GHG benefits of Innovative Material Components beyond weight reduction
### Warm Weather Trip Cycle

<table>
<thead>
<tr>
<th>Glazing factors for GHG emissions</th>
<th>Parked Car</th>
<th>Moving Car</th>
<th>Moving Car</th>
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<tbody>
<tr>
<td>Solar transmission (air @ wind speed)</td>
<td>Cabin temperature &gt; ambient</td>
<td>Solar transmission (air @ car speed)</td>
<td>Solar transmission (air @ car speed)</td>
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<td>Thermal transmission</td>
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<td>Comfortable</td>
<td>Weight</td>
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<td>Ambient</td>
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<td>Soak</td>
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<td>Time</td>
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<tr>
<td>Cabin Temperature</td>
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</tbody>
</table>

**Analogy...**

House insulation : utility bills

Glazing thermal conductivity : steady state HVAC load
SABIC-IP CFD* analysis quantifies thermal conductivity effect

Air speed
Temperature and radiation data
Phoenix
Minneapolis

Glazing parameters
Area
Orientation
Solar transmission
Thermal transmission
Thermal conductivity
Thickness

Changes in steady state HVAC load due to changes in glazing thermal conductivity

Changes in steady state GHG emissions & Battery discharge rate & life

**e.g. 5 gCO2/mile reduction due to reduced thermal conductivity of polycarbonate rooflite and backlite vs. baseline glass, Phoenix, 100 kmph

Reduced glazing thermal conductivity → reduced steady state HVAC load
→ reduced GHG emissions & battery discharge rate (hybrids)

*Computational Fluid Dynamics
Conclusions

Reduced glazing thermal conductivity ...
  - Aids maintenance of comfortable cabin temperature
  - Hot weather: GHG reduction, additive to weight reduction benefits
  - Cold weather: battery discharge rate reduced & life extended ...

  *Indirect GHG benefit*

  *Supports value proposition of hybrid vehicles*

Trip Cycle Analysis (origin to destination) recognizes ...
  - Initial cabin temperature
  - Transition to comfortable temperature
  - Maintenance of comfortable temperature

Drive cycle for AC indirect emissions should ...
  - Encompass steady state cabin temperature
  - Simulate air flow over moving car