Effects to energy balance | Software + thermal bridge atlases | Good practice guidance | Promotion of good building practice | Execution quality | Advanced technical development |
|---|---|---|---|---|---|---|

**Basic questionnaire: 16 questions answered by experts from 18 EU Member States:**
**B, NL, GR, D, N, F, P, I, ES, PL, SF, CZ, DK, LT, HU, RO, UK, IRL**

| MS approaches in regulation | Effects to energy balance | Software + thermal bridge atlases | Good practice guidance | Promotion of good building practice | Execution quality | Advanced technical development |
|---|---|---|---|---|---|---|
| • new designs + renovation<br>• simplified approaches<br>• compliance and control | • impact on energy<br>• national studies<br>• heating and cooling | • collection of tools and (national) atlases<br>• fed into databases | • parts of standards, technical information notes<br>• fed into databases | • collection + analysis of promotional activities<br>• courses for practioners, PR activities, student curric. | • ways to assess execution problems<br>• stimuli for improved execution | • innovative solutions by the industry<br>• potential of good regula-tions on buil-ding practice/ innovation |
| information paper #1 | information paper #2 | information paper #3 | information paper #4 | | information paper #5 | information paper #6 |

↓

**Final report of ASIEPI WP4: Summary of all collected information + best practice examples**

Internet information session #1 | Internet information session #2

ppt-presentation on demand #1 | ppt-presentation on demand #2

Handling of thermal bridge related questions asked to EPBD Building Platform helpdesk

Thermal bridge related information to EPBD Building Platform databases: publications, standards, events, websites

# Impact of thermal bridges on the energy performance of buildings

**Questions to be answered:**

- How big are the transmission losses due to thermal bridge effects in absolute and relative values?
- What is the influence on the total energy use or primary energy of a building?
- Should an energy performance assessment method for buildings include a possibility for a detailed calculation of the impact of thermal bridges?

# Impact of thermal bridges on the energy performance of buildings

Basis is the analysis of 9 different national studies

1. **Germany:** **Demonstration project 3-liter-houses Celle – Thermal bridge influence on the energy performance of the Ziegel-Aktiv-Haus** [Erhorn, H.; Gierga, M.; Erhorn-Kluttig, H.]
2. **France:** **Thermal bridge influence on the primary energy** [Lahmidi, H.; Leguillon, F.]
3. **Denmark:** **Low energy class 1 typehouses according to the Danish building regulations** [Rose, J.; Kragh, J.; Svendsen, S.]
4. **The Netherlands:** **Effect of using default values for thermal bridges in the EP calculation versus using detailed calculations** [Spiekman, M.]
5. **Czech Republic:** **Influence of thermal bridge details on the energy performance of houses with different energy quality** [Šubrt, R.]
6. **Poland:** **Quantitative study of thermla bridgs in residential buildings** [Wojnar, S.; Firlag, S.; Panek, A.]
7. **Belgium:** **Study on the energy aspects of new dwellings in Flanders: insulation, ventilation, heating** [BBRI report]
8. **Belgium:** **Development of limits for the linear thermal transmittance of thermal bridges in buildings** [Janssens, A. et al]
9. **Greece:** **The impact of thermal bridges on the energy demand of buildings with double brick wall constructions** [Theodosiu, T.G.; Papadoupoulous, A.M.]

# Impact of thermal bridges on the energy performance of buildings

1. Germany: Demonstration project 3-liter-houses Celle – Thermal bridge influence on the energy performance of the Ziegel-Aktiv-Haus
[Erhorn, H.; Gierga, M.; Erhorn-Kluttig, H.]

- Concepts for high performance houses have been developed and some of the concepts have been built.
- Aim: Primary energy of less than 34 kWh/m²a
  -> less than 3 liter oil per m² and year for space heating, ventilation and auxiliary energy.
- Different technologies and strategies, incl. the reduction of energy losses due to thermal bridges
- Development of advanced building joints +
  study on the comparison of the default values for thermal bridges according to German energy performance code with the explicitly calculated values
- German standard DIN V 4108-6 foresees default values
  -> for standard joints: $\Delta U$=0,10 W/m²K
  -> for state of the art joints according to a leaflet with example joints: $\Delta U$=0,05 W/m²K

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# Impact of thermal bridges on the energy performance of buildings

1. Germany: Demonstration project 3-liter-houses Celle – Thermal bridge influence on the energy performance of the Ziegel-Aktiv-Haus
[Erhorn, H.; Gierga, M.; Erhorn-Kluttig, H.]

- 16 linear joints analysed and improved: external wall corners, window and door frame connections, roof-wall joints, dormer constructions, connections between wall and slab

| Savings of Ziegel-Aktiv-Haus compared to | Standard | State of the art |
|---|---|---|
| ΔU [W/m²K] | - 0.081 | -0.031 |
| Energy need for heating [kWh/m²a] | -11.4 | -4.4 |
| Primary energy for heating [kWh/m²a] | -9.9 / -12.6* | -3.8 / 4.8* |

* two different heating systems in the double house halves.

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# Impact of thermal bridges on the energy performance of buildings

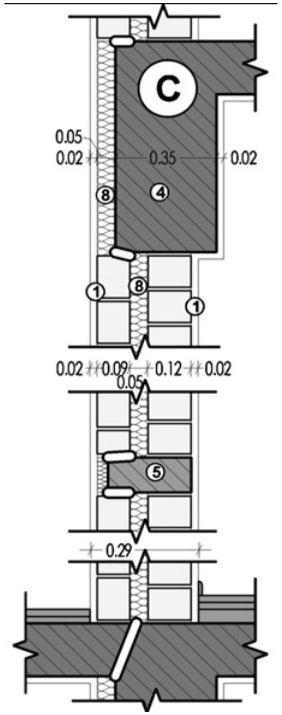
1. Germany: Demonstration project 3-liter-houses Celle – Thermal bridge influence on the energy performance of the Ziegel-Aktiv-Haus
[Erhorn, H.; Gierga, M.; Erhorn-Kluttig, H.]

Main results of the German study on the impact of thermal bridges:

- Improved joints can reduce the energy need for heating by 11.4 kWh/m²a (compared to standard constructions) and 4.4 kWh/m²a (compared to state of the art constructions)
- At high performance buildings the primary energy for heating can be reduced by 4 to 5 kWh/m²a. This is 15 % of the allowed demand for a 3-liter house.
- Thermal bridges can have the same influence as solar thermal hot water generation.

# Impact of thermal bridges on the energy performance of buildings

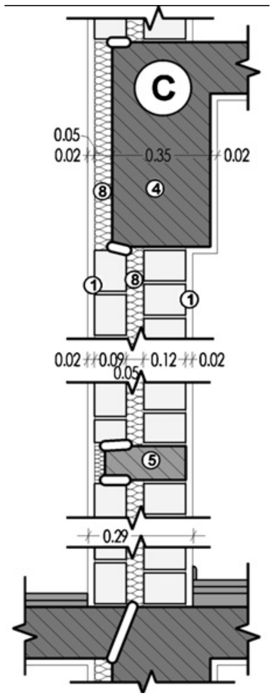
**8. Greece:** **The impact of thermal bridges on the energy demand of buildings with double brick wall constructions [Theodosiou, T.G.; Papadopoulous, A.M.]**




- Study on representative configurations of thermal insulation at external walls
- Investigation of the impact of thermal bridges on the energy consumption in both summer and winter conditions.
- 3-storey apartment building equipped with heating and cooling systems was calculated with a dynamic simulation program under the climate of Thessaloniki.
- 4 different insulation scenarios from typical application to external insulation
- Calculation of the (total) impact of thermal bridges on the heating and cooling need.
- For this information paper the results of the thermal insulation scenario according to the minimum requirements for the coldest zone in Greece (5 cm insulation thickness) are summarised in the following table.

# Impact of thermal bridges on the energy performance of buildings

**8. Greece:** The impact of thermal bridges on the energy demand of buildings with double brick wall constructions [Theodosiou, T.G.; Papadopoulous, A.M.]




- Results of the thermal insulation scenario according to the minimum requirements for the coldest zone in Greece (5 cm insulation thickness):

| Characteristic value | Unit | Excluding thermal bridges | Including thermal bridges |
|---|---|---|---|
| Specific annual energy use for heating | kWh/m²a | 71 | 92 |
| Maximum heating load | kW | 24.8 | 30.4 |
| Specific annual energy use for cooling | kWh/m²a | 30 | 31 |
| Maximum cooling load | kW | 15.4 | 17 |

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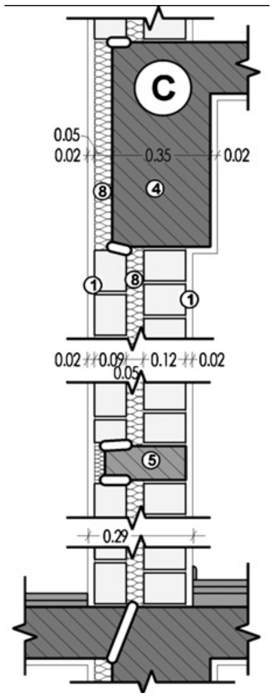
# Impact of thermal bridges on the energy performance of buildings

8. Greece: The impact of thermal bridges on the energy demand of buildings with double brick wall constructions [Theodosiou, T.G.; Papadopoulous, A.M.]




Main results of the Greek study on the impact of thermal bridges:

- The impact of the thermal bridges on the annual energy use for heating is 30 % or 21 kWh/m²a.
- The specific energy use for cooling difference is much lower with 1 kWh/m²a or 3 %.
- On the other hand, the calculations show that also the summer influence of thermal bridges shouldn't be neglected as the difference of the maximum cooling load is more than 10 %.
- It can be assumed that if the climate region would have been warmer, the impact on the cooling load and cooling energy need would have been higher.

# Impact of thermal bridges on the energy performance of buildings

## Summary

- Presented results of the national studies on the impact of thermal bridges on the energy demand of buildings should be read with care.
    - Two types of studies:
        - Comparison of existing default values for thermal bridge impacts in national standards with detailed thermal bridge calculations of improved joints (German, French, Danish, Dutch + Polish studies)
        - Total impact of thermal bridges on the energy performance, no comparison to default values (Czech, Belgian + Greek studies)
    - Amount of analysed joints, the building geometry, the climate, etc. vary

- The total impact of thermal bridges on the heating energy need is in general considerable and can be as high as 30 %.
- The impact on the cooling energy need is significantly lower. However: still a significant summer influence regarding the maximum cooling load.
- Countries with national default values for thermal bridges have mostly set those values in order to be on the “safe side” meaning that they result in slightly higher impact than if the joints are analysed in detail with 3D-simulation programs.

# Impact of thermal bridges on the energy performance of buildings

## Summary

- If national default values are compared with improved joints regarding the energy quality, the difference of the heating energy can be as high as 11 kWh/m²a energy need or 13 kWh/m²a primary energy. Another study showed an influence of 18 kWh/m²a primary energy.
- The relative impact of improved joints compared to national default values on the primary energy for heating can amount to 15 %.

## Conclusions

- Impact of thermal bridges in both winter (heating energy demand and heating load) and summer performance of buildings (cooling load) can't be neglected and should be included in the national calculation methods by default values and/or detailed calculations.
- Motivation for improvements of joints -> standards should offer to use lower values than the default value for thermal bridges according to the result of detailed calculations. -> improved joints can be used as method to improve the energy performance of buildings similar to better insulation, more efficient systems, etc.
- Better joints do not only reduce thermal bridge losses but also improve the airtightness of the building.

# Impact of thermal bridges on the energy performance of buildings

[European projects]

EPBD BUILDINGS PLATFORM

PXX

11-02-2009

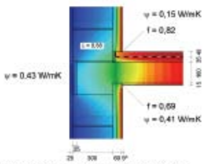
## Impact of thermal bridges on the energy performance of buildings

Heike Erhorn-Kluttig
Hans Erhorn
Fraunhofer Institute for Building Physics
Germany

ASIEPI

More information can be found at the ASIEPI project website: *www.asiepi.eu*

Similar Information Papers on ASIEPI and/or other European projects can be found at the Buildings Platform website: *www.buildingsplatform.eu*




*Example of a thermal bridge effect at a concrete ceiling embedded in the external wall.*
Calculation of the thermal bridge loss coefficient and the dimensionless temperature coefficient. The colours illustrate the temperature distribution within the construction.


Thermal bridges have influence on the surface temperature of building components, but also on the energy performance of buildings. The ratio of losses due to thermal bridges compared to the total transmission losses are small in existing, non-retrofitted buildings but can become quite considerable in new and especially in high performance buildings. This paper summarises studies on the impact of thermal bridges on the energy performance of buildings in different European Member States and gives therefore an indication on the relevance of including detailed thermal bridge assessments in the EPBD calculation methods.

### 1 > Questions to be answered

Thermal bridges in building structures and component joints have impact on the surface temperature of the relevant building components. Due to the lower thermal resistance, the internal surface temperature on components with thermal bridges is reduced and can in many cases lead to problems with moisture and mould. Additionally thermal bridges have impact on the energy performance of buildings as they increase the heat transfer through the building envelope, that means they cause additional transmission losses in summer and winter. Yet:

- How big are those transmission losses due to thermal bridge effects in absolute and relative values?
- What is the influence on the total final or primary energy consumption of a building?
- Should an energy performance assessment method for buildings include a possibility for a detailed calculation of the impact of thermal bridges?

The Intelligent Energy Europe project ASIEPI has collected studies dealing with the influence of thermal bridges on the energy performance of buildings which have been performed in different European Member States. They are summarised here and a conclusion concerning the importance of a detailed assessment method within the energy performance calculation of buildings is drawn.

### 2 > International studies on the quantification of thermal bridge effect on the energy performance

As presented in Information Paper 64 "Thermal bridges in the EPBD context: overview on MS approaches in regulations" [1] not all analysed countries consider the influence of thermal bridges in their regulations for

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