VOLVO PLANS TO BE FULLY ELECTRIC BY 2030 : IMPACT FOR EXTERIOR LIGHTING

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DVN Shanghai 2021, High Tech Lighting, Impact on Safety and Regulation

DrivingVisionNews.com
Automotive lighting and driver assistance technologies

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Volvo Cars is committed to becoming a leader in the fastgrowing premium electric car market and plans to become a fully electric car company by 2030.

By then, the company intends to only sell **fully electric** cars and phase out any car in its global portfolio with an internal combustion engine, including hybrids.

Volvo Cars launched its first fully electric car, the XC40 Recharge, in markets around the globe last year. In coming years Volvo Cars will roll out several additional electric models, with more to follow.

Already by 2025, it aims for 50 per cent of its global sales to consist of fully electric cars, with the rest hybrids.

VOLVO

MID-DECADE ELECTRIC
PORTFOLIO

XC40

VOLVO

New C40

Consumer information available at https://www.volvocars.com/intl/v/cars/c40-electric

Pixel Technology

VOLVO

Power consumption stakes – BEV

Range is the key for daily usage

XC40 : 78 KWh Battery – autonomy 418 km in WLTP mode
Smart : 17 KWh Battery – autonomy 130km in WLTP mode

Consumption of 100W during 1 hour = 100Wh
* Volvo XC40 : 0,1%
* Smart : 0,5%

Power consumption stakes – BEV

Bigger autonomy =

- Bigger Battery size
- Smaller engine (less consumption)

But also = **longer time to charge the battery**

1 hour charging @home (without fast charger) = 2000 Wh

Exterior lighting power consumption – by day

Emission homologation / Range calculation

In Europe : WLTP norm : Worldwide Harmonized Light Vehicles Test Procedure

@ Day

Car	DRL	WLTP consumption
XC40	20	40
Halogen car	25	50

Exterior lighting power consumption – by day

Emission homologation / Range calculation

In Europe : WLTP norm : Worldwide Harmonized Light Vehicles Test Procedure

@ Day

Car	DRL	WLTP consumption
XC40	20	40
Halogen car	25	50

XC40 : 78 KWh Battery – autonomy 418 km in WLTP mode

Smart : 17 KWh Battery – autonomy 130km in WLTP mode

Consumption of 50W during 1 hour = 50Wh

* Volvo XC40 : 0,06%

* Smart : **0,3%**

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Exterior lighting power consumption – by day

Emission homologation / Range calculation

In Europe : WLTP norm : Worldwide Harmonized Light Vehicles Test Procedure

@ Day

Car	DRL	WLTP consumption
XC40	20	40
Halogen car	25	50

/!\ Electrical car driver will not drive only by day

V O L V O

Exterior lighting power consumption - total

Example with 2 cars :

- Full bulb vehicle
- XC40

Yellow = LED

	DRL	Low Beam	High Beam	folamp	front Position lamp	rear turn indicator	rear turn indicator	reverse	stop	Rear fog	Rear position lamp	total / car
XC40	20	25	22	20	2	28	21	3	21	21	3	372
halogen car	25	65	65	65	5	25	25	25	25	25	5	710

Exterior lighting power consumption - total

Example with 2 cars :

• Full bulb vehicle

• XC40

Yellow = LED

	DRL	Low Beam	High Beam	folamp	front Position lamp	rear turn indicator	rear turn indicator	reverse	stop	Rear fog	Rear position lamp	total / car
XC40	20	25	22	20	2	28	21	3	21	21	3	372
halogen car	25	65	65	65	5	25	25	25	25	25	5	710

XC40 : 78 KWh Battery – autonomy 418 km in WLTP mode

Smart : 17 KWh Battery – autonomy 130km in WLTP mode

Consumption of 372W during 1 hour = 372Wh

* Volvo XC40 : 0,5%

* Smart : 2%

Exterior lighting power consumption - total

Example with 2 cars :

- Full bulb vehicle

- XC40

Yellow = LED technology

	DRL	Low Beam	High Beam	folamp	front Position lamp	rear turn indicator	rear turn indicator	reverse	stop	Rear fog	Rear position lamp	total / car
XC40	20	25	22	20	2	28	21	3	21	21	3	372
halogen car	25	65	65	65	5	25	25	25	25	25	5	710

XC40 : 78 KWh Battery – autonomy 418 km in WLTP mode

Smart : 17 KWh Battery – autonomy 130km in WLTP mode

Consumption of 710W during 1 hour = 710Wh (Halogen car)

* Volvo XC40 : 0,9%

* Smart : 4%

Exterior lighting power consumption - average

Usage factor defined by European Commission for eco-innovation

Extract from Eco-innovation documents

COMMISSION IMPLEMENTING DECISION (EU) 2019/1119

EUR-Lex - 32019D1119 - EN - EUR-Lex (europa.eu)

Table 6

Usage factor for different vehicle lights

Vehicle light	Usage factor (UF) [-]	
Low beam headlamp	0,33	
High beam headlamp	0,03	
Front position / *Daytime running lamp*	0,36	*0,64*
License plate	0,36	
Front fog lamp	0,01	
Rear fog lamp	0,01	
Front turn signal lamp	0,15	
Rear turn signal lamp	0,15	
Reversing lamp	0,01	
Cornering lamp	0,076	
Static Bending lamp	0,15	
Stop lamp	*0,15*	

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Exterior lighting power consumption - average

car	DRL	DRL usage	Low Beam	LB usage	High Beam	HB usage	front PL	front PL usage	TI	front TI usage	Rear TI	rear TI usage	reverse	reverse usage	stop	stop usage	Rear fog	rearfog usage	Rear PL day	Rear PL usage day	Rear PL night	Rear PL usage night	average consumption	WLTP consumption
XC40	20	63%	25	33%	47	3%	2	36%	28	15%	21	15%	3	1%	21	15%	21	1%	3	63%	3	36%	66	40
Halogen car	25	63%	65	33%	120	3%	5	36%	25	15%	25	15%	25	1%	25	15%	25	1%	5	63%	0	36%	107	50

Exterior lighting power consumption - average

car	DRL	DRL usage	Low Beam	LB usage	High Beam	HB usage	front PL	front PL usage	TI	front TI usage	Rear TI	rear TI usage	reverse	reverse usage	stop	stop usage	Rear fog	rearfog usage	Rear PL day	Rear PL usage day	Rear PL night	Rear PL usage night	average consumption	WLTP consumption
XC40	20	63%	25	33%	47	3%	2	36%	28	15%	21	15%	3	1%	21	15%	21	1%	3	63%	3	36%	66	40
Halogen car	25	63%	65	33%	120	3%	5	36%	25	15%	25	15%	25	1%	25	15%	25	1%	5	63%	0	36%	107	50

XC40 : 78 KWh Battery – autonomy 418 km in WLTP mode

Smart : 17 KWh Battery – autonomy 130km in WLTP mode

Consumption of 66W during 1 hour = 66Wh (Halogen car)

* Volvo XC40 : 0,08%

* Smart : **0,4%**

Exterior lighting power consumption - average

car	DRL	DRL usage	Low Beam	LB usage	High Beam	HB usage	front PL	front PL usage	TI	front TI usage	Rear TI	rear TI usage	reverse	reverse usage	stop	stop usage	Rear fog	rearfog usage	Rear PL day	Rear PL usage day	Rear PL night	Rear PL usage night	average consumption	WLTP consumption
XC40	20	63%	25	33%	47	3%	2	36%	28	15%	21	15%	3	1%	21	15%	21	1%	3	63%	3	36%	66	40
Halogen car	25	63%	65	33%	120	3%	5	36%	25	15%	25	15%	25	1%	25	15%	25	1%	5	63%	0	36%	107	50

XC40 : 78 KWh Battery – autonomy 418 km in WLTP mode

Smart : 17 KWh Battery – autonomy 130km in WLTP mode

Consumption of 107W during 1 hour = 107Wh (Halogen car)

* Volvo XC40 : 0,14%

* Smart : **0,6%**

Exterior lighting power consumption - ADB

Adaptive Driving Beam is only **3%** of the time in the usage factors defined by European commission

Exterior lighting power consumption - ADB

Adaptive Driving Beam is only **3%** of the time in the usage factors defined by European commission

Not realistic !

Exterior lighting power consumption - ADB

Adaptive Driving Beam is only **3%** of the time in the usage factors defined by European commission

Extract from Darmstadt university study - Objective Assessment of the Safety Contribution of Today's Automotive Headlamps - ATZ worldwide 06|2020

"...

While with manually switched high beam, the duty cycle is approximately **10 %,** an automatically switched high beam increases the usage to approximately **30 %** – with the ADB even an average high beam usage of approximately **70 %** is possible

..."

- Manuel high beam : 3% of time

- Automatic high beam activation : 10% of time

- ADB : 20% of time (10% with partial high beam, 10% with full high beam)

Exterior lighting power consumption - ADB

car	DRL	DRL usage	Low Beam	LB usage	High Beam	HB usage	average consumption	
XC40	20	63%	25	33%	22	3%	64	Manual high beam activation
XC40	20	63%	25	33%	22	10%	67	automatic high beam activation
XC40	20	63%	25	33%	22	20%	72	ADB

Calculation with same high beam flux / same optical system

Power consumption Xc40

Low Beam : 750lm – 25W

High Beam : Emax 130Lux

High beam usage 10% : 47W

Power consumption Xc60 - ADB

Low Beam : 1000lm – 30 Watt

High Beam : Emax 160Lux

ADB : Sail Beam

ADB usage in sail beam 10% : 38W (tunnel +/-2⁰ width)

High Beam usage : 10% : 57W

Sail beam module

High beam   Low beam   L-Shape (right)

Power consumption C40
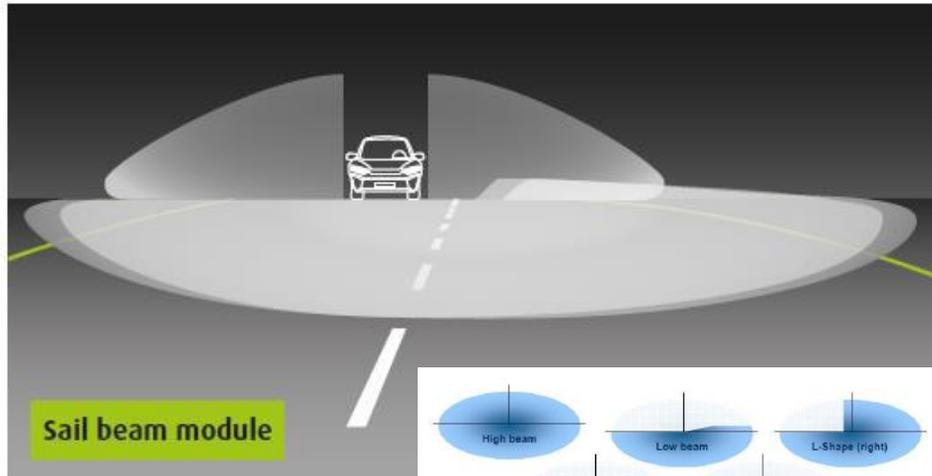
Pixel 84 + foreground Low Beam

Low Beam : 1100lm – 55 Watt

High Beam : Emax 160Lux

ADB : Pixel

ADB usage 10% : 95W (tunnel +/-2⁰ width = 2 pixels OFF)

High Beam usage : 10% : 100W

Segment OFF in ADB if preceding car

"Pixel" light pattern

Power consumption Bi_matrix 11 segment

Low Beam : 1000lm – 20 Watt

High Beam : Emax 110Lux

ADB : Matrix

ADB usage 10% : 44W (tunnel +/-2° width = 3 segments)

High Beam usage : 10% : 54W

Not enough flux for Volvo cars requirement

Segment OFF in ADB if preceding car
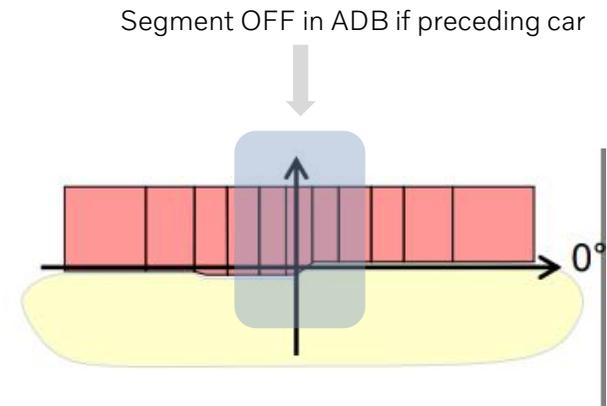
Extract from ZKW interview, September 2018 in DVN newsletter

Power consumption Bi_matrix 11 segment + DLP

Low Beam : 1000lm – 30/80* Watt (Bi_Matrix + DLP)

High Beam : Emax 200Lux

ADB : Matrix + DLP

ADB usage 10% : 97W

High Beam usage : 10% : 107W

* With DLP, you can only increase the complete Field of illumination

- *30W if small contribution of DLP in low beam*
- *80W if big contribution of DLP in low beam*
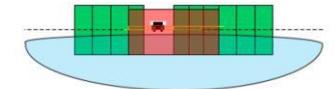

High resolution DMD module + low resolution LED matrix

This combination makes a lot of sense – headlight efficacy is a mix of matrix and DMD module

$0.4*24lm/W + 0.6*45lm/W^{(1)} = $ **36.6lm/W**

[1] E.-O. Rosenhahn, "New Systems for Safety and Comfort, Improvement by High Resolution Flexibility," SIA Vision, Paris, 2018.
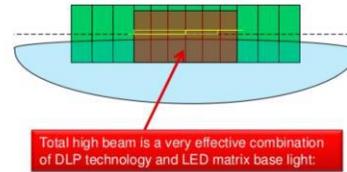
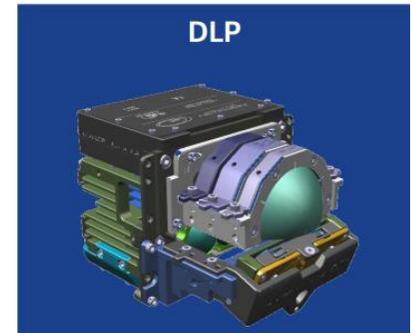system **performance** is set by DMD module

system **efficiency** enhanced by low cost matrix base light

Total high beam is a very effective combination of DLP technology and LED matrix base light:

Source : DVN Rochester, January 2010 from Texas instrument presentation

TEXAS INSTRUMENTS

DLP

Extract from ZKW VISION2020 presentation, Reza Larimian

Power consumption Bi_matrix 11 segment + MicroLED

Low Beam : 1000lm – 25 * Watt (Bi_Matrix + MicroLED)
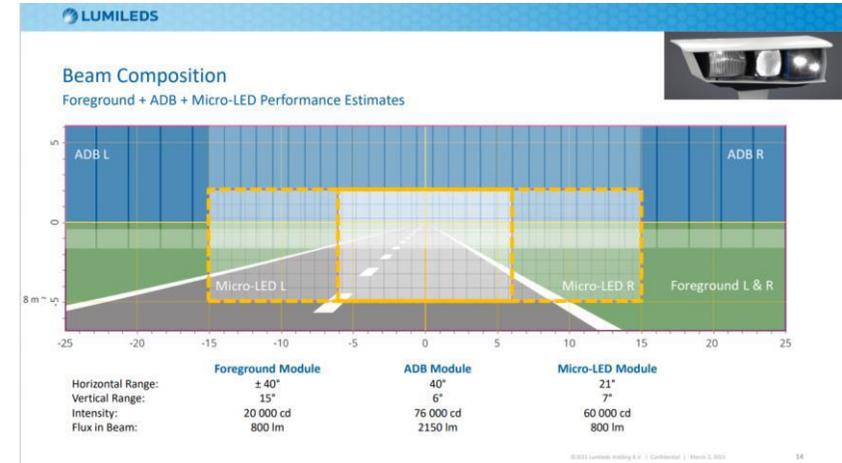
High Beam : Emax 220Lux

ADB : Matrix + MicroLED

ADB usage 10% : 94W

High Beam usage : 10% : 110W

* *With MicroLED, you can increase the Field of illumination with activation of dedicated LEDs (just where you want)*
  - *Kink*
  - *Emax*

Source : VISION2020, Lumileds

Extract from ZKW VISION2020 presentation, Reza Larimian

VOLVO

Synthesis – power consumption – low beam + ADB

Concept / Watt/lamp	Low beam	LB / Car	High beam	HB / car	ADB	ADB / car
xc40	25	50	47	94		
Sail Beam	30	60	57	114	38	76
Matrix 11 segment	20	40	54	108	44	88
Pixel + foreground	55	110	100	200	95	190
DLP (min)	30	60	107	214	97	194
DLP (max)	80	160	107	214	97	194
MicroLED	25	50	110	220	94	188

Synthesis – power consumption – Low beam + ADB

Concept / Watt/lamp	Low beam	LB usage	High beam	HB usage	ADB	ADB usage	average additional signraling function/car	average power consumption	battery % usage / hour				
									Smart average	XC40 average	worse case power consumption	XC40 max	Smart max
halogen car	65	33%	120	3%			47	97,1	0,6%		250	0,3%	1,5%
xc40	25	33%	47	3%			47	66,32	0,4%		104	0,1%	0,6%
xc40 auto High beam	25	23%	47	10%			47	67,9	0,4%		104	0,1%	0,6%
Sail Beam	30	16%	57	10%	38	10%	47	75,6	0,4%	0,1%	124	0,2%	0,7%
Matrix 11 segment	20	16%	54	10%	44	10%	47	73	0,4%	0,1%	118	0,2%	0,7%
Pixel + foreground	55	16%	100	10%	95	10%	47	103,6	0,6%	0,2%	210	0,3%	1,2%
DLP (min)	30	16%	107	10%	97	10%	47	97,4	0,6%	0,2%	224	0,3%	1,3%
DLP (max)	80	16%	107	10%	97	10%	47	113,4	0,7%	0,2%	224	0,3%	1,3%
MicroLED	25	16%	110	10%	94	10%	47	95,8	0,6%	0,2%	230	0,3%	1,4%

Driving at night : 36% of the time :
- Manuel high beam : 3% of time
- Automatic high beam activation : 10% of time
- ADB : 20% of time (10% with partial high beam, 10% with full high beam)

Average day+ night

Worst case full high beam

VOLVO

Conclusion : Power consumption @ average usage
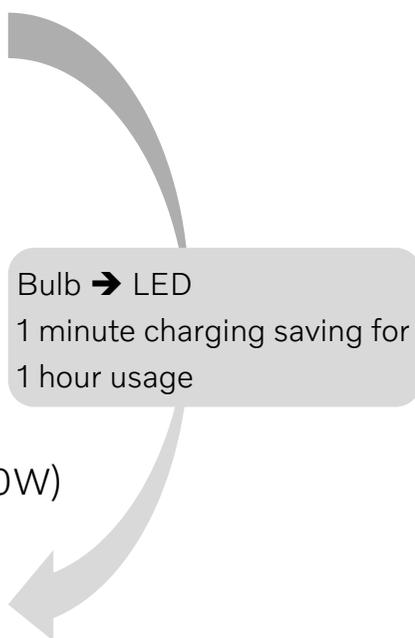
Bulb ➔ LED @ same performance : saving 30W

LED lamp ➔ ADB "low resolution" : + 10W

ADB "low resolution" ➔ ADB "high resolution" : + 30W

ADB "high resolution" > halogen bulb power consumption

DLP ➔ MicroLED technology : we reduce a bit the power consumption, but not drastically (~-10W)

At home : 1 hour charging = 2000 Wh, 1 minute charging = 30Wh

Bulb ➔ LED
1 minute charging saving for
1 hour usage

Conclusion on average usage low beam + High beam

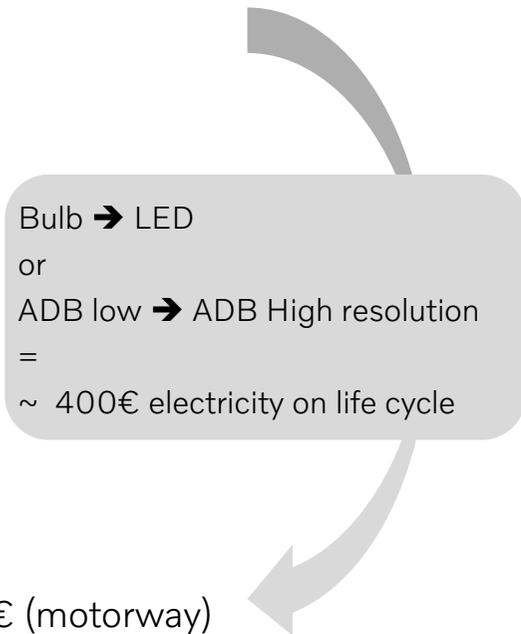Electrical Car usage : 10 000 hours / 15 years

Average usage exterior lighting 65W = 650 000 Wh

Average usage exterior lighting ADB "high resolution" : 105W = 1 050 000 Wh

Cost of electricity for 1000 Wh ~ 0,2€ (home) / 1€ (Motorway)

Average usage exterior lighting 65W = 130€ (home) / 650€ (motorway)

Average usage exterior lighting ADB "high resolution" or Bub : 105W : 210€ (home] / 1050€ (motorway)

Bulb ➔ LED
or
ADB low ➔ ADB High resolution
=
~ 400€ electricity on life cycle

Conclusion on Range

Not really an issue if big battery, SUV

Issue If small battery size, for a city car, lighting consumption can be 1% of battery capacity / hour

Conclusion for ADB "high resolution" system

1st generation system with Pixel 84 or DLP were great

2nd generation with MicroLED are promising

We need a 3rd step with a drastically reduction of global power consumption

Thank you