

Designing for the Dark Sky.

How a lighting scheme proves that it will not take the night away. A working method from LUCID Consulting Group, used on public realm and landscape projects across MENA and Europe. A practical method for turning dark sky requirements into design criteria, calculations, controls and as-installed verification.

FOR ARCHITECTS, LANDSCAPE ARCHITECTS, DEVELOPERS AND LEAD CONSULTANTS

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ABOUT THIS HANDBOOK

A method, not a manifesto.

Dark sky compliance is the worked example in this handbook. The method behind it is the point: identify the requirements that govern the project, agree the assessment framework and criteria before the concept is fixed, build the design around those criteria, calculate the relevant impacts, define the operating states, and verify what is actually installed.

Who this is for

Architects and landscape architects who need to know what a dark sky requirement will do to their scheme. Developers selling a place on the quality of its night. Lead consultants and project managers who write the requirement into a brief and then have to check that someone met it. It assumes you work in the industry, and the glossary at the back covers the terms that are easy to mix up.

What this is not

Not a product catalogue, and not a plea for darkness. Good public realm lighting and a dark sky are usually the same brief, written by someone who did the arithmetic first. It is not a universal dark sky code. Local law, authority requirements, ecological conditions and the criteria of a specific certification programme always take precedence where they apply. It is not a substitute for the applicable code, and it is not an ecological assessment.

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01 · WHY NOW

The night sky became a design constraint.

Obtrusive light has moved from a specialist lighting concern to a mainstream project requirement. Four forces drove that shift, and behind all of them sits one expectation: that performance after dark is demonstrable rather than assumed.

Requirements became measurable

Across MENA, the Abu Dhabi Lighting Manual sets out light pollution mitigation in numbers a design has to be tested against, and destination design manuals across Saudi Arabia do the same. Europe has no single directive but plenty of binding national and regional law: France, Slovenia, Croatia, most Italian regions and several Spanish communities set numeric limits on upward light, colour temperature and hours.

Destinations are being sold on the night

Mountain resorts, desert lodges and coastal developments now market stargazing as an amenity and apply for dark sky accreditation. When the brochure promises the Milky Way, the lighting design has to deliver it, and someone will measure whether it did.

Ecology moved from soft to hard

Nesting turtles, migratory birds, bats and insects respond to artificial light at night in ways that are now documented well enough to appear in environmental permits. For bats the practical reference is ILP Guidance Note 08, written with the Bat Conservation Trust, which is what an ecologist will cite back at a lighting designer. On coastal and protected sites the lighting scheme is part of the environmental case, not an appendix to it.

Energy became the easy argument

Controls reduce burn hours and operating energy while supporting dark sky objectives. They carry capital, commissioning and management costs, but one control layer serves environmental compliance, energy and operational flexibility at once.

02 · THE REGULATORY MAP · MENA

In MENA, requirements are project and authority led.

There is no single regional dark sky code. Requirements arrive through authority manuals, environmental permits, destination standards and masterplans, usually contractual rather than statutory. The first task is to establish which document has authority here, not to assume that the absence of a national law means no requirements apply.

WHERE	WHAT IS IN FORCE	WHAT IT MEANS ON THE DRAWING
United Arab Emirates	Abu Dhabi Lighting Manual, version 3.0 of July 2021. Part 2 Section F states light pollution mitigation in numbers, with lighting zones LZ1 to LZ4 and a compliance table. The earlier Dark Sky Policy is the general framing, written around luminaire form.	Compliance is demonstrated with calculated values against published limits, per site, as a submitted document.
Saudi Arabia	Requirements are destination-specific. AIUla is the regional benchmark: four areas were designated International Dark Sky Parks across 2024 and 2025, together forming roughly 6 146 km² of protected dark sky landscape. Further Saudi designations followed in 2025.	The applicable standard sits in the project design manual, and there is now a certified benchmark inside the market.
Oman	No dedicated nationwide dark sky lighting code identified in this review as of August 2026. A starlight reserve has been designated in the western Hajar mountains.	The project writes its own compliance framework from the international set and defends it. A drafting task, not a gap.
Jordan	No dedicated nationwide dark sky lighting code identified in this review as of August 2026. Wadi Rum is a UNESCO site marketed on its night sky, with conditions carried by the protected-area management plan.	The constraint arrives through heritage and tourism consent rather than a lighting standard, so it is read early or not at all.
Qatar, Bahrain and Kuwait	No dedicated dark sky code. Requirements arrive through masterplan authorities, environmental permitting and coastal protection conditions.	Treat it as Oman: agree a framework in writing at concept, before anyone can argue that none applied.
North Africa	Morocco is developing the Atlas Dark Sky Reserve around the Oukaïmeden observatory, which would be the first of its scale on the continent.	Desert astro-tourism is moving the same way as the Gulf, one destination at a time.

Accreditation has become the regional benchmark

AIUla is certified, Wadi Rum is sold on the same asset, and Morocco is preparing a reserve larger than either. Once a neighbouring destination can point to a certificate, the question on the next masterplan stops being whether to bother, and becomes how close you can get.

Architects of Light.

03 · THE REGULATORY MAP · EUROPE

In Europe, the country sets the standard.

Here it arrives from the top down, through environmental law, and changes at every border. There is no single European directive on obtrusive light, which surprises people who assume the EU regulates everything. What there is instead is binding national and regional law with real numbers in it.

WHERE	WHAT IS IN FORCE	WHAT IT MEANS ON THE DRAWING
France	Arrêté of 27 December 2018, with requirements by lighting type. For specified exterior lighting and car parks, nominal output above the horizontal must be below 1% and the installed condition below 4%. A 3000 K maximum applies to specified categories, lower in protected park cores. Operating hours vary by type.	The law sets parameters rather than a product label, so the specification has to answer the parameter for that lighting type. Facade, car park and shop window lighting run on a legal timetable.
Slovenia	Decree on limit values due to light pollution, 2007, the first national law of its kind in the EU.	No flux above the horizontal for most luminaire types, and a national cap expressed per head of population.
Spain	National regulation on energy efficiency in outdoor lighting, plus regional law: Catalonia 6/2001, Canary Islands 1988, Andalusia 2007.	Sites are placed in protection zones E1 to E4, and the zone sets the limits before concept starts.
Italy	Regional law in most regions, from Veneto 1997 and Lombardy 2000.	Zero upward flux is the normal requirement, and the applicable text changes when you cross a regional boundary.
Croatia	National law on protection against light pollution, aligned with international practice on shielding and colour temperature.	Shielding and spectrum are regulated, not just quantity.

03 · THE REGULATORY MAP · EUROPE

Where the limits arrive through consent.

In two jurisdictions the numbers are not published as a national code at all. They are negotiated case by case, which changes what a lighting consultant has to bring to the table.

WHERE	WHAT IS IN FORCE	WHAT IT MEANS ON THE DRAWING
United Kingdom	No single national numeric code, but artificial light from premises can be a statutory nuisance: England and Wales under the Environmental Protection Act 1990 as amended in 2005, Scotland under the Public Health etc. (Scotland) Act 2008. Planning policy and ILP GN01/26 shape the assessment.	Numeric limits arrive through planning consent, not statute, so they are negotiated. Evidence matters more.
Ireland	Requirements arrive through planning and environmental assessment. No separate nationwide numeric code identified in this review as of August 2026.	Treat the planning condition and the environmental report as the governing text.

What holds the patchwork together

CIE 150 is the technical reference behind much of this, which is why a scheme engineered to it travels reasonably well. European requirements are not one harmonised system, though: each project needs a jurisdiction-specific review of the law, guidance, planning conditions and method.

04 · THE PROBLEM

Four effects, **four different fixes.**

Dark sky work is often reduced to buying shielded fittings. That covers one failure out of four. A design only holds up when all four are controlled, and when each one is measured against the location and limit that the governing criteria actually name.

01 · Light intrusion and nuisance

Light reaching premises or other sensitive locations where it causes an unwanted effect. The common assessment is vertical illuminance at the relevant windows, but the applicable location and limit come from the governing criteria, not from a default.

02 · Spill light

Light falling outside the intended task or lit area. Controlled through optical distribution, aiming, position, mounting geometry and shielding. A site boundary is the assessment location only where the applicable method requires it.

03 · Bright luminaires and glare

A bright source seen against a darker background causes discomfort or reduces visual performance. It destroys dark adaptation, which matters more on a rural or coastal site than anywhere else. CIE-based assessment uses luminous intensity toward defined, maintained observer positions, and depends on viewing distance and the projected bright area of the luminaire.

04 · Upward light and sky glow

Direct upward emission and light reflected off illuminated surfaces both feed sky glow. ULR is the primary luminaire-level control; UFR covers the whole installation where it applies. Surface reflectance belongs to the same calculation rather than being a separate lever: for a given perceived brightness, darker paving needs more illuminance, so the two are set together.

Transport-system effects, and the luminance of illuminated facades, signs and digital displays, can require separate assessment again. ILP GN01/26 uses this four-part split; earlier practice often collapsed the first two into one category called light trespass, a term the same document has now retired.

04 · THE PROBLEM

Why a low ambient site **is the hard case.**

In a city, an installation sits inside an already bright environment. On a mountain plateau, a desert site or a stretch of undeveloped coast, there is almost no background light. The same luminaire that reads as modest in a dense district becomes the dominant source on the horizon. Limits tighten by roughly an order of magnitude between the two situations, and the design has to change with them, not just the product schedule.

This is why the governing requirements and the assessment framework are agreed before the concept is fixed. Where an environmental zone system applies, the zone is then one of the earliest decisions, because it decides the numeric limits, and the limits decide the concept. Working the other way around produces a scheme that has to be redesigned after the first compliance review.

The question is never whether a fitting is dark sky friendly. It is how much light the site can carry, and where the design chooses to spend it.

05 · STANDARDS

The framework we design to.

These references are not equivalent, and the order matters. What governs the project comes first. The international technical framework comes next, and gives the assessment method where no local numbers exist. Practice guidance, ecology and certification programmes sit on top of that. We write the resulting set into the lighting criteria at concept stage and report against it at every issue.

LAYER 1 · WHAT GOVERNS THE PROJECT

Local legislation, authority manuals, planning conditions, environmental permit conditions and destination standards. Where these are binding they take precedence over everything below, and the first task on any project is to establish which of them applies and in what order.

LAYER 2 · THE TECHNICAL ASSESSMENT FRAMEWORK

REFERENCE	WHAT WE TAKE FROM IT
CIE 150, limitation of obtrusive light from outdoor lighting installations	Environmental zone limits for upward light ratio, boundary illuminance, luminous intensity and building luminance, including the pre-curfew and post-curfew split. The technical backbone of most national law in Europe.
IES and DarkSky International, Five Principles for Responsible Outdoor Lighting	The design test applied to every fitting on the drawing: useful, targeted, no brighter than needed, controlled in time, warm in colour.
IDA and IES Model Lighting Ordinance, 2011. Legacy reference	The origin of the widely used LZ0 to LZ4 framework. DarkSky states that the document is no longer being updated, and IES does not currently endorse a specific model ordinance, so it is treated here as a historical and public-policy reference rather than a current compliance framework. Use it only where an authority or a project has explicitly adopted it.
ANSI/IES RP-43-25, lighting design for outdoor pedestrian applications	The current IES recommended practice covering lighting zones, environmental considerations, controls and glare for the pedestrian environment, and the place to look now that the Model Lighting Ordinance has stopped being maintained.
IES TM-15, Luminaire Classification System (BUG)	Backlight, uplight and glare ratings written into the specification, so a contractor cannot substitute a fitting that fails the compliance case.
ILP GN01/26, The Avoidance of Obtrusive Light	Current UK professional guidance, published July 2026 and replacing GN01/21. It applies CIE-based methods, updates the environmental zone guidance, introduces baseline considerations for residential receptors, and supplies the vocabulary that planning authorities in the UK recognise. The title matters: the emphasis is on avoiding the effect from the start of design rather than reducing it once it appears.

Architects of Light.

LAYER 3 · METHOD, ECOLOGY AND CERTIFICATION

REFERENCE	WHAT WE TAKE FROM IT
CIE Position Statement on Obtrusive Light and Light Pollution, 2025	The current CIE position on balancing the benefits of light at night against its unwanted effects, including a frank acknowledgement of where measurement methods and research are still developing. Useful when a client asks how settled the science actually is.
CIE 150, upward flux ratio (UFR) for installations of four luminaires or more	The second uplight measure, counting direct emission and reflected light together. The ULR table deliberately excludes the reflected component, which becomes the larger of the two once direct uplight approaches zero.
ILP Guidance Note 08, bats and artificial lighting at night, produced with the Bat Conservation Trust	The mitigation hierarchy where protected species are present, and the requirement for dark corridors and dark foraging habitat. It belongs in the criteria sheet rather than in the environmental appendix.
EN 12464-2, lighting of outdoor work places	Task illuminance for the parts of a site that are workplaces, so safety requirements are met rather than argued away.
EN 13201, road lighting	Class selection and adaptive lighting, which is where most of the achievable reduction on a masterplan actually sits.
Abu Dhabi Lighting Manual Part 2 Section F, version 3.0 of July 2021	A working regional precedent for parks and public realm with published numeric limits, used across the Gulf as a reference even outside the emirate.
DarkSky Approved luminaire programme and Dark Sky Place certification	A shortlist filter at product stage, and the route to accreditation where a destination wants third-party recognition.

What each site can carry.

LUCID DESIGN STARTING POSITION · NOT A REGULATORY TABLE

The most consequential decision in a dark sky project is the lighting zone, and it is usually taken in the first week by someone who is not a lighting designer. This table is the conversation we have at kick-off.

SITE CONDITION	CANDIDATE ZONE FOR DISCUSSION	INDICATIVE COLOUR POSTURE	INDICATIVE OPERATING POSTURE	WHAT GOES WRONG IF THE ZONE IS SET TOO HIGH
Dark sky reserve core, observatory buffer	LZ0	2200 K	Unlit by default, presence only	The asset the project exists to protect is gone.
Mountain or desert destination	LZ1	2200 to 2700 K	Amenity light off, access retained	The scheme reads as a settlement from the valley floor.
Heritage landscape	LZ1	2200 to 2700 K	Event-based, dark outside opening	Surface luminance overwhelms the monument and breaches consent.
Coastal, marine-sensitive	LZ0 to LZ1	1800 to 2200 K amber	Seasonal, tied to nesting periods	The environmental permit is refused, which stops the site, not just the lighting.
Rural village and low density edge	LZ1	2700 K	Part-night, reduced after curfew	Residents lose the sky they moved for, and complain through the authority.
Master-planned community	LZ2	3000 K	Dimmed to 50 %, features off	Window illuminance exceeds the limit, and the fix happens on site.
Urban park and promenade	LZ2 to LZ3	3000 K	Dimmed, features and sport off	Energy and maintenance rise for no gain in perceived safety.
City centre, commercial	LZ3 to LZ4	3000 K	Facade and signage curfew	Little, but neighbouring zones inherit the sky glow.

Where this table comes from, and where it stops

The zone classification is taken from the IDA and IES Model Lighting Ordinance, with environmental zone limits from CIE 150. It is our starting position for a kick-off discussion, not a regulation, and it is not the Abu Dhabi Lighting Manual, whose zones run LZ1 to LZ4 and which carries its own numeric limits. Where a local code applies, that code wins. Where an authority and a designer disagree on the zone, the stricter case is made with calculated values, not with adjectives.

06B · THE NUMBERS

What the zone actually allows.

Every page in this handbook says the zone sets the limits. This is what those limits are. The values below are the CIE 150:2017 environmental zone limits, as carried in current ILP guidance. The applicable ILP reference is now GN01/26, The Avoidance of Obtrusive Light, published July 2026 and based on CIE 150:2017. Where a local code applies, that code wins and its numbers replace these.

Upward light ratio, per luminaire

%	E0	E1	E2	E3	E4
ULR	0	0	2.5	5	15

Counts direct emission only. CIE 150 states explicitly that it does not account for light reflected upward off the ground, which also contributes to sky glow.

Vertical illuminance at windows, lux

	E0	E1	E2	E3	E4
Pre-curfew	n/a	2	5	10	25
Post-curfew	n/a	<0.1	1	2	5

The post-curfew figure in E1 may rise to 1 lx where the installation is public road lighting. These values are the sum of every installation affecting that window, not the contribution of yours alone.

Upward flux ratio, whole installation

FOUR LUMINAIRES OR MORE	E0	E1	E2	E3	E4
Road	n/a	2	5	8	12
Amenity	n/a	n/a	6	12	35
Sports	n/a	n/a	2	6	15

Direct and reflected components together. UFR is not a universal test for every scheme with four luminaires: GN01/26 recommends considering it for defined installation types and in sensitive dark sky contexts, such as sites near observatories or an E1 zone adjoining E0. Confirm applicability before it goes into the criteria sheet. "n/a" means an installation of that type is not normally expected in that zone at all.

Average surface luminance, cd/m²

	E0	E1	E2	E3	E4
Building facade	<0.1	<0.1	5	10	25
Sign	<0.1	50	400	800	1000

Design average illuminance multiplied by reflectance and divided by π . In E0 and E1 both values fall to zero after curfew: facade and sign lighting goes off rather than dims.

Source: CIE 150:2017, Guide on the Limitation of the Effects of Obtrusive Light from Outdoor Lighting Installations, 2nd edition, as carried in ILP GN01/26. The numeric values are the intellectual property of the CIE and are reproduced here for reference and discussion. They are not a substitute for the source documents, which should be obtained and consulted for any project use.

Luminous intensity toward an observer

Limits scale with the projected area of the bright part of the luminaire and with the distance d in metres between it and the observer. Two figures matter more than the rest of the table. In E0 the limit is zero candelas, before and after curfew, for every luminaire size, achievable only with complete cut-off in those directions. In E1 the limit falls to zero after curfew. Everywhere else the pre-curfew limit is a multiple of d , so a luminaire that passes at one distance fails at another and the assessment has to name the observer.

Near-horizontal intensity, observatory-adjacent sites

80° to 90°	below 2.0 cd / 1000 lm
90° to 100°	below 0.5 cd / 1000 lm
100° to 110°	0 cd, or 0.5 % for bollards

Verifying these requires photometry measured across the full gamma range from 0 to 180°, which is not always supplied. Ask for it at shortlist stage rather than at submittal. Curfew itself is set as a planning condition rather than by the standard: in practice it starts between 21:00 and 23:00 and runs until 07:00.

Two zone systems, not one

This handbook uses LZ0 to LZ4 from the IDA and IES Model Lighting Ordinance for site typology, and E0 to E4 from CIE 150 for numeric limits, because European law is built on the latter. They are not interchangeable and their numbers differ. Where a project cites one, do not silently substitute the other: state which system the criteria sheet runs on and keep it consistent to closeout. Two rules from ILP GN01/26 are easy to miss. Where a site lies close to the boundary between two zones, the limits of the more rigorous zone apply. And zone E0 must always be surrounded by an E1 zone, so an observatory or reserve core carries a buffer that is itself a design constraint.

Where these numbers come from, and where they stop

The CIE 150 thresholds are not the product of ecological research. They descend from Dutch work on lighting nuisance in the 1990s, reached CIE 150:2003 through the NSVV guidance of 1998, and the values for zones E1 and E4 were expert extrapolation rather than measurement. They are built around human visual perception and around light sources that are no longer specified. They remain the right starting point, because they are what the codes are written on. They are not the finishing point where habitat is involved: there the local code and the ecological assessment take precedence over the table. These are technical limits for defined obtrusive light effects, not ecological thresholds.

Source for the account above: A. K. Jägerbrand and M. Nilsson Tengelin, *Origins and Ecological Relevance of International Obtrusive Light Thresholds*, 2024.

07 · METHOD

Nine decisions, in the order they happen.

This is the sequence we run on every landscape or public realm scheme with a dark sky requirement. The order matters more than any individual step, because each decision narrows what the next one has to solve, and because the first two are the ones most often skipped.

- 01 **Identify what governs the project.** Map the legislation, authority requirements, client standards, environmental conditions and any certification programme, and establish which are mandatory and which are voluntary. Everything downstream inherits this answer.
- 02 **Establish the assessment framework and classification.** Where an environmental zone system applies, propose and agree the classification against the governing document. Do not assume E0 to E4 or LZ0 to LZ4 before that document has been identified.
- 03 **Identify receptors, assessment locations and baseline.** Map the relevant windows, maintained observer positions, roads and habitat edges, and establish the existing lighting baseline where the method requires it.
- 04 **Agree the ecological constraints before layout is fixed.** Unlit areas, dark corridors, seasonal restrictions and spectrum requirements are settled with the environmental team while luminaire positions are still easy to move.
- 05 **Define the operating states and issue one criteria sheet.** Establish when light is actually needed, define the states that apply to this project, and record every parameter, value, source, assessment location and operating state in one controlled document.
- 06 **Design the geometry before locking the product.** Position, mounting height, optical distribution, aiming and shielding are one system. Lower mounting is not automatically better: GN01/26 notes that it can increase spill and glare in some geometries.
- 07 **Eliminate direct uplight.** Flat glass, full cut-off, no upward tilt. In zones E0 and E1, and in LZ0 and LZ1, the permitted upward light ratio is zero, so lighting a tree or a feature from below is not a design option there and should not be offered as one. From E2 upward, where a feature genuinely requires it, we use narrow optics with shields, cap the count, exclude anything that is habitat, and put those circuits on the earliest curfew. Planting and canopies elsewhere read by light reflected off the ground plane, not from fittings of their own.
- 08 **Design the controls and write performance into the specification.** Control groups, dimming levels, triggers and switch-off conditions are issued as a commissionable schedule, and the substitution requirements are written so the compliance case survives procurement.
- 09 **Calculate, commission and verify what was installed.** Report the design and obtrusive light scenes for every relevant operating state, review substitutions, commission the controls, check aiming at night, and complete the as-installed verification the criteria require.

Most of these are inexpensive when they are made early and expensive when they are discovered late. They are decisions, taken by someone who already knows what they will be asked to prove.

Architects of Light.

Seven decisions, one night-time result.

LZ2

ZONE ASSESSED
AND APPLIED

3000 K

COLOUR CEILING
HELD THROUGHOUT

U0

UPLIGHT WRITTEN
INTO EVERY LINE

2

CONTROL GROUPS,
TWO TIME SCENES

PUBLIC REALM SCHEME DELIVERED TO A PUBLISHED DARK SKY STANDARD. THE LIGHTING SITS ON THE GROUND PLANE, THE PLANTING READS BY REFLECTION, AND THE SKY IS LEFT ALONE.

Half of dark sky is a timetable.

Lighting that is right during active evening use is often wrong later at night, so the operating states belong in the design rather than in commissioning. Most of the reduction comes from control, not hardware. We write the programme as part of the design and issue it as a table the controls contractor can commission against.

AREA	EVENING	AFTER CURFEW	TRIGGER
Primary paths and entrances	100 %	off	Scheduled, astronomical
Secondary paths	100 %	off until dawn	Scheduled, re-energised at dawn
Green and public areas	100 %	50 %	Scheduled
Tree and landscape features	100 %	off	Earliest curfew of all circuits
Facades and signage	100 %	off	Fixed hour, often set by law
Sport and event areas	100 % in use	off, 30 % standby	Presence or booking, separate circuits

Three levels of control, and where each one stops

01	Standalone Astronomical time switch in the lighting cabinet, running a fixed weekly programme.	Adequate for a small site with one operator. It has no feedback, so nothing proves the curfew ran. We still specify it, and we say what it does not do.
02	Zoned Dimming groups and presence detection per area, programmed at the cabinet or a local controller.	Enough for a park or a single plot. Changes need a site visit, and evidence is still a matter of trust.
03	Central management system Where scale justifies it, addressable luminaires on interoperable architectures such as D4i with a Zhaga node, reporting through an open interface. Infrastructure, not compliance in itself.	The scheme becomes measurable. Dim level, burn hours and energy are logged per luminaire, faults report themselves, and the curfew can be changed for a season without a truck.

Why this is a compliance argument, not a gadget

A management system turns the curfew from a promise into a record. When an authority asks whether the installation really ran at fifty percent after curfew, the answer is an export, not an assurance. We specify open interfaces so that record is never hostage to one supplier: D4i, the digital driver standard inside the luminaire; a Zhaga socket for the control node; and a TALQ-compliant management interface. The control layer is decided at concept, because retrofitting addressability later means changing drivers and usually the luminaire with them.

Architects of Light.

The scheme that reports on itself.

A dark sky design is a time-based design. It promises that at a given hour the installation will be somewhere other than where it was at dusk. Promises like that drift quietly over years of operation. Active management is what stops the drift, and it is how the promise leaves a trace that anyone can audit.

CAPABILITY	WHAT IT DOES FOR THE NIGHT SKY	WHAT IT DOES FOR OPERATIONS	EVIDENCE IT PRODUCES
Scheduled dimming, per luminaire	Delivers the curfew exactly where it was designed, not per cabinet	Cuts burn hours on the largest circuits first	Dim level and time stamp, per address
Presence and adaptive control	Light appears only when someone is there, so unlit areas stay unlit	Lowers average load without lowering perceived safety	Occupancy and switching history
Astronomical and seasonal scheduling	Tracks dusk through the year, and nesting or stargazing seasons	One programme instead of monthly manual changes	Schedule versions with dates
Energy metering in the driver	Confirms the installation runs at the levels that were calculated	Turns the energy case from a claim into a measurement	Consumption per luminaire and per zone
Fault and failure reporting	Electrical and communication faults surface automatically. Physical changes, such as altered aiming or a lost shield, still need inspection	Maintenance moves from routine visits to targeted ones	Fault log and time to repair
Temporary zone override	The site returns to the compliant programme automatically after an event	No permanent creep from temporary permissions	Override log with duration and authoriser
Open reporting interface	The compliance record survives a change of supplier	The asset stays a platform rather than a closed box	Exportable data, not screenshots

Where this meets smart city

Outdoor lighting is usually the first layer of a smart city platform, because the poles are already there, already powered and already spaced across the whole site. Once the luminaires are addressable, the same network carries environmental sensors, counting and safety devices. A masterplan that specifies an open interface at concept is not buying a lighting controller. It is buying the ground floor of everything that comes after it.

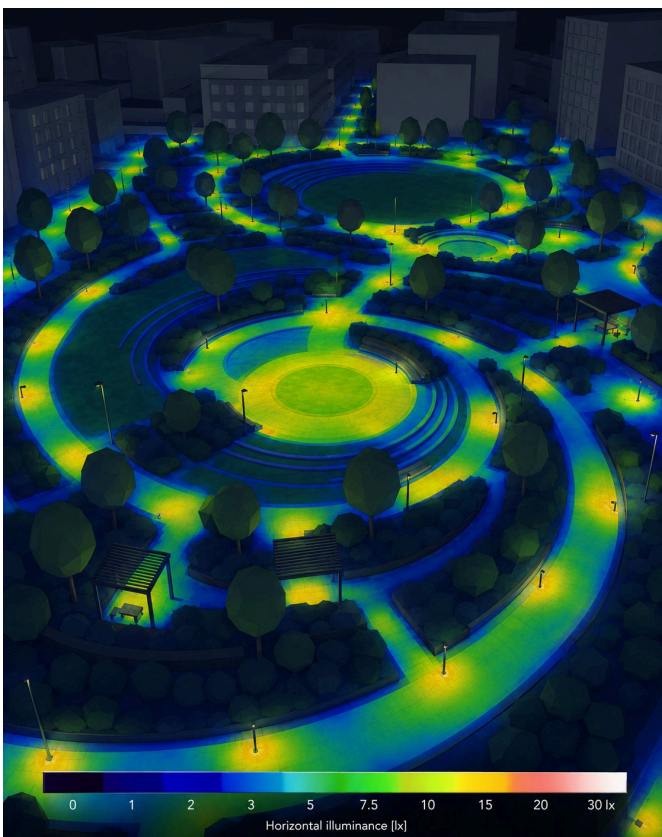
The correlation nobody prices

The controls package is small against the luminaire package, and it is the only line that keeps producing value after handover. It carries the dark sky compliance, the energy case and the maintenance case on one investment. Priced separately, each of the three looks marginal. Priced together, it is the easiest decision in the scheme.

10 · HOW WE VERIFY

The obtrusive light scene is a deliverable.

Compliance is calculated in the same model as the design, using a separate obtrusive light scene. Where a curfew or another change of operating state applies, each relevant condition is calculated and reported separately. On a typical scheme that means the evening operating condition and the post curfew condition. A scheme that only reports one of them has not been verified.



HORIZONTAL ILLUMINANCE ACROSS A PUBLIC REALM SCHEME, 0 TO 30 LX. PATHS HELD AT TARGET, LAWN AND PLANTING DELIBERATELY LEFT LOW.

Model

Site geometry, planting, buildings and terrain are built once, then reused for the photometric, energy and obtrusive light calculations. One model, three answers.

Measure

Surfaces placed where the failures actually occur: on the boundary line, at the assessment distance past it, and on the glazing of whatever sits closest.

Report

A standalone mitigation report per site, with the required and achieved table, the scene definitions and the control programme.

Check on site

Submittals reviewed against the compliance case, an aiming and focusing session at night, and a closeout statement that records what was actually installed.

Why it is separate

The design scene answers whether the place works. The obtrusive light scene answers whether it is allowed. They use different surfaces, different metrics and different acceptance criteria, so they are never the same calculation.

11 · WHAT COMPLIANCE LOOKS LIKE

Not compliant by opinion. Compliant by number.

One neighbourhood park from a 94-park programme in Abu Dhabi, lighting zone LZ2. Required values are the limits of the Abu Dhabi Lighting Manual Part 2 Section F. Achieved values come from the calculation model of the issued design. This is what a mitigation report contains.

PARAMETER	LZ2 LIMIT	ACHIEVED	MARGIN
Initial illuminance at site boundary	1.1 lx	0.20 lx	82 % below
Initial illuminance 3 m beyond boundary	< 1.0 lx	0.27 lx	73 % below
Direct upward light	2.0 %	1.58 %	21 % below
Vertical illuminance at windows, 07:00 to 23:00	5.0 lx	4.10 lx	18 % below
Vertical illuminance at windows, 23:00 to 07:00	1.0 lx	0.63 lx	37 % below
Luminaire source intensity, 07:00 to 23:00	7.5 kcd	0.81 kcd	89 % below
Luminaire source intensity, 23:00 to 07:00	0.5 kcd	0 kcd	switched off

The limits in this table are those of the Abu Dhabi Lighting Manual, whose lighting zones run LZ1 to LZ4 and carry their own numbers. They are not the CIE 150 environmental zone values, nor those of the Model Lighting Ordinance. Comparing across the three systems without conversion is one of the more common ways a compliance argument falls apart.

The installation behind those numbers

307 luminaires across the park, 631 447 lm of installed flux at 5 109 W, an average of 123.6 lm/W. All general lighting at 3000 K. Two control groups, so the evening scene and the post-curfew scene represent the commissioned control strategy rather than one global dimming factor applied to the same result.

Why the margin matters

A design that lands one percent under the limit will fail on site, because real installations drift. Fittings get aimed by hand, lamps get substituted, planting grows or does not. We design to a margin so the scheme still complies after the things that always happen have happened.

Architects of Light.

12 · WHAT IT COSTS TO FIND OUT LATE

The same problem, at six different prices.

The underlying problem does not change, but the number of available options falls quickly as the project advances. What begins as a criteria decision becomes a coordination change, then a procurement issue, then a remedial package. What changes is how much of the project has already been built on top of the wrong assumption. This is the pattern we see, described in the order it usually happens.

FOUND AT	WHAT HAS TO CHANGE	WHO ABSORBS IT
Criteria and concept	A line in the criteria sheet and a zone decision.	Nobody. This is the whole argument for doing it here.
Schematic design	Layout, mounting heights, a product family. The concept survives.	Design fee already committed, no capital cost.
Detailed design	Optics, aiming, circuiting and the control zoning. Coordination with landscape and civil is reopened.	Design programme, and usually a delayed IFC package.
Tender	Re-specification and re-pricing, or an approved equal that quietly breaks the compliance case.	Procurement float, and a risk that survives into construction.
Construction and handover	Shields and louvres retrofitted, fittings re-aimed at night, sometimes replaced. A second round of calculations to close out.	Contractor claim, and a handover date.
After handover	Authority or community complaint, remedial works on a live site, and in a protected area a permit condition to answer.	The asset owner, in cash and in reputation, on a destination that was sold on its night sky.

The asymmetry is the point

At concept stage the fix is a sentence. At handover it is a scaffold tower, a night shift and a revised report. The engineering content is identical. Only the timing changed.

What triggers the late discovery

Almost always one of three things. The lighting zone was never formally agreed, the obtrusive light scene was never calculated, or a substitution at tender was approved by someone who did not know what the fitting was carrying.

13 · MISCONCEPTIONS

Six things people get wrong.

These come up in almost every kick-off meeting. None of them is stupid. All of them change the design if they go unchallenged.

"Dark sky means a dark park"

It means light on the surfaces people use and nowhere else. A compliant park is often easier to walk through than an over-lit one, because the eye is not fighting glare while trying to read the ground.

"Full cut-off means compliant"

Full cut-off addresses direct uplight, which is one part of one of the four effects on page 07. Glare at angles below the cut-off, spill outside the lit area, light intrusion at a window and uplight reflected off a pale pavement are all untouched by it. This is why CIE 150 carries a second measure. The upward light ratio table counts direct emission only and says so; the upward flux ratio exists to capture the reflected component, which becomes the larger of the two once direct uplight approaches zero.

"Low CCT solves ecology"

Colour temperature limits blue content, which matters for ecology and circadian effect. A 2700 K floodlight aimed at the horizon is still a problem. Spectrum and geometry are separate controls.

"We will fix it with dimming"

Dimming reduces illuminance and luminous intensity together, but it cannot correct geometry. A luminaire aimed into a window, a habitat or the horizon is still aimed there when dimmed. Direction, shielding and position are solved first; controls then reduce what remains.

"Certification proves compliance"

Dark sky accreditation is increasingly a destination marketing asset, applied for by resorts, parks and whole municipalities. It is also the cheapest defensible answer to a planning objection.

"Less light means less safety"

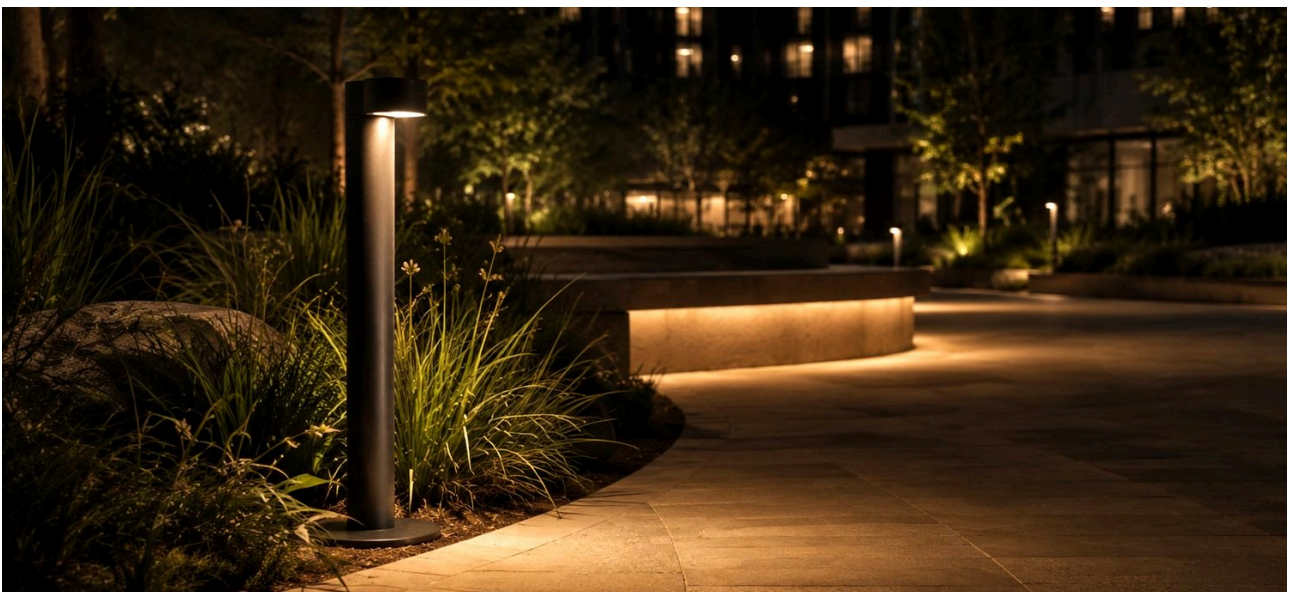
Perceived safety tracks uniformity, vertical illuminance on faces and the absence of glare, not the average lux on the ground. Many schemes improve on all three while lowering the total installed flux.

Restraint is the **design**, not the **constraint**.

Dark sky compliance is usually described as a list of things you cannot do. In practice it pushes the design toward what good landscape lighting was always trying to be: light concentrated where it is needed, high-angle emission controlled, source brightness limited, and darkness kept where light serves no purpose.



HANDRAIL-INTEGRATED LINEAR LIGHT ON A COASTAL BOARDWALK. THE WALKING SURFACE IS LIT, THE WATER AND THE SKY ARE NOT.



BOLLARD THROWING LIGHT DOWN ONTO THE PATH. NOTHING ABOVE THE HORIZONTAL, NO SOURCE IN THE FIELD OF VIEW, THE PLANTING BEHIND IT STAYS DARK, AND THE PAVING KEPT DARK ENOUGH THAT REFLECTED FLUX STAYS INSIDE THE BUDGET.

15 · SELECTED WORK

Public realm, **lit at night.**

Every image here is a night scene, because that is the only condition in which this discipline can be judged. Each one is a warm, low, shielded installation with the sky left dark.



PROMENADE LIT FROM THE EDGE, SO THE LIGHT LANDS ON THE DECK AND NOTHING POINTS OUTWARD.



COASTAL BOARDWALK AGAINST A HERITAGE WALL. THE WATER STAYS BLACK.



PARK PATH AT 3000 K, BOLLARDS SPACED FOR UNIFORMITY AT LOW LEVEL.



LANDSCAPE AND FACADE SEPARATED, SO THE BUILDING IS NOT A SOURCE.



PLANTING READ BY LIGHT REFLECTED OFF THE PATH, WITH NOTHING AIMED INTO THE CANOPY.

15 • SELECTED WORK

Coast, heritage and mountain.

The harder the setting, the less light it can carry. These are the conditions where a dark sky brief and a good landscape scheme stop being a compromise and start being the same thing.



BOARDWALK OVER A SHORELINE. GUIDANCE AT ANKLE HEIGHT, NOTHING AIMED AT THE WATER OR THE SKY.



SHADE STRUCTURES LIT FROM WITHIN THE STRUCTURE, NOT FROM A POLE BESIDE IT.



SEATING AT VERY LOW LEVEL. ENOUGH TO READ THE GROUND, NOT ENOUGH TO GLARE.



WAYFINDING AT NIGHT: CAPPED FACE LUMINANCE, NO SPILL ONTO THE LANDSCAPE.



MOUNTAIN PATH UNDER A DARK SKY. THE LIGHTING STOPS WHERE THE LANDSCAPE BEGINS.

16 · DELIVERABLES BY STAGE

No black box. Deliverables at every stage.

This is what should leave a lighting consultant's office at each stage on a scheme with a dark sky requirement. Use it to check what you are being offered, whoever you appoint.

STAGE	WHAT SHOULD ARRIVE
Criteria and concept	Requirements register and source hierarchy, applicable assessment framework, proposed environmental zone classification where relevant, receptor and assessment location plan, baseline strategy where required, area by area lighting strategy, unlit area and dark corridor plan, operating state principles, preliminary criteria sheet and preliminary compliance position.
Schematic design	Lighting layouts, mounting and aiming principles, first photometric calculations, first receptor-specific obtrusive light check, ecology interface check, control operating state diagram, outline luminaire schedule stating the optical, uplight, backlight, glare and spectral requirements applicable to the selected framework, with BUG classification where relevant and available.
Detailed design	Coordinated layouts in the model, full photometric and energy calculations, mitigation report with the required and achieved table, control programme table, luminaire specification, mounting details, load schedule.
Tender and IFC	Tender drawings and specification, bill of quantities, approved equal criteria written so a substitution cannot break compliance, technical query support during tender.
Construction support	Submittal review against the compliance case, site aiming and focusing sessions, as installed verification, closeout compliance statement.

Interfaces that have to be managed

- Landscape architect on planting, hardscape and fitting integration
- Electrical engineer on loads, circuiting and control cabinets
- Civil on ducting, foundations and pole positions
- Sustainability and environmental consultant on the compliance narrative

The test of a good package

A contractor should be able to build the scheme without asking what was intended, and an authority should be able to check it without asking for anything that was not issued. If either of those needs a phone call, the package was not finished.

17 · HOW TO BRIEF A LIGHTING CONSULTANT

Twelve clauses worth writing in.

Most dark sky failures are briefing failures. The requirement was implied rather than written, so nobody priced it and nobody proved it. These clauses are written to be pasted into a scope of services and adapted.

- 01 The consultant shall propose and justify a lighting zone classification for the site, with reference to the applicable standard, before concept design begins.
- 02 Compliance criteria shall be issued as a standalone criteria sheet at concept stage, stating boundary illuminance, upward light and upward flux, vertical illuminance at windows, source intensity and surface luminance limits, and the curfew hours assumed.
- 03 All exterior luminaires shall be specified with a BUG rating in accordance with IES TM-15, with the uplight component stated as U0 unless a written exception is agreed.
- 04 Correlated colour temperature shall not exceed the stated ceiling for the zone, and the specification shall state the requirement rather than name a single product.
- 05 An obtrusive light calculation scene shall be delivered in addition to the design scene, reporting both the pre-curfew and post-curfew conditions.
- 06 Calculation surfaces shall be placed on the site boundary, at the assessment distance beyond the boundary, and on the windows of the nearest affected receptors at their actual height.
- 07 Areas intended to remain unlit shall be shown as unlit on the drawings and shall not be revised without written instruction.
- 08 A control and curfew programme shall be issued as a commissionable table, area by area, with the trigger for each change of state.
- 09 Approved equal criteria shall be written so that a substitution cannot be accepted unless it meets the same BUG rating, colour temperature ceiling and intensity limits.
- 10 The consultant shall attend a night-time aiming and focusing session and shall issue an as installed compliance statement at closeout.
- 11 Where the site adjoins habitat, a watercourse, a tree line or a protected area, the consultant shall agree dark corridors with the project ecologist and show them as unlit on the drawings before layout is fixed.
- 12 The compliance criteria sheet shall state which zone system it uses, CIE 150 environmental zones or a lighting zone framework, and shall not mix the two.

One sentence that does most of the work

If you write nothing else, write this: the consultant shall demonstrate compliance by calculation against a stated numeric criteria sheet, for two time scenes, before tender.

18 · SELF-AUDIT

Thirteen questions before you sign off a concept.

If the answer to any of these is a shrug, the scheme is not ready, whatever it looks like on the visualisation. None of them requires you to be a lighting designer to ask.

- | | | | |
|----|--|----|---|
| 01 | What document actually governs the dark sky requirement on this project? | 02 | Which lighting zone is this site in, and who agreed it? |
| 03 | What are the numeric limits that come with that zone, in writing? | 04 | Has anyone calculated the illuminance at the site boundary? |
| 05 | What is the upward light ratio of the scheme, has anyone looked at the reflected component, and is UFR actually applicable here? | 06 | Which windows are the nearest receptors, and what do they receive? |
| 07 | What is the colour temperature ceiling, and is it in the specification? | 08 | Is there a single fitting on this drawing aimed above the horizontal? |
| 09 | Which areas are intended to stay unlit, and are they drawn that way? | 10 | What happens to this installation at one in the morning? |
| 11 | Who commissions the curfew, and what proves it was commissioned? | 12 | Can a contractor substitute a fitting without breaking compliance? |
| 13 | Who checks the installation at night, before handover? | | |

Thirteen questions, about fifteen minutes. That is the entire difference between a scheme that can be defended and a scheme that has to be repaired.



19 · THE SAME METHOD, OTHER CONSTRAINTS

Dark sky is **the worked example.**

Everything in this handbook is one pattern applied to one constraint: agree the criteria, build one model, calculate, report, control, verify on site. The constraint changes from project to project. The pattern does not.

THE REQUIREMENT	WHAT GETS MODELLED	WHAT GETS REPORTED
Obtrusive light and dark sky	Boundary and receptor surfaces, two time scenes	Required against achieved, per site
Energy and operating cost	Installed load, burn hours, control programme	Annual consumption per scene, against target
Ecology on sensitive sites	Spectrum, spill onto habitat, seasonal operation	Compliance with the permit condition
Heritage and facade luminance	Surface luminance, contrast with the setting	cd/m ² against the consent limit
Human factors after dark	Vertical illuminance on faces, uniformity, glare	Visibility, reassurance and comfort against the applicable pedestrian criteria, not average horizontal illuminance alone
Sport and event use	Task planes, spill outside the field of play	Class compliance plus obtrusive light

A studio that already works this way answers a new constraint by changing the criteria sheet, not by changing how it works.

The terms that get mixed up.

Written for the people who have to approve this work rather than produce it.

Sky glow

The brightening of the night sky caused by natural and artificial light scattered in the atmosphere. A single installation contributes to it, while the observed effect is usually cumulative across a wider area.

Light intrusion and nuisance

Light affecting premises or other sensitive receptors where it causes an unwanted effect. In CIE and ILP assessment, vertical illuminance at windows is the common example. These are the current terms; GN01/26 has retired "light trespass".

UFR, upward flux ratio

The share of an installation's flux that ends up above the horizontal, counting both direct emission and light reflected off the ground. A whole-installation measure covering direct and reflected upward components. It exists because the ULR table deliberately excludes reflected light, which becomes the larger of the two once direct uplight approaches zero. GN01/26 recommends considering UFR for defined installation types and sensitive dark sky contexts rather than as a universal test for every scheme with four or more luminaires.

UO

The uplight component of a BUG rating at its lowest value: no flux emitted at or above the horizontal in the installed position. Written into a specification so a substitution cannot introduce uplight.

D4i, Zhaga, TALQ

Open interface standards for controllable lighting: D4i is the digital driver inside the luminaire, Zhaga the standard socket for a control node on top of it, TALQ the interface a management system exposes to the outside. Specified together so the compliance record is not locked to one supplier.

Obtrusive light

The umbrella term for unwanted effects of artificial light outside its intended function: upward light and sky glow, spill light, light intrusion and nuisance, and bright sources or glare. Specific assessments may also cover transport effects and illuminated facades or signs.

Spill light

Light falling outside the area or task it was intended to illuminate. The relevant assessment location depends on the governing method and is not automatically the site boundary.

Light trespass

A term retired by ILP GN01/26 on the grounds that light cannot trespass. Spill light, light intrusion and nuisance are the current terms. Still in use in United States practice.

Environmental zone, E0 to E4

The CIE 150 classification, referenced or adopted by a number of professional, planning and regulatory systems, from an intrinsically dark protected area to a high-brightness urban centre. Parallel to, but not the same as, the LZ0 to LZ4 lighting zones of the Model Lighting Ordinance. The two carry different numeric limits.

Dark adaptation

The eye's adjustment to low light levels, which takes tens of minutes and is undone in seconds by a glare source. It is the reason a bright fitting on a dark site does more harm than the same fitting in a city.

Glare

A visual condition caused by excessive brightness or contrast that causes discomfort or reduces visual performance. For obtrusive light assessment, bright luminaires are judged from defined observer positions using luminous intensity and viewing geometry.

ULR, upward light ratio

The proportion of a luminaire's flux emitted above the horizontal in its installed position. Several national codes now require it to be effectively zero.

Lighting zone, LZ0 to LZ4

A lighting zone framework used in IES and public policy contexts to describe the intended ambient night-time environment. The exact definitions and limits depend on the document that adopts the zone system, so do not assume that every LZ0 to LZ4 framework carries the same numbers.

CCT

Correlated colour temperature, in kelvin. A useful specification constraint, but it does not fully describe spectral power distribution or biological response. Where ecology drives the project, spectral requirements are agreed with the environmental specialist rather than inferred from CCT alone.

Uniformity

The ratio of minimum to average illuminance across an area. It affects visual comfort, adaptation and how a space reads, but perceived safety depends on several lighting and non-lighting factors together.

Full cut-off

A luminaire distribution with no direct emission at or above the horizontal in the installed orientation. An important control in many dark sky applications, and on its own not a demonstration of whole-project compliance.

Assessment location

The point, line, plane or maintained observer position at which a criterion is calculated or measured. A resident may be the receptor while the bedroom window is the assessment plane; a habitat may be the receptor while its edge is the assessment line. The correct location follows the criterion, not the site geometry.

Spectral power distribution, SPD

The distribution of optical power across wavelength. It describes spectral content far more directly than CCT does, and becomes the relevant parameter wherever ecological response is part of the criteria.

Obtrusive light scene

A calculation scene separate from the design scene, containing only the surfaces and metrics used to assess compliance. The deliverable an authority actually reads.

BUG rating

Backlight, Uplight and Glare classification from IES TM-15. A three-part code that makes a luminaire's behaviour specifiable rather than descriptive.

Curfew

The hour after which stricter limits apply. Most standards publish two sets of values, one before and one after. A design is only verified if both are reported.

Illuminance and luminance

Illuminance is light arriving at a surface, in lux. Luminance is light leaving a surface toward the eye, in cd/m². Codes use both, for different failures.

Maintenance factor

The allowance for lumen depreciation and dirt over the maintenance cycle. Task lighting is commonly assessed at maintained values, while some obtrusive light assessments use initial conditions. The applicable convention belongs in the criteria sheet rather than in an assumption.

Receptor

A person, property, habitat or other element that may be affected by the installation. A receptor is not the same thing as the point or plane used to calculate the effect on it.

Baseline condition

The documented existing lighting condition used to assess the change a proposed installation causes. GN01/26 introduces this explicitly for residential amenity receptors, where the increase in vertical illuminance is considered alongside the environmental zone limit. A lighting baseline is not a night sky quality survey.

ALAN

Artificial Light at Night. A broad environmental term covering exterior and interior sources, wider than the project-level assessment of obtrusive light.

Four disciplines. One studio.

LUCID Consulting Group is an independent design studio run personally by four partners. We work on public realm, hospitality, cultural and mixed-use projects across MENA and Europe, and we are used to being the specialist that a lead consultant puts in front of their client.

Lighting

Architectural, landscape and public realm lighting, from criteria through to site. Photometric, energy and obtrusive light calculation in house.

Signage and Wayfinding

Decision-point mapping, bilingual information strategy, carrier design and production documentation.

Art and Digital Placemaking

Landmark and landscape art, projection, interactive media and the digital layer of a place, engineered to the same rigour as the building.

Urban Custom Furniture

The furniture layer of the public realm, designed as architecture and detailed for fabrication.

How we are set up

Project delivery hub in Warsaw for modelling, calculation and documentation, working BIM-first in Revit. Local presence and partners across the region, including Muscat, Abu Dhabi, Dubai and Riyadh, for client meetings, authority coordination and site work.

One team carries all four disciplines, so a landscape masterplan is coordinated in a single model rather than across three vendors. Each discipline can also be engaged on its own.

The partners

Tomasz Makarski, Managing Partner. Firm management and commercial lead.

Paweł Kmieciak, Design Partner. Design direction and technical authorship.

Eligiusz Rożański, Partner, Business Development. Gulf pipeline and delivery.

Witold Śmidowski, Partner, Strategic Relations. Government and institutional clients.

Supported by a key team including **Jumana Al-Sammaraie**, Lead Designer, and **Ali Al Ezzi**, Lead Technical Designer and BIM Manager.

22 · WORK WITH US

Send us the brief, the site and the requirement.

With a site plan, the landscape layout and the position of anything sensitive, we will come back within a week with a lighting zone recommendation, a first compliance criteria sheet and a scope proposal for the stages you want covered. There is no charge for that, and no obligation attached to it.

Three ways this usually starts

- A dark sky requirement has landed in a brief and nobody has priced it yet
- A scheme is at detailed design and the compliance case has never been calculated
- A destination wants accreditation and needs to know what that will cost in design terms

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If this handbook saved you one late discovery on one project, it has done its job. If you want the same discipline applied to yours, that is a shorter conversation than you think.

CONSULTING
GROUP

LUCID

ARCHITECTS OF LIGHT

Designing for the Dark Sky
LUCID Handbook 01 · Edition 02, August 2026

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