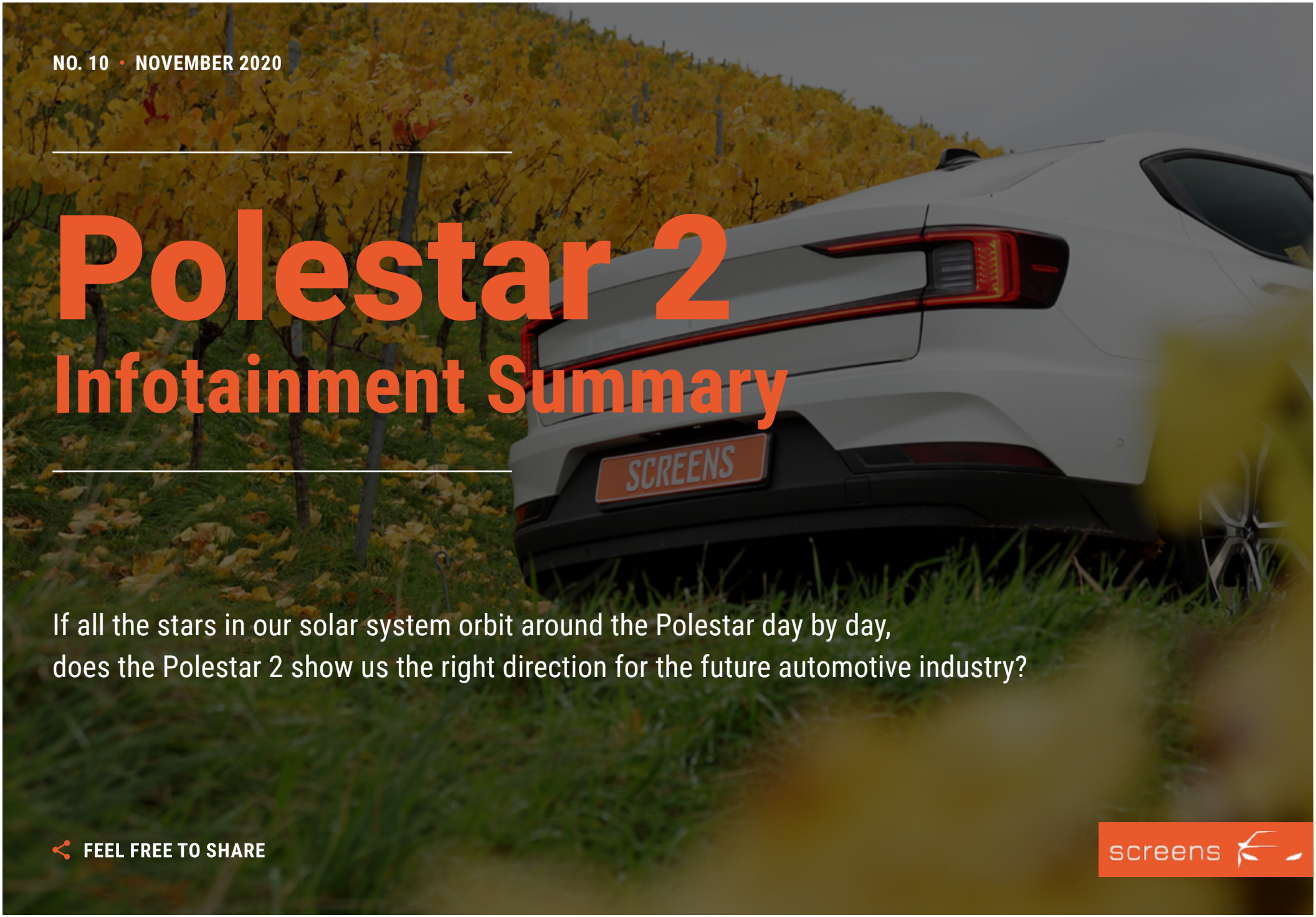
NO. 10 • NOVEMBER 2020

Polestar 2
Infotainment Summary



If all the stars in our solar system orbit around the Polestar day by day,
does the Polestar 2 show us the right direction for the future automotive industry?

FEEL FREE TO SHARE

screens

READ ME!

For this report we spent more than 50 hours testing this car's infotainment system. Thousands of interactions were made and literally every possible button was used.

We went through hundreds of use cases, both stationary and while driving, and looked at the car as intensely as possible. We guess the only other people were probably its developers. This report represents only a fraction of our findings.

We captured the entire HMI structure and documented every possible click in a giant tree with hundreds of entries.

Therefore: Contact us if you have any questions about this infotainment system. We know almost everything that can be found out when using it.

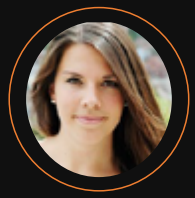
The best part about this:

We have recorded everything and made the video material available in a tool called screens. screens is an interactive video-based online platform, which enables you to compare the latest infotainment systems in-depth.

Whether it is ADAS, media, apps, navigation, speech or radio. Operated in the Instrument Cluster, the Head Unit, the Head-up Display or in the Rear Seat Entertainment. You can check out every possible interaction on video. We render the videos searchable and interactive so you can find a particular sequence much faster than in the actual car.

Click here to create your trial account and dive deeply into the infotainment system right from your desk.

We are looking forward to your feedback!



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HOW TO USE THIS REPORT?

This report is not yet related to video content on screensstudio.

You can explore the full infotainment system of the Polestar 2 in December by using your login data and the upcoming licence key.

www.screensstudio.com/signup

Have fun exploring the new Polestar 2.


10:55
Maps
Play the news
screens Android
Absolut OLDIE
HI
HI
CAR OVERVIEW

Overview

The term „Android Automotive“ has been used in the automotive industry for quite some time. In the Polestar 2, the system will hit the road for the first time and is soon to be re-launched in the Volvo XC40, too. While Android Auto and Apple CarPlay make functions and features of the Android or iOs operating system accessible via Bluetooth and USB connection via the smartphone, Android Automotive OS represents an integrated operating system for the infotainment system of the car. In short: Polestar meets Google. The all-electric Polestar 2 is the first series-produced vehicle and a flagship within the Android Automotive theme. Volvo and Geely are moving forward with it and General Motors, Groupe PSA and Renault-Nissan-Mitsubshi want to follow suit in the coming years.

Through connectivity and the integration of Google Services, the car becomes an office and a streaming service oasis. The smartphone can safely stay in your pocket while you have access to Google Maps, Google Assistant or Google services such as the Google Calendar via voice command. Through the integration of the Google Play Store it is possible to download more third party applications. While the Google Play Store offers 23 applications to download at the moment it will extend its product breadth with.

A special feature is the possibility for other developer groups to create and test applications and services for Android Automotive. The Polestar 2 Emulator for Android Studio would be established in this case.

In the Polestar 2, however, a symbiosis between vehicle functions and the Google operating system has been created. It is possible to access the vehicle's control elements by using the touchscreen. In some cases, they can also be accessed via Google Assistant. We can, for example, adjust the A/C via voice command or display the current battery status. In addition, the Polestar 2 is the first vehicle in which the map view in the Instrument Cluster is displayed solely by Google Maps. Similar to a smartphone, the Polestar's operating system is to be kept up to date with over-the-air updates (OTA). That's the reason, the Polestar 2 includes three years worth of internet data volume in the purchase price.

The buzzwords are quite clear: connectivity, agility and pioneer thinking. What happens if the vehicle is offline or the Internet connection is interrupted, though? And what advantages and special features does Android Automotive OS offer?

In the following report we will go into more detail about the various features, displays and input modalities.

Google Maps

Along with Google Assistant, Driver performance, Radio, Bluetooth Media Player and Phone, Google Maps represents a basic application. This means that these applications are available even after resetting the system and that they cannot be deleted or removed from the system. While there are various media applications available in the system's integrated Play Store, Google Maps is currently the only **navigation and route guidance feature**. If we were to compare the online application on the smartphone and the application within the framework of Android Automotive, the focus on the essential user scenario of the navigation feature is evident: entering a destination or key word primarily via the comprehensive search - starting route guidance - receiving route updates via the system.

Google Maps initially welcomes the user with a large **map view**, extending across the entire 11-inch screen. The map view shows streets, favourites and POIs regarding charging stations, educational institutions and outdoor spots. Pressing and holding a point on the map selects destinations which are supplemented by suggestions from nearby Google destinations. The representation of Google Maps in the 12-inch **Instrument Cluster** is the continuation in the Head Unit. The map is very clear and the colours are intense. However, the map in the Instrument Cluster is used exclusively to display the route. There is no navigation menu available, which means that route guidance can only be started and cancelled via voice input or the Google Maps feature in the Head Unit.

The **search bar**, where we can enter cities, address sections or keywords, forms the base for entering destinations in the Head Unit. The search request results in a list of suggested destinations, which varies in informatoinal depth depending on the detail level of the entry. In addition, recent destinations can be selected, as well as favourites defined in the system or the connected Google account.

Google Maps

Unlike other navigation features, **there are no** submenu items for coordinates, step-by-step address entry or overview and selection of POI categories. Everything can be entered via a comprehensive search. Depending on the information available, the destination preview is supplemented with opening hours, Google ratings, details of charging possibilities and the option to make a direct call.

Once route guidance has been started, it is constantly updated with real-time data in the form of alternative routes and notifications regarding traffic jams. When you arrive at a destination, a small **„Welcome“** and a picture of the destination (if stored in Google) will appear.

Google Street view, as we find it for example in the Toyota Camry, does not exist.

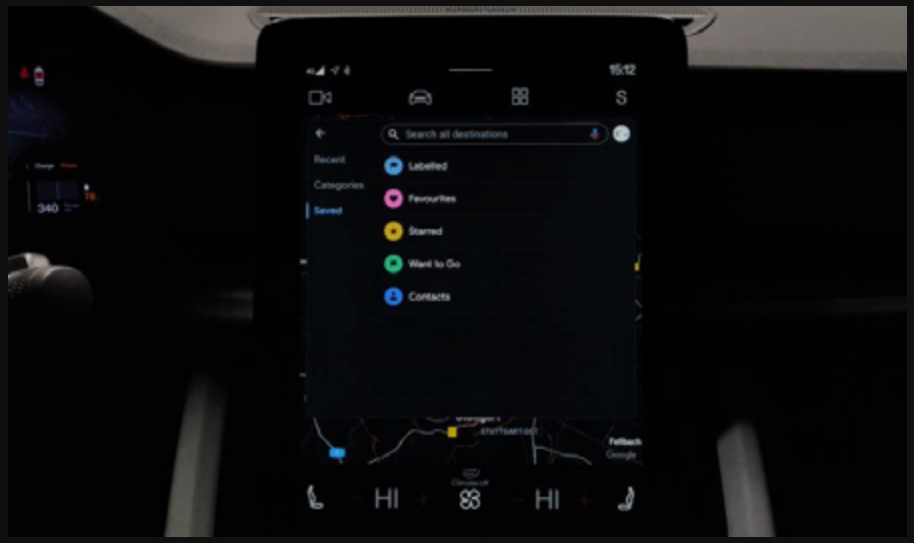
What if the Internet connection is lost?
If the vehicle no longer has a mobile Internet connection, no route can be started. The exception is the so-called offline map material. Within the Google Maps settings, areas of the map can be selected and downloaded as online map material, which then serve as the basis for route guidance in the event of internet loss.

Based on the current location, map areas are suggested to the user. In addition, an automatic download can be activated, which saves the current map in regular intervals.

Google Maps

Assessment

+ Destinations are primarily accessed and selected via a Google Map search, which lists places, streets and POIs in the search results. This results in a flat content architecture, which bases the system on the intelligent search and lets the user start the route only with a few clicks.
+ Current information such as traffic jams or road works are continuously updated and communicated via announcements, icons and pop-ups.
+ All individual destinations stored in the Google Account can be easily integrated. The possibility of connecting the Google account with the profile or logging in directly means that favourites or most recently visited destinations stored in the Google account are stored directly in the infotainment system.
– Faster or slower routes are not shown in the Instrument Cluster, but only in the Head Unit. Therefore a look at the Head Unit remains necessary.
– POIs are only displayed in the Instrument Cluster while driving, but not in the Head Unit. There is no 3D view or satellite mode like in the Google Maps application for the web browser and smartphone.
– Incoming calls are not displayed in the Google Maps feature of the Instrument Cluster. For the other two features a pop-up window appears, which is minimised once the call has been accepted.
– Due to the high degree of connectivity, it should not be forgotten to download offline material, preventing route guidance from being interrupted due to poor reception or low data volume.
– The night and day mode cannot be set manually and are based solely on the detection of the external lighting situation.



Google Assistant

There are many questions you can ask yourself, for example: „What will the weather be like tomorrow?“, „How big do polar bears get?“, „What is „good day“ in Japanese?“ or „What does the fox say?“. In the Polestar 2 you can ask these questions and get an answer. Just like Google Maps, the Google Assistant is one of the basic applications of Android Automotive. Voice control **can be activated** by a hard key on the right part of the multifunction steering wheel or by an application in the Head Unit and the words „Hey Google“. However, the voice activation function via „Hey Google“ can be switched off in the settings.

The function fields of voice control extend beyond the context of the vehicle and use the general Google database. In addition, **access to other basic applications** like Google Maps, Phone, Radio and Bluetooth Media Player is possible. In addition we can play songs via Spotify and YouTube Music. If the applications have not yet been installed, the system prompts the user to do so. Even though Deezer is mentioned as well, we weren't able to find this provider in the Play Store, yet.

However, in order to **protect personal data**, not every function can be executed directly. If the user receives a text message on his connected phone and wants to have this message read out loud, nothing happens. The Google Assistant first informs the user that the corresponding settings for „Assistance in your car“ must be adjusted. This item is located under settings and includes „Allow personal results in your car“ and the setting „Get notifications from your assistant“. Only after entering the Google Account data under „Allow personal results in your car“ is it possible to have the message read out to you. With regard to the vehicle functions, the Google Assistant has no access to all settings, which can be seen in the screens studio use case category „Speech“.

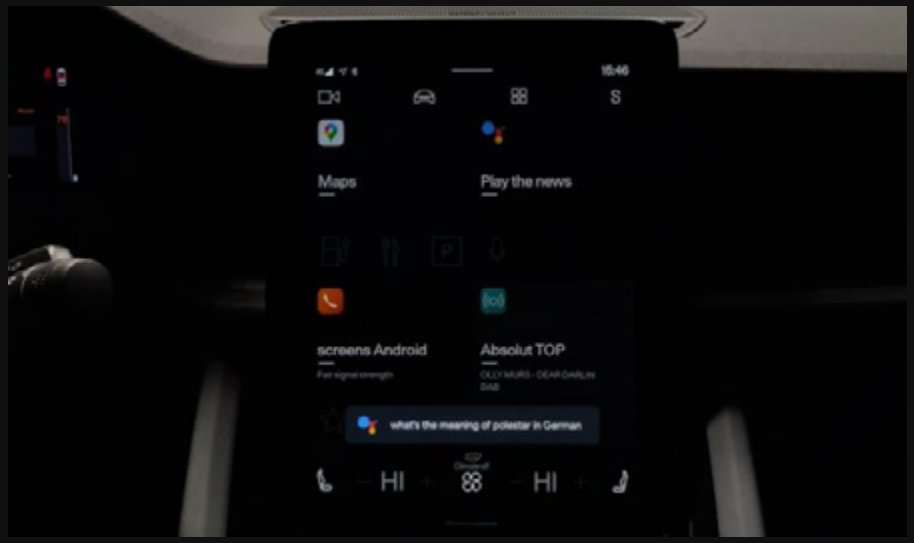
Google Assistant

What if the internet connection is lost?

If the Internet connection is weak or interrupted, the system can be activated, but the user is informed of the attempted connection (yellow, „Try to connect“) or the missing internet connection (red; „No internet connection“) by means of a colour code and a text. Since the Polestar 2 does not have an integrated voice assistant, the voice input is, in this case, not available.

Assessment

+ The activation of the system is very well distributed throughout the vehicle and can therefore be controlled multimodally: Steering wheel button, feature Google Assistant in the Head Unit and „Hey Google“.
+ The system answers complex questions, refers to context-related articles, reads them out and interacts with Google services. Although the questions and instructions directly related to the vehicle are still limited, direct access to the features Google Maps, Radio, Phone and the streaming applications Spotify and Youtube is made easier.
+ As long as one‘s own Google Account is connected to the system, it is possible to access or edit content such as lists or calendar entries or add new ones. In addition, even smart home devices can be connected.This way different functions can be activated or deactivated from the vehicle, already.
– The system is completely dependent on a constant internet connection.
– The voice input must be very fast. The sentence must not be interrupted for a longer period of time, since the input will then not be accepted entirely.
– There is no actual tutorial function, which is normally activated by words such as „Help“ or „Help + [Feature]“. Therefore, the exact function area is not visible to the user at first.



Google Play Store

Through the integration of Google Services, the Google Play Store also becomes a central element of the personalisation of Android Automotive OS. We can access the Play Store by using the feature Applications. The Playstore is only accessible after logging in with your own **Google Account**. However, it differs from the usual structure due to the application offer. The Play Store only displays applications that can currently be downloaded to the vehicle and were developed and certified for Android Automotive. The focus is currently on **media and podcast applications**. These are (as of 03.11.2020):

- Google Maps: Navigating & exploring (basic app)*
- Google Play Books: Ebooks, audiobooks and comics
- ARD Audiothek: ARD and German radio podcasts
- Libby, by OneDrive: Libary ebooks
- Sveriges Radio Play: Swedish radio
- TuneIn Radio: Live sports, news, music & podcasts
- Spotify: Free music and podcasts streaming
- NRK Radio: Norwegian radio
- YouTube Music: Streaming songs & music videos
- NPR One: Radio news, stories and podcast
- Pocket Casts: Podcast player
- Radio France: Podcasts, radio en direct
- Google Assistant: Hands-free help in the car (basic app)*
- myCANAL: Vos programmes en live ou en replay
- RadioLine: International radio
- radio.net: Free live FM radio
- Audioburst: AAOS: Short personalized talk audio
- Trebble FM: Daily shortcasts to stay informed
- Radioplayer Norge Automotive: Norwegian radio
- Radioplayer.be: Belgian radio
- Radioplayer.de Automotive: German radio
- UK Radioplayer Automotive: British radio
- Castbox: Podcast player & podcast app

Assessment

+ The Play Store is divided into three sections: „Stay informed“ „Stream your favourites“ „Explore all apps“. The first two categories mentioned above allow you to quickly access the apps. The last category contains a clearly arranged general list.
+ The installation and uninstallation process is intuitive and corresponds to the procedure in the common Google Play Store.
– The data source of the suggestions regarding „Stream your favourites“ is not clearly evident.

Each application comes with a description, preview images, developer information and rating possibilities. The apps can be installed or uninstalled with a single click and then automatically appear in the **feature Application** in the tile in the right hand corner. Except for Google Maps and Google Assistant, they can also be uninstalled by a drag and drop function or directly in the Play Store. We can move them to another tile and they will be located at this position on the home page. Please note that the application which is located in the upper left corner of a tile is always displayed in a large size on the **home screen**. Applications cannot be deleted from the Play Store. In the feature itself you can actively search for updates. The Play Store cannot be accessed while driving.

* Google Maps and Google Assistant can not be uninstalled because they are so-called basis apps. The features Phone, Radio, Driver Performance and Bluetooth Media Player are OEMs software components, which are not listed in the Play Store.

Google Play Store

Profil & Account

Nowadays personalisation is an important factor in the field of vehicle-human interaction. The key to this is a special interface. Many manufacturers not only rely on the key as an object, but also on the virtual key within the framework of an application. Polestar also advertises its Polestar App, which will make the vehicle remember its driver. However, the full application will not be available until mid 2021 and currently only has an informative function. Nevertheless, Polestar convinces with its ability to remember. The basis for this is the key and the creation of a profile. It is possible to create up to six profiles.

If you do not create a profile or log out of a created profile, you will be redirected to a **guest profile** with limited functions. In this profile it is not possible to log in to your Google Account and thus access favourite destinations on Google Maps or create shopping lists or calendar entries via the Google Assistant.

However, if you create an entire profile under the feature of the same name, you can either **add a Google Account** in one of the five profile creation steps or - if one skips this point - in other areas such as

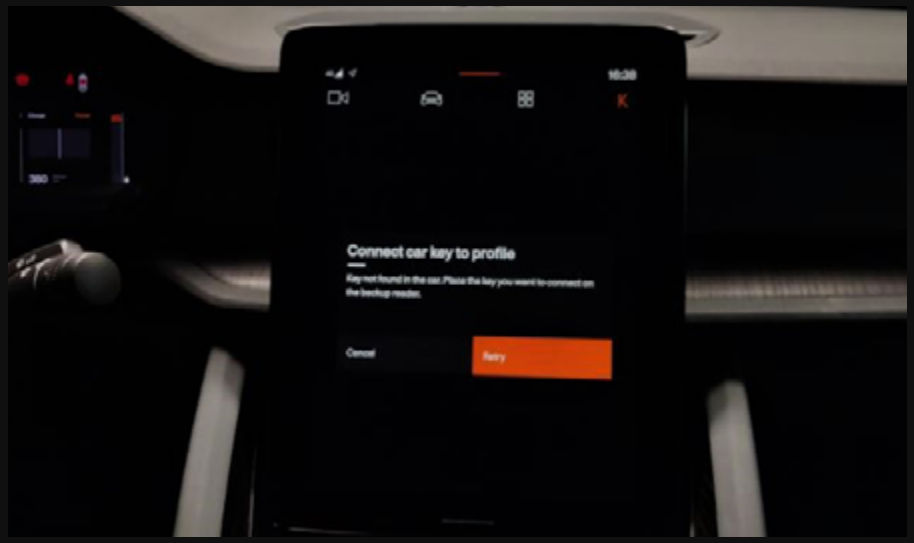
- Google Maps > Sign in to account
- Profile settings > Add account
- Play Store > Sign in to account
- General settings > Google

Profil & Account

Only one **Google Account** can be assigned to a profile. The system offers three options to sign up:

- Sign in on the car screen: Entry of the login data directly via the Head Unit.
- Sign in with Android phone: A pop-up window appears on the Android devices in the vicinity. By clicking on the pop-up message on the smartphone, a code is shown. This code is also displayed in the Head Unit and must be confirmed. Afterwards a login area for the Google account appears on the Android device. The successful login is then displayed on the smartphone and in the Head Unit.
- Sign in with iPhone: A QR Code is displayed in the Head Unit. By scanning it you can access the login area for the Google Account on your smartphone. The successful login is then displayed on the smartphone and in the Head Unit.

Once you have created a **profile**, the seat and temperature settings, the settings for the steering behaviour and the One-Pedal-Drive, the mirror settings and the last arrangement as well as the number of different applications, which were downloaded from the Google Play Store with the assigned Google Account in this profile, are copied.



However, we can link the **key to the profile**, in case we do not want to activate it manually. This is done via a surface in the centre console. Once this has been done, it is sufficient to approach the vehicle with the key. When you get in, the system automatically activates the stored profile. This makes it possible to continue listening to the last played Spotify playlist directly in the vehicle.

Profil & Account

Assessment

+ The process of creating a profile can be cancelled at any time. The points not specified, such as the Google account or settings for so-called „personal results“ can be added later.
+ The recognition of the profile by the key is easy and fast. The currently activated profile is indicated by the first letter of the profile name and takes the position of the profile feature icon in the upper right corner.
+ If you log in to your Google Account when creating the profile, the first and last name stored in the Google Account will be used as the profile name automatically.
+ The profile can be optionally secured by two types of screen locks: Pin input or a pattern. This must be specified when switching between profiles or when getting into the vehicle with a key connected do a profile and then starting the operating system.
– You cannot assign your own pictures to the profile or use avatar pictures as in the BMW X7 system.
– The system does not have any style settings regarding colouring. Only the arrangement of the applications in the home screen and on the corresponding application feature is possible.
– No home or work address is asked during profile creation. It is also not possible to connect a prioritised telephone (see Audi Q8 or Audi e-tron). The home and work address must be created in the Google Maps feature or is copied when linking the Google account. In the case of the telephone feature, the last telephone connected is simply reconnected, provided that it is in the vicinity of the vehicle. No prioritisation is possible in the system itself.


SCREENS
CAR OVERVIEW

6 facts about Android Automotive Os (AAOS)

It's intuitive: The system has a clean design and using it feels intuitive. This stems from the fact that it reminds one using a smartphone, thanks to its structure containing Google Play Store, applications and being able to swipe from top to bottom or vice versa. The user can expand the system individually and feel up to date with over-the-air updates, at all times.

It's individual: The Android system is a widely used operating system. By linking it to your own Google account, already saved navigation routes are displayed or access to calendar entries and shopping lists is made possible by voice. Even when you get out of the vehicle, appointments etc. are available via your smartphone and different Google services. Consequently, the time spent in the vehicle is integrated into the user's digital ecosystem without much additional effort.

It's Google: In order to use full service of all applications, the user links his Google account, meaning valuable data, with the system. At this point the topic of data protection is crucial, as usage data is shared with Google.

It's an open platform: It is possible for third parties to develop applications for the Play Store within Android Automotive OS. Anyone can develop an application to run on Android Automotive OS. Therefore you can find a Polestar system emulator, an app development community and an developer portal.

It offers visions: If I can pay via smartphone and Google Pay, will I soon be able to make purchases via the Head Unit of my car? If it is open to different developers, which apps will I still be able to use in my Play Store in my vehicle?

It's a construction kit: All in all, Android Automotive Os offers OEMs the possibility to link their UI and individual software components with the open source system's offer. The advantage for car manufacturers is the reduction of software development costs, since important features such as navigation, media player or language assistant are delivered directly with the system, depending on the license model. Comparable to the smartphone, Android Automotive is therefore to be understood as a full-stack infotainment platform, whereby the in-vehicle infotainment system ultimately consists of three components:

- Google Automotive Services (GAS): Google Maps & Navigation, Google Assistant, Google Playstore, Setup Wizard and the Automotive Keyboard
- OEM software components: Nevertheless, internal software components and applications can of course be integrated e.g. Phone or Radio.
- Third party applications: Further apps such as Castbox, Pocket Casts, Spotify can be downloaded in the Play Store.

Overview

The instrument Cluster of the Polestar 2 consists of a 12-inch digital display. The Instrument Cluster has a rather dark colour scheme and works mainly with orange as a highlight colour. Basically, the user can switch between four features by using two hardkeys on the right-hand side of the multifunction steering wheel. There is no further menu navigation under all three main features, which means that no route can be started or stopped under Google Maps in the Instrument Cluster, for example. Only the feature Trip can be resetted.

The buttons on the left-hand side of the multifunction steering wheel are used to activate and control the driving assistance systems, such as the Limiter, Automatic Speed Limiter, Cruise Control, Adaptive Cruise Control and a Pilot Assist. It should be noted that the selection of the driving assistance systems is, however, made via the Head Unit. Feature „Vehicle“, followed by „Drive“ and then on to select the Limiter, Cruise Control and Adaptive Cruise Control. If the Limiter is active, the Automatic Speed Limiter is selected by pressing the left arrow on the left-hand side of the multifunction steering wheel. If Adaptive Cruise Control has been activated via the Head Unit, the Auto Pilott can be selected by pressing the right arrow on the left part of the multifunction steering wheel.

Display Size 12“

Features & Content Distribution

The majority of the different elements is arranged in the middle of the flat infotainment system architecture.
The last element to be operated is the confirmation of the trip reset.

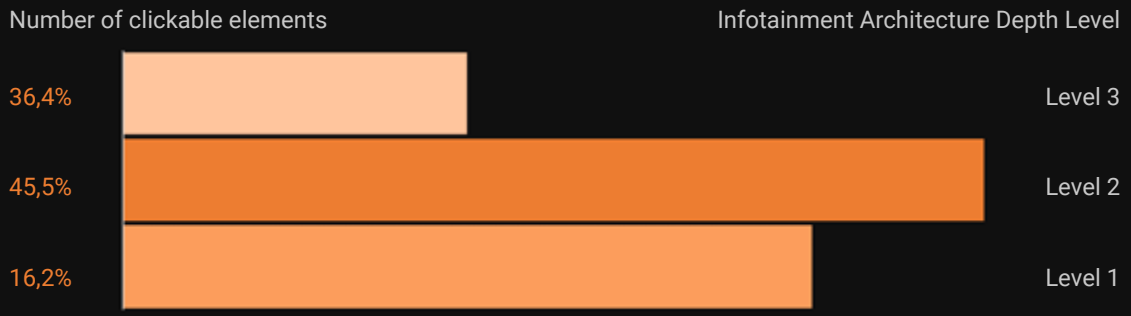
Features

Speed and battery status

Driving Assistance

Google Maps

Trip



HMI-SITEMAP

Overview

The Head Unit consists of a vertical 11-inch display. Similar to the Tesla models, the Head Unit resembles a freestanding tablet unit.
The basic construction of the Head Unit consists of

- an upper bar which can be pulled down from top to bottom and displays, as well as controls current notifications, missed calls and loading processes.
- a home area which the user can access at any time by swiping from the bottom to the top. Similar to the upper bar, a horizontal line is used as a surface for the action.
- four features located in a top bar: Camera, Vehicle, Application and Profiles, which can be accessed in all menu items and
- the climate settings which are opened by swiping from the bottom left or right edge upwards or by clicking on the climate settings bar at the bottom of the touchscreen unit.

Display Size 11“

Overview

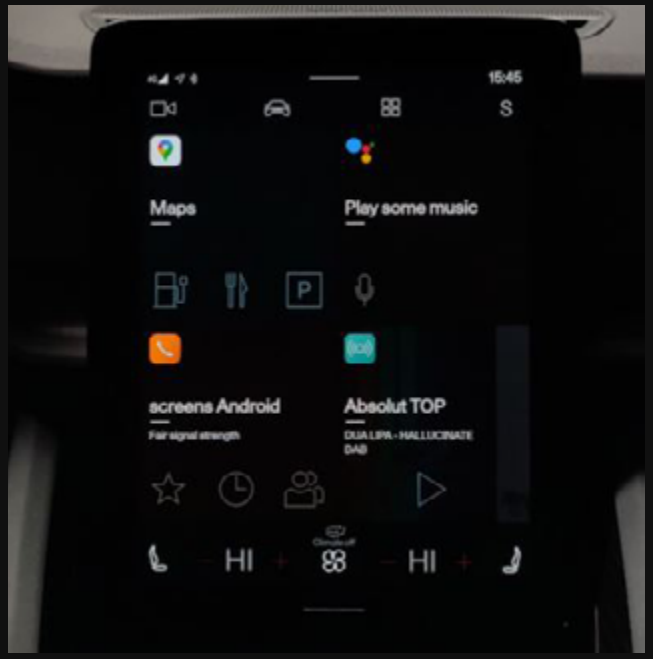
In addition to the main features **Camera, Vehicle, Applications and Profile**, which cannot be changed in their order in the top bar, there is an addtional selection of different applications - the so-called basic applications and individual applications, which can be downloaded from the Play Store within the feature Application. The so-called basic apps Google Maps, Google Assistant, Phone, Bluetooth Media Player and Driver Performance cannot be deleted or removed from the system. The respective applications can be rearranged in the feature Applications and appear on the Home screen depending on this arrangement. The home screen itself consists of four slightly coloured tiles. These tiles are fixated and cannot be exchanged or changed in shape. If you reset the vehicle to the factory settings, the basic apps are arranged differently in the four tiles. This shows that the four tiles basically represent four different application areas:

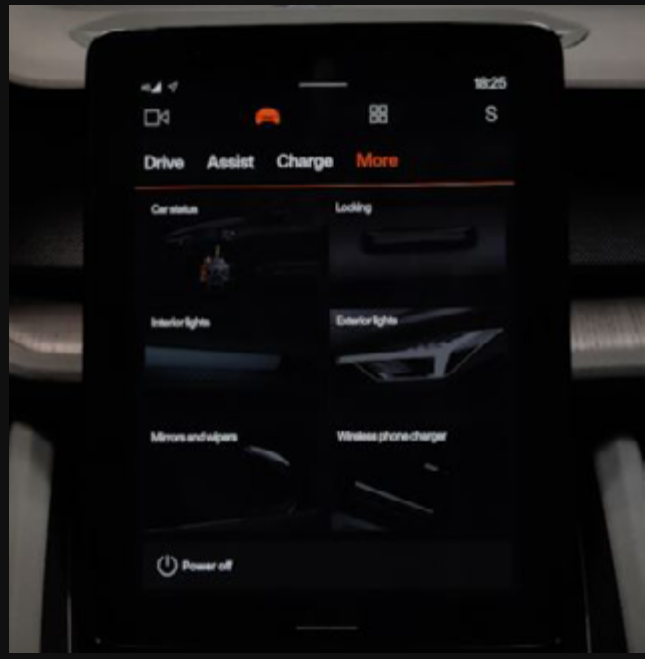
- Tile upper left: Google Maps (Navigation)
- Tile upper right: as a primary App Google Assistant and as a further application Driver Performance (Vehicle)
- Tile lower left: Phone (Telephone)
- Tile bottom right: as a primary App Radio and as further application the Bluetooth Media Player. If you download new applications from the Play Store (currently media and podcast apps), they are automatically saved and displayed in this tile. (Radio and Media)

However, the placement of the applications can be changed in the **Applications feature**, which is the basis for the Home screen display. This is where applications can be moved by dragging and dropping them. However, a tile can never be empty and must contain at least one application.

The application that is placed in a tile in the upper left corner is displayed on the Home screen as the **primary application**.This allows application specific shortcuts in the individual tiles to be controlled. In the case of media features, the tile background then indicates the cover of the track or station currently playing. Applications not stored as primary applications in the first tile can be displayed and selected on the home screen by swiping across the tile.

Overview


15:45
Maps
Play some music
screens Android
Absolut TOP
HI
HI

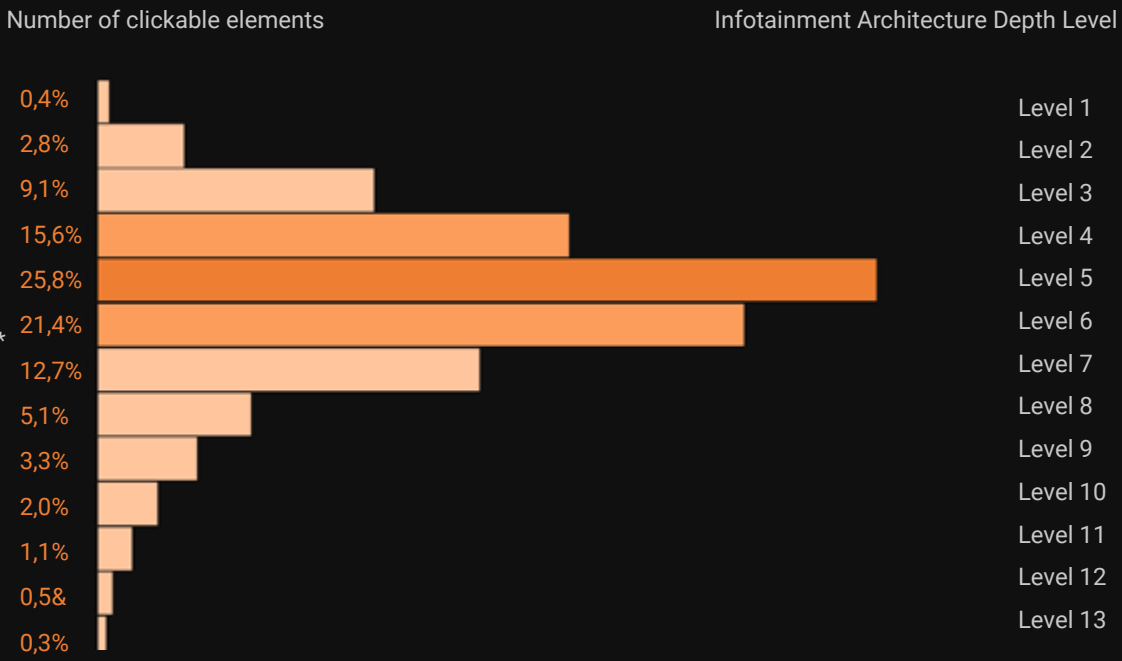

Drive
Assist
Charge
More
Power off

Features & Content Distribution

The majority of the different elements is arranged in the first half of the infotainment system architecture. The elements of level 12 are part of an active navigation route in the navigation. The features are colorfully desigend with animations and a modern kind of design.

Features

Upper Bar
Google Maps*
Google Assistant*
Driver performance*
Radio*
Phone*
Bluetooth Media Player*
Climate
ARD Audiothek**
Google Maps**
Google Play Books**
Libby, by OneDrive**
Sveriges Radio Play**
TuneIn Radio**
Spotify**
NRK Radio**
YouTube Music**
NPR One**
Pocket Casts**
Radio France**
Castbox**
Google Assistant*
myCANAL**
RadioLine**
radio.net**
Audioburst**
Trebble FM**
Radioplayer Norge Automotive**
Radioplayer.be**
Radioplayer.de Automotive**
UK Radioplayer Automotive**

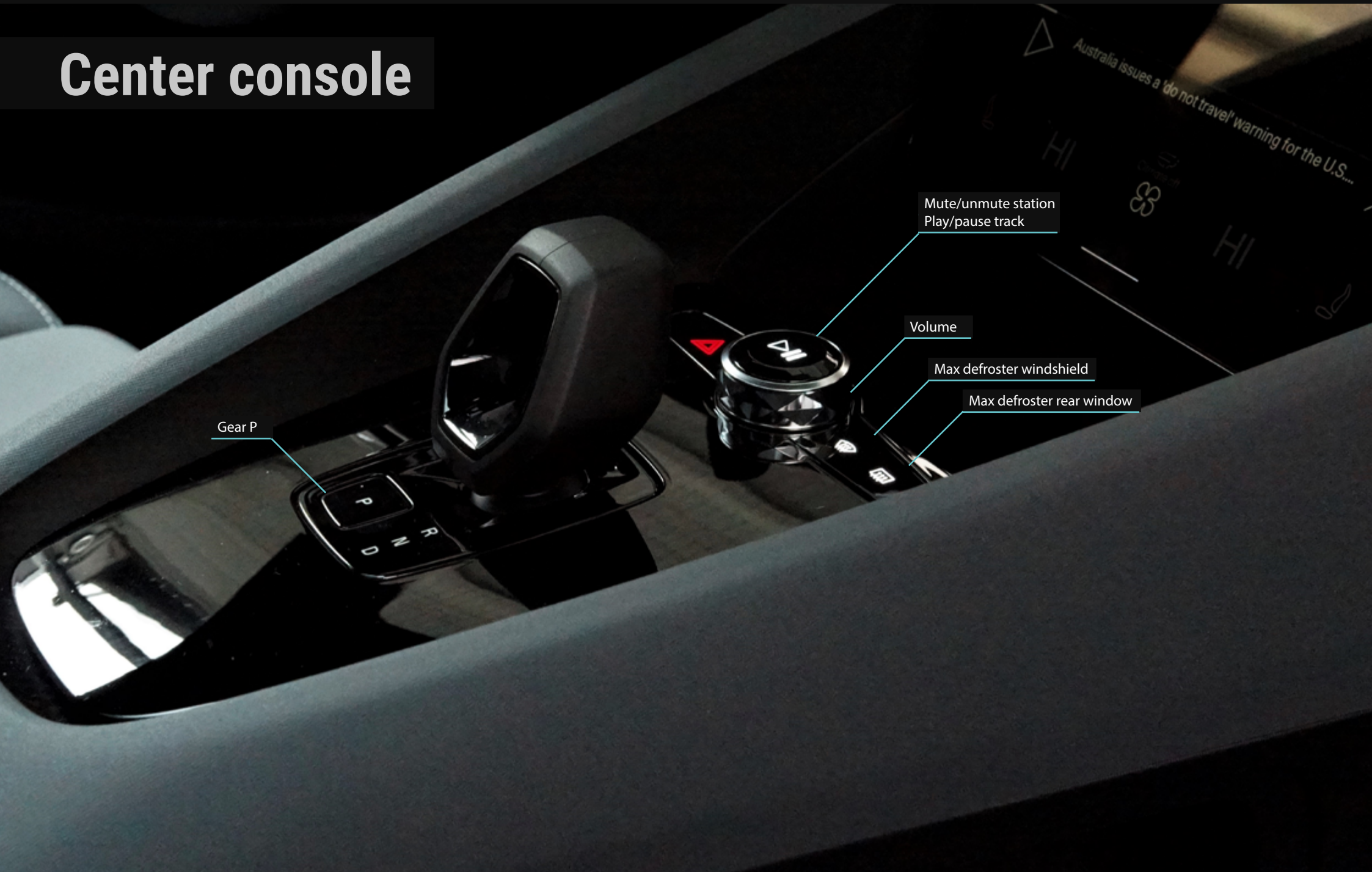


* basic application ** individual app via Google Play Store

HMI-SITEMAP

Steering Wheel

Center console



Equipment Level

Equipment packages: „Pilot“ „Plus“ „Performance“

Display Sizes

Head Unit	11“
Instrument Cluster	12“

Input Modalities

Touchscreen

Speech

Application

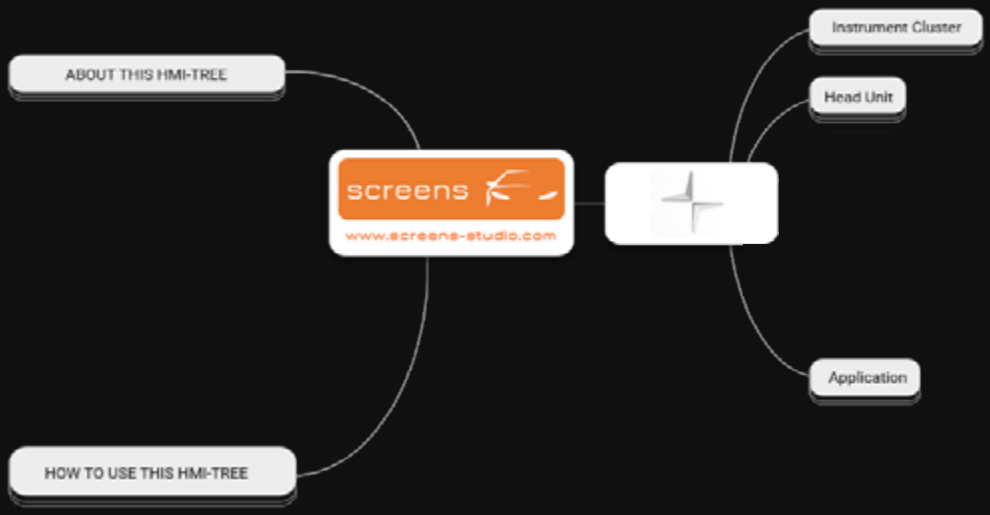
Polestar

Connectivity

CAR OVERVIEW

HMI-Sitemap

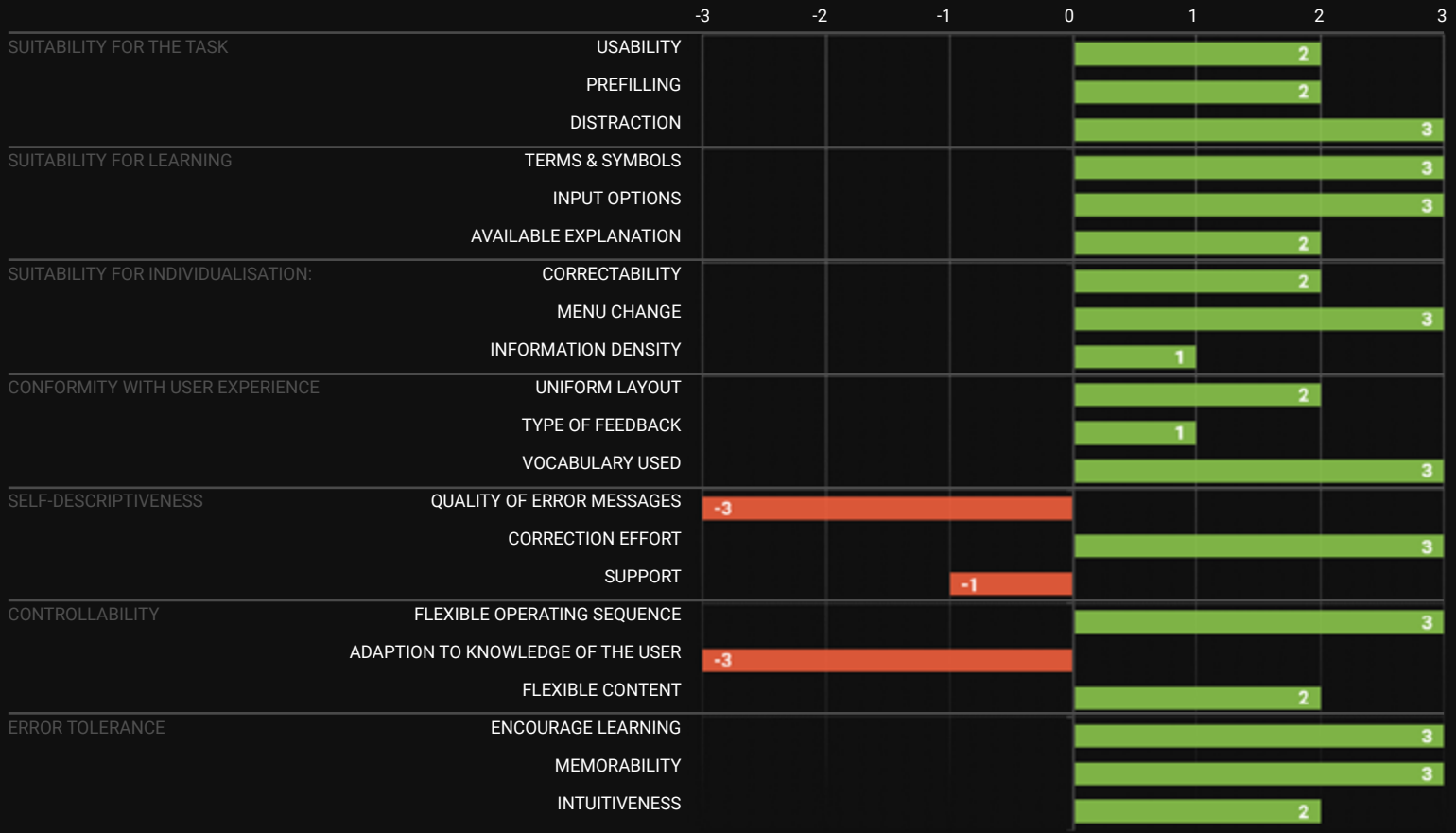
This HMI tree is an exact copy of all clickable buttons in the infotainment system of the vehicle. To make the structure easier to understand, the **HMI-sitemap** also contains logical layers created by our HMI experts. Those layers do not represent any clickable buttons. Nevertheless, you can follow the original click paths, just as they would be in the actual vehicle. Click on the following link to navigate through the different displays and levels.
You don't need a login.



HMI-SITEMAP

UX Assessment

The following evaluation is based on the assessment of our HMI experts, who evaluate the overall infotainment system in accordance with the seven criteria of the **DIN EN ISO 9241-110**: Suitability for the task, suitability for learning, suitability for individualization, conformity with user expectations, self-descriptiveness, controllability and error tolerance. If you have any further questions or questions regarding our evaluation, please do not hesitate to contact us.



A new vehicle every three weeks

We have analyzed over 350 vehicles and selected the most interesting ones in terms of infotainment systems.Currently we are providing a new vehicle in the database **screens** every three weeks. We will increase the number of units as soon as we can offer vehicles, available on the American and Asian markets in addition to the European market as well.

CW 47

Mazda MX 30

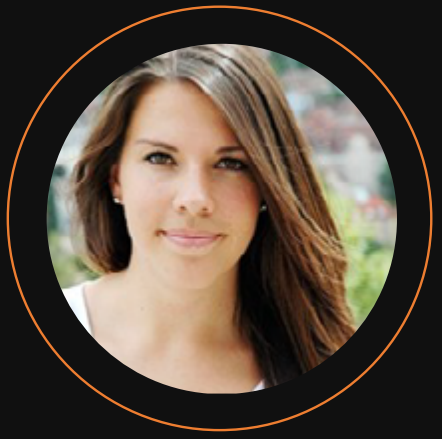
CW 50

Polestar 2

Feel free to contact our experts!

Do you have questions, suggestions, praise or criticism?

Do not hesitate to contact us! We spend almost 24/7 in the car and know (almost) everything about infotainment systems. You wouldn't believe how motivated we are to share this knowledge with you.



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