OPTICAL AND THERMAL DESIGN AND MODELLING OF ARCHITECTURAL SHADIG SYSTEMS

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Need for solar control

Solar control devices

Simulation of thermal behaviour of buildings

Shading device model

Case study

Façade orientation
Glazing ratio
Geographic location
Shading strategy

Conclusions

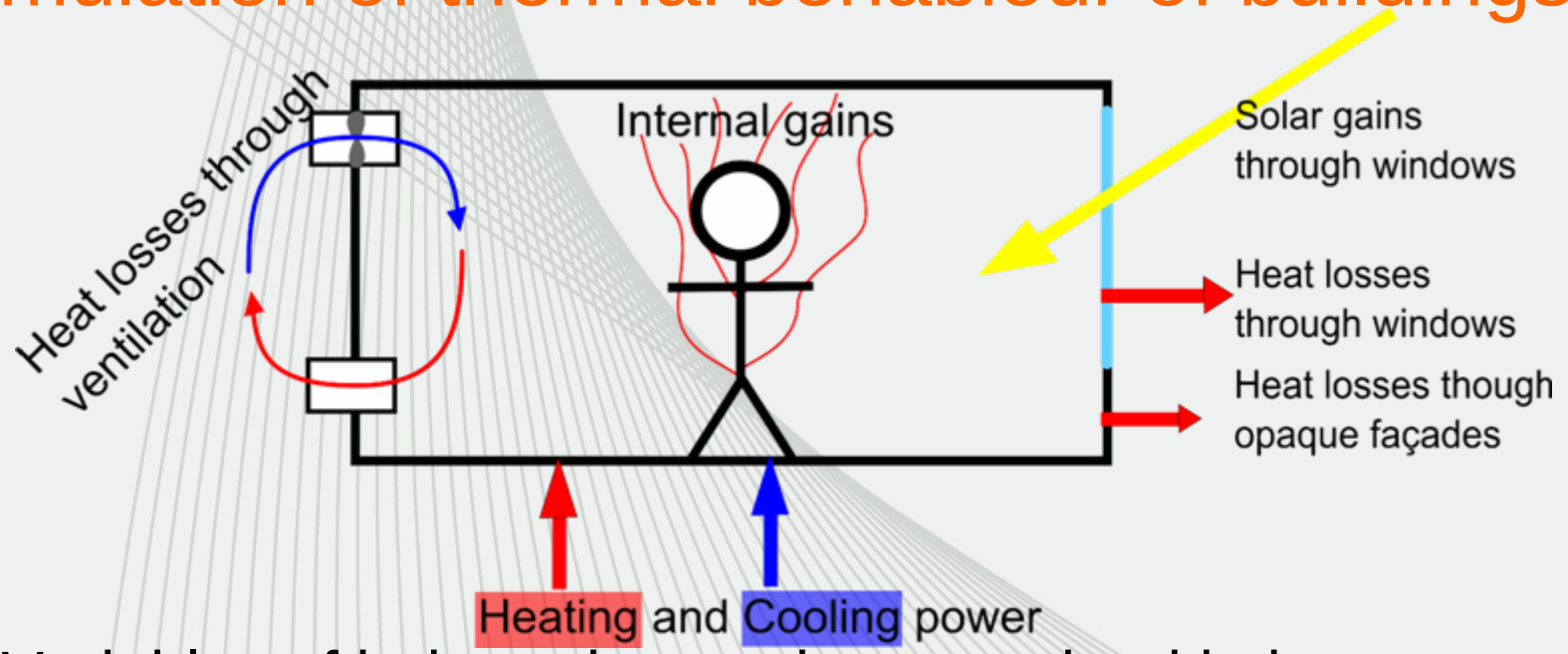
Need for Solar Control

- Technical advances allow larger glazed areas.
- An increasing amount of buildings are built with curtain wall fenestration.
- Larger glazed areas lead to higher daylight availability but can cause glare discomfort.
- Overheating is produced by excessive solar gains.

Solar Control Devices

- Internal shading devices / Blinds
- Solar control glazing
- External shading devices
  - Fixed / Moveable

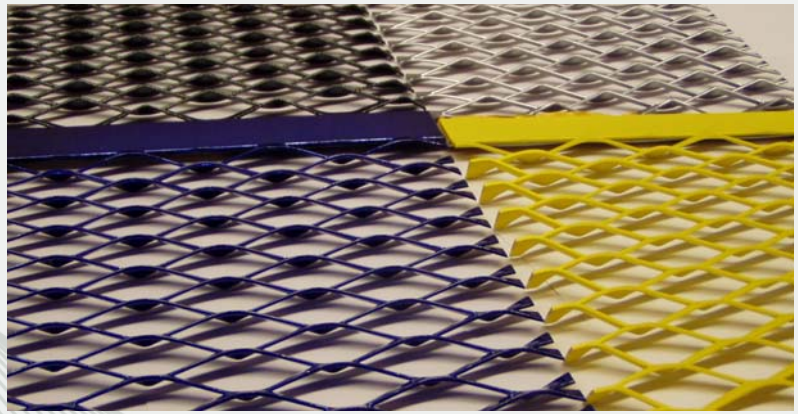
Simulation of thermal behabiour of buildings



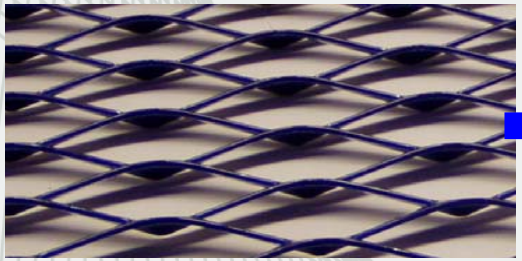
- Variables of indoor air must be mantained in human confort range.
- Heating and cooling devices are used to deliver and substract energy from the conditioned areas.
- Simulation software is used to assess heating and cooling requirements.

Shading device model. Chosen shading device

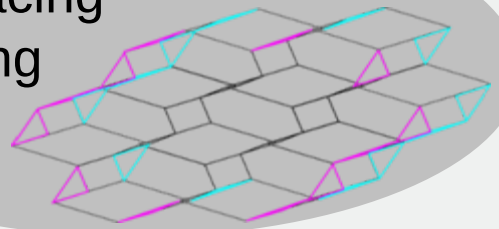
- Expanded sheet
- Fixed shading
- Shading parallel to windows

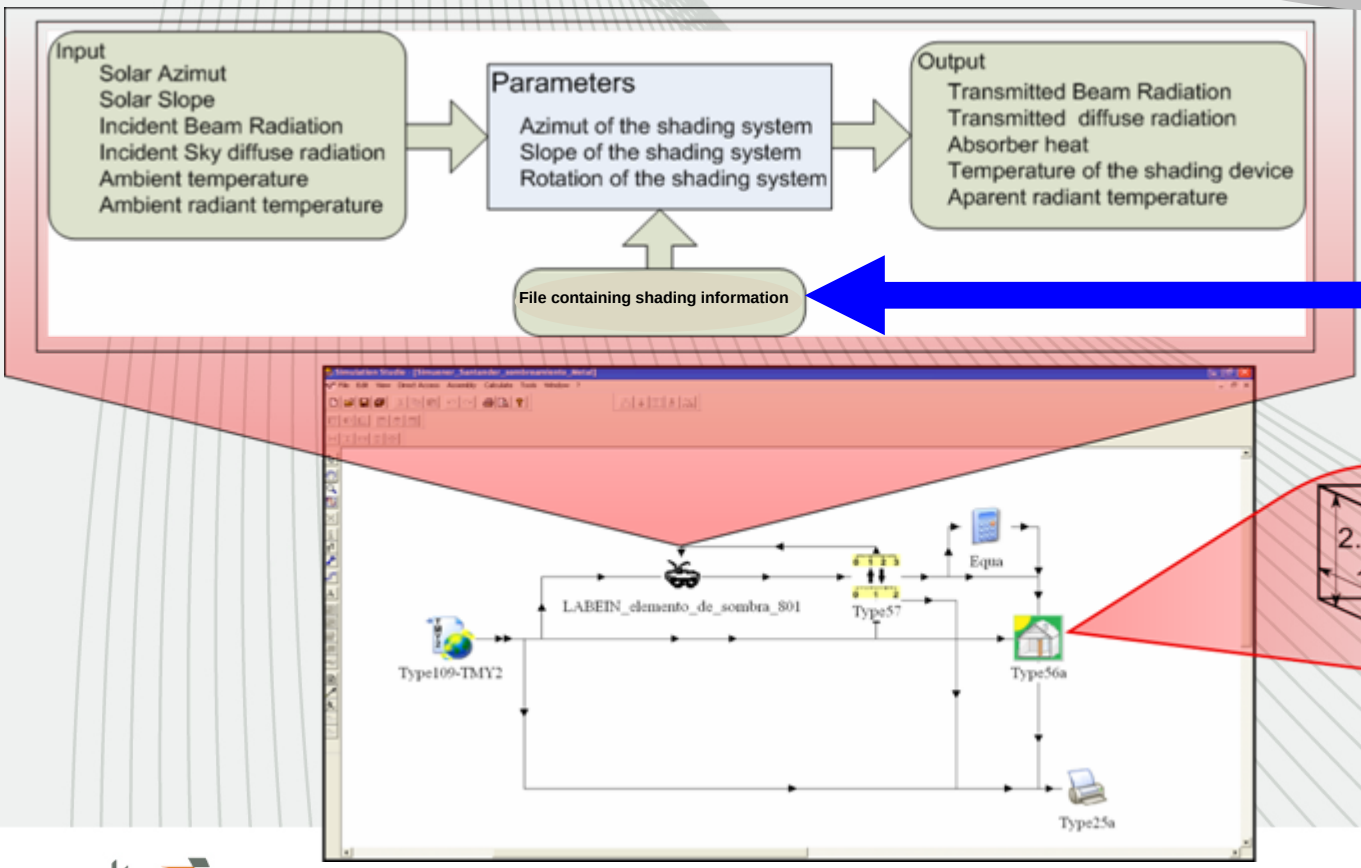


Shading device model. Thermal model in TRNSYS



Ray-Tracing modelling





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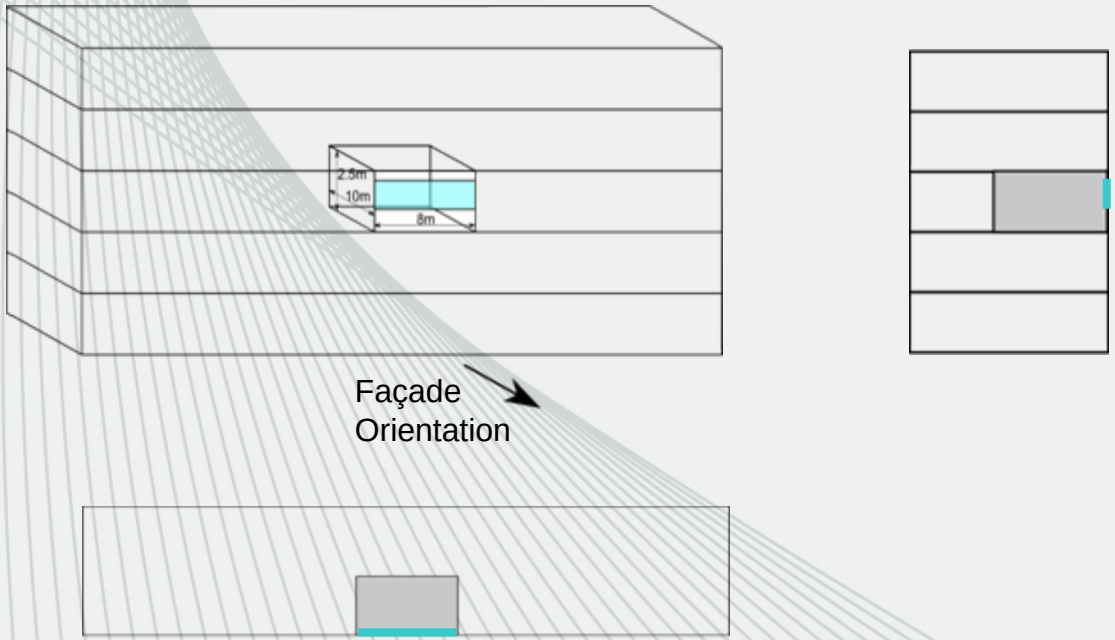
Case Study. Building definition

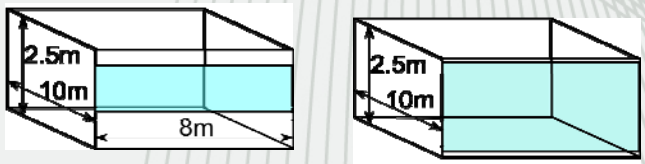
- Small office space into a larger office building.



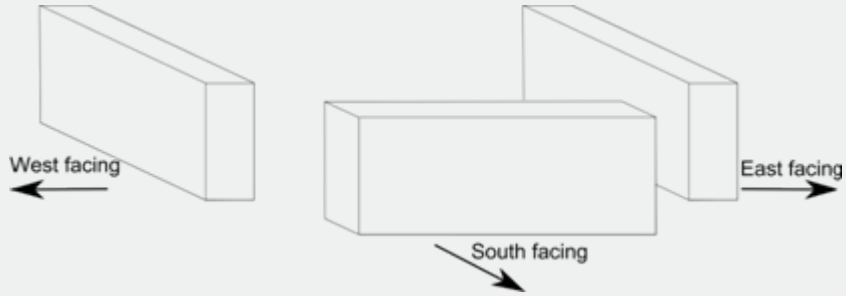
- Densely occupied office space.
  - High internal gains.
  - High ventilation rate.
- Mainly cooling loads are present.

Case Study

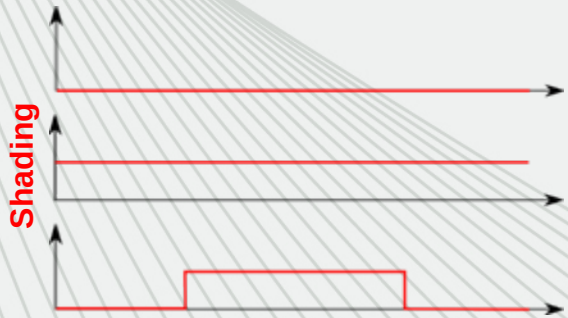
- Fenestration rate:
  - Traditional fenestration: 30%
  - Curtain wall: 90%



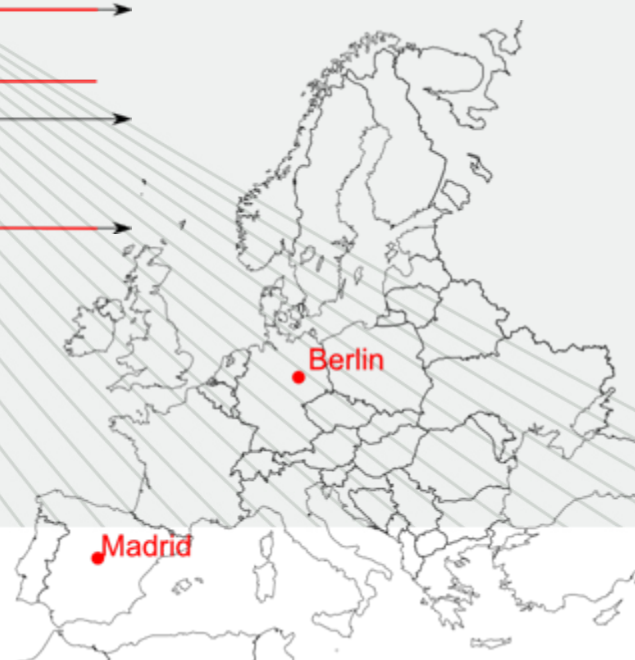
- Orientation:



- Shading scenario:
  - No shading
  - Fixed shading
  - Variable shading (Seasonal)



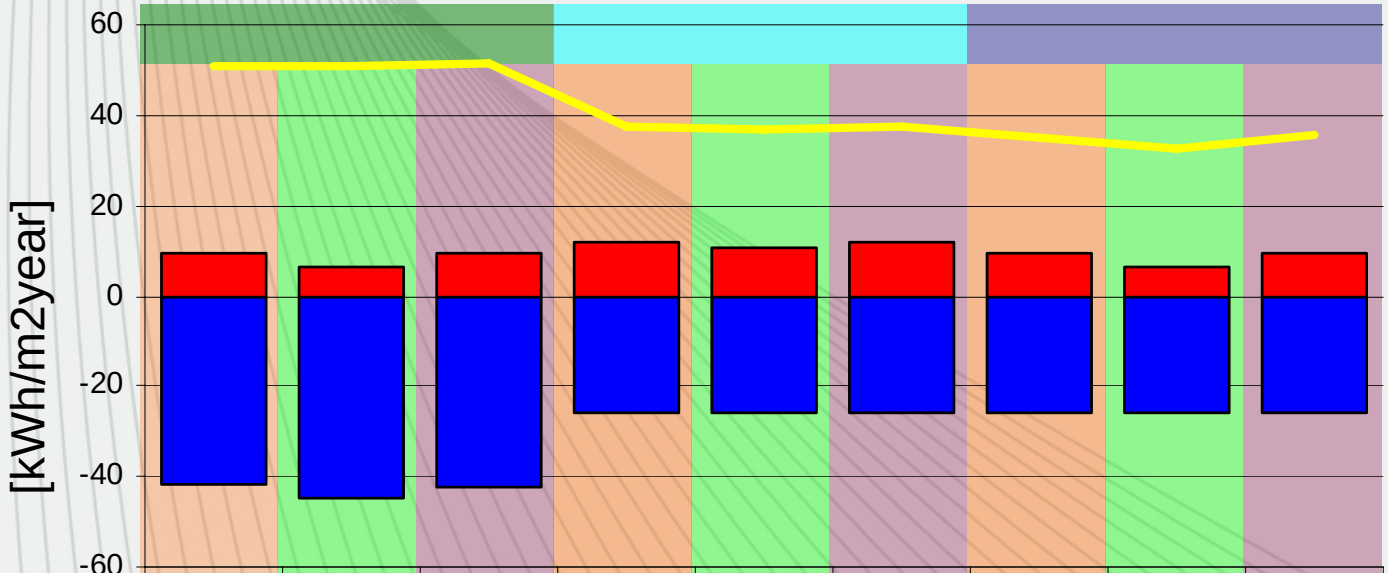
- Locations:
  - Central Europe: Berlin (52ºN)
  - Southern Europe: Madrid (40ºN)



Demand variation for East, South and West-facing façades

Modeled offices perform similarly for the considered façade orientations.

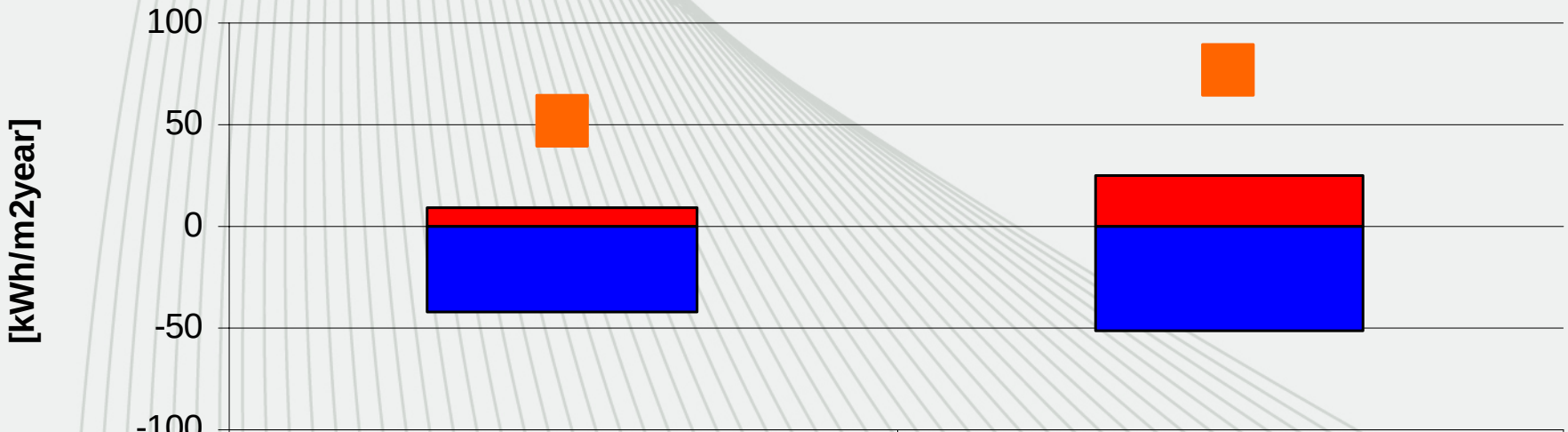
Berlin. 30% glazed façade.



	East	South	West	East	South	West	East	South	West
	No shading			Full shading			Variable shading		
Heating	9	6	9	12	11	12	9	6	10
Cooling	-42	-45	-42	-26	-26	-26	-26	-26	-26
Total	51	51	52	38	37	38	35	32	35

Glazing Ratio

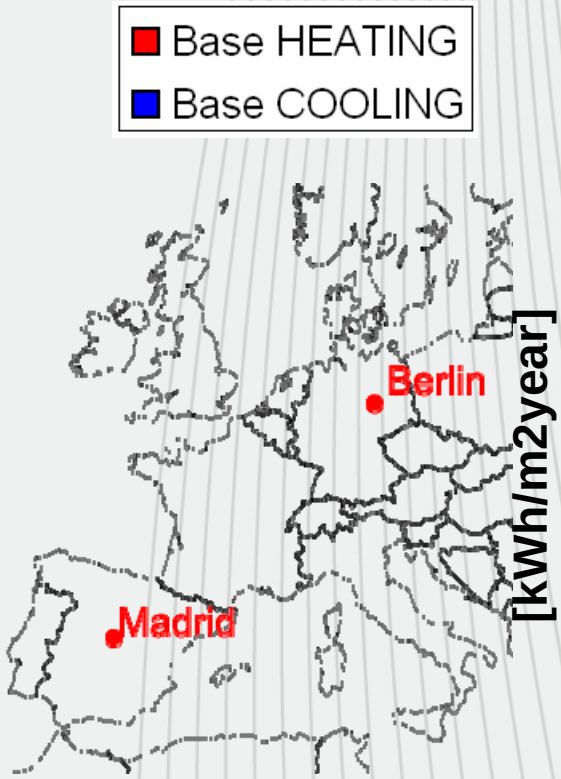
Higher glazing rate → Higher cooling load AND Higher heating load



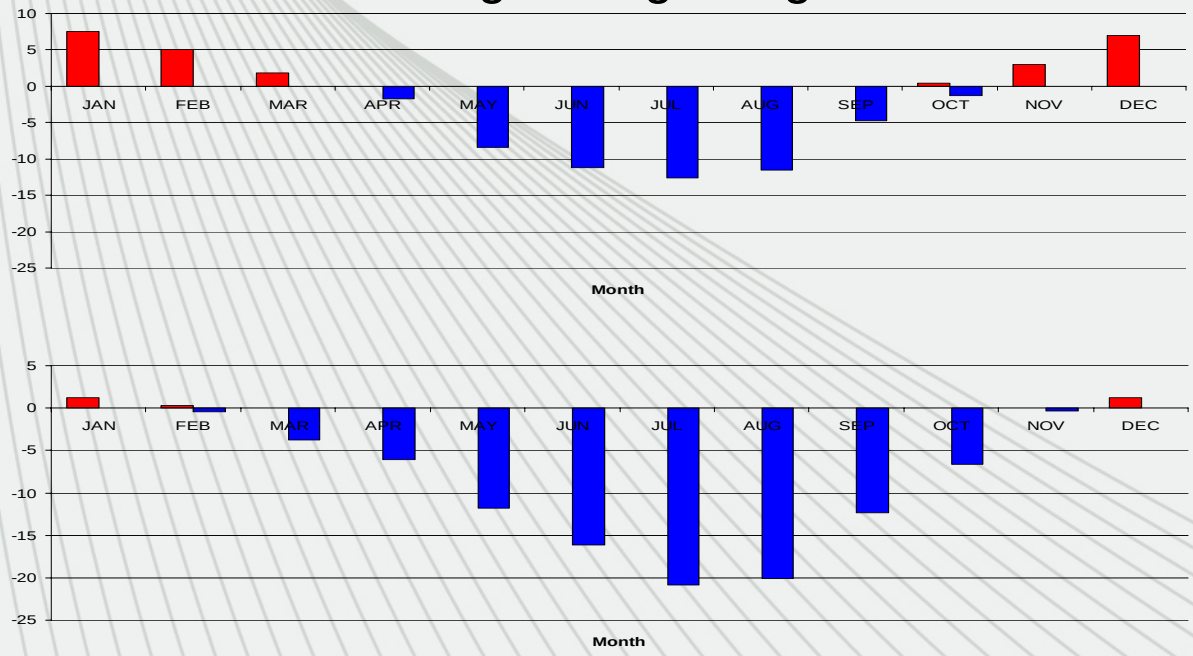
	30% glazing	90% glazing
Heating	9	25
Cooling	-42	-52
Total	51	76

Geographic Location

Shading is more needed in Southern Europe as higher cooling loads are present.



Berlin, East facing 90% glazing rate.

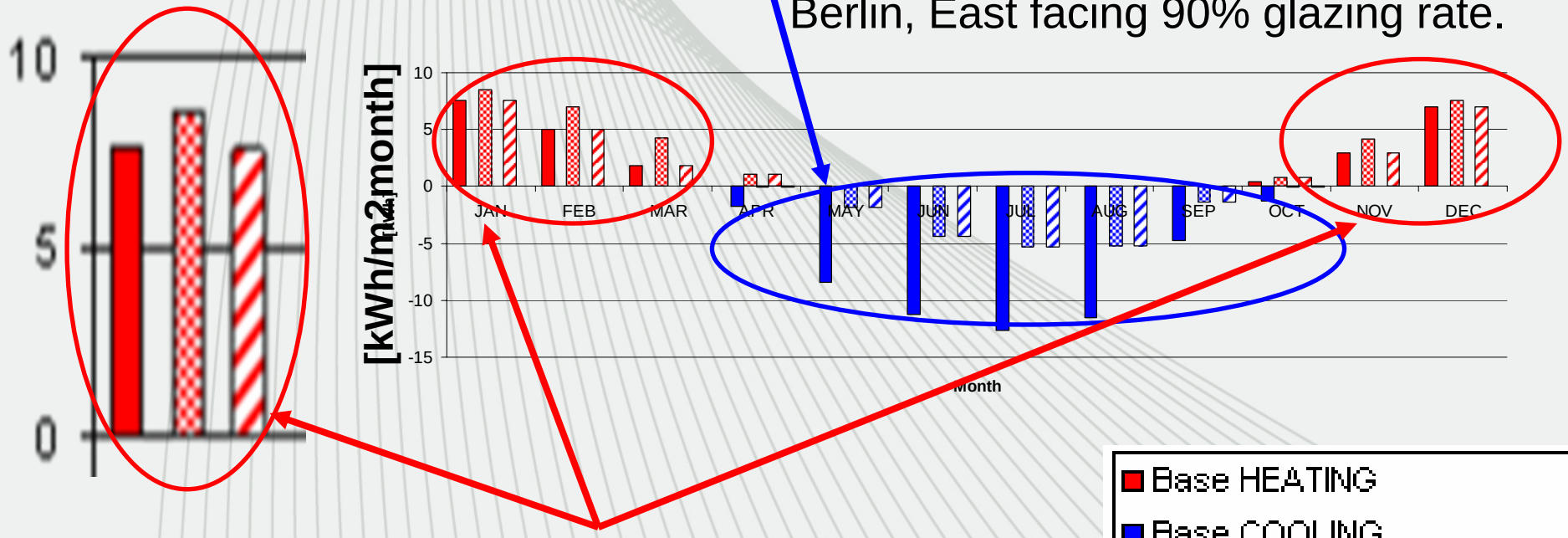


Madrid, East facing 90% glazing rate.

Load reduction with shading devices

Cooling loads are heavily reduced with shading devices.

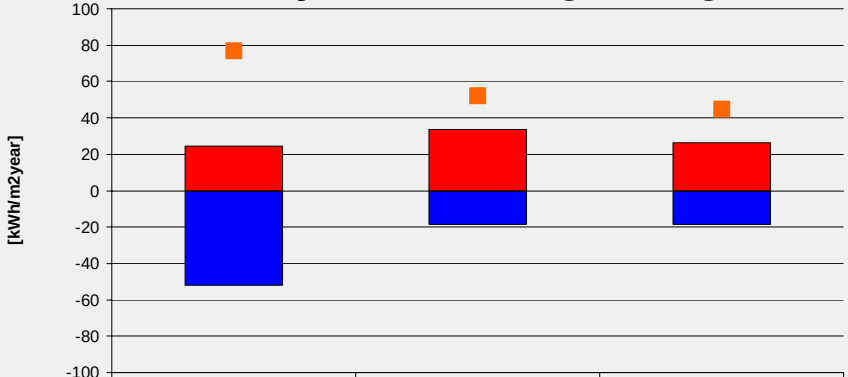
Berlin, East facing 90% glazing rate.



Fixed shading increases heating loads in winter.

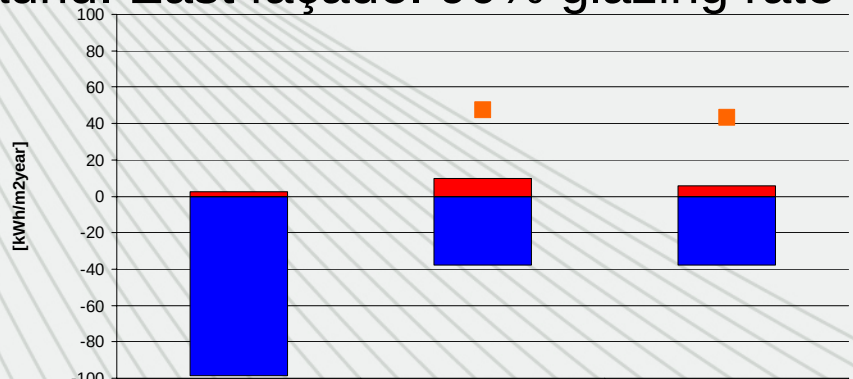
Load reduction for different locations and shading strategies

Berlin. East façade. 90% glazing rate



	Base	Sh	Var
Cooling	-52	-18	-18
Heating	25	33	26
Total	76	52	45

Madrid. East façade. 90% glazing rate



	Base	Sh	Var
Cooling	-98	-38	-38
Heating	3	10	6
Total	101	48	43

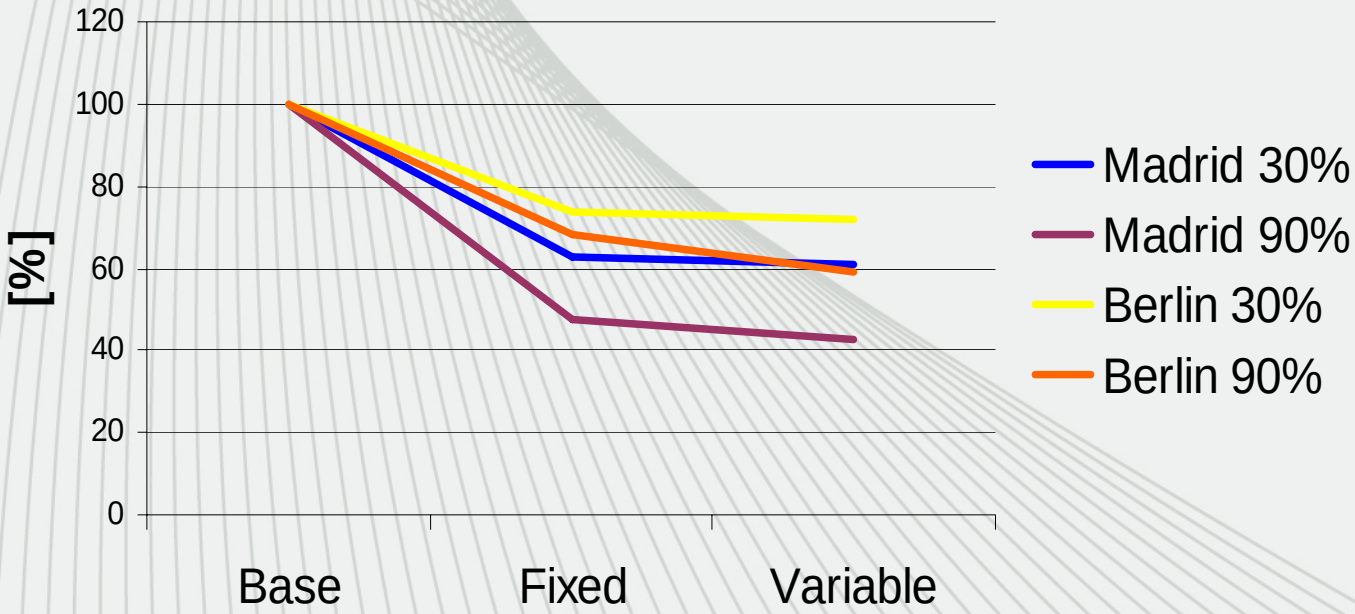
Summary

- Modern office buildings have increasingly large glazed areas, which create glare discomfort and increase energy demand (Heating & Cooling).
- The need for solar control has led to the development of solar shading devices and control strategies.
- A 3D expanded sheet shading device has been modelled in order to assess solar control strategies.

Conclusions

- Fixed Solar shading always decreases energy consumption.

  {Reduction of 25-50% over total energy demmand}



- Variable solar shading further decreases energy consumption for highly glazed areas in Central Europe.

  {An aditional 10% reduction for Berlin 90% glazed}

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