

# SPD “Smart” Windows and Energy Efficiency

Presented by:

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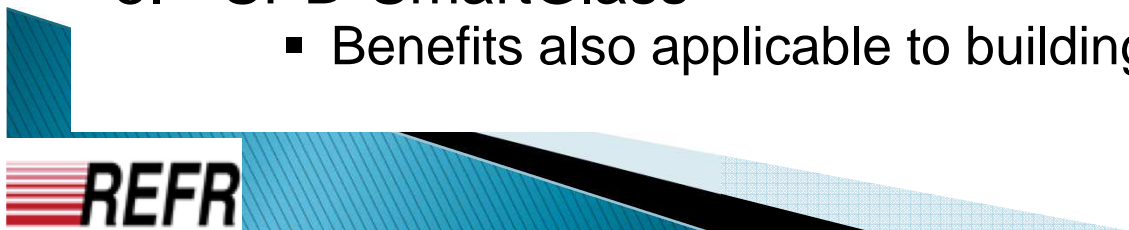
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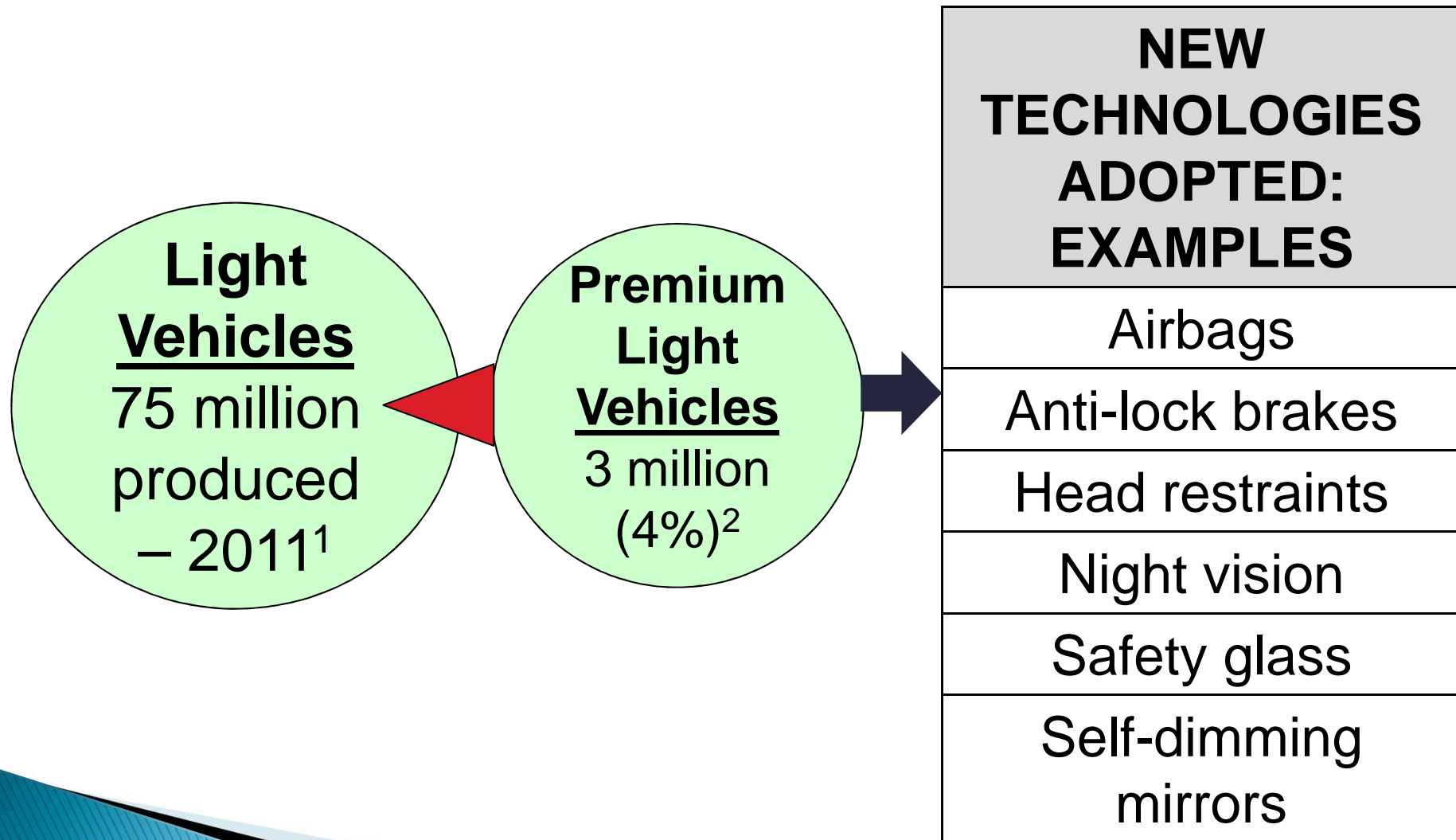
# Presentation Overview

1. Premium Vehicles:
  - Early adopters of innovative technology
2. Trends in the Automotive Sector – Consumer preferences
  - Daylighting/More glass in vehicles
3. More glass in Vehicles – Implications
  - Challenges to vehicle fuel efficiency/CO<sub>2</sub> emissions
4. SPD “Smart” Windows, Sunroofs and Roof Systems
  - Help satisfy consumer preferences
  - Improve privacy/security
  - Reduce heat build-up in interiors:
    - Save on HVAC demands
    - Improve energy efficiency
    - Reduce emissions
5. SPD-SmartGlass
  - Benefits also applicable to buildings and other applications

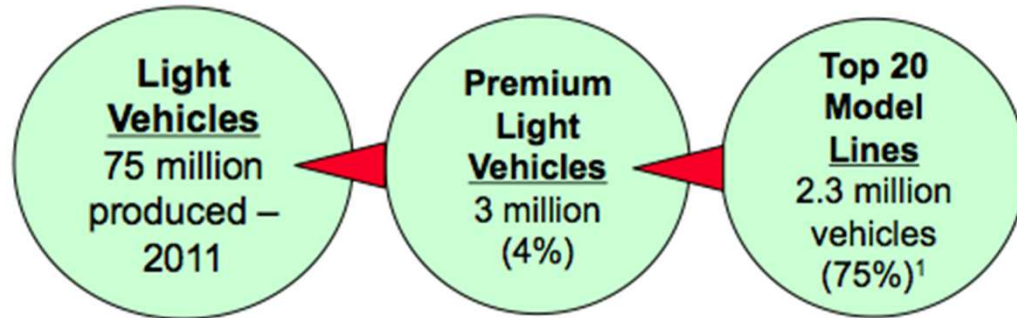


# Premium Light Vehicles:

Frequently Early Adopters of Technological Innovation



# Premium Light Vehicles: Leaders in Design Innovation



## “TOP 20” DESIGN FEATURES<sup>1</sup>

- Sunroof:
  - Standard – 70%
  - Option – 30%
- Panoramic Roof:
  - Option – 55%

## OVERALL MARKET<sup>1</sup>

- Approximately 1/3 of all vehicles are purchased with a sunroof

**Conclusion: Roof glass is used extensively, elevating the need for solar control.**



Mercedes-Benz Viano Vision Pearl luxury concept van exhibited at the 2011 Frankfurt Auto Show



Audi A2 concept all-electric vehicle exhibited at the 2011 Frankfurt Auto Show

# Consumers' Needs: Leading to More Glass in Vehicles

## NEEDS

- More natural light in the vehicle
- Improved views with on-demand privacy/security
- “Open-air” feeling even during inclement/cold weather



Mercedes-Benz 2012 SLK; Photo credit: Daimler AG

*Light has become the new luxury.*

- Ford Motor Company (August 2011)

### ***Auto Buyers Picking Panorama Roofs Instead of Convertibles***

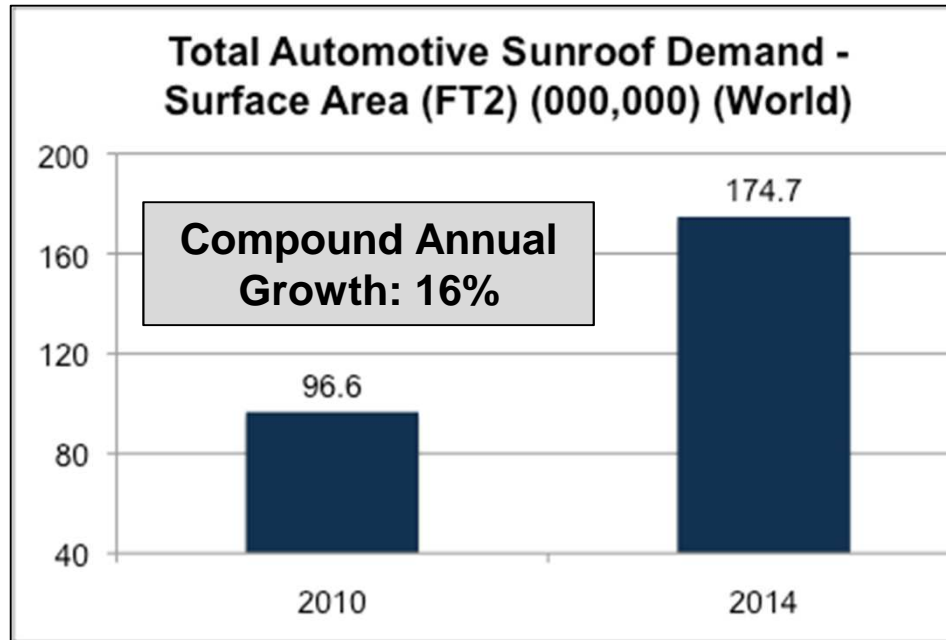
*Auto buyers are trading the open air for high-tech glass. Ford Motor Co. reports that the sales of vehicles with so-called vista or panoramic roofs are soaring. About half the buyers of its Explorer and Edge SUVs are purchasing the option...*

- Los Angeles Times (August 15, 2011)

*Huge double sunroofs are growing more popular.*

- New York Times (October 2, 2011)

# Growing Total Surface Area of Sunroofs



## Main Factors

- Increasing % of vehicles with a sunroof
- Larger sunroofs

## ENERGY EFFICIENCY AND DESIGN CHALLENGES

- **Excessive heat build-up** in vehicle interiors
  - More exposure to solar energy
  - More weight and/or more energy devoted to HVAC system to meet cooling requirements
  - **Net: Reduced fuel efficiency**
- **Large glass surface areas** not as compatible with mechanical systems

# Solution:

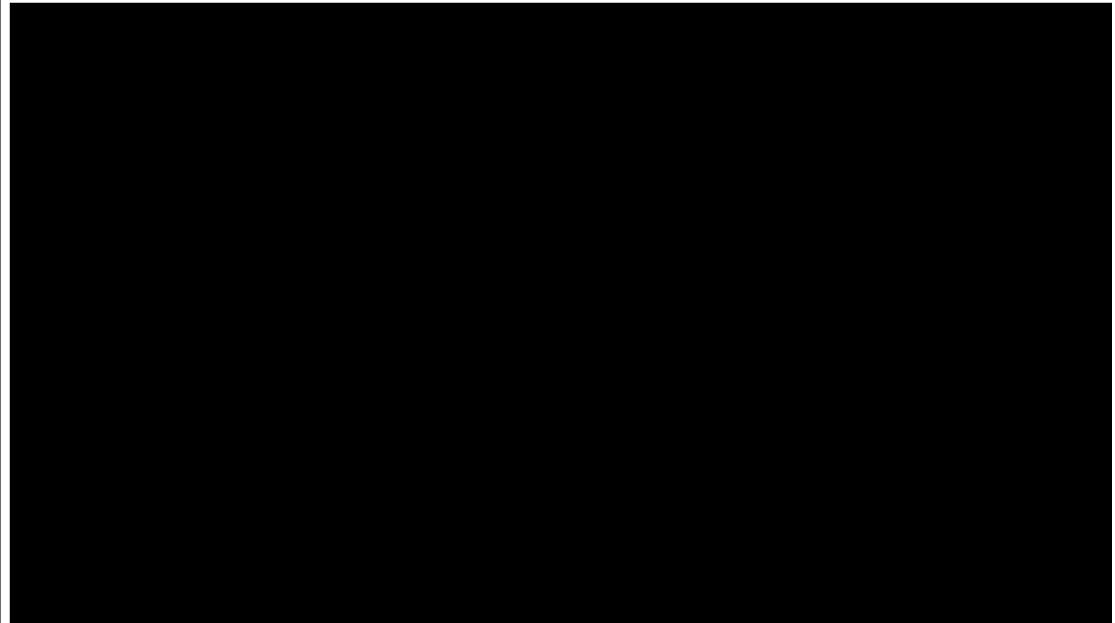
## SPD “Smart” Windows, Sunroofs & Roof Systems

### ▪ VARIABLE TINTING

- Control over amount of light entering the vehicle’s interior
- Very dark tinted state
  - > 99.5% light blockage
- Infinite intermediate states
- Instant switching
- UV rejection > 99%
- Low power draw: 1.8 mA/FT<sup>2</sup>
- Control – manual, automated

### ▪ LAMINATED FABRICATION

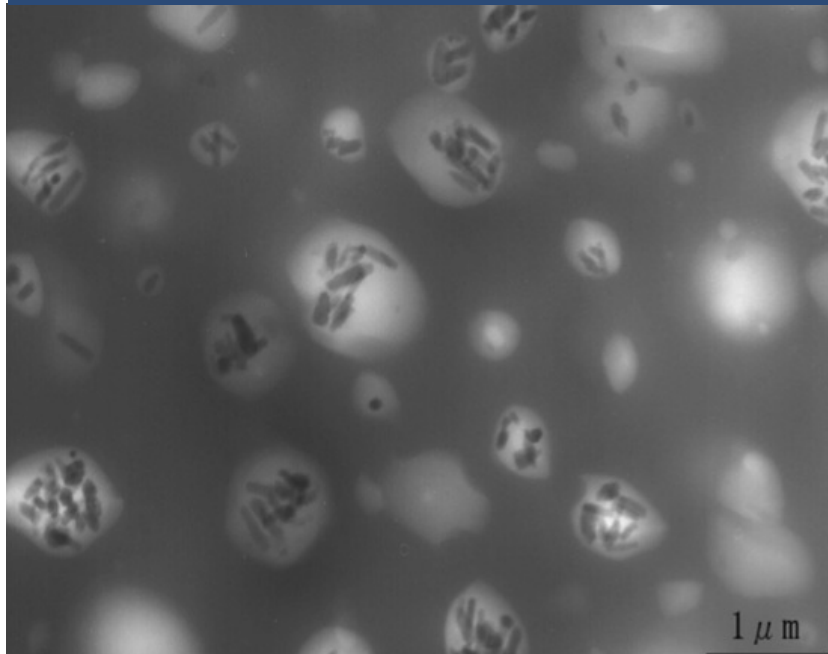
- Glass or polycarbonate
- Flat or curved
- Custom sizes and shapes



PANORAMIC ROOF WITH SPD LIGHT-CONTROL TECHNOLOGY IN CADILLAC CTS

# SPD Light-Control Technology

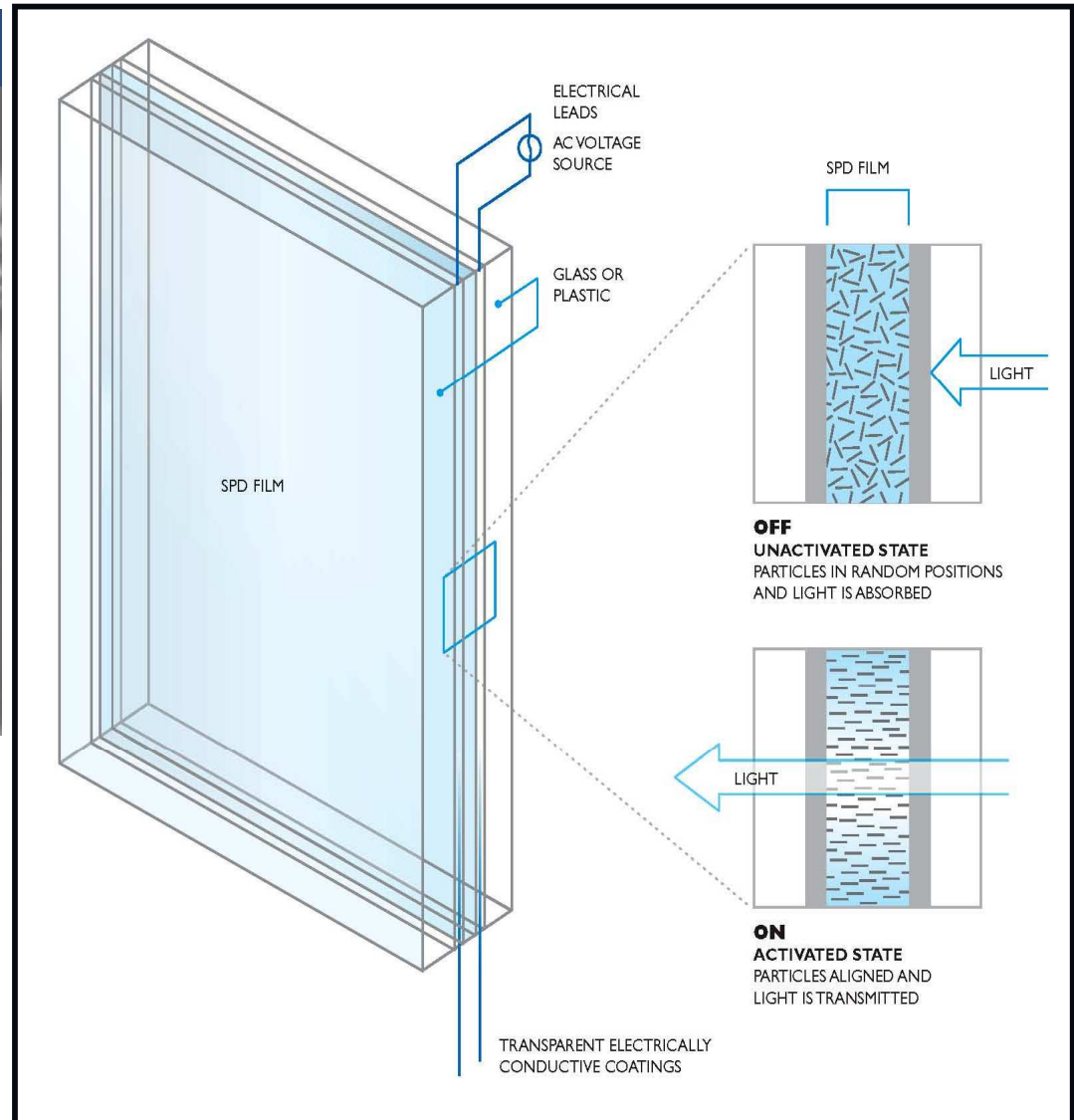
SPD = Suspended Particle Device



Proprietary nano-particles that can change orientation to control light

Image credit: Hitachi Chemical Co., Ltd.

Diagram credit: Research Frontiers Inc.



# SPD Light-Control Technology: Adopted by Mercedes-Benz

- SPD technology on panoramic roof Mercedes-Benz SLK (photo)
- First series production on Mercedes-Benz Viano Vision Pearl concept
- **SPD at 2011**
  - Mercedes-Benz Viano Vision Pearl concept

## Contributions to Heat Build-Up in a Typical Vehicle:

- Windshield – 40%
- Sunroof – 20%
- Side and Rear Windows – 40%

**SPD “Smart” Glass addresses >60%  
of heat build-up  
(up to 95% heat rejection)**



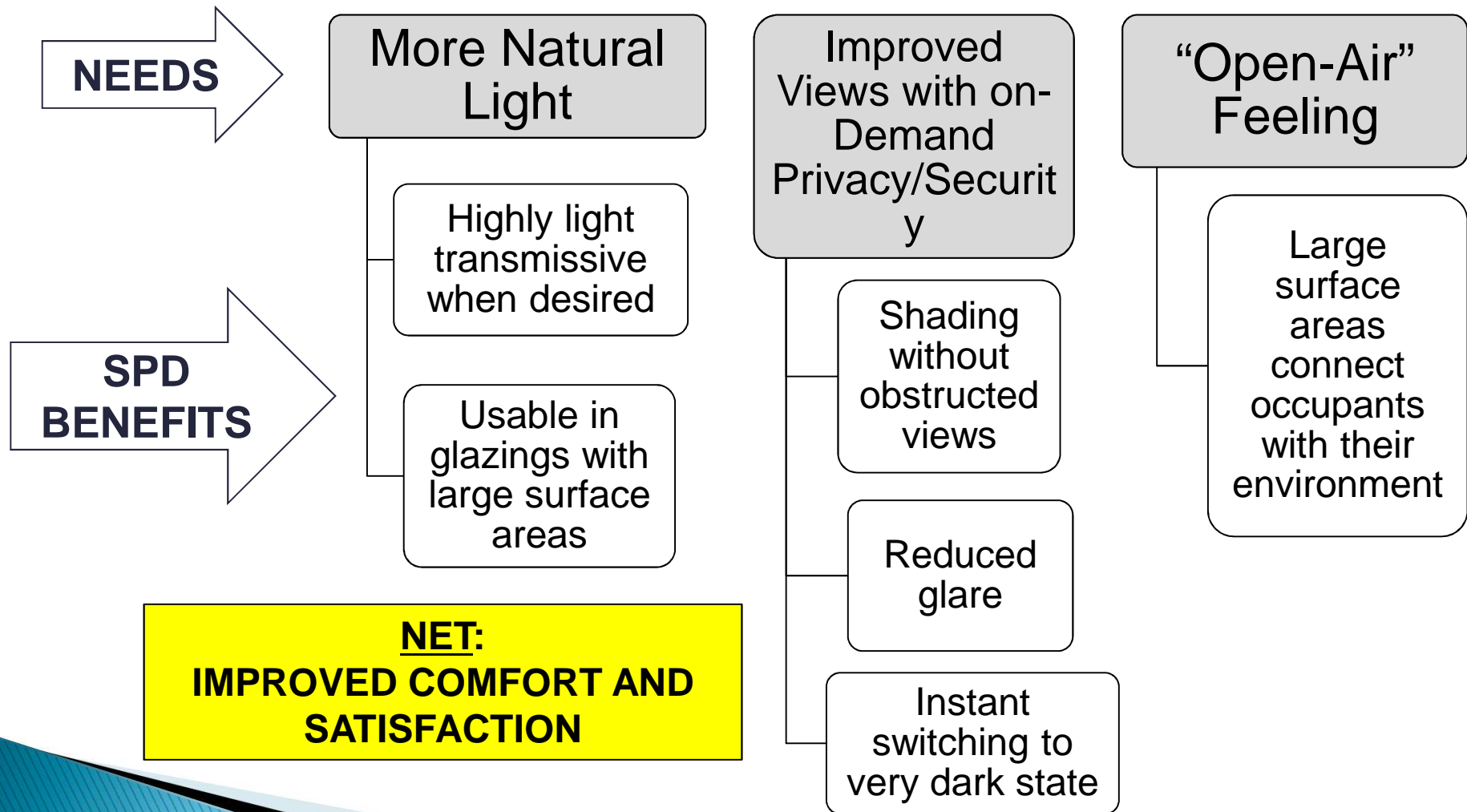
- Audi A2 all-electric concept (roof)<sup>3</sup>



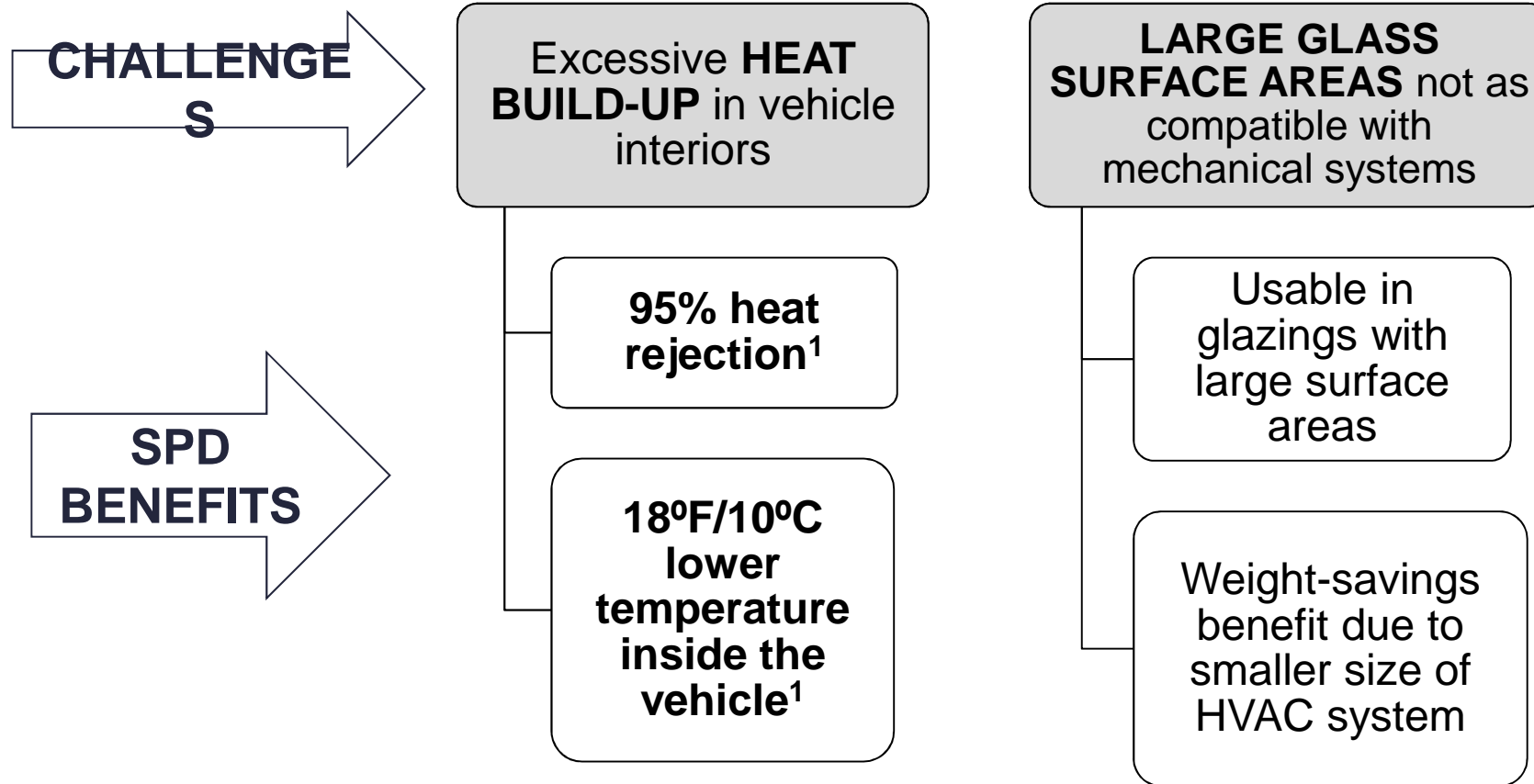
SPD TECHNOLOGY

- Less energy to cool the car
- Potential for smaller AC system
- Greater driving range

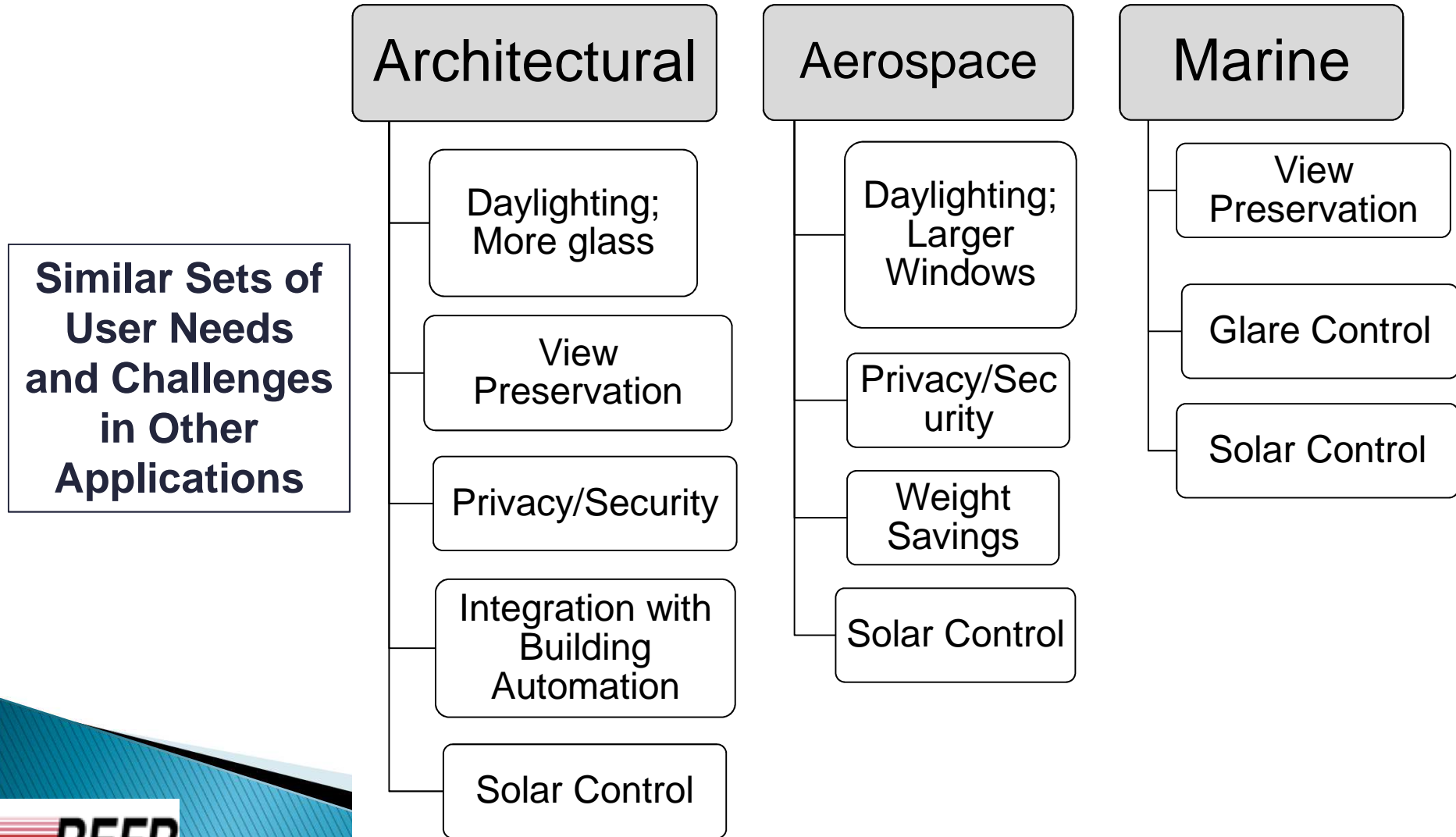
# SPD Light-Control Technology: Meets Consumers' Needs



# SPD Light-Control Technology: Meets Energy Efficiency & Design Challenges



# SPD Light-Control Technology: Benefits Applicable to Buildings and Other Applications



# SPD Light-Control Technology

Evidence of the heat-rejecting and solar control capabilities of SPD light-control technology is supported by third-party testing:

- DSET Laboratories: 94% heat rejection
- University of Cambridge – UK:
  - Heat rejection
  - SPD: *"...reduces the fluctuation of the internal room temperature quite considerably, as well as minimizing the peak daily temperature."*



Energy efficient SPD windows used in government-owned Henry House located in Fort Knox, KY.

SPD “smart” glass: *“automatically darkens and lightens to harvest daylight & save energy.”*<sup>1</sup>

## APPLICATIONS

### Automotive

Sunroofs, roof systems, side- and rear-windows

### Architectural

Windows, skylights, partitions, doors

### Aerospace

Windows, partitions

### Marine

Windows, hatches, skylights, partitions, doors

# Thank you.

- ▶ Questions and discussion.
- ▶ For more information, please contact:

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