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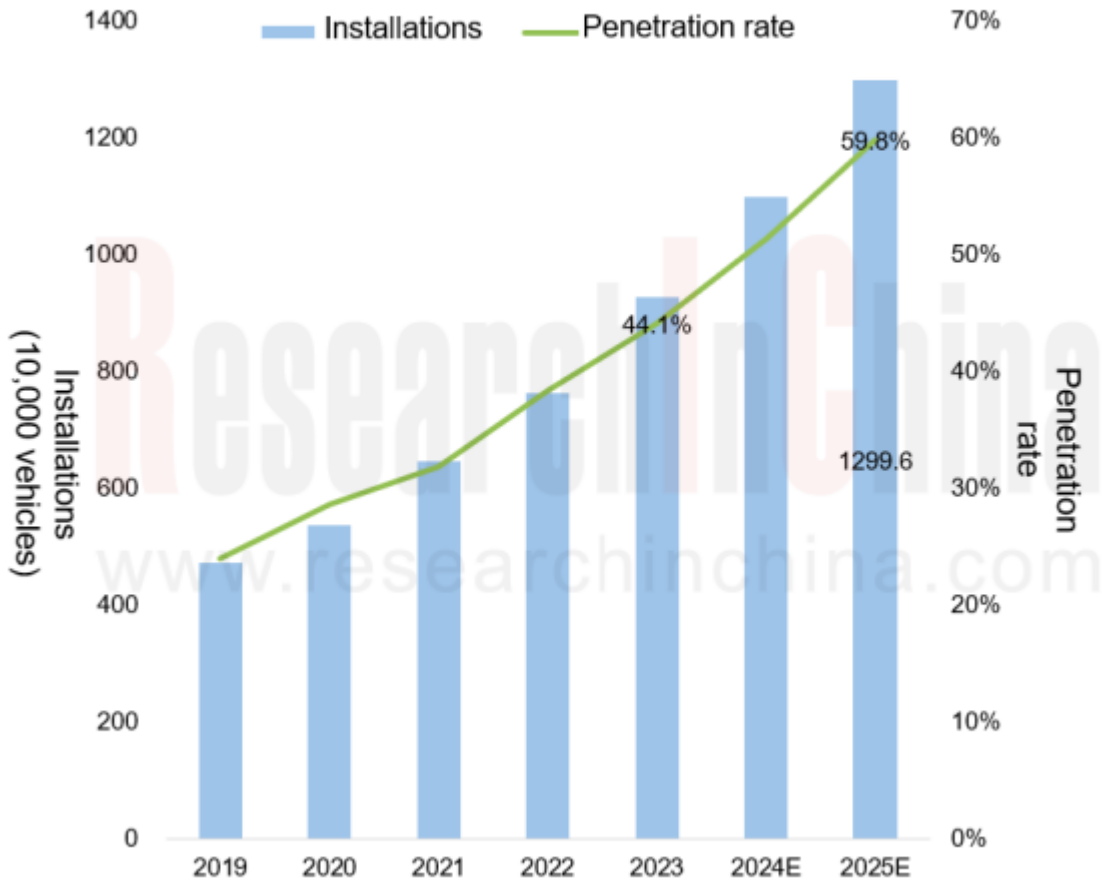
Global and China Automotive Lighting System Research Report, 2023-2024

Mar. 2024

Installations of intelligent headlights and interior lighting systems made steady growth

From 2019 to 2023, the installations of intelligent headlights and interior lighting systems grew steadily. Interior lighting mainly includes ambient, reading, trunk, door, and cluster lights. Among them, the ambient light boasted a penetration of 44.1% in 2023, and sustained an AAGR of 16.3% in recent five years. ResearchInChina predicts that the ambient light as a standard configuration will be installed in 13 million vehicles in 2025, with a penetration rate of nearly 60%.

Installations and Penetration Rate of Ambient Light in Passenger Cars, 2019-2025E



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TOP10 Brands by Touch Reading Light Installations, 2023

The installations of touch reading light soared from 2019 to 2023, with penetration up to 16.8% in 2023, and the most models equipped with this function were from BYD, Audi, and Li Auto.

TOP10 Brands by Touch Reading Light Installations, 2023

Rank	Brand	Installations (10,000 vehicles)
1	BYD	73.7
2	Audi	44.9
3	Li Auto	37.7
4	Volkswagen	27.4
5	Honda	25.3
6	Aion	16.4
7	NIO	15.1
8	Denza	11.2
9	Haval	9.3
10	AITO	9.2

Source: ResearchInChina

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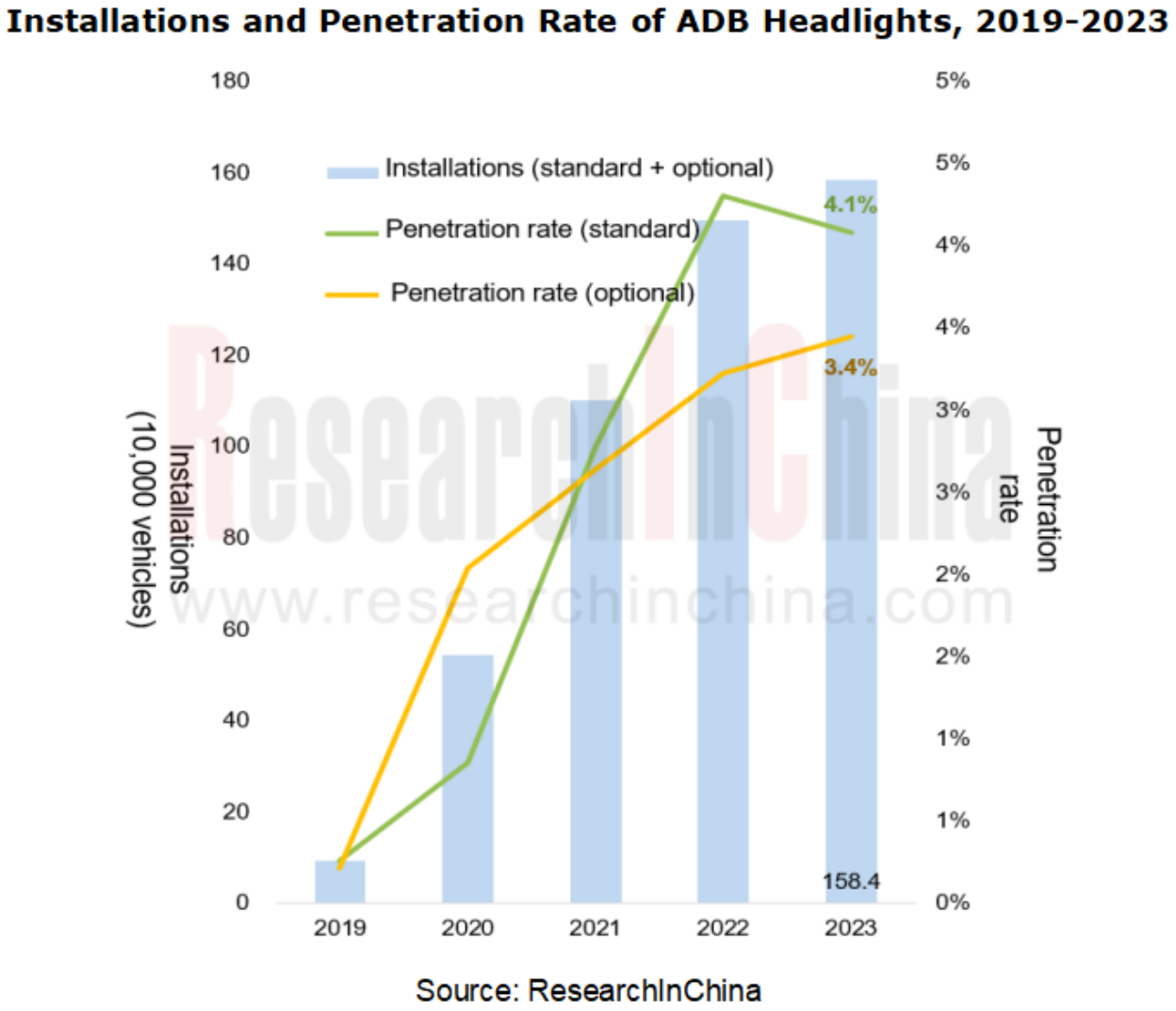
Installations and Penetration Rate of ADB Headlights, 2019-2023

Intelligent headlights are led by DLP headlights, digital headlights, programmable headlights, and adaptive driving beam (ADB) headlights. They can enable such functions as autonomous driving assistance, exterior interaction, and entertainment projection.

In 2023, the mainstream light source of intelligent headlights was LED combination, sweeping about 84% of the installations; halogen headlights made up 15%; laser headlights still took a less than 0.5% share. In 2023, among intelligent headlights, matrix headlights were installed most, and mounted on 2,229,000 vehicles; geometric multi-beam headlights followed, with installation in 231,000 vehicles.

In recent five years, the installations of ADB headlights were on the rise: in 2021, the installations of the standard ADB headlights exceeded the optional for the first time; in 2023, ADB headlights were installed in 1,584,000 vehicles.



Intelligent headlights bear interaction, entertainment and intelligent driving assistance functions

In late 19th century, the first electric headlamp was available on market, mainly for night lighting.

In 2023, headlights became more diversified. As technology evolves, they begin to carry functions other than lighting, including: intelligent driving assistance, interaction, and entertainment.

Applied Technologies for Lighting Interaction / Entertainment / Intelligent Driving Assistance Function

Function	Typical Technologies	Typical Models
Intelligent driving assistance	ADB headlights, matrix headlights, DLP, MicroLED	AITO M9, Jiyue 01, etc.
Interaction	Programmable headlights, DLP, MicroLED	ZEEKR 007/001, EXEED STERRA ES, Avatr 12, BMW iX1, Rising R7, etc.
Entertainment	Programmable headlights, pixel headlights, DLP, MicroLED	AITO M9, etc.

Source: ResearchInChina

The diversification of automotive lighting functions has not only expedited the application of lighting technologies, but also fueled the integration of automotive lighting with other auto parts

The diversification of automotive lighting functions has not only expedited the application of lighting technologies like DLP, MicroLED, and pixel headlights, but also fueled the integration of automotive lighting with other auto parts, for example, "lighting-screen integration" (using displays for exterior lighting and display), "lighting-surface integration" (integrating smart surface technology into the lighting system, mainly exterior grille lights and interior ambient/door lights), and "perception lighting" (integrating sensors into lights to enhance intelligence).

In the case of interaction function of intelligent lighting, the images projected by headlights and the pixel graphics showed by the LED display convey the user's intents for interaction with pedestrians and vehicles. This technology is mainly enabled by the projection of pixel headlights and the light information interaction mode of programmable headlights.

Xpeng was the first to introduce the light information interaction function, and used it in P7 in 2020, a model with sales of about 5,000 units. This function was available to P5 and G9 in 2022, and smart#1, Avatr 11, SAIC Rising/IM series, and Hongqi H9 began to follow suit in the year. In 2023, the models equipped with lighting information interaction function began to boom, with 330,000 vehicles installed with it, the penetration rate up to 1.6%.

ZEEKR 007 packs Valeo ZEEKR STARGATE, an integrated intelligent light curtain in the front face. The front light curtain supports the light information interaction design, adopts the "light-screen integration" approach, and allows customization of intelligent expressions and courtesy signs. ZEEKR STARGATE is independently controlled by 75 automotive-grade driver ICs provided by TI.

Emoticons on ZEEKR 007 ZEEKR STARGATE Light Curtain

Source: ZEEKR

AITO M9 was officially released

In December 2023, AITO M9 was officially released with Huawei's XPixel automotive lighting technology. DLP projection enables intelligent driving assistance functions such as lane change and turning alert, lane guidance, and light blanket projection. In terms of interaction function, AITO M9's ISD lights with more than 1,000 pixels have built in over 10 animation effects such as welcome, charging animation and light information interaction, as well as over 40 customized patterns. The 4M high-speed serial communication realizes smoother animation effects, and the customized animations can be refreshed via OTA updates to meet the customization requirements of different target groups.

Pattern Display on AITO M9 Taillight

Source: Huawei

Intelligent automotive lighting is integrated with sensors

As autonomous driving technology advances, automotive lighting systems are no longer limited to lighting functions, but further integrated with radar, camera and other ADAS sensors. They utilize intelligent perception function and common EEA to further enhance lighting intelligence, and keep evolving towards perception lighting.

Design Logic of Automatic Lighting

Status Quo of Lighting System Design	Next design logic for lighting system
Enhanced driver's visual perception	• Enhance driver's visual perception: higher brightness, longer distance, more humanized design; • Enhance visual perception of robot cars: provide a more suitable perception environment for cameras, LiDAR and other perception hardware. In the future, the perception system and lighting system may be jointly designed to improve the safety and perception efficiency of intelligent driving.

Source: ResearchInChina

# of Jiyue 01's lighting system and full intelligent driving domain adopt the same visual system

In the case of Jiyue 01, a model launched in October 2023, its lighting system and full intelligent driving domain adopt the same visual system. The intelligent interactive lighting system is applicable to lighting interaction designs for different scenarios such as autonomous driving, voice interaction and safety protection. Headlights and high/low beam can be switched automatically through the visual system.

For example, the perception system recognizes the environment before and after entering the lane, and then automatically turns the lights on or off through the autonomous driving execution system. The next step is to automate the lever and directly use vision to determine which lane to enter, and then determine whether to turn left or right. In the future, users will not need to pay attention to the left or right turn when driving.

Jiyue 01 Pixel Headlights with Sensors Integrated into the Lampshade

Source: Jiyue Auto

ZKW and REHAU Automotive decided to jointly drive forward the integration of modern lighting systems in vehicle fronts

ZKW has been researching the integration of sensors and lighting systems since 2019, and has launched products that integrate radar sensors and lighting systems, for example, the "Project Dragonfly".

In May 2023, ZKW and REHAU Automotive decided to jointly drive forward the integration of modern lighting systems in vehicle fronts. They will promote the “seamless intelligent vehicle front” project where light, sensor technology and electronics in the vehicle front are connected. The seamless vehicle front is enriched with light, logo, sensor and heating elements and thus becomes an intelligent design object.

ZKW & REHAU Seamless Intelligent Vehicle Front Adopts "Lighting-screen Integration" Mode

Source: ZKW

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