LED, BETWEEN MODE AND LONG TERM EFFICIENCY

Prof.dr.ing. Cătălin-D. Gălăţanu

FEASIBILITY STUDY FOR THE REPLACEMENT OF CLASSICAL LED LIGHT SYSTEMS IN LOCALITIES IN THE MUNICIPALITY OF REŞIŢA: CÂLNIC, ŢEROVA, DOMAN, SECU, CUPTOARE AND MONIOM

- The object of the study - 6 localities belonging to the municipality of Resita: Câlnic, Ţerova, Doman, Secu, Furnaces and Moniom.
- This study aimed at upgrading the street public lighting system where the existing lighting is deficient and degraded to a great extent (the last major modernization of the lighting system took place in 2006 when generating the lighting with sodium vapor lamps).
- In general, the lighting requirements imposed by the SR 13433 standard were not ensured, and the energy consumption is a determinant performance criterion, having a negative effect on the community budget (most of the areas close to Reşiţa).

FEASIBILITY STUDY FOR THE REPLACEMENT OF CLASSICAL LED LIGHT SYSTEMS IN LOCALITIES IN THE MUNICIPALITY OF REŞIŢA: CÂLNIC, ŢEROVA, DOMAN, SECU, CUPTOARE AND MONIOM

- The object of the study included the modernization of the street public lighting systems related to national, county and village roads in the aforementioned districts having a total length of about 29.45 km.
- The analyzed lighting systems comprise about 908 aerial poles (mostly non-isolated) equipped with about 802 luminaires.
- Lighting fixtures are mostly equipped with 70, 100 or 150W sodium lamps.

FEASIBILITY STUDY FOR THE REPLACEMENT OF CLASSICAL LED LIGHT SYSTEMS IN LOCALITIES IN THE MUNICIPALITY OF REŞIŢA: CÂLNIC, ŢEROVA, DOMAN, SECU, CUPTOARE AND MONIOM

- Increasing the overall efficiency of the lighting system, reflected by increasing the level of illumination simultaneously with the decrease in energy consumption, is the main element of progress of the project.
- The modernization of the street public lighting consists in combining and balancing the theoretical solutions with the practical and economic ones (low energy consumption, minimal maintenance and installation costs, and the total costs of the lighting system administrator).
- It can be appreciated that achieving a comfortable light climate with minimal energy consumption with the most intense use of efficient and reliable lighting sources and luminaires and a minimum investment is a criterion for appreciating a modern lighting system efficient.

FEASIBILITY STUDY FOR THE REPLACEMENT OF CLASSICAL LED LIGHT SYSTEMS IN LOCALITIES IN THE MUNICIPALITY OF REŞIŢA: CÂLNIC, ŢEROVA, DOMAN, SECU, CUPTOARE AND MONIOM

- Bringing street public lighting to the parameters set by SR 13433/99 as well as alignment with European norms required the change of incandescent lamps and lighting fixtures with reliable and efficient lamps, the arguments presented both on the indirect and economic benefits line reveal the necessity of increasing the efficiency of street public lighting In the neighboring areas of Resita.
- According to SR 13433/99 and the technical norms in force, the streets were light-technical in the ME5 category.
- In all areas around Resita, the existing lighting fixtures have been replaced with 65W led lamps.
- In the Doman district, where lighting was generally disposed of 2 in 2 pillars, the amplification of the lighting system was made by equipping all the pillars in the existing power grid, where consoles and lighting fixtures would be mounted.

- **Street centralizer on the projected situation of rehabilitated public lighting systems**

Nr. Crt.	*Strada*	*Nr. total stalpi existenti*	*Nr. total corpuri ilum. Existente*	*Putere instalata existenta [W]*	*Nr. total corpuri ilum. Propuse*	*Putere instalata unitara in corpul modernizat [W]*	*Putere instalata propusa [W]*
0	***1***	***2***	***3***	***4***	***5***	***6***	***7***
a	Sălnic	177	178	12460	178	65	11570
b	Cuptoare	119	110	7700	110	65	7150
c1	Driglovăţ, din care	42	42	4200	42	65	2730
c2	Zonă străzi acces spre Driglovăţ	60	47	3620	60	65	3900
d	Doman	159	91	6370	166	65	10790
e	Moniom	65	60	9000	60	65	3900
f	Poiana Golului	66	63	4970	63	65	3105
g	Secu	132	123	8610	123	65	7995
h	Ţerova	88	88	6160	88	65	5720
	TOTAL	**908**	**802**	**63090**	**890**		**56860**

FEASIBILITY STUDY FOR THE REPLACEMENT OF CLASSICAL LED LIGHT SYSTEMS IN LOCALITIES IN THE MUNICIPALITY OF REŞIŢA: CÂLNIC, ŢEROVA, DOMAN, SECU, CUPTOARE AND MONIOM

Capacities (in physical and value units)

- There will be modernization in terms of lighting technology and brought to the level of the standards in force a number of 6 neighboring localities in the municipality of Reşiţa having a total length of approximately 29.45 km, the installed existing electric power decreasing from 63.09kW (76kW inclusive Loss on ballasts) to about 56.86kW.
- These streets will be equipped with an additional number of 88 new lighting fixtures, the total number of new bodies being 890 pieces.

FEASIBILITY STUDY FOR THE REPLACEMENT OF CLASSICAL LED LIGHT SYSTEMS IN LOCALITIES IN THE MUNICIPALITY OF REŞIŢA: CÂLNIC, ŢEROVA, DOMAN, SECU, CUPTOARE AND MONIOM

Other indicators specific to the field of activity where the investment is made:

A) before the investment is made:

- Specific annual electricity consumption (lei / km): 9559.0 RON / km / year
- Annual specific electricity loss (kWh / km): 2760.0 kWh / km / year
- Specific power losses (kW / km): 0.778 kW / km

B) after the realization of the investment:

- specific annual electricity consumption (lei / km): 4929.5 RON / km / year
- Specific electricity loss (kWh / km): 488.1 kWh / km / year
- Specific power losses (kW / km): 0.222 kW / km

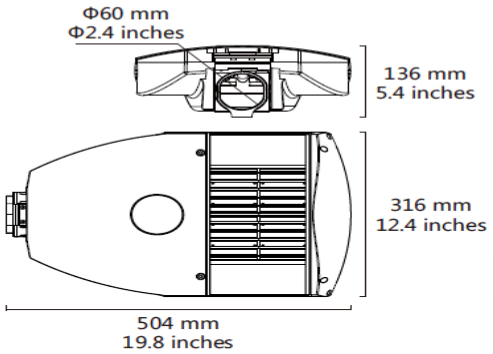
FEASIBILITY STUDY FOR THE REPLACEMENT OF CLASSICAL LED LIGHT SYSTEMS IN LOCALITIES IN THE MUNICIPALITY OF REŞIŢA: CÂLNIC, ŢEROVA, DOMAN, SECU, CUPTOARE AND MONIOM

- 65W LED Lighting Specifications:

T1-65W

Introducing a New Premium Experience

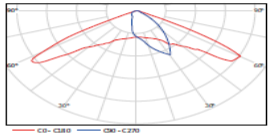
Op□cal control func□on is supported by op□onal
Dimming func□ons are supported by op□onal
+ Three in One (1-10V DC or PWM Signal or Resistance)



Specif caΘons

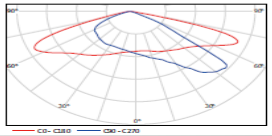
Electrical Specif ca□ons:

Model No.	*ZGSM-LD65H*
Nominal Wa©age	*65W*
Nominal Voltage	*AC 100-240V /277V, 50/60Hz* *DC 24V*
Maximum Current	*AC 0.67A -120V, 0.33A -240V, 0.29A -277V* *DC 3.01A -24V*
Op□mal Opera□ng Temperature	*-40 ºC to +50 ºC*



1S

Order Ref.
ZGSM-LD65H1S



2M

Order Ref.
ZGSM-LD65H2M

IN2RURAL
Innovative Practices in Renewable Energies to Improve Rural Employability

URBIOLED

Exterior lighting - EC requirements

- The EU has set new energy efficiency requirements for lamps produced on the EU market as of 1 September 2009.
- EU regulation affects not only "household lamps" but also all inefficient lamps as well as inefficient ballasts and lighting fixtures:

2010	• Eliminarea lămpilor fluorescente liniare ("halofosfat") • Etichetarea balasturilor pentru lămpile fluorescente • Eficiența minimă necesară a balasturilor
2011	• Informații obligatorii despre produs pentru corpurile de iluminat
2012	Eliminarea: • Lămpilor fluorescente T12 (38 mm) • Precizarea eficiențe balastului pentru lămpile cu descărcare in vapori de intensitate ridicată • Cerințe minime pentru Factorul de conservare al fluxului luminos (LLMF) & Factorul de supravietuire al lampii (LSF)
2015	Eliminarea: • Lămpilor cu mercur de înaltă presiune • Lămpilor plug-in cu sodiu de înaltă presiune
2017	• Cerințe mai mari pentru lămpile cu halogenuri metalice • Eliminarea balasturilor magnetice, raman doar balasturile electronice

Outdoor lighting - types of lamps

Tehnologie	Imagine	Cota*	Aplicatii uzuale in prezent	Tendinte
Lampi cu vapori de sodiu de inalta presiune		38%	Iluminat stradal, spatii parcare si tuneluri, partial spoturi	Drumurile principale si tunele, in prezent numar de aplicatii in crestere, din 2015 descreste
Lampi cu vapori de mercur de joasa presiune		35%	Iluminat stradal, spatii parcare	Dispare eticheta CE in 2015
Lampi fluorescente in format alungit		9%	Iluminat stradal, spatii parcare	Nepotrivit pentru iluminat stradal Eficienta scazuta Calitatea iluminatului neconforma cu cerintele prezente, vor fi inlocuite cu solutii LED
Lampi fluorescente compacte		9%	Iluminat stradal, spatii parcare, zone pietonale	
Lampi cu descarcare in halogenuri metalice		6%	Spoturi, baze sportive, zone pietonale	Aplicatiile pentru iluminat stradal in crestere
LED		2%	Spoturi, marcaje & efecte luminoase	Aplicatiile pentru iluminat stradal in crestere

*raportat la iluminat stradal in Austria; 100% = 0,84 mil.puncte iluminat

Sursa: Philips, Ianuarie 2010

The main features of the different types of lamps:

Tipul lămpii	Eficacitatea lămpii [lm / W]	Durata de viață probabilă [ore]	Indice de redare a culorilor [IRC]
bec incandescent	8-15	1.000	100
halogen cu tensiune joasă	12-25	2.500	100
halogen cu filtru infraroșu	25-35	5.000	100
lampă fluorescentă compactă	50-84	6.000 – 15.000	85
lămpi fluorescente (T8, balast convențional)	47-83	8.000	>90
lămpi fluorescente(T8, lămpi cu trei benzi, balast electronic)	până la 100	19.000	
Lămpi fluorescente (T5, balast electronic)	67-110	20.000-30.000	80-90
Lămpi cu halogenuri metalice	84 - 104	10.000 – 15.000	>80
Lămpi cu sodiu cu presiune înaltă	90 - 150	20.000 - 30.000	25
Lămpi cu sodiu cu presiune scăzută	120 - 200	12.000 - 20.000	
Diodă emițătoare de lumină (LED)	30 – 90 (până la 130)	50.000 +	>80
OLED	25	~10.000	>80

Why LED?

The LED is an electronic device with a p-n junction that emits an optical radiation in the event of an electric excitation.

Advantages of the LED

- Constant output color regardless of the level of illumination
- It does not contain mercury
- Not UV and infrared radiation
- Reduces the number of insects attracted
- Resistant and stable
- Wide range with different levels of quality available on the market

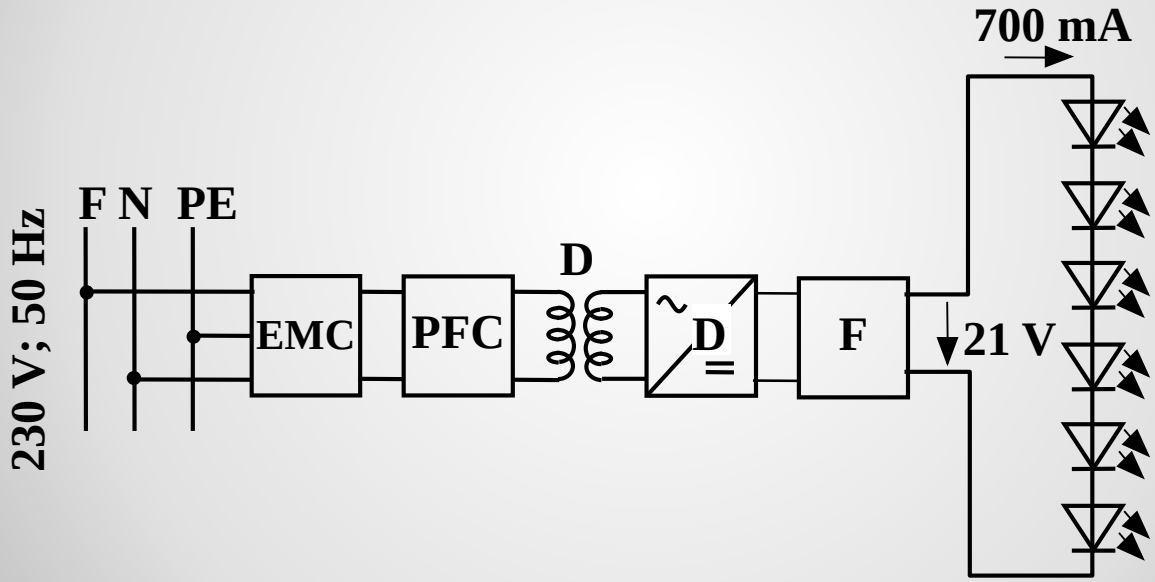
Design

- Direct light
- Minimum side light losses (180o emission angle)
- Light almost does not produce heat in the light cone
- Good color rendering
- Simple and flexible design for mounting and encapsulation

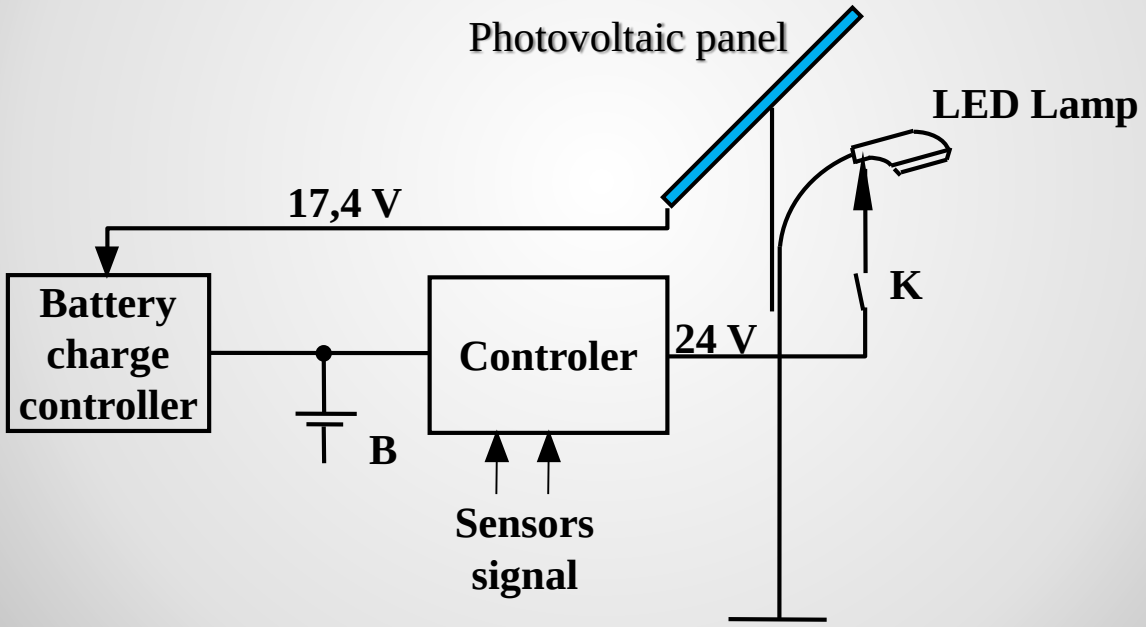
Efficiency & costs

- Very long life (50,000 and over)
- Currently, the light output of various lamps is:
- CFL-approx. 60 lm / W,
- "High Power LEDs" up to 100 lm / W, laboratory values up to 200 lm / W
- Currently, high investment costs

- **LED Lamp - Principle Electric Circuit**



- The schematic diagram of an autonomous lighting system with photovoltaic panels



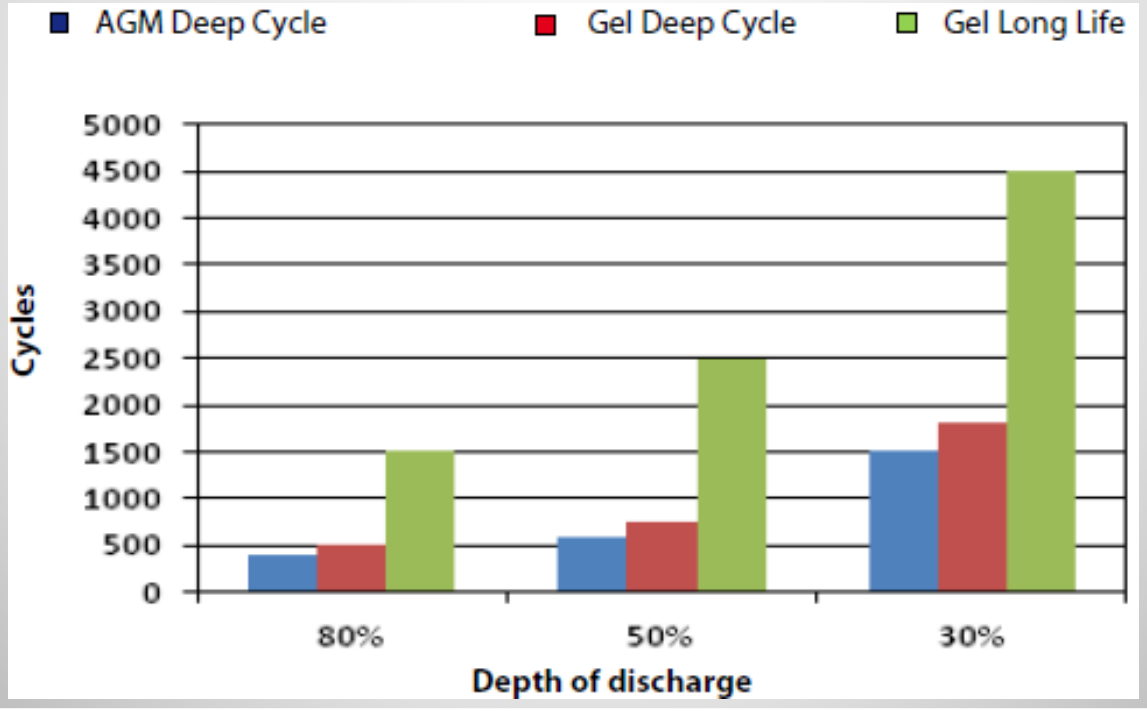
- Technical specifications of some batteries used to store solar energy

  A) The life span of various types of gel batteries depending on the ambient temperature

Average Temperature	AGM Deep Cycle years	Gel Deep Cycle years	Gel Long Life years
20 °C / 68 °F	7 - 10	12	20
30 °C / 86 °F	4	6	10
40 °C / 104 °F	2	3	5

Technical specifications of some batteries used to store solar energy

- B) Number of cycles supported by different types of gel batteries depending on the discharge level



- Technical and economical analysis of an energy-led led lighting system produced by solar panels
- It has been attempted to replace existing luminaires equipped with classical lamps through LEDs. By replacing existing light sources with LED light sources that will provide higher levels of illumination than those of the present, more appropriate to the purpose and destination of the roadway, improved visual comfort.
- By using solar panels, it was intended to reduce the cost of electricity to zero.
- An analysis of indirect benefits and costs may take into account two aspects: reducing maintenance costs and reducing electricity consumption in public street lighting.

- Technical and economical analysis of an energy-led led lighting system produced by solar panels
- The materialization of the proposed solution for the modernization of the lighting system involves the execution of the following categories of works:
- Replacement of existing street lighting with new, modular, LED, 40-60W, depending on the class of illumination adopted according to SR13433 / 99
- Giving up electricity from the public system
- Installation of 60-90-120W Solar Panel Systems with local power storage and its subsequent use at night when supplying the LED lighting body

Technical and economical analysis of an energy-led led lighting system produced by solar panels

The economic analysis was considered for the classic system:

- Periodic replacement of lamps, which at present according to field studies are economic, of relatively low power, whose lifetime is about one year;
- An annual revision of the entire lighting system.

For the upgraded system, according to the working parameters of the electrical energy storage elements, it was considered:

- Replacing batteries every four years
- A periodic replacement / maintenance of the load module every five years, and
- An annual revision of the entire lighting system.

- Technical and economical analysis of an energy-led led lighting system produced by solar panels

EVALUATIONS

MODERNIZATION OF THE PUBLIC ILLUMINATED SYSTEM WITH LED LIGHTS AND SOLAR PANELS

Object Public street lighting

A Works C+M:

Construction works:

Total Lucrări de construcţii: = 0 lei = 0.0€

2. Electrical installation works:

LED lamp mounting outdoor on existing pole	1 corp de iluminat 60.0 W/buc					
1 pcs x 585.6 lei / pcs	=	586	lei	=	131.7	€
Total Electrical installation works:	=	586	lei	=	131.7	€
Total A	=	586	lei	=	131.7	€

B ECHIPAMENTE:

1. Equipment with mounting

Street lighting with LED 60 W						
1 pcs x 4325 lei / pcs	=	4325	lei	=	973.0	€
Total Equipment with mounting	=	4325	lei	=	973.0	€
Total B	=	4325	lei	=	973.0	€
TOTAL GENERAL	=	4911	lei	=	1104.7	€

Technical and economic analysis of an energy-led led lighting system produced by solar panels

ANNUAL COSTS AND REVENUE REVENUE - EURO								
	Year							
	1	2	3	4	5	6	7	8
Annual energy price index update	1	1	1.02	1.02	1.02	1.02	1.02	1.02
Cumulative energy update index	1	1.00	1.02	1.04	1.06	1.08	1.10	1.13
Electricity price	0.130	0.130	0.133	0.135	0.138	0.141	0.144	0.146
Electricity cost classic lighting system with 30W economical bulbs, no losses on the network, euro / year	17.08	17.08	17.42	17.77	18.13	18.49	18.86	19.24
Cost of network power losses of the lighting system, euro / year	1.71	1.71	1.74	1.78	1.81	1.85	1.89	1.92
Generic cost electrical energy lighting system with 60W LED bulbs powered by solar panels, euro /an	34.16	34.16	34.85	35.54	36.26	36.98	37.72	38.47
Generic cost network power losses of the modernized lighting system, euro / year	3.42	3.42	3.48	3.55	3.63	3.70	3.77	3.85

Technical and economic analysis of an energy-led led lighting system produced by solar panels

INVESTITII TOTALE - mii Euro

	ANUL									
	1	2	3	4	5	6	7	8	9	10
Object										
Public street lighting	1.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other expenses	0.01									
Fixed assets	1.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Residual value										-0.84
Total investment costs	1.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.84

Residual value is recorded as a negative value because it represents an input stream.

Technical and economic analysis of an energy-led led lighting system produced by solar panels

OPERATING COSTS AND INCOME - thousands of EURO										
	ANUL									
	1	2	3	4	5	6	7	8	9	10
Cost of electricity classic lighting system	0.019	0.019	0.019	0.020	0.020	0.020	0.021	0.021	0.022	0.022
Periodic maintenance of classic lighting system	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.007
Administrative costs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total operating system cost of operation	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.007
Cost-saving energy-efficient lighting system	0.038	0.038	0.038	0.039	0.040	0.041	0.041	0.042	0.043	0.044
Periodic maintenance of modernized lighting system	0.003	0.003	0.003	0.359	0.035	0.003	0.003	0.388	0.003	0.038
Administrative costs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total operating costs of the upgraded system	0.003	0.003	0.003	0.359	0.035	0.003	0.003	0.388	0.003	0.038
Budget subsidies	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Venituri de exploatare, realizat prin economii la buget	0.051	0.051	0.052	0.053	0.054	0.055	0.056	0.057	0.058	0.059
Venit net din exploatare	0.048	0.048	0.049	-0.306	0.019	0.052	0.053	-0.331	0.055	0.021

Technical and economic analysis of an energy-led led lighting system produced by solar panels

FINANCIAL SUSTAINABILITY - thousands Euro

	YEAR									
	1	2	3	4	5	6	7	8	9	10
Total financial resources	1.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sales	0.051	0.051	0.052	0.053	0.054	0.055	0.056	0.057	0.058	0.059
Total entries	1.170	0.051	0.052	0.053	0.054	0.055	0.056	0.057	0.058	0.059
Total operating costs	0.003	0.003	0.003	0.359	0.035	0.003	0.003	0.388	0.003	0.038
Total investment costs	1.119	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.839
Total exits	1.122	0.003	0.003	0.359	0.035	0.003	0.003	0.388	0.003	-0.801
Total cash flow	0.048	0.048	0.049	-0.306	0.019	0.052	0.053	-0.331	0.055	0.861
Cumulative total cash flow	0.048	0.096	0.145	-0.161	-0.142	-0.090	-0.037	-0.368	-0.312	0.548

As can be seen from the previous table, the total cumulative cash flow is not positive for all the years projected after the implementation of the investment

- **Analiza tehnică şi economică a unui sistem de iluminat cu led-uri alimentat cu energie produsă de panouri solare**

RATA INTERNA A RENTABILITATII FINANCIARE A INVESTITIEI - mii Euro										
	ANUL									
	1	2	3	4	5	6	7	8	9	10
Vanzari	0.051	0.051	0.052	0.053	0.054	0.055	0.056	0.057	0.058	0.059
Venituri totale	0.051	0.051	0.052	0.053	0.054	0.055	0.056	0.057	0.058	0.059
Costuri de exploatare totale	0.003	0.003	0.003	0.359	0.035	0.003	0.003	0.388	0.003	0.038
Costurile totale ale investitiei	1.119	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.839
Cheltuieli totale	1.122	0.003	0.003	0.359	0.035	0.003	0.003	0.388	0.003	-0.801
Disponibil de numerar net	-1.071	0.048	0.049	-0.306	0.019	0.052	0.053	-0.331	0.055	0.861
Rata de actualizare	5.0%									
Rata interna a rentabilitatii financiare a investitiei	-6.7%	<5%								
Valoarea actuala neta financiara a investitiei	-0.8	<0								
Raport cost - beneficiu	0.33	<1								

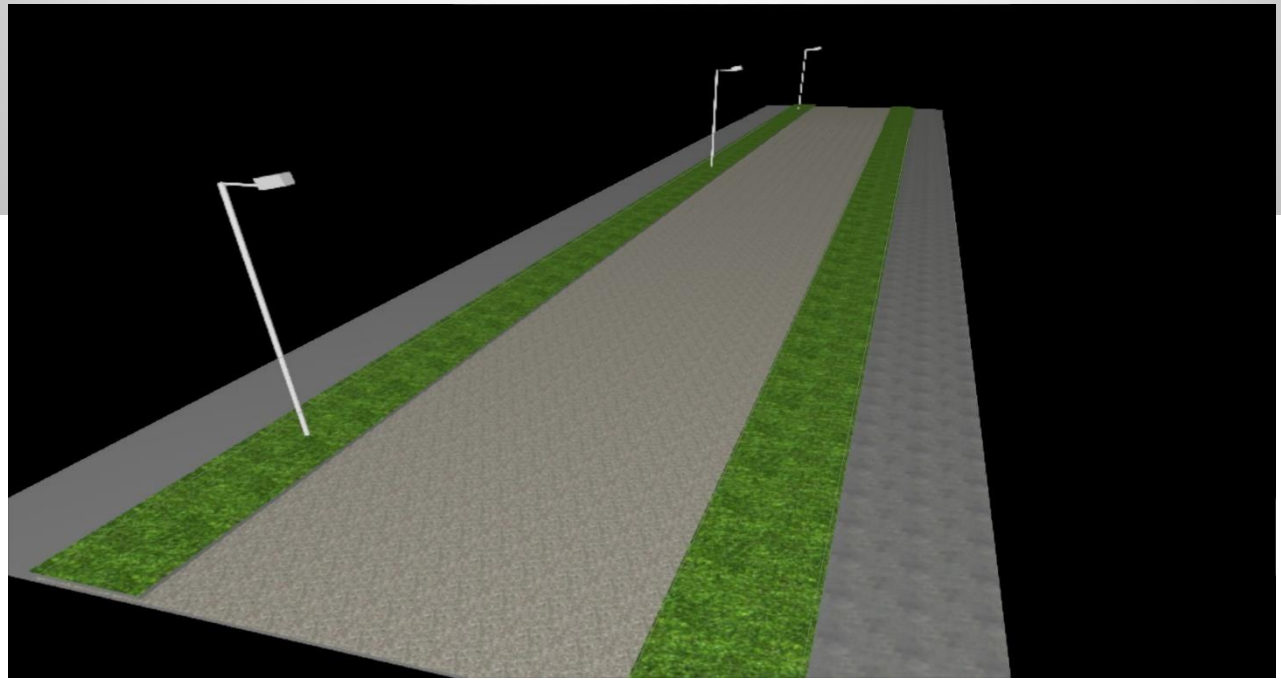
- **Analiza tehnică şi economică a unui sistem de iluminat cu led-uri alimentat cu energie produsă de panouri solare**

- **Valoarea actualizata neta raportata la investitie este negativa, ceea ce semnifică faptul ca proiectul nu poate fi realizat de beneficiar deoarece nu generează suficiente economii la bugetul beneficiarului pentru amortizarea investitiei.**

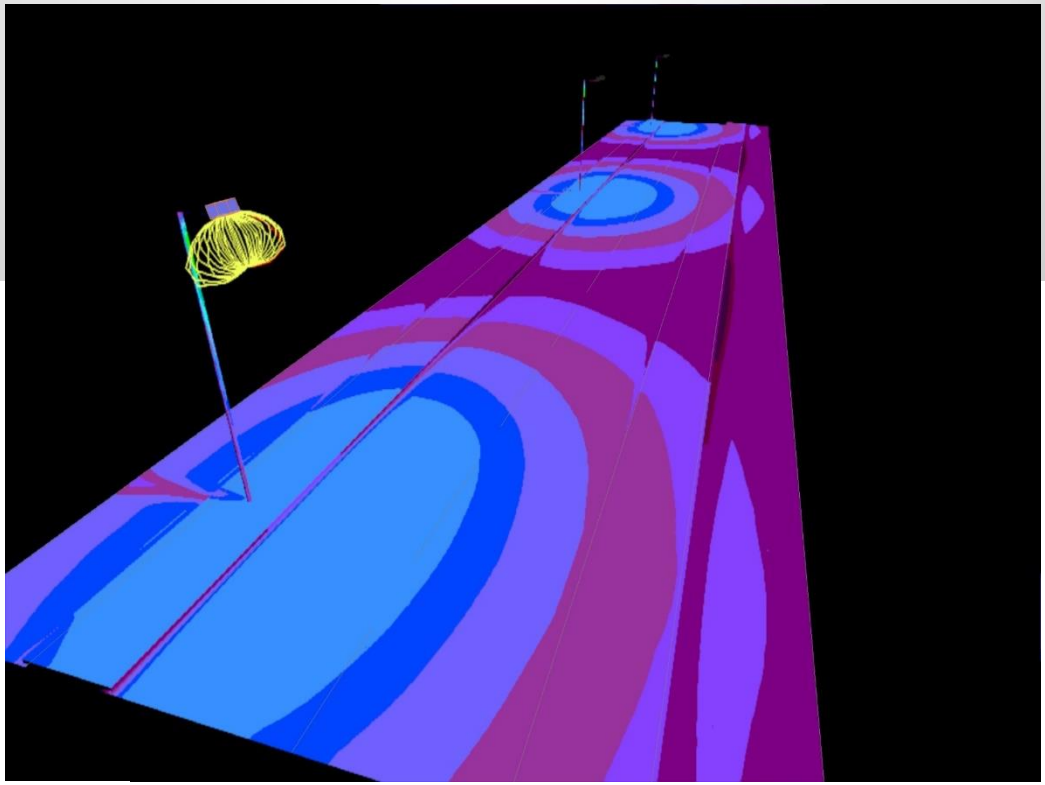
- **Fluxul cumulat de numerar, nu prezinta valori pozitive pe fiecare an, ceea ce dovedeste ca proiectul nu este durabil din punct de vedere financiar.**
- **Totuşi, acest proiect fiind un proiect de infrastructură de utilitate publică, el va necesita surse de finanţare nerambursabile.**

- **Daca analiza economica s-ar face pentru corpuri de iluminat clasice cu vapori de sodiu de 70-125W (si nu cu lampi economice), economiile generate la bugetul beneficiarului prin utilizarea lampilor cu leduri ar fi permis amortizarea investitiei cu necesitatea mai redusa a unor surse de finanţare nerambursabile.**

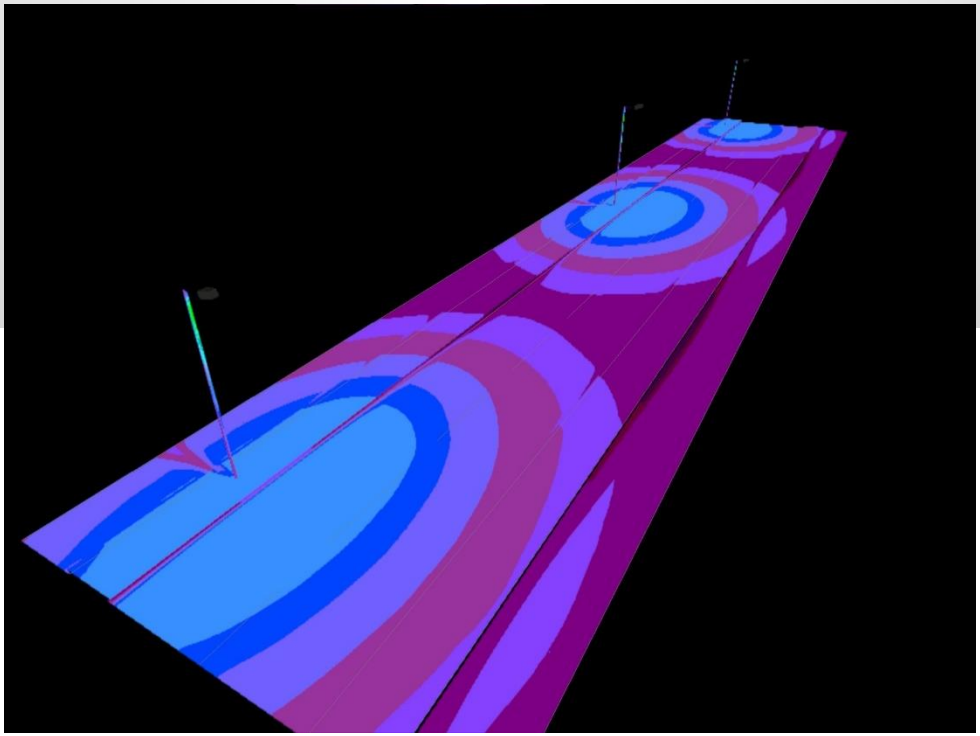
The classic solution



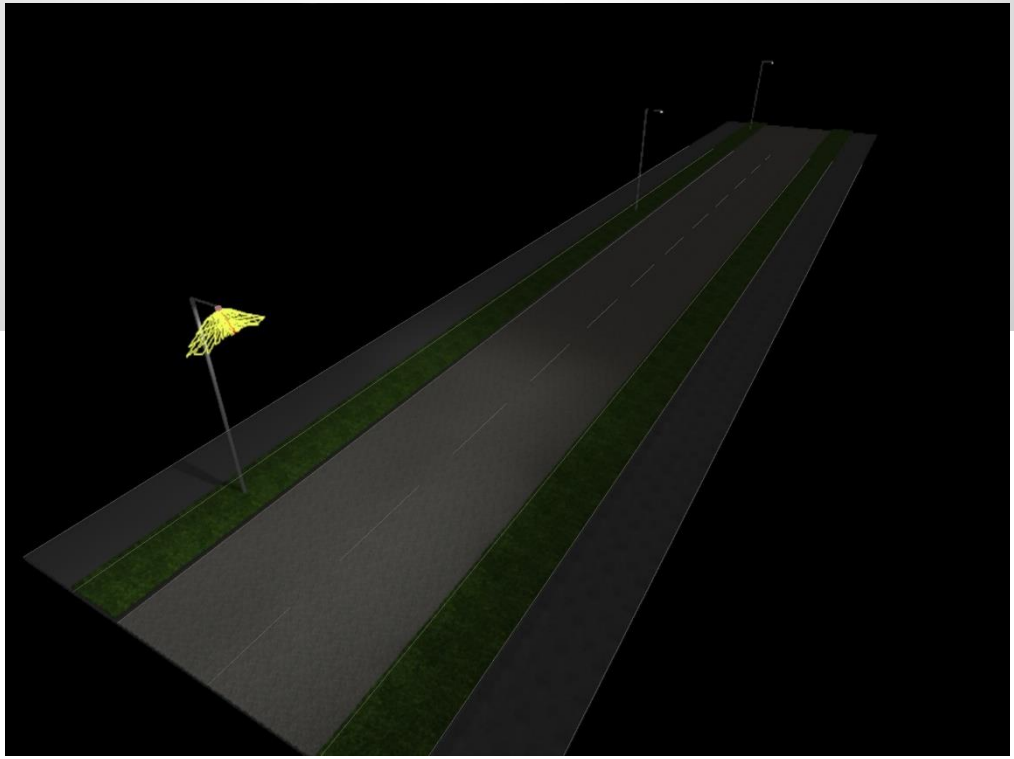
Classic system, HPS



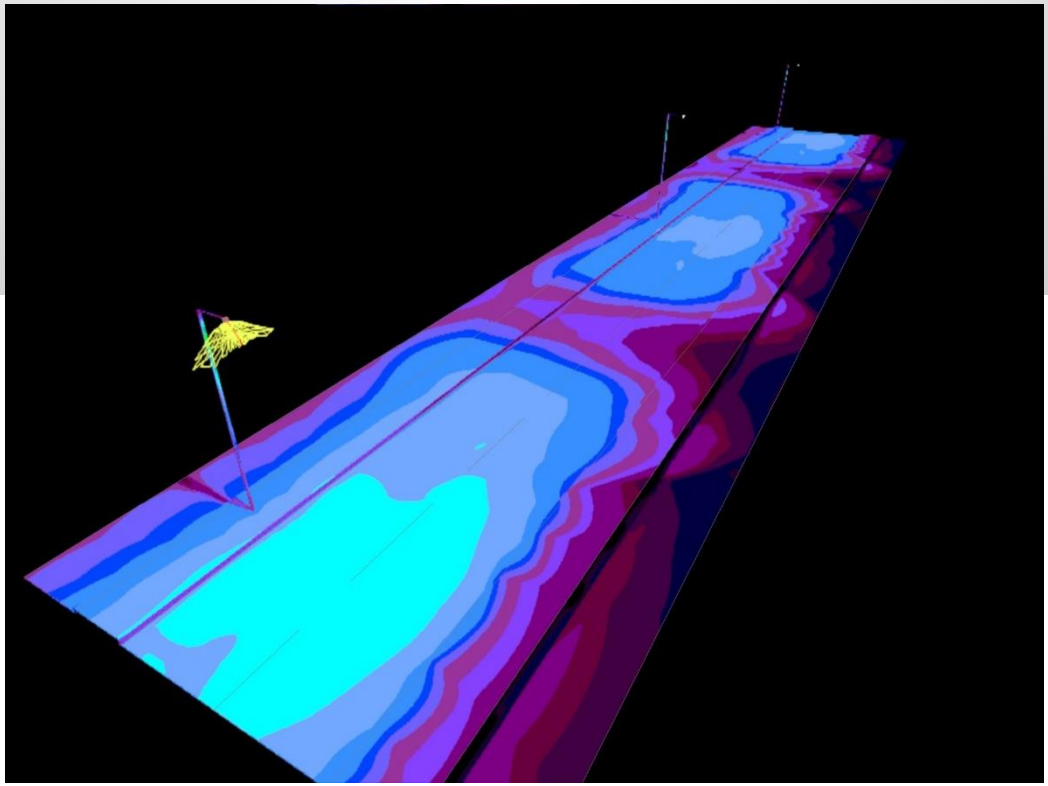
Classic system, fake colors



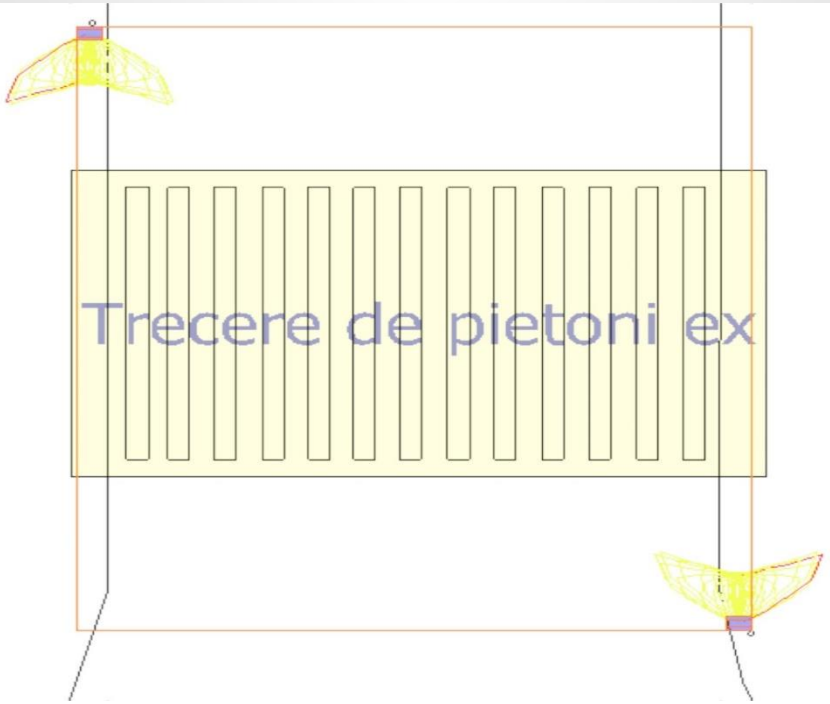
LED System "clasic"!



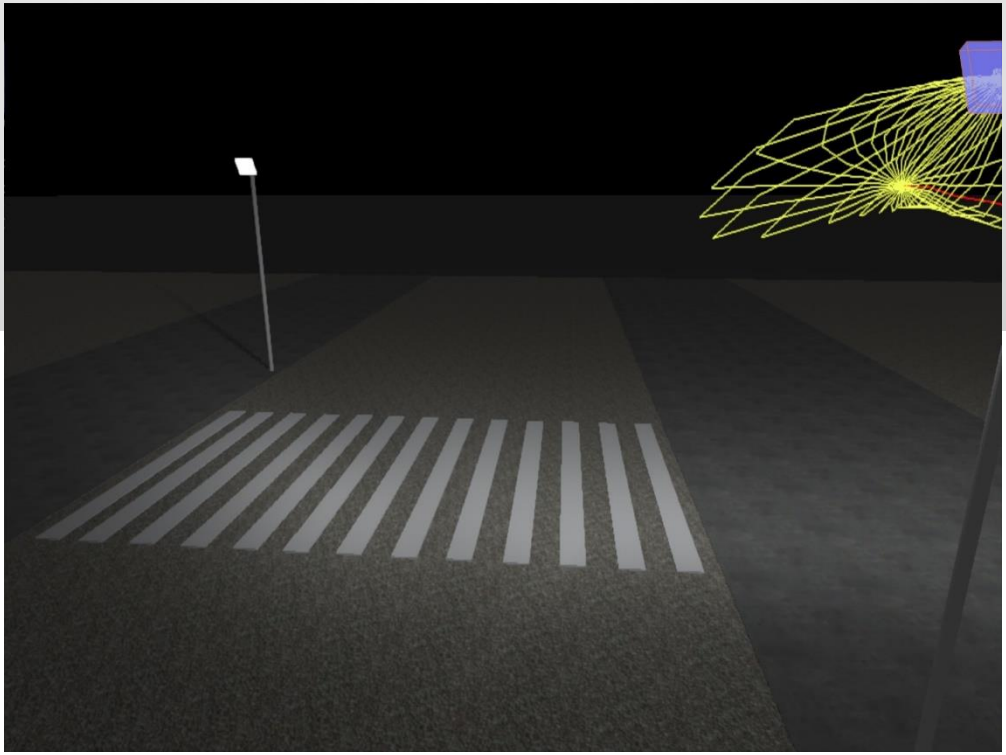
LED system, classic distribution!



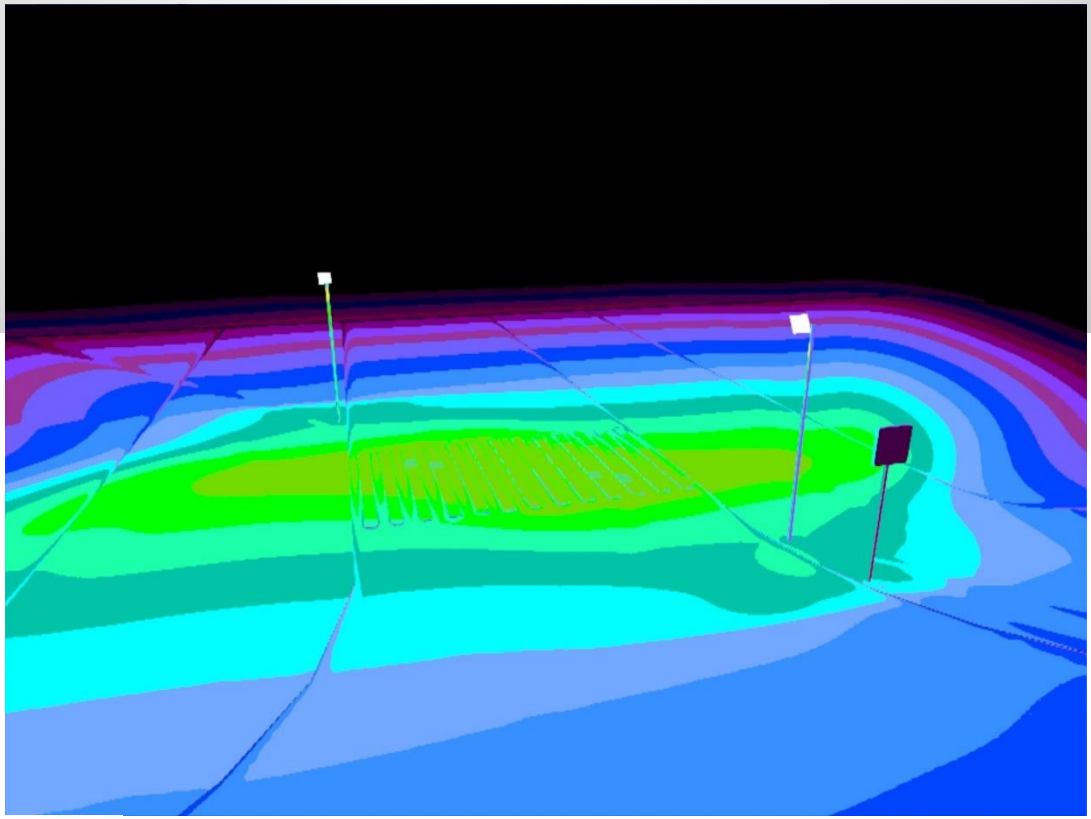
Crosswalk!



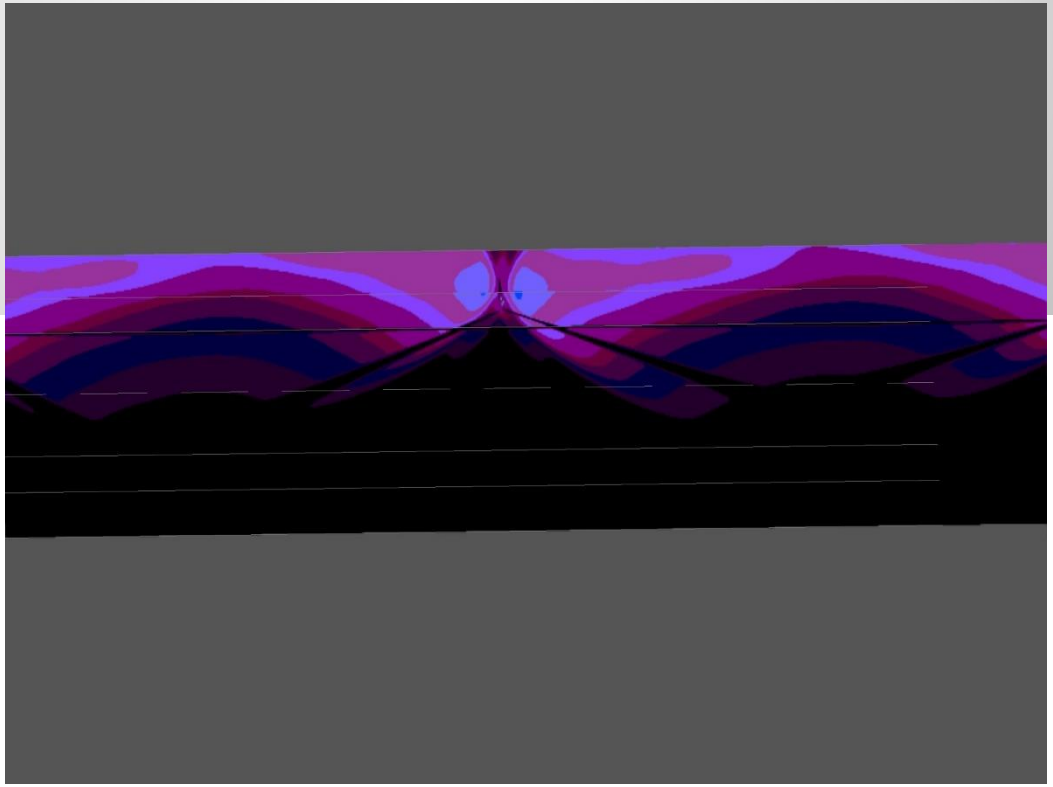
Pedestrian crossing: perspective



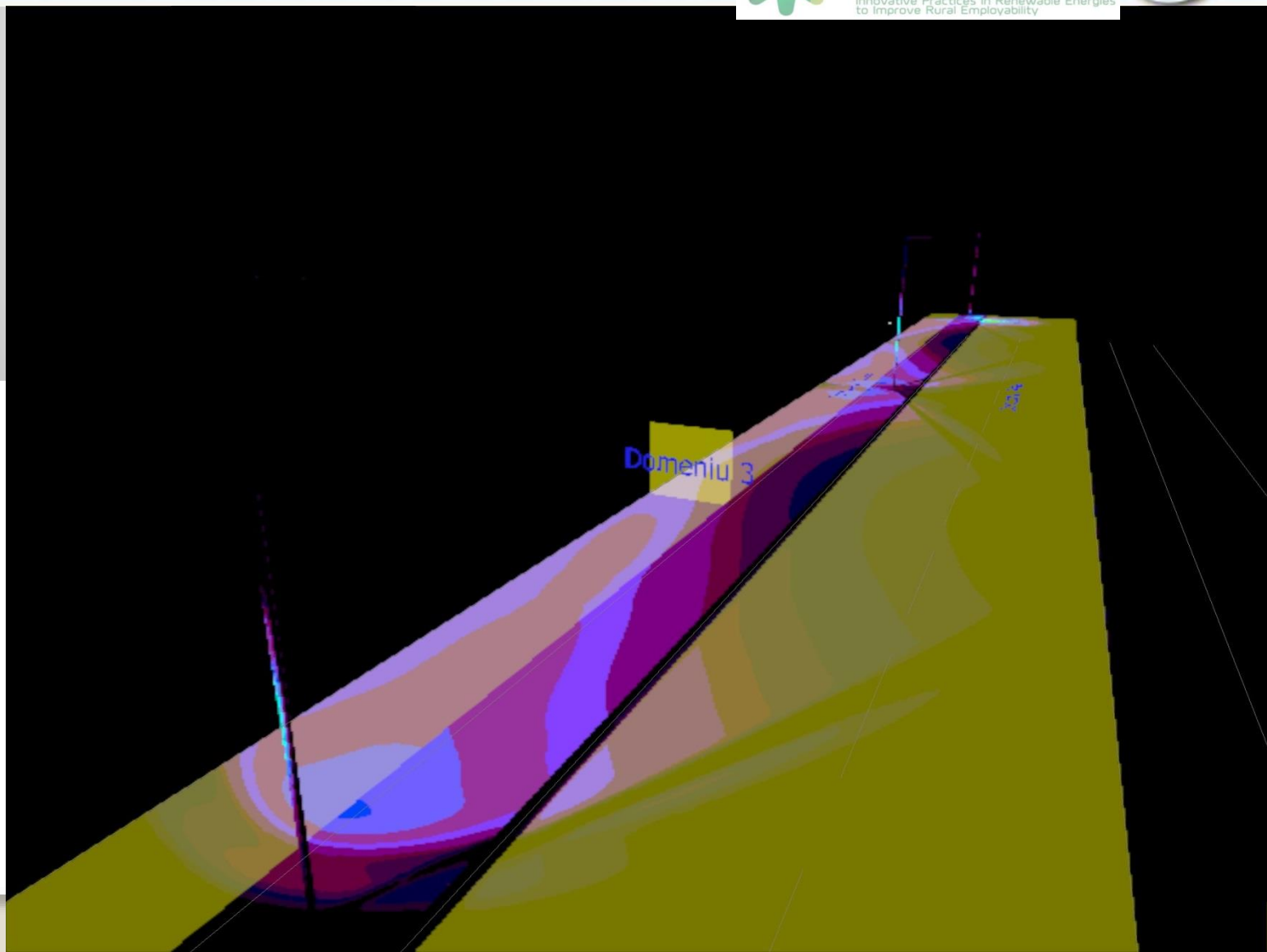
Asymmetric solution!



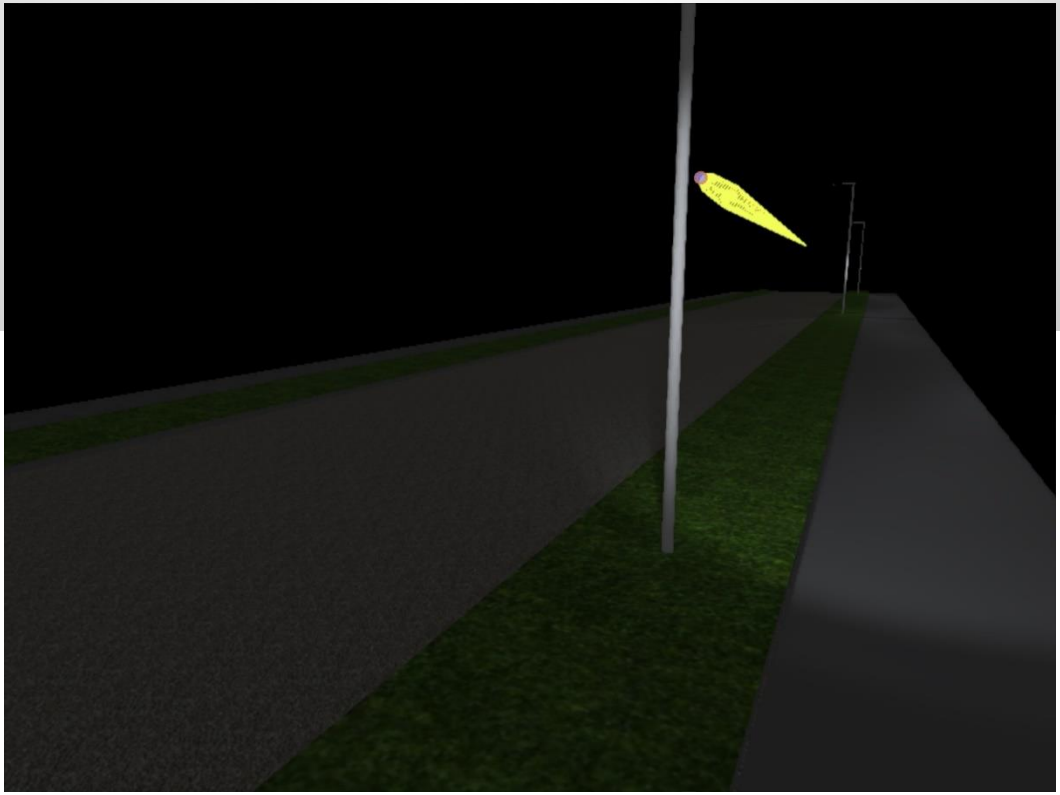
Sidewalk!



Iluminarea verticala!



Sidewalk!



Conclusions:

Nr	Parametru	UM	HPS Clasic	LED clasic	LED vertical
1	Putere unitara	W	125	65	18
2	E med	lx	6,28	13,6	7,2
3	E max	lx	18,5	26,1	42,4
4	LENI	kW/km/100lx	63,7	13,67	7,14
5	E min/med	-	0,24	0,27	0,04