Passivhaus Trust

#UKPHC20

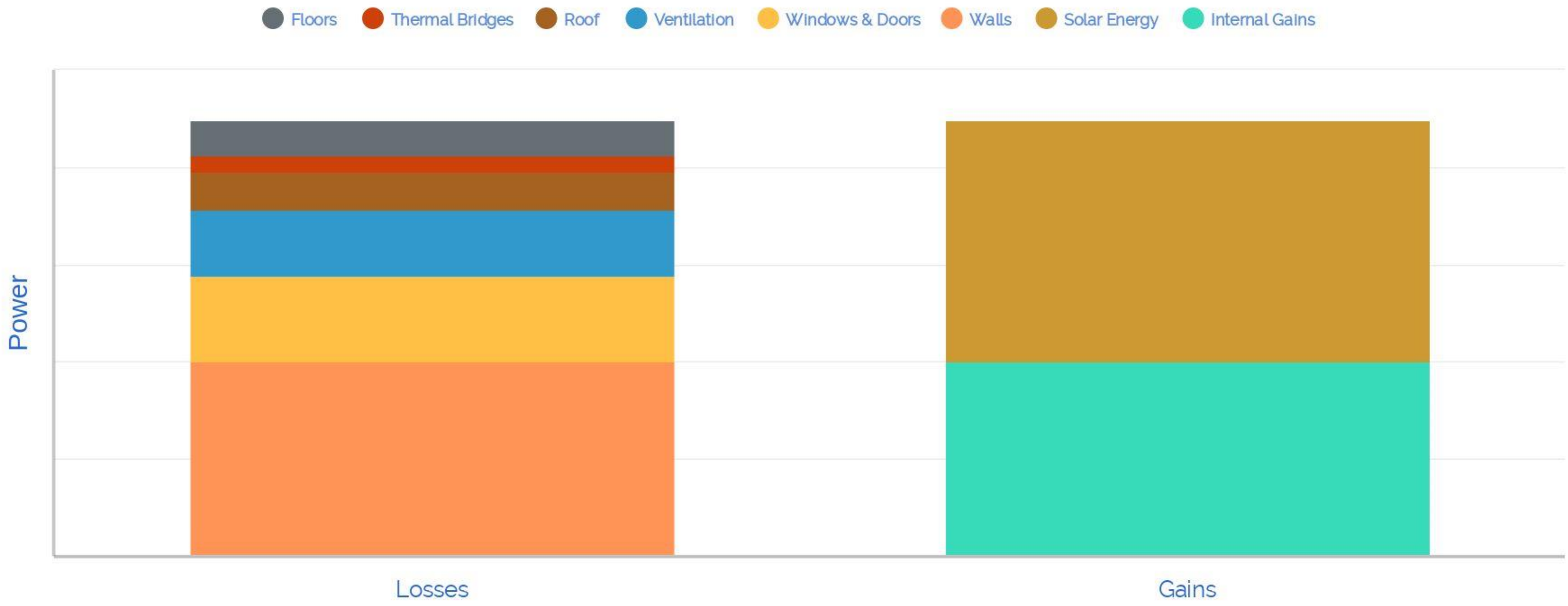
Summer Overheating

John Palmer, Passivhaus Trust

Agenda

1. How do buildings overheat?
2. Strategies to counter overheating?
3. Do Passivhaus buildings overheat?
4. Key Indicators
5. Stress Tests
6. Summer Overheating supplementary tool

How do buildings overheat?



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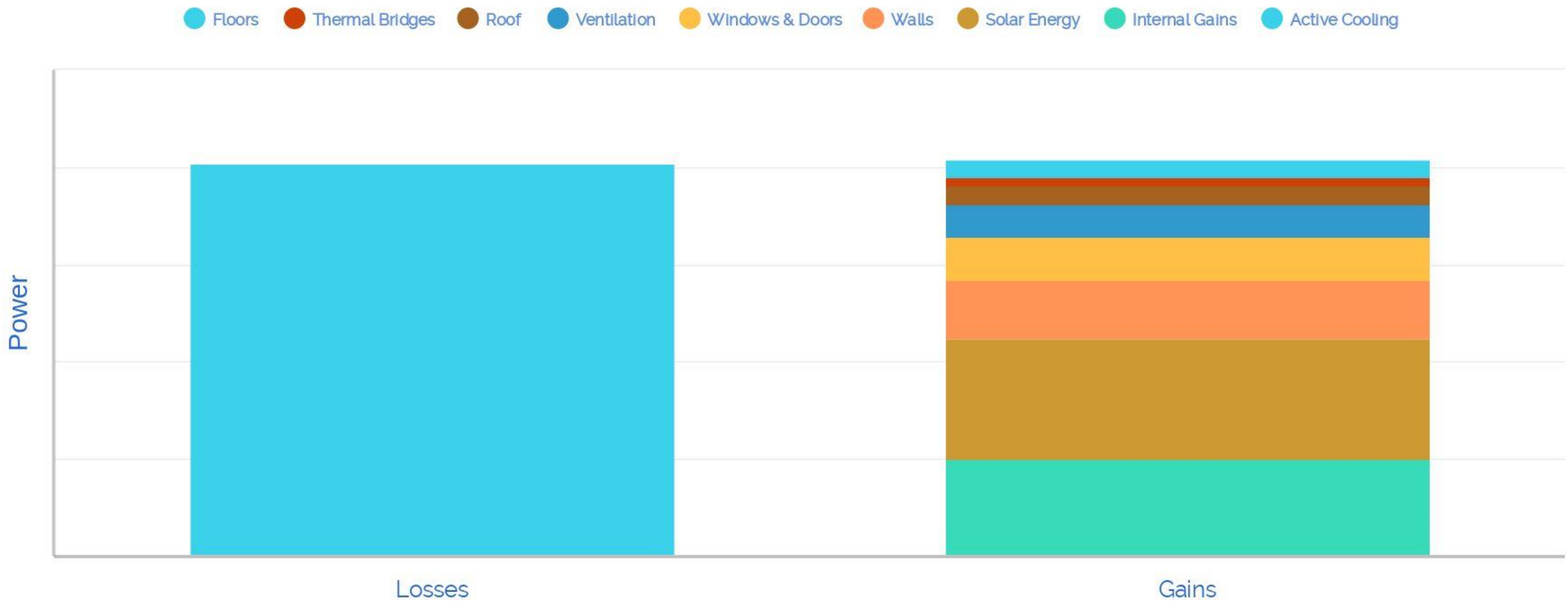
Baby it's hot outside ...



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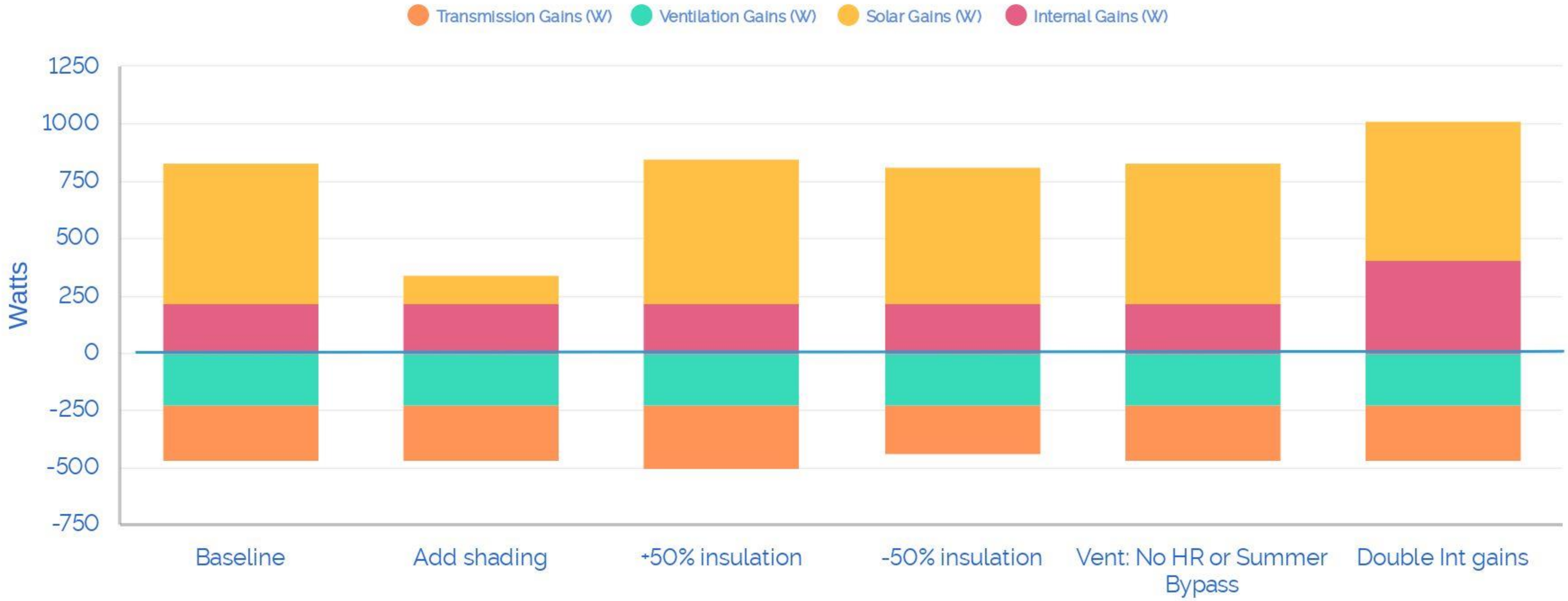
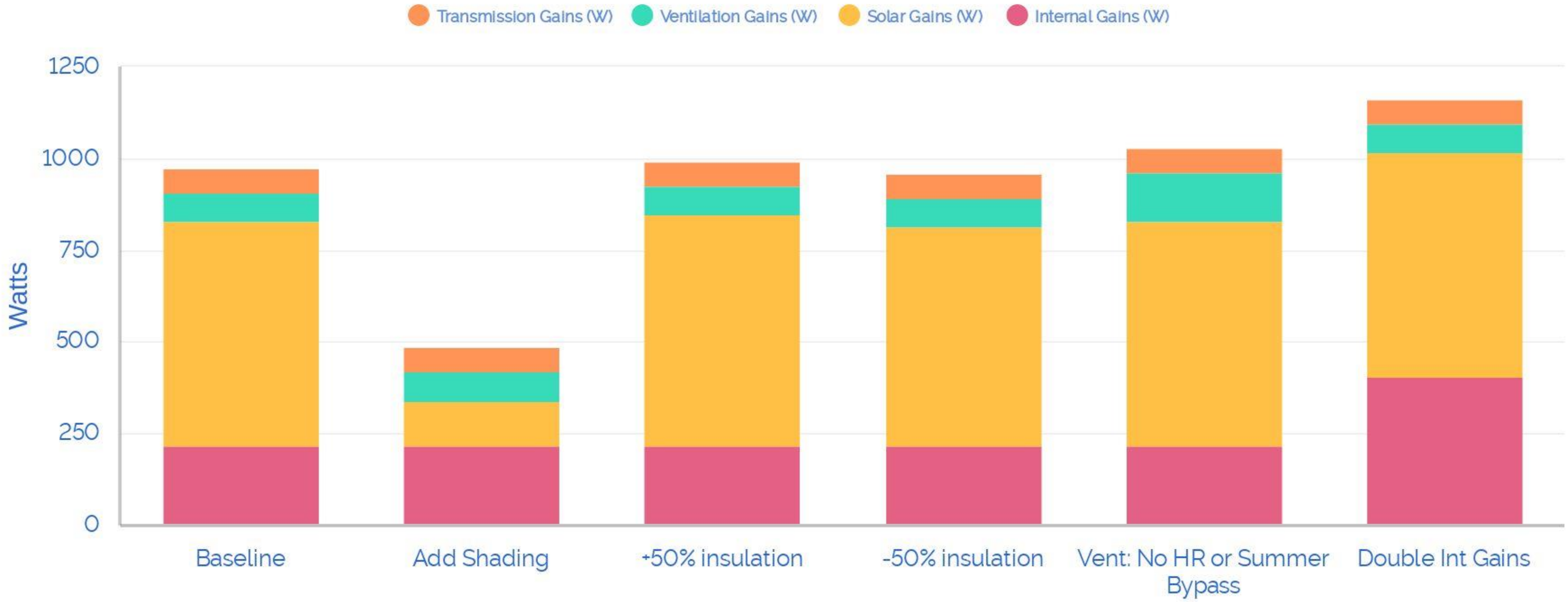
Heating mechanisms

- Solar
- Internal gains from systems
- Internal gains from occupancy

Relative Impact and Sensitivity of heat sources



What about in a warming climate?



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Prevention is better than cure

- Shading
- Reduce internal gains
- Occupancy factors

Removing heat

- Opening windows
- Fabric losses
- Mechanical ventilation
- Active cooling

Robustness and Effectiveness of Design Strategies

Scenario	Assessment of Robustness	Robustness (1-10)	Effectiveness (1-10)	Overall Score
Overhang Shading	Robust in all situations	10	9	19
Reduced g-value	Robust in all situations	10	8	18
Reduced glazing area	Robust in all situations	10	7	17
Increase MVHR Flow rate	Subject to correct control systems	8	7	15
External Blinds	Subject either to automation or action by occupants. Automation could fail and occupants may be disinclined to use due to loss of external views.	3	10	13
Reduce Domestic Hot Water Gains	Moderately robust – other than usage/duration which will be subject to occupancy habits	6	6	12
Internal Shading	Subject either to automation or action by occupants. Automation could fail and occupants may be disinclined to use due to loss of external views.	3	7	10
Increase window opening time	Subject to action by occupants and to external factors such as noise or pollution	3	7	10
Reduce Internal gains from appliances	Subject to both appliance types/numbers and usage by occupants	2	6	8

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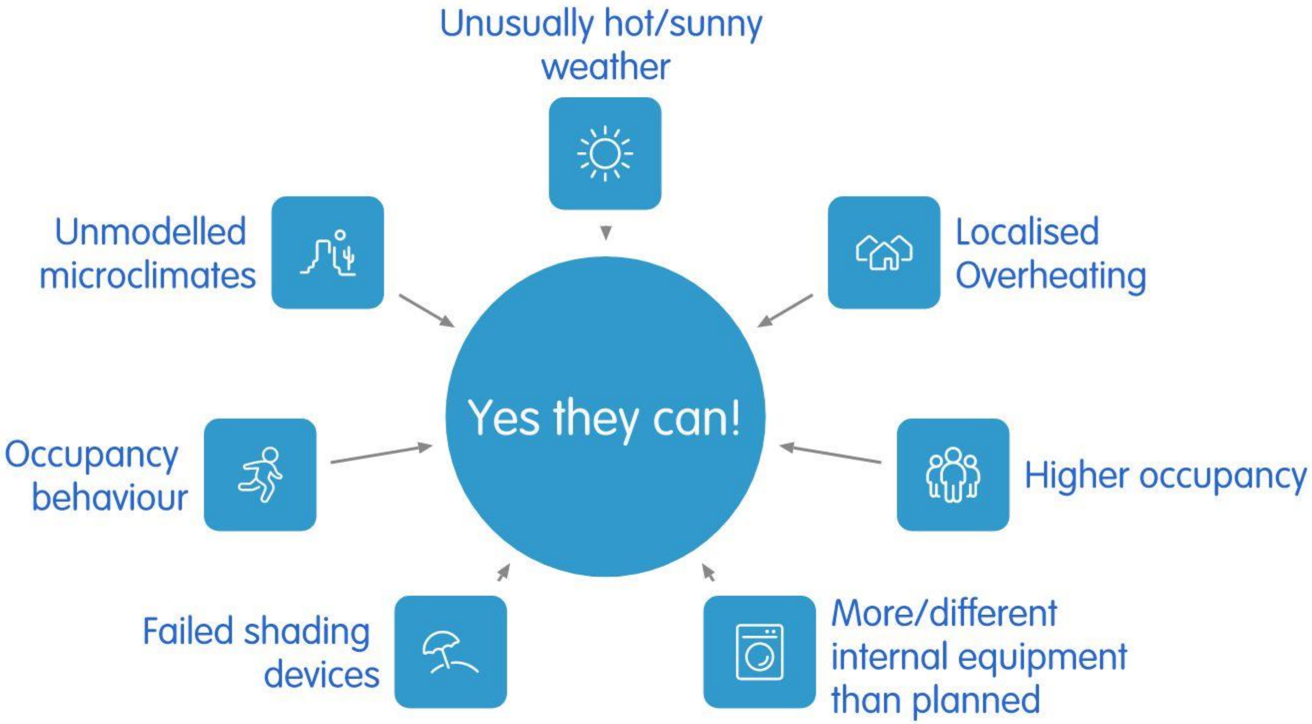
Do Passivhaus Buildings Overheat?



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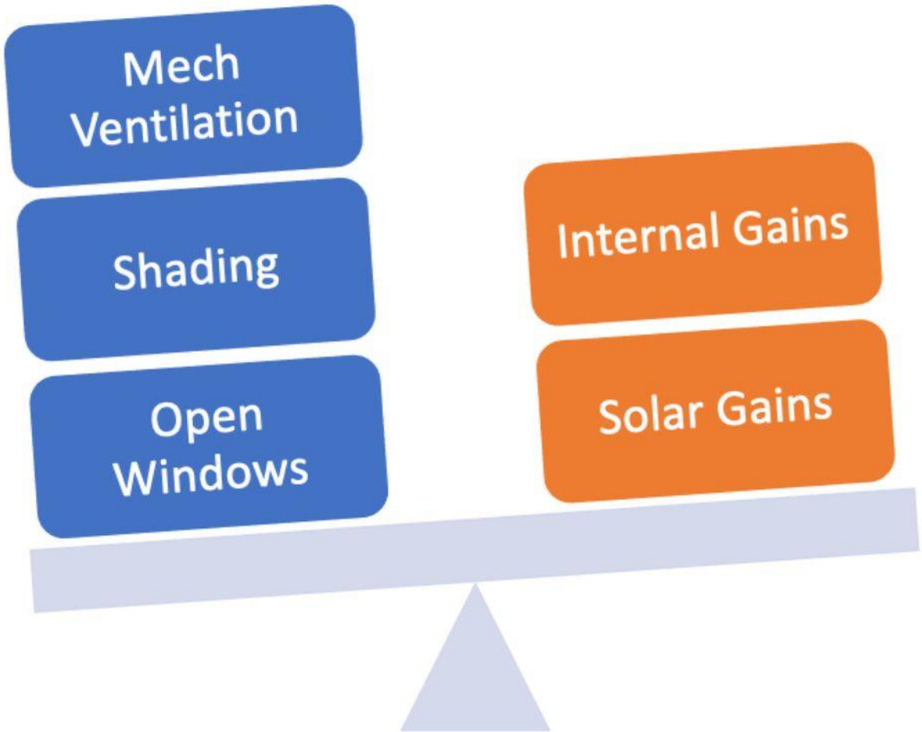
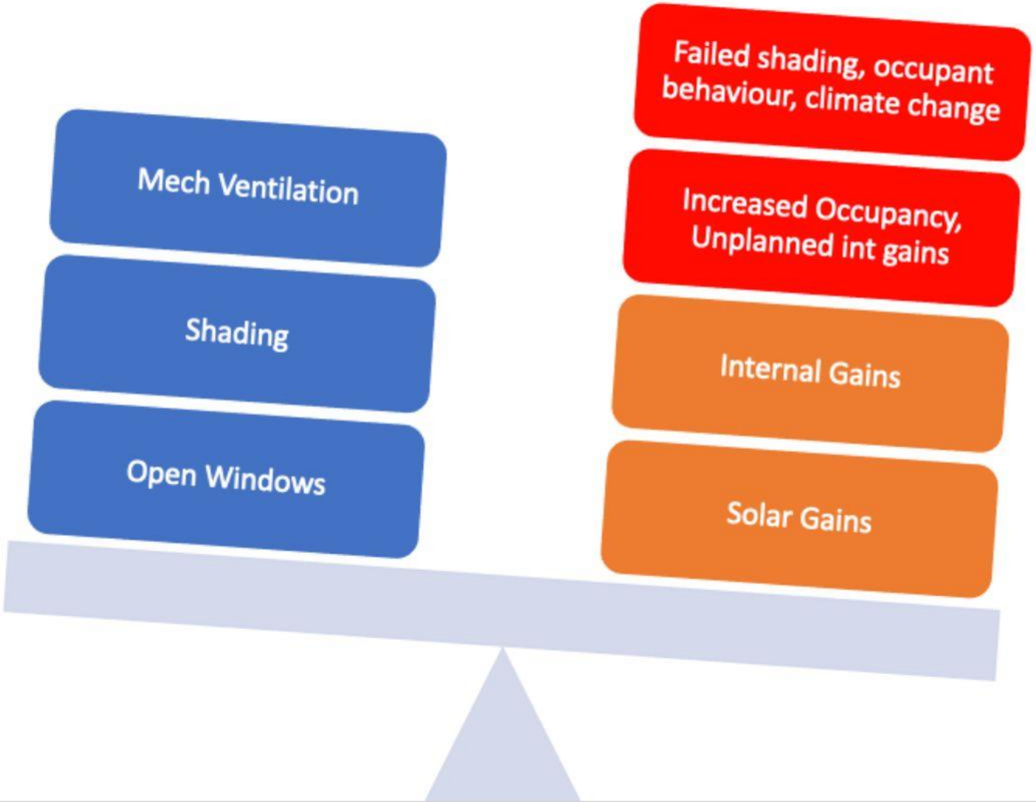
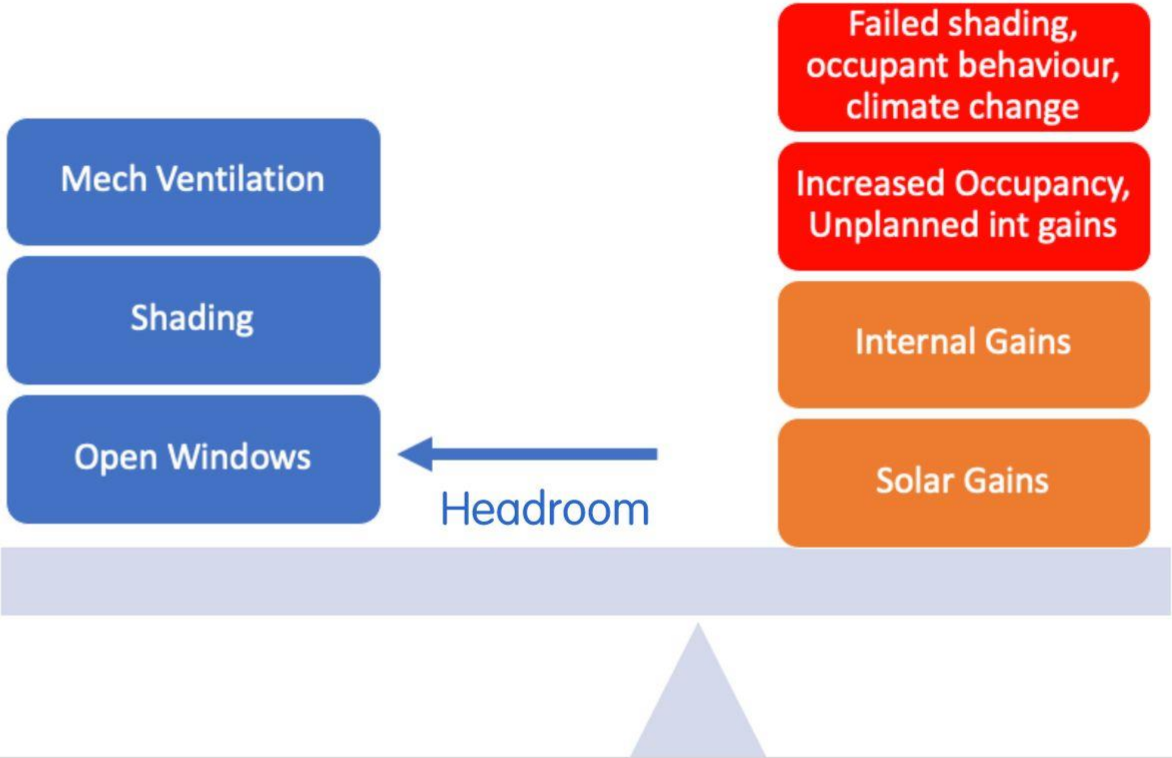
Overheating balance ...



Sprinkle on some unknowns/unplanned



So, we need some headroom ...



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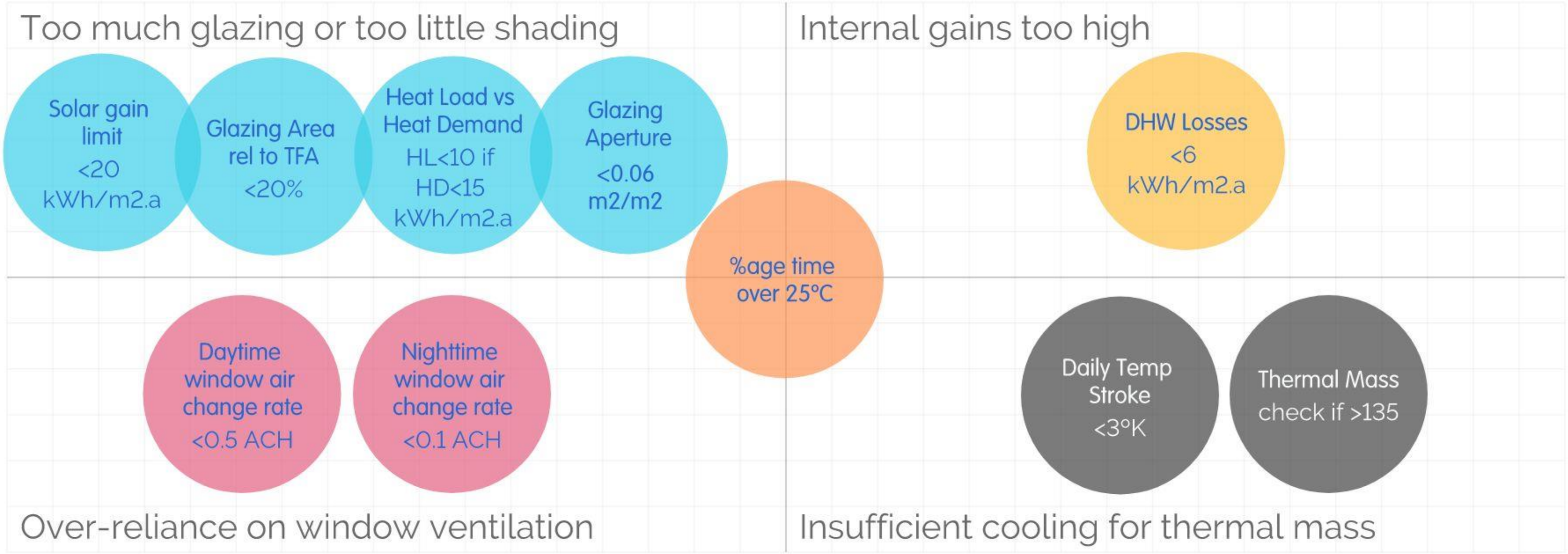
Key Indicators - how much headroom do we have?

1. Percentage time above 25°C
2. Solar gain limit
3. Glazing area as a proportion of TFA
4. Glazing Aperture
5. Heating Load vs Heating Demand
6. Domestic Hot Water losses
7. Daytime air change rate from windows
8. Nighttime air change rate from windows
9. Daily Temperature Stroke
10. Thermal Mass

Key Indicators



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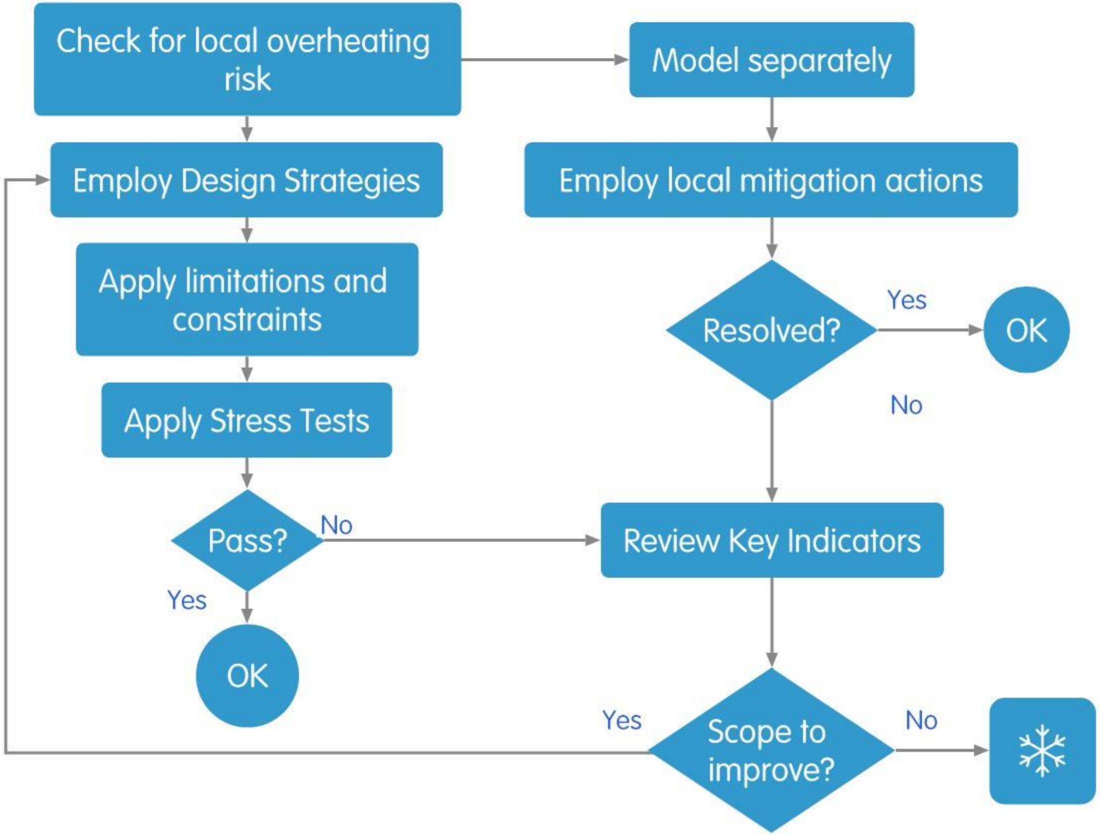
How to use the strategies, indicators and stress tests ...



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Stress Tests

Reduce window daytime ventilation rate to zero

Reduce window nighttime ventilation rate to zero

Remove all temporary shading

Increase occupancy to 50% or fill all bed spaces

Use future climate data (1.5°C) and/or heat island effect

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Summer Plus Sheet

Passivhaus Trust SummerPlus

Design Strategies

	Impact on overheating	Hints and Tips
Overhang shading	Reduces solar gain in summer whilst maintaining winter gains	Aim to subtend an angle of 60° from the end of the overhang to the lower edge of the glazing
Reduced glazing g-value	Reduces solar gains	Be aware that this is likely to increase space heating demand. Consider lower g-values in specific at-risk areas.
Reduce glazing area	Reuces solar gains	Will need to be balanced against reduced gains and reduced daylighting
Increase MVHR flow rate in summer	Increases ventilation rate without opening windows	Acoustic issues of 'oversizing' the ventilation ducts will need to be considered. A robust control mechanism for triggering increased flow will also need to be implemented.
External vertical shading	Reduces solar gain	Subject to occupancy habits, so control mechanism should be robust and easy to use. Overhang shading should be prioritised.
Reduce domestic hot water losses	Reduces internal gains	Consider shorter and small diameter pipe runs, small bore pipes if lengths allow, smaller storage volumes and lower storage temperatures.
Internal shading	Reduces solar gains	Less effective than external shading and subject to occupancy habits. Last resort after external shading.

Risk of Localised Overheating

	Is this statement true (Yes/No) (to be completed by designer)	Further action required?	Area specific modelling and, if necessary, mitigation action taken? (to be completed by designer)	Status
Is there an area which has a higher glazing proportion than overall?	Yes	Area specific modelling recommended	No	Further action advised
Is there an area where window opening is restricted compared to the rest of the builing? e.g. for noise or security reasons	No	None	No	No further action
Is there an area which is not subject to the same shading objects as the majority of the façade?	No	None	Yes	No further action
Is there an area in which only single aspect ventilation is possible?	Yes	Area specific modelling recommended	Yes	No further action
Is there an area which is adjacent to a particular internal heat source (e.g. plant room	Yes	Area specific modelling recommended	Yes	No further action
Are there any rooms where rooflight areas are greater than 10% of the room area?	No	None	Yes	No further action
Have bedrooms been checked to see if they have operable windows and cross ventilation?	Yes	Area specific modelling recommended	Yes	No further action

Limitations and Constraints

	Is this statement true (Yes/No) (to be completed by designer)	Confirm that these have been addressed in the modelling input (Yes/No) (to be completed by designer)	Evidence of rationale provided to certifier? (Yes/No)	Further action required?
Will external noise limit window opening?	Yes	Yes	No	Further action advised
Will external pollution limit window opening?	No	Yes	Yes	No further action
Will security issues limit window opening?	No	Yes	Yes	No further action
Are there significant restrictions on internal air movement?	Yes	Yes	Yes	No further action
Are windows difficult to access and open?	Yes	No	Yes	Further action advised
Is any shading difficult to access or deploy?	Yes	Yes	Yes	No further action
Are occupants likely to be absent when windows need to be opened?	Yes	Yes	Yes	No further action
Will external shading restrict views?	Yes	Yes	Yes	No further action

Overheating Key Indicators

	Current Value		Suggested Limit	Requires attention?	Implication:	Potential actions to address	Potential secondary impacts:
Current summer overheating rate	6.2%	%	0%	Yes	Building could potentially overheat if occupancy or modelling assumptions prove to be invalid	Consider all potential design strategies below to reduce below limit	Reductions in glazing area need to be balanced against good daylighting
Daily Temperature Stoke	4.19	K	<3K	Yes	A large temperature stroke could indicate that overnight cooling may not be able to sufficiently reduce elevated temperatures	Check the thermal mass input (Verification sheet) is correct. Consider actions to reduce solar and/or internal gains.	Reductions in glazing area need to be balanced against good daylighting
Solar gains	8.9	kWh/m².a	<20	No	A high proportion of solar gains could indicate that glazing has been increased to achieve a lower space heating demand and is could therefore result in elevated summer gains	Check glazing proportions/apertures. Check provision of robust summer shading. Consider reducing glazing	Reductions in glazing area need to be balanced against good daylighting
Domestic Hot Water Losses	6.5	kWh/m².a	<6	Yes	There are higher than expected internal gains arising from domestic hot water which could exacerbate overheating. There is therefore potential to improve in this area	Consider shorter and small diameter pipe runs, small bore pipes if lengths allow, smaller storage volumes and lower storage temperatures.	Pressure loss will need to be considered for small bore pipes. See ref for futher guidance. Disinfection cycles will need to be included if storage temperatures are <55°C
Glazing area as a proportion of TFA	21%	%	<20%	Yes	There is too much glazing area in relation to the floor area	Consider reducing glazing area. Note that glazing should also be well distributed.	Reductions in glazing area need to be balanced against good daylighting
Glazing Aperture	0.048	m²/m²	<0.06	No	There is too much glazing area in relation to the floor area which is not subject to shading or solar gain reduction	Consider additional shading or reduce glazing area. Note that <0.04 m²/m² is considered best practice for flats.	Reductions in glazing area need to be balanced against good daylighting
Relationship between Heating Load and Demand	15.3 9.9	kWh/m².a W/m²	<15 <10	No	If the heating demand has been met, but the peak load has exceeded the limit of 10 W/m2, this could indicate that excessive solar gains are being used to reduce the heat demand.	Check glazing proportions/apertures. Check provision of robust summer shading. Consider reducing glazing	Reductions in glazing area need to be balanced against good daylighting
Ventilation air change rate from windows (Day-time)	0.25	ACH	<0.5	No	The cooling strategy is overly reliant on air flow from opening windows which is subject to occupancy behaviour and thus may not be realised.	Consider all potential design strategies above to reduce this reliance.	
Ventilation air change rate from windows (Night-time)	0.00	ACH	<0.1	No	The cooling strategy is overly reliant on air flow from opening windows at night which is subject to occupancy behaviour and noise/pollution constraints	Consider all potential design strategies above to reduce this reliance.	
Thermal Mass	60	Wh/K.m²	N/A	N/A	Thermally massive buildings (>135) could be at greater risk of overheating be perpetuated in warm periods, thus additional 'headroom' should be considered. In these cases, all the key indicators should be considered.	Ensure thermal mass has been correctly calculated (thermal mass within the thermal envelope) and take action to keep all other indicators within recommended limits.	

Stress Testing

	Stressed Overheating Limit (to be inserted by designer)	Suggested Limit	Status	What does this test demonstrate?	Potential actions to address
Reduce window day ventilation rate to 0 (SummerVent sheet, cell L31)	8%	0%	Warning	Whether there is a significant reliance on window ventilation to achieve summer comfort	Consider all potential design strategies above to reduce this reliance. Use key indicators to determine what is most impacting overheating.
Reduce window night ventilation rate to 0 (SummerVent sheet, cell P59)	4%	<6%	Pass	Whether there is a significant reliance on window ventilation to achieve summer comfort	Consider all potential design strategies above to reduce this reliance. Use key indicators to determine what is most impacting overheating.
Remove all temporary shading (Temporarily remove all entries in column AH in Shading sheet)	12%	<10%	Warning	Whether there is a significant reliance on temporary shading measures which could fail or not be deployed by occupants	Consider switching to fixed shading or otherwise ensure robust deployment mechanisms
Increase occupancy by 50% or fill all bed spaces (Apply 'User Determined' occupancy in cell Q29 on Verification sheet)	4%	<6%	Pass	Whether the building is sensitive to increased occupancy in terms of its overheating response	Consider all potential design strategies above to reduce this reliance. Use key indicators to determine what is most impacting overheating.
Use Future Climate Data (Use PHPP Summer Overheating tool to apply a 1.5°C increase and/or heat island effect)	9%	<6%	Warning	Whether the building is at risk of overheating in future climates	Consider all potential design strategies above to reduce this reliance. Use key indicators to determine what is most impacting overheating.

Design Strategies

	Impact on overheating	Hints and Tips
Overhang shading	Reduces solar gain in summer whilst maintaining winter gains	Aim to subtend an angle of 60º from the end of the overhang to the lower edge of the glazing
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Reduce glazing area	Reuces solar gains	Will need to be balanced against reduced gains and reduced dayligting
Increase MVHR flow rate in summer	Increases ventilation rate without opening windows	Acoustic issues of 'oversizing' the ventilation ducts will need to be considered. A robust control mechanism for triggering increased flow will also need to be implemented.
External vertical shading	Reduces solar gain	Subject to occupancy habits, so control mechanism should be robust and easy to use. Overhang shading should be prioritised.
Reduce domestic hot water losses	Reduces internal gains	Consider shorter and small diameter pipe runs, small bore pipes if lengths allow, smaller storage volumes and lower storage temperatures.
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Solar gains	8.9	kWh/m^2.a	<20	No	A high proportion of solar gains could indicate that glazing has been increased to achieve a lower space heating demand and is could therefore result in elevated summer gains	Check glazing proportions/apertures. Check provision of robust summer shading. Consider reducing glazing	Reductions in glazing area need to be balanced against good daylighting
Domestic Hot Water Losses	6.5	kWh/m^2.a	<6	Yes	There are higher than expected internal gains arising from domestic hot water which could exacerbate overheating. There is therefore potential to improve in this area	Consider shorter and small diameter pipe runs, small bore pipes if lengths allow, smaller storage volumes and lower storage temperatures.	Pressure loss will need to be considered for small bore pipes. See ref for further guidance. Disinfection cycles will need to be included if storage temperatures are <55ºC
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Ventilation air change rate from windows (Night-time)	0.00	ACH	<0.1	No	The cooling strategy is overly reliant on air flow from opening windows at night which is subject to occupancy behaviour and noise/pollution constraints and thus may	Consider all potential design strategies above to reduce this reliance.	
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Remove all temporary shading (Temporarily remove all entries in column AH in Shading sheet)	12%	<10%	Warning	Whether there is a significant reliance on temporary shading measures which could fail or not be deployed by occupants	Consider switching to fixed shading or otherwise ensure robust deployment mechanisms
Increase occupancy by 50% or fill all bed spaces (Apply 'User Determined' occupancy in cell Q29 on Verification sheet)	4%	<5%	Pass	Whether the building is sensitive to increased occupancy in terms of its overheating response	Consider all potential design strategies above to reduce this reliance. Use key indicators to determine what is most impacting overheating.
Use Future Climate Data (Use PHPP Summer Overheating tool to apply a 1.5ºC increase and/or heat island effect)	9%	<5%	Warning	Whether the buidling is at risk of overheating in future climates	Consider all potential design strategies above to reduce this reliance. Use key indicators to determine what is most impacting overheating.

Summer overheating

Reduce window daytime ventilation rate to zero

Reduce window nighttime ventilation rate to zero

Remove all temporary shading

Increase occupancy to 50% or fill all bed spaces

Use future climate data (1.5°C) and/or heat island effect

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A HEALTHY & GREEN FUTURE

THANK YOU

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