Big Fuel Savings with Advances in Automotive Climate Control

Likely one of the last things on a driver's mind is how much energy they use for cabin heating or air conditioning. Yet surprisingly, this component of a vehicle's energy consumption is relatively large. Consider that running a vehicle's air conditioning system on full is equivalent to driving 35 miles per hour in terms of energy consumption, which can reduce a vehicle's fuel efficiency by 26%. Heating a vehicle will have a similar impact on fuel efficiency.[i] In fact, one estimate has a vehicle's HVAC system consuming 5% of the gas burned in the average American's vehicle – that's up to 30 gallons of fuel (100 litres) per year.[ii]

Clearly this is a problem vehicle manufacturers should be overcoming, especially given consumer anxiety over the rising price of fuel. It's not surprising, then, to find component manufacturers and OEMs racing to find the best advances in HVAC technology to harness waste heat and find other more efficient ways to heat and cool a vehicle's cabin.

This issue is being tackled on a variety of fronts. For instance, manufacturers and other research organizations are experimenting with things such as more efficient glazings, better insulated seats and insulation, EDV thermal systems, and more energy efficient HVAC systems. Each of these technologies has the potential to reduce fuel burned and shrink the carbon footprint of the average vehicle, which is good for consumers' pocketbooks and good for the environment as well.

Advanced Sensors and Controls for More Energy Efficient Automotive Cooling and Heating

Fine-tuning the inner workings of the conventional heating, ventilation, and air conditioning (HVAC) system of a vehicle is one way to ensure it operates more efficiently. Just like conditioning only those rooms in a home that are in use, providing warm or cool air to only those zones in a vehicle that are occupied is one way to reduce a vehicle's fuel consumption.

Building on this idea, Lexus has introduced a new S-Flow technology into their 2013 GS vehicle, which will provide greater energy efficiency and a much lower power drain for climate control. The system works by employing sensors that determine whether or not the rear and front seats are occupied. Using that information, the S-

Flow technology then automatically ensures that the climate control system works only to cool or warm seats that are occupied. All vents are shut for unoccupied seats.[iii]

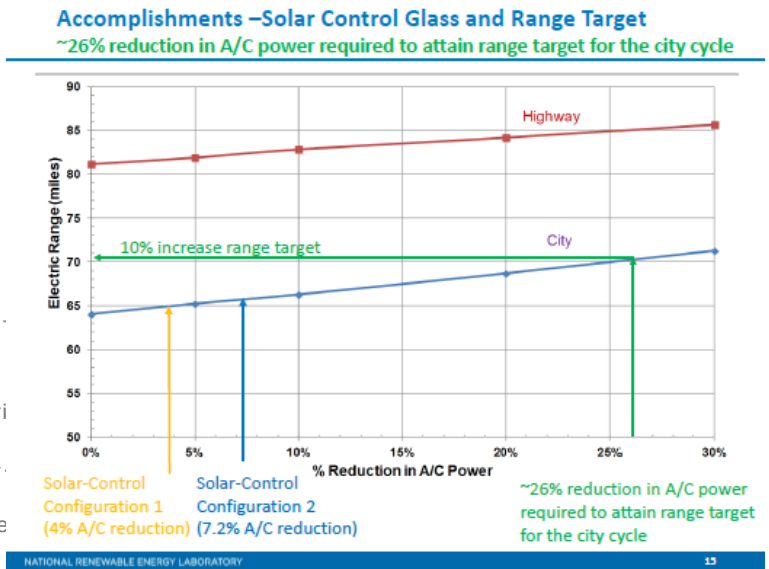
Additionally, sensors measure the temperature outside the vehicle as well as temperatures inside the vehicle. This information is fed into the system to determine the best possible level of air conditioning based also on insulation levels in the vehicle. The passengers and driver are also able to use the "Temperature Airflow Output control" to tailor the airflow volume to their liking. This two-tier interior and exterior air control also helps to prevent window fogging.

To add to its appeal, the S-Flow is equipped with Lexus' *nanoe* system which cleans the air automatically whenever the air conditioning is engaged. The *nanoe* system removes nanoparticles to purify the air expelled from the vents and eliminate odour in the cabin. The S-Flow technology garnered Lexus the "Production Vehicle Interior Innovation of the Year" award by the Automotive Interiors Expo in June 2012.

Another innovative take on reducing the energy consumed for air conditioning is the independently controlled auto A/C system. Though not a new technology, some companies are pushing for individual climate controls as another way of reducing energy consumption. Japanese company Denso recently announced that they had developed a new air conditioning system that would allow driver and passengers to control their temperature zones separately. While this may seem more of a luxury than an energy-saver, Denso estimates that such a system could reduce energy consumption by 20% annually per vehicle, especially when front and back seating areas can be controlled separately.[iv]

Advanced Glazing options for Improved Vehicle HVAC Energy Efficiency

The type of glass used for a vehicle's windows also impact the solar heat gain and loss of



a vehicle. As such, many of the newest automotive climate control technologies being introduced today involve advanced glazings.

The National Renewable Energy Laboratory (NREL), for instance, has been working with several technologies to achieve greater energy efficiencies for EV climate control systems. In particular, they have been working with solar control glass to achieve a 26% reduction in air conditioning power required to attain a 10% increase in range target for the city cycle.[v]

Another player in the advanced glazing market is Solutia's *Saflex S and Q* series solar interlayers, which were recently awarded the Frost & Sullivan 2012 North American Award for New Product Innovation. These interlayers are solar-absorbing products that work to lower air conditioning energy consumption and passenger comfort. As noted by Solutia, previous adjustments to a vehicles' window glazing have included the use of metal components that reflect solar energy, but this comes with the downside of negatively impacting vehicle electronic devices. These heavy window glazings have also been criticized for the impact they have on visible light transmission, which can negatively impact visibility and driving.

The Solutia solution is to use polyvinyl butyral (PVB) interlatyers that consist of solar-absorbing nanoparticles. Rather than reflecting solar energy, these interlayers absorb solar energy – specifically the heat-causing mid-infrared rays. They also block 99% of all ultraviolet radiation, thereby protecting the vehicle occupants from cancer-causing solar radiation, as well as protecting the vehicle's interior (dashboard, steering wheel, seats, upholstery, etc) from solar damage. Because these interlayers are made without metal-coated glass or metallic reflecting films, they do not impact electronic devices. And the *Saflex* Q series also offers an acoustic buffering benefit to decrease noise from outside the vehicle.[vi]

The Enhanced Protective Glass Automotive Association (EPGAA) has also been working with solar control glass to reduce the need for air conditioning and extending the range of an electric vehicle. They have developed "Advanced Solar Control Glass", which is designed to reduce the solar heat gain within a vehicle so that air conditioning system load is also reduced. Citing, the fact that 50% of all US drive segments occur between noon and 5 pm – a period of time that is the hottest portion of the day – the EPGAA has identified this as an area with significant energy-reducing potential.

Their Advanced Solar Control Glass can reduce cabin temperatures at startup by up to 20 degrees C lower than normal. Used in an electric vehicle, this glass can improve range by as much as 30% during high air conditioning usage seasons, significantly dropping "range anxiety" that is a problem for many potential EV-owners and drivers.[vii]

Additional benefits of the Advanced Solar Control Glass include intrusion resistance (since it's harder to break), sound reduction, UV protection (and cancer prevention), as well as reducing battery core temperatures by up to 3.5 degrees C, which should enhance battery life.[viii]

Innovations in Insulation and Solar-Powered A/C for Greater Efficiency in Automobile Thermal Comfort

Another interesting development in the world of energy efficient thermal comfort for vehicles is the idea of using better insulation for chairs to manage a person's body temperature. Leather and vinyl seats, for instance, can make a passenger feel chilled in the winter and sweaty in the summer, but Daimler's Forvision Smart concept car is hoping to address this with fleece-wrapped chairs that keep passengers comfortable – cool in warm weather and warm in cold weather.[ix]

Daimler's Smart Forvision concept car

This concept Smart car also incorporates infrared reflective glass that helps to keep the interior of the vehicle from heating up when parked in the sun. Like other advanced glazing technologies, this is accomplished using polymer films added to the windows

to reflect thermal radiation.[x]

And the icing on the cake is a roof-mounted transparent, light-activated solar cell system that powers the vehicle's climate control system. The system is designed to automatically switch from fuel power to solar power for the air conditioner when the engine shuts off. The solar panels collect and stores energy in a separate, stand-alone electric air conditioning battery.

This solar-powered system also good for the environment given that letting a vehicle idle with the air conditioning on for 10 minutes daily is equivalent to burning 100 litres of fuel (26.4 gallons).[xi] As such, the Forvision's solar-powered A/C may be especially interesting for taxi drivers and soccer moms who sit waitng for their passengers – they can collect energy for cooling their vehicle without running the engine.

More Breakthrough Technologies Coming for Low-Energy Automobile Climate Control

Many component designers are working on other incremental changes in a vehicle's HVAC system to improve energy efficiency. Consider Delphi's solutions which include an HVAC module with fans designed for efficiency in a small package. They also produce a pulse width modulator (PWM) blower motor controller that saves the average driver 2.65 gallons (10.03 litres) of fuel annually over existing PWM technology.

Delphi's has also developed both fixed and variable compressors to gain additional energy savings. And their spot heating and cooling systems - such as heated and cooled seat technology - uses thermoelectric technology to provide on-demand, customized heating. With all of their systems combined, Delphi estimates that the average fuel savings from reduced air conditioning energy consumption would equal approximately 40%.[xii]

With more and more small innovations like this turning down the energy on heating and cooling the future of low-energy vehicle HVAC systems looks relatively breezy.

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A student of all things green, Maryruth has a special interest in cleantech and green buildings. In recent years, Maryruth has worked as the senior editor of The Green Economy magazine, is a regular blogger for several green business ventures, and has contributed to the editorial content of not one, but two eco-living websites: www.ecolife.com and www.GreenYour.com. You can learn more about Maryruth's work by visiting her site, www.jadecreative.com.

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