SOLAR CONTROL WITH METAL MESH

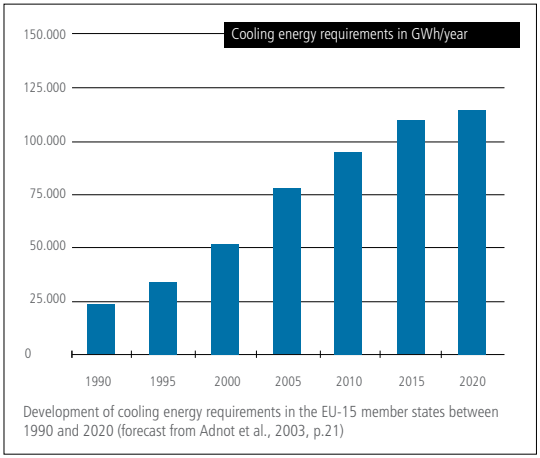
BASICS | REQUIREMENTS | SOLUTIONS | REFERENCES

INTERWEAVING EXCELLENCE FROM CONCEPT TO COMPLETION

GKD METALFABRICS®

Solar Protection Systems and Requirements in the Field of Architecture

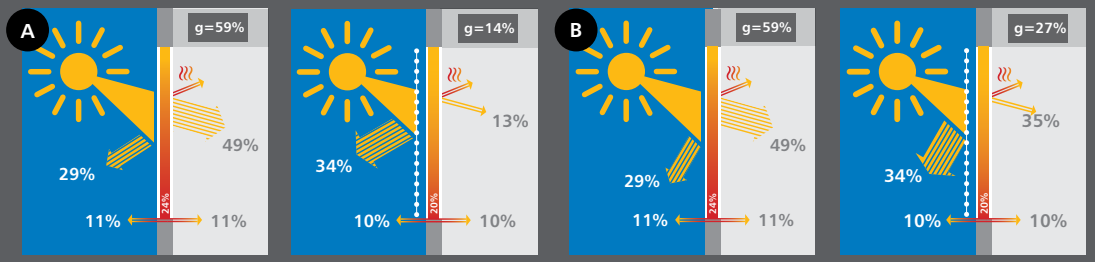
Modern workplace design starts with planning a well-conceived building shell and functional solar protection. Our goal is to achieve optimum energy efficiency using the outer shell to support energy-efficient climate control by allowing solar heat into the building in winter and screening the building from solar radiation during summer. Besides creating a pleasant working atmosphere for employees, modern solar protection plays a key part in supporting sustainable energy efficiency concepts in buildings. Early and comprehensive planning of an individual solar protection concept is important in order to achieve a quality project and solar efficiency.



Development of cooling energy requirements in the EU-15 member states between 1990 and 2020 (forecast from Adnot et al., 2003, p.21)

A Thermal Comfort - Protection from Overheating in the Summer

Solar protection systems reflect thermal radiation before it reaches the actual building shell. To efficiently screen insulating glass surfaces, systems of this type have to be installed outside the glazing. Yet this is precisely where materials are exposed to all manner of environmental conditions, such as wind, rain, snow or frost. Choosing the right material is thus vital in securing the longevity of solar protection systems. GKD metal fabric is manufactured from stainless steel and so ideally suited to applications of this kind.



Omega 1510 horizontal, solar irradiation angle 60°

Omega 1510 horizontal, solar irradiation angle 30°

B Use of Solar Heat Gains During the Heating Period

So that available solar heat energy can be used efficiently, solar protection should be deactivated during the heating period. However, some form of screening may still be necessary to prevent glare. For this reason modern buildings often employ a combination of externally-mounted solar protection and internal glare screening. Thanks to their open structure, metal fabrics from GKD offer good screening when the sun is high in the sky and good solar heat gains when it is low.

C Glare Protection

Direct sunlight can cause glare, particularly for staff working on monitors. In consequence this can negatively affect work performance as well as overall well-being. A combination of solar protection and independent glare protection makes good sense. GKD metal fabrics are ideal for providing effective solar protection and can be combined with a large number of glare protection systems.

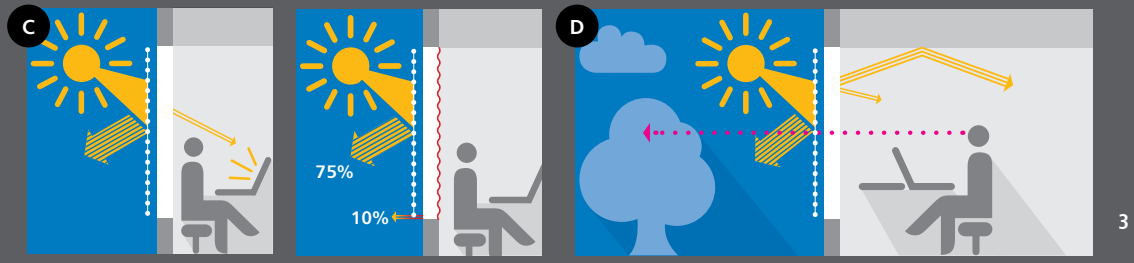
D Daylight Usage & Visual Contact to the Outside World

Controlling daylight and maintaining a clear outward view are important factors that can help staff feel comfortable at the workplace. In many countries these basic conditions are legally required for workplaces even when active solar protection systems are in place. In addition, daylight can help reduce power consumption in offices in two different ways. Firstly, it minimizes the need for artificial lighting. Secondly, since less artificial lighting is used, less waste heat is generated. The open structure of GKD metal fabrics allow daylight to enter the building without restricting any outward views.

Functional Classification of Solar Protection Systems

Today solar protection systems are divided into four different categories:

1. **Exterior:** The solar protection systems are installed outside the glazed surfaces.
2. **Interior:** The solar protection systems are installed inside the glazed surfaces.
3. **Dynamic:** The solar protection systems can be adapted to outside conditions and retracted if necessary.
4. **Static:** The solar protection systems are permanently installed in one position.



Solar Parameters – Standards and Principles

Sustainable building has become an important topic across the globe. In Europe, the basis for assessing solar protection systems and glazing are described in the following specific standards:

EN 410	Glass in building
EN 13363	Solar protection devices
EN 14501	Blinds and shutters – thermal and visual comfort
EN 13561	External blinds and awnings

The detailed requirements can vary quite markedly depending on the country and climate zone. They are set out in the following national requirements profiles, standards and directives:

Germany:	ENEV 2014, BNB*1
Austria:	OIB Directive 6, Technology*2
Switzerland:	Minergie Standard
France:	RT 2012
USA:	ASHRAE 90.1-2010

As per EN 14501, the thermal and optical performance of a solar protection system is stated in combination with the following reference glazing types

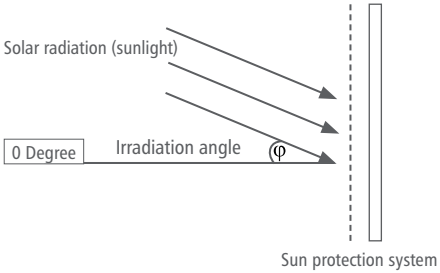
REFERENCE GLAZING	U W/(m²K)	g	τ_e	ρ_e	ρ'_e
A	5.8	0.85	0.83	0.08	0.08
B	2.9	0.76	0.69	0.14	0.14
C	1.2	0.59	0.49	0.29	0.27
D	1.1	0.32	0.27	0.29	0.38

*1 Rating system for sustainable building / *2 City of Vienna solar protection guidelines

Solar Protection Characteristics of GKD Metal Fabrics

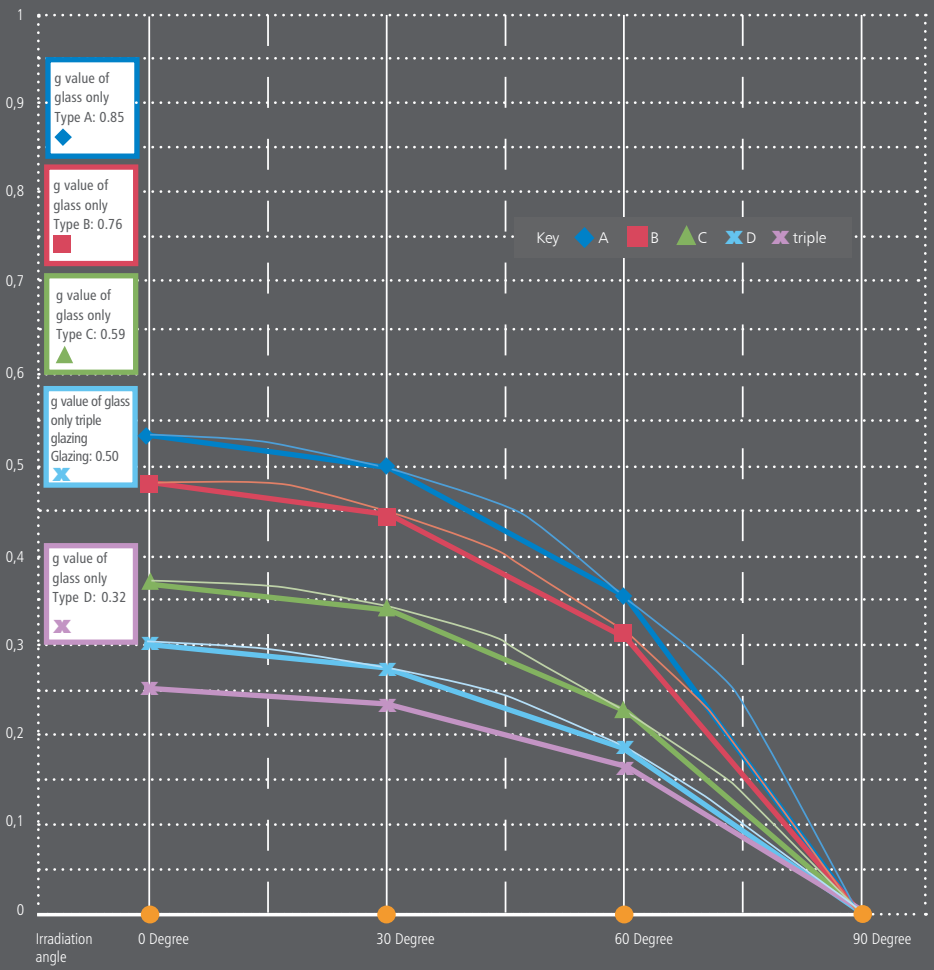
GKD metal fabrics are not only visually appealing, they also offer excellent solar radiation properties as per EN 410. They combine good to excellent solar protection characteristics with a pleasant outward view - particularly when the sun is high in the sky. When it is low in the sky during winter, solar heat gains can be achieved, depending on the type of glazing used. Tests from independent institutes have repeatedly confirmed this.

The following formula can be used to calculate the solar parameters of a solar protection system for any type of glazing as per EN 13363-1:



$$g_t = r_{e_1B} \cdot g + \alpha_{e_1B} \frac{G}{G_2} + r_{e_1B}(1-g)\frac{G}{G_1} = r\omega$$

$$\alpha_{e_1B} = 1 = r_{e_1B} = \rho_{e_1B}$$
$$G_1 = 5W/(m^2 \cdot K)$$
$$G_2 = 10W/(m^2 \cdot K)$$
$$G = \left(\frac{1}{U_g} + \frac{1}{G_1} + \frac{1}{G_2}\right)^{-1}$$



Overall energy transmittance based on the example of the Omega 1520 horizontal weft wire metal fabric at various levels of sunlight in connection with reference glazing types A-D, as well as standard triple glazing with the following properties:

G value of glass TRIPLE GLAZING

U/(m²K)	g	τ_e	ρ_e	ρ'_e
0.7	0.5	0.75	0.17	0.17

Shading Function of GKD Metal Fabrics

Modern façade-cladding materials generally allow the heat generated by solar radiation to enter the building very quickly. During the summer months or in climate zones with a lot of daily sunshine, additional cooling is required which has a negative impact on the building's energy balance. We are able to reduce this effect thanks to the shading function of our GKD metal fabrics. When used as solar protection systems, our architectural fabrics reduce the surface temperature of façades significantly, which can also reduce the amount of insulation required for the building shell. In a practical test performed at the Eastern Michigan University (Ypsilanti, USA) in August at an outside air temperature of 23.9°C, GKD metal fabrics were able to reduce the wall temperature by 19%. Whereas a temperature of 34.4°C was measured on the non-shaded wall, the wall temperature in the shaded area was just 27.8°C.

Types of Metal Fabrics and Characteristics

Cable Metal Fabrics

Flexible cable in one direction, monofilament wire in the other. These meshes are available in various wire diameters and mesh openings.

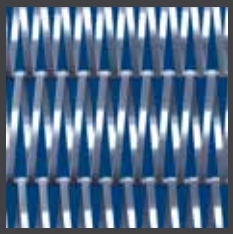
MATERIAL: Stainless steel
DIMENSIONS: Up to 8m wide; lengths of 30m and more are possible. These meshes are primarily suitable for large-area fixed elements, although roll-up solutions are also possible.

PC-Metal Fabrics

Monofilament wire in both directions. These meshes are available in various wire diameters and mesh openings. They are ideal as sliding shutters, folding shutters or segmented façades.

MATERIAL: Stainless steel or aluminium
DIMENSIONS: For reasons of transport, the dimensions should not exceed 4m x 2m.

Spiral Metal Fabrics – Escale



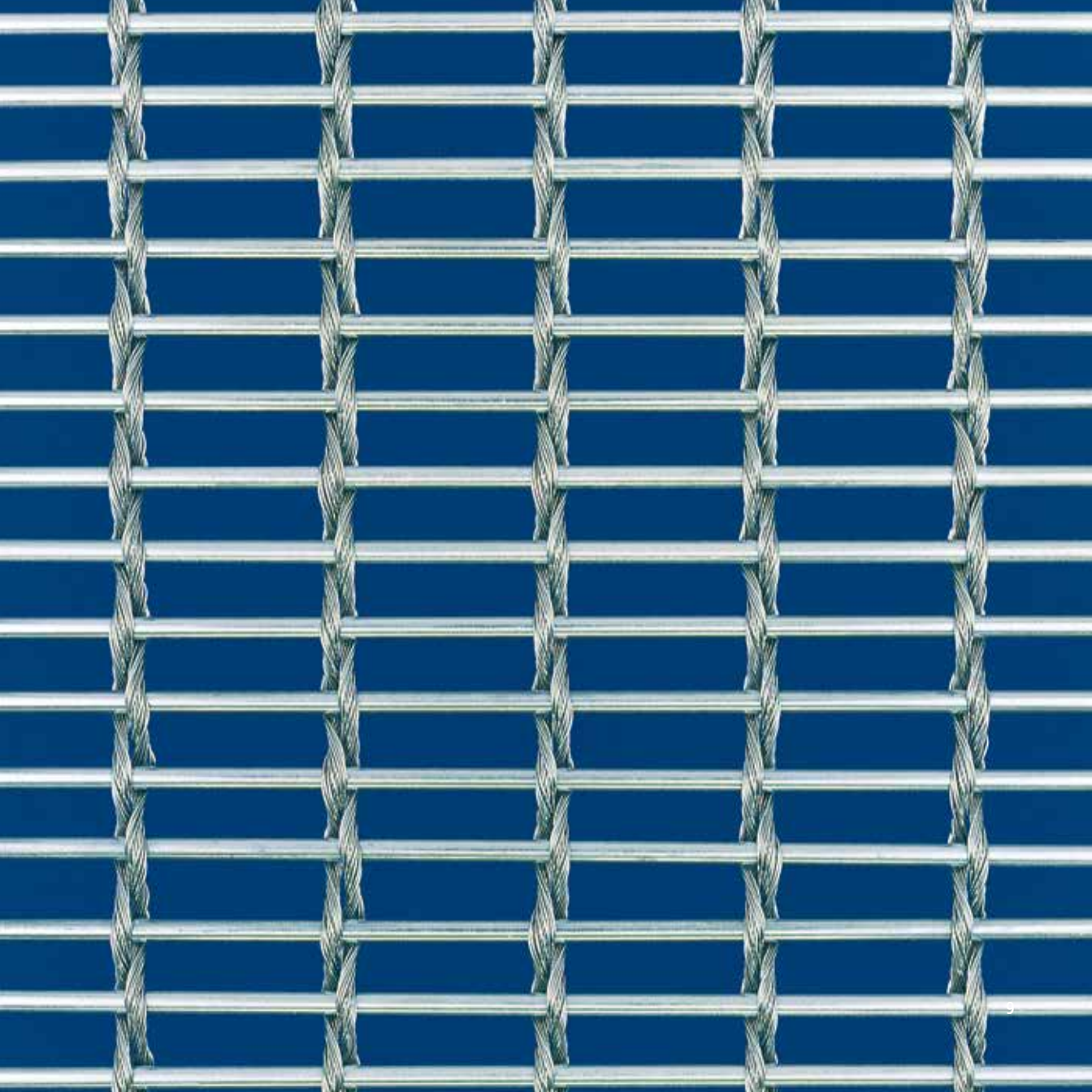
The elements in the Escale 7x1 product range can be seamlessly combined to produce visually endless elements. They are particularly well-suited to 3D façades.

MATERIAL: Stainless steel or aluminium
DIMENSIONS: Up to 6m wide; lengths are virtually endless.

Spiral Metal Fabrics – Licorne

Spiralling flat wire in one direction and monofilament wire in the other. These meshes are available in various wire diameters and mesh openings. They are particularly well-suited to roll-up solutions.

MATERIAL: Stainless steel or aluminium
Up to 4m wide; lengths are virtually endless.



Sliding Elements - Folding Shutters

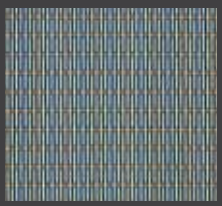
Luna Apartments, Melbourne, Australia

With our ALU 6010 GKD aluminum fabrics, the Australian architects of this apartment building in Melbourne have demonstrated how solar protection, energy efficiency and a pleasing visual appearance can all harmoniously work together. The metal fabric was anodized in a batch process creating a bronze/ gold shimmering effect. Around 300 visual and solar protection elements of various widths - some of which are movable - clad the glazed surface of approximately 600 square meters. Thanks to its tapering form, the apartment building blends in perfectly with the surroundings.

Architect: Elenberg Fraser Architects, images: ©GKD/Elenberg Fraser

Metal Fabric: Alu Gold 6010

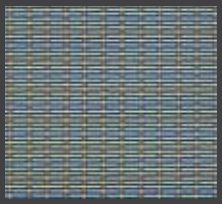
Solar Parameters



ALU 6010 | vertical alignment

g_{total}	Solar irradiation angle		
	0°	30°	60°
gtot B	0.46	0.41	0.44
gtot C	0.35	0.35	0.33
gtot D	0.24	0.24	0.23

Fc	Solar irradiation angle		
	0°	30°	60°
Fc B	0.60	0.53	0.57
Fc C	0.59	0.59	0.56
Fc D	0.74	0.73	0.71



ALU 6010 | horizontal alignment

g_{total}	Solar irradiation angle		
	0°	30°	60°
gtot B	0.46	0.36	0.24
gtot C	0.35	0.32	0.16
gtot D	0.24	0.22	0.12

Fc	Solar irradiation angle		
	0°	30°	60°
Fc B	0.60	0.48	0.31
Fc C	0.59	0.54	0.28
Fc D	0.74	0.68	0.38

Determining the Fc and gtotal values in connection with reference glazing types B, C, D as per EN 14501

Three-Dimensional Façade

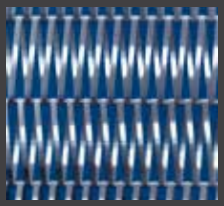
Lake Nona, Orlando, USA

Natural light incidence, outward transparency and optimum solar protection - these are the key characteristics offered by the Escale 7x1 solar protection system at the Research Center in Lake Nona, Florida. The metal fabric is ideally suited to three-dimensional applications. The solar protection façade, which spans approximately 750 square meters, is made up of ten trapezoidal metal fabric panels that also lend the building its shimmer. The semi-transparent metal fabric wraps around the sickle-shaped front of the building like a protective shield. By reducing the intensity of solar radiation, GKD has made a significant contribution to the building's energy efficiency and thereby helped it obtain the LEED Platinum certification.

Architect: HOK Architects, images: ©GKD/NY Focus

Metal Fabric: Escale 7x1

Solar Parameters



ESCALE 7x1 | horizontal alignment

g_{total}	Solar irradiation angle
	0°
gtot B	0.37
gtot C	0.28
gtot D	0.9

Fc	Solar irradiation angle
	0°
Fc B	0.49
Fc C	0.47
Fc D	0.61

Determining the Fc and gtotal values in connection with reference glazing types B, C, D as per EN 14501

Fixed Elements

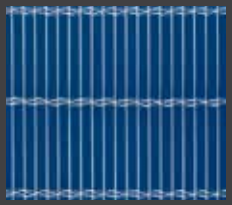
Capital Gate, Abu Dhabi, UAE

Low weight and individual formability - it was with these characteristics that GKD's Tigris stainless steel fabric won over the planners of the 35-story Capital Gate building in Abu Dhabi. The façade is made up of 580 panels of different sizes which have been arranged horizontally at an angle of up to 25° to create parallelograms. In total the architects fitted around 5,000 square meters of the double-warp GKD stainless steel fabric. The result is a combination of efficient solar protection and maximum transparency. Alongside office areas, the 160m tall building of the Abu Dhabi National Exhibitions Company is also home to a five-star hotel.

Architect: RMJM Architects, images 1 + 2: ©GKD/Waagner-Biro Stahlbau AG; image 3: ©GKD/Thomas Holtkötter

Metal Fabric: Tigris 2100

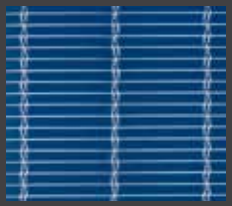
Solar Parameters



TIGRIS | vertical alignment

g_{total}	Solar irradiation angle		
	0°	30°	60°
gtot B	0.59	0.56	0.57
gtot C	0.46	0.46	0.44
gtot D	0.31	0.31	0.30

Fc	Solar irradiation angle		
	0°	30°	60°
Fc B	0.78	0.73	0.75
Fc C	0.78	0.78	0.75
Fc D	0.97	0.96	0.93



TIGRIS | horizontal alignment

g_{total}	Solar irradiation angle		
	0°	30°	60°
gtot B	0.59	0.54	0.45
gtot C	0.46	0.44	0.34
gtot D	0.31	0.30	0.23

Fc	Solar irradiation angle		
	0°	30°	60°
Fc B	0.78	0.71	0.59
Fc C	0.78	0.75	0.58
Fc D	0.97	0.93	0.73

Determining the Fc and gtotal values in connection with reference glazing types B, C, D as per EN 14501

Large Rotating Fins

Asfinag, Innsbruck, Austria

In Innsbruck, a vertical GKD solar protection fabric is making a key contribution to the representative, efficient and sustainable façade cladding of a new office complex. The system employs 680 electrically adjustable fins that are covered in GKD's PC-Omega stainless steel fabric. These were fitted to a façade area of approximately 1,100 square meters. At GKD, we wove each element individually using three different mesh openings in each panel. This makes the metal fabric increasingly dense towards the top, thereby offering greater protection where it is needed. ASFINAG, which is responsible for managing and maintaining Austria's road network, put the building design out to tender in an architectural competition. Anyone wishing to tender had to meet strict requirements, as the client was looking for effective solar protection in combination with maximum transparency. The building concept was awarded the title *Best Architects 13*.

Architect: Atelier Peter Lorenz, images: © GKD/g.r. wett

Metal Fabric: PC-Omega 1510-1520-1530

Solar Parameters

OMEGA 1510 | vertical alignment

g_{total}	Solar irradiation angle		
	0°	30°	60°
gtot B	0.40	0.34	0.38
gtot C	0.30	0.30	0.28
gtot D	0.21	0.21	0.19

Fc	Solar irradiation angle		
	0°	30°	60°
Fc B	0.52	0.44	0.49
Fc C	0.51	0.51	0.48
Fc D	0.64	0.64	0.61

OMEGA 1510 | horizontal alignment

g_{total}	Solar irradiation angle		
	0°	30°	60°
gtot B	0.40	0.30	0.20
gtot C	0.30	0.27	0.14
gtot D	0.21	0.19	0.10

Fc	Solar irradiation angle		
	0°	30°	60°
Fc B	0.52	0.39	0.27
Fc C	0.51	0.46	0.23
Fc D	0.64	0.59	0.33

Determining the Fc and gtotal values in connection with reference glazing types B, C, D as per EN 14501

Double-Skin Façade

European Court of Justice, Luxembourg

Gold-anodized GKD aluminum fabric transforms the two office towers of the European Court of Justice in Luxembourg into purist, shimmering sculptures. Similarly to GKD's 6010 aluminum fabric, the type of material used here excels through its long service life, recyclability and low weight of just 2.6 kg/m^2. The architect required a particularly lightweight metal fabric that could also be bent into a zigzag shape to offer maximum opaqueness from outside when looking into the two 24-storey office towers. The 7,724 panels (20,190 m^2) were fitted between two window panes in the façade, where they also provide interesting reflective light effects.

Architect: Dominique Perrault Architecture, images: ©GKD/Thomas Holtkötter

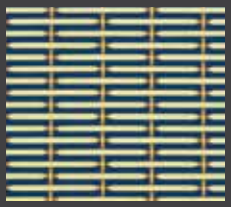
Metal Fabric: Alu 6010

Solar Parameters

ALU 6010 | vertical alignment

g_{total}	Solar irradiation angle		
	0°	30°	60°
gtot B	0.46	0.41	0.44
gtot C	0.35	0.35	0.33
gtot D	0.24	0.24	0.23

Fc	Solar irradiation angle		
	0°	30°	60°
Fc B	0.60	0.53	0.57
Fc C	0.59	0.59	0.56
Fc D	0.74	0.73	0.71



ALU 6010 | horizontal alignment

g_{total}	Solar irradiation angle		
	0°	30°	60°
gtot B	0.46	0.36	0.24
gtot C	0.35	0.32	0.16
gtot D	0.24	0.22	0.12

Fc	Solar irradiation angle		
	0°	30°	60°
Fc B	0.6	0.48	0.31
Fc C	0.59	0.54	0.28
Fc D	0.74	0.68	0.38

Determining the Fc and gtotal values in connection with reference glazing types B, C, D as per EN 14501

Tensioned Vertical Louvers

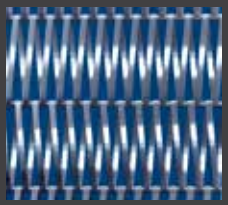
One North Bank, Sheffield, UK

Solar protection systems made of GKD metal fabric do not always have to be installed parallel to the façade. At the One North Bank office building in Sheffield (UK), the architects chose to use 13 metal fabric panels, which were installed along the south-east façade of the building to trace the path of the sun. When selecting the material, they decided to go with GKD's Escale 7x1 stainless steel fabric. When the sun strikes the building from the south at around midday, the 10.4 x 0.75 meter panels made of GKD spiral fabric offer optimum shading without restricting outward views. Effective solar protection has therefore been combined with an appealing architectural design here.

Architect: BDP Architekten, images: ©GKD/ Cadisch

Metal Fabric: Escale 7x1

Solar Parameters



ESCALE 7x1 | horizontal alignment

g_{total}	Solar irradiation angle
	0°
gtot B	0.37
gtot C	0.28
gtot D	0.19

Fc	Solar irradiation angle
	0°
Fc B	0.49
Fc C	0.47
Fc D	0.61

Determining the Fc and gtotal values in connection with reference glazing types B, C, D as per EN 14501

Axially Twisted Metal Fabric

Sanral Pretoria, South Africa

In South Africa's capital city of Pretoria, GKD's Omega stainless steel fabric lends an 8,500 square-meter new building its unmistakable character, while also providing protection from continuous solar radiation. To make the designer's vision a reality, some 161 individual elements of varying density were custom-woven and then installed in an axially-twisted configuration based on the angle of solar radiation. This not only provides the headquarters building of the South African National Roads Agency the greatest possible transparency, it also yields optimum solar radiation protection. The building was awarded a 4-star rating by the South African Green Building Council and also won the 2013 Fulton Award.

Architect: Activate Architecture, images: 1, 2: ©GKD

Metal Fabric: Omega 1510-1520-1530

Solar Parameters

OMEGA 1520 | vertical alignment

g_{total}	Solar irradiation angle		
	0°	30°	60°
gtot B	0.49	0.44	0.45
gtot C	0.38	0.37	0.34
gtot D	0.26	0.25	0.23

Fc	Solar irradiation angle		
	0°	30°	60°
Fc B	0.65	0.58	0.59
Fc C	0.64	0.63	0.58
Fc D	0.80	0.79	0.73

OMEGA 1520 | horizontal alignment

g_{total}	Solar irradiation angle		
	0°	30°	60°
gtot B	0.49	0.41	0.32
gtot C	0.38	0.35	0.23
gtot D	0.26	0.24	0.17

Fc	Solar irradiation angle		
	0°	30°	60°
Fc B	0.65	0.53	0.42
Fc C	0.64	0.59	0.40
Fc D	0.80	0.74	0.52

Determining the Fc and gtotal values in connection with reference glazing types B, C, D as per EN 14501

Roll-Up Solar Protection

Rabobank Geldrop, The Netherlands

GKD's Licorne 13a aluminum fabric is particularly well suited to roller applications – such as the rollable elements of the modernized Rabobank building in Geldrop (Netherlands). The architects designed a complete façade with floor-length windows around an existing building. These windows were to be equipped with a movable solar protection system, employing rollers guided in rails, that underlines the transparent character of the new building shell. This is why the architects elected to go with Licorne 13a, a GKD spiral fabric that boasts excellent solar protection properties without restricting outward views. The 47 metal fabric panels were silver-anodized, which allows them to fit in seamlessly with the overall image. The building concept was awarded BREEAM certification as *Very Good*.

Architect: van den Pauwert Architekten BNA, images 1, 3: ©GKD/KO&CO Benelux,

Metal Fabric: Licorne 13a

Solar Parameters

LICORNE 13a | horizontal alignment

g_{total}	Solar irradiation angle
	0°
gtot B	0.30
gtot C	0.22
gtot D	0.15

Fc	Solar irradiation angle
	0°
Fc B	0.39
Fc C	0.37
Fc D	0.48

Determining the Fc and gtotal values in connection with reference glazing types B, C, D as per EN 14501

Transparent Media Façades

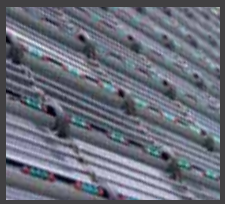
American Airlines Arena, Miami, USA

The first large and transparent media façade in the USA was created at the American Airlines Arena in Miami using MEDIAMESH® from GKD. Almost 320 square meters of stainless steel mesh with integrated LED profiles trace the contours of the glazed arena. The media façade offers optimum image resolution that guarantees sharp and bright images, both during the day and at night. With its 70% transparency, the façade with display function also gives an unobstructed outward view from the lounges, yet still provides effective solar protection. The fact that it requires no maintenance and consumes very little energy was also a key factor behind the decision to go with the mesh. Thanks to its weather resistance, GKD MEDIAMESH® is also able to withstand the region's annual hurricanes, during which wind speeds of up to 145mph are commonly experienced.

Architect: ADC, Florida/ag4, Köln, images 1, 2: ©Miami in Focus

Mediamesh: V5–H4.25

Solar Parameters



MEDIAMESH V5 – H4,25 | horizontal alignment

g_{total}	Solar irradiation angle		
	0°	30°	60°
gtot B	0.59	0.54	0.45
gtot C	0.46	0.44	0.34
gtot D	0.31	0.30	0.23

Fc	Solar irradiation angle		
	0°	30°	60°
Fc B	0.78	0.71	0.59
Fc C	0.78	0.75	0.58
Fc D	0.97	0.93	0.73

Determining the Fc and gtotal values in connection with reference glazing types B, C, D as per EN 14501

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