

KEYLIOS®

POWER & DATA CABLE INFRASTRUCTURES
TO BOOST SOLAR ENERGY COMPETITIVENESS,
RELIABILITY AND SUSTAINABILITY





GROWING PHOTOVOLTAIC CAPACITY

Decarbonization has become a global issue against global warming.

This international public concern received a further boost by the Paris Agreement negotiated during the 2015 UN Climate Change conference, COP 21, in which 195 countries committed themselves to limit greenhouse gases to below 2% in coming years in keeping with Intended Nationally Determined Contributions (INDCs) based on data submitted per country and per inhabitant. This effort was pursued in Marrakech (Morocco) in 2016, and Bonn (Germany) in 2017.

With 40% of global energy-related CO₂ emissions coming from the power sector, the widespread deployment of low-carbon, zero-harm and affordable energy sources represents the only path for bringing emissions under control to meet world power demands. Primary Energy Sources (Energy Mix) must evolve towards Renewable Energies. Solar now represents around 1% of the Energy Mix. But growth will be exponential. Solar is now the world's highest investment priority.

The cost of both decentralized and utility-scale photovoltaic power plants has declined 80% recently, making "grid parity" an achievable goal for solar energy as it becomes as competitive as commercially available grid power based on coal, natural gas, nuclear energy and offshore wind.

Installed capacity crossed the threshold of 300 GW worldwide in 2017, and is expected to double by 2020. Solar PV technology is proving its competitive value, not only in developed economies, but also in emerging ones, which are often blessed with free and abundant solar resources. In fact, it has been calculated that harnessing 1.2% of the Sahara desert could easily equal current world power generation at a fraction of the cost and with a minimal CO₂ footprint.

What you expect from your cable solutions supplier

- Capex & Opex savings to meet competitive Power Purchase Agreements and ROI targets
- Innovation capability for enhanced savings
- Long lifetime for your assets to secure your business model (25-40 years)
- Fulfillment of the updated International Standards to assure Asset Value
- Minimal environmental impact through lower CO₂ emission during full life cycle
- Recycling for circular economies in line with your Sustainable Development strategy
- Expertise in energy, data networking and grid connectivity
- Cooperation with a bankable cable solution partner to reduce financial costs and limit risk
- Support for your international development plan (certification, local delivery with local sourcing at equal level of quality)

One of the major benefits of large-scale solar generation is that plants can be built relatively quickly, often within a year, compared to hydro and fossil fuel projects that may require five years to complete. This not only means enhanced savings for initial investment, but also lower long-term maintenance costs. To achieve viability for your photovoltaic power plant in keeping with your specific economic, social and environmental concerns requires a well-balanced energy and data cable infrastructure to guarantee low costs and optimal performance.



KEYLIOS® CABLES, SOLUTIONS AND SERVICES

Nexans is an innovative provider of a full range of cable solutions and associated services covering both Energy and Data Infrastructures to ensure prolonged efficiency and reliability of plant Solar Farm assets, while reducing initial investment and long-term operating costs.

Our widely acclaimed KEYLIOS® products can outfit a complete utility-scale photovoltaic power plant, assuring that all elements are fully interoperable and compatible and meet PV Plant International Standards. We provide end-to-end power and data cable solutions which can operate reliably and sustainably in harsh conditions to ensure the flow of electricity and boost efficiency.

We produce every cable and associated connectivity for Solar Farm efficiency: from photovoltaic LV/DC cables for linking separate PV panels to MV cables for carrying energy from strings to inverters or from the entire array to the grid. Nexans has several cable solutions for reliable inverter-transformer-switchgear connections. We also provide innovative optimization of the MV-AC collector network, combining cable-specific installation methods for proven savings and fewer joints.

To complement Energy Infrastructure, Nexans can also provide a complete Data Infrastructure. To meet the mission-critical criteria of Smart Grids (especially in harsh environments), we provide copper and fiber solutions with active switches for data monitoring to transmit communication and sensor inputs to the SCADA of the Power Utility.

KEYLIOS® reliable cable solutions and services for sustainable solar assets

- Complete power (LV/MV/HV) and data transmission (copper and fiber) infrastructures
- End-to-end solutions combining cables and connectivity from solar plant to utility grid
- Network construction support (both power and data)
- Definition of bills of materials with international certification
- Speedy and efficient installation on challenging terrains
- Pre-connectorized solutions of the PV array (factory-fitted harnesses)
- Complete infrastructure packages in containers delivered onsite
- Environmental declaration based on Life Cycle Assessment

Beyond cables, Nexans is also unique in being able to provide essential services focused on optimizing Solar Farm lifetime capital and operating costs, including:

- Container delivery of complete Energy and Data Infrastructure cable solutions onsite
- Engineering support and simulation to co-design and optimize the PV array network, integrating climatic and installation conditions
- Sub-array PV factory-fitted cable harnesses,
- Innovative trefoil installation solutions combined with innovative cable processes to minimize number/cost of MV joints and reduce the MV network's overall installed cost
- Environmental declaration based on life cycle assessment for evaluating environmental impact, including carbon footprint of the cable from material extraction to disposal.

KEYLIOS® ENERGY AND DATA CABLE SOLUTIONS AND

KEYLIOS® energy solutions to increase output

Photovoltaic cables



These state-of-the-art 1.0/1.0 kV AC (1.5 kV DC) cross-linked Energyflex® cables offer exceptional performance, easy installation and long-term reliability for

short DC connections. They link photovoltaic panels on rooftops or solar fields, and also connect them to the array box (if one exists), or to the inverter which transforms DC solar energy into usable AC electricity. Resistant to extreme temperatures (-40°C to +120°C), ozone and UV, these zero-halogen cables are low-smoke and flame-retardant for enhanced fire security. Compliant to EN50618, certified by LCIE (BUREAU VERITAS), they fit main connectors, are color-stripped for easy installation and phase identification, meet RoHS directives, and are fully recyclable. Through its multiple plant capacity, Nexans is able to provide them anywhere in the world. At its Nexans Research Center, Nexans tests Energyflex® in especially harsh conditions.

> Nexans supplied Schneider Electric with over 1,000 km of Energyflex® photovoltaic cables in a mere two-and-a-half months for a photovoltaic farm in Sanpietro Vernetico, near Brindisi, Italy. We also provided Eiffage with over 3,000 km of Energyflex® photovoltaic cables for the gigantic Cestas solar farm. These cables are used to interconnect panels, and also connect module strings to the inverter.

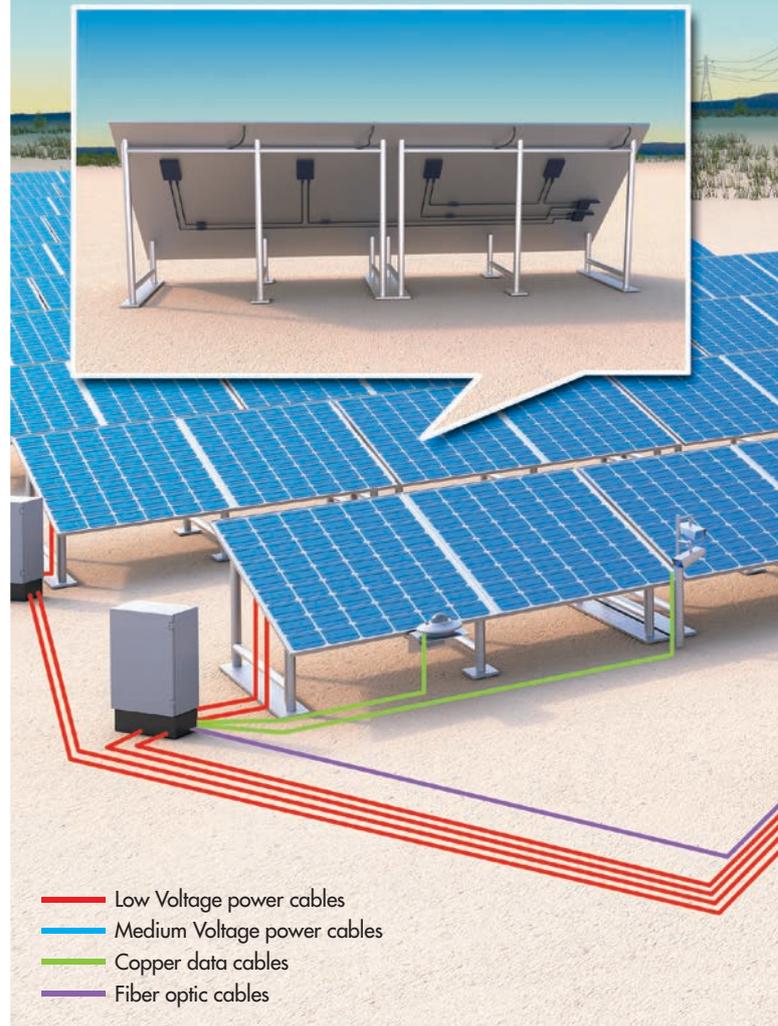
MC4 connectors



This state-of-the-art MC4-type connector can connect individual PV modules in both series (strings) and parallel in large arrays, typically connecting 4, 6 and 10

mm² copper energy cables. Easy to connect and disconnect through a male/female design they can be delivered as factory-fitted and tested harnesses or installed onsite. They can also be used in combiner boxes and as branch joints to link up diverse strings to easily expand an array. Very light, UV- and high-temperature resistant, MC4s allow utilities to save time and money during installation, plan for future growth and protect their infrastructure investment. All connectors are TÜV certified and meet the European EN 50521, international IEC 62852 and US UL6703 standards. Plugs, sockets and connectors also meet the design requirements for PV arrays, according to IEC62548:2016.

> Both Energyflex® cables and MC4 connectivity have been provided for France's 300 MW Cestas solar plant near Bordeaux, which is the largest single array on the European continent. The project has proven that photovoltaic is on a par with wind power and more competitive than new nuclear energy.



MV-AC cables

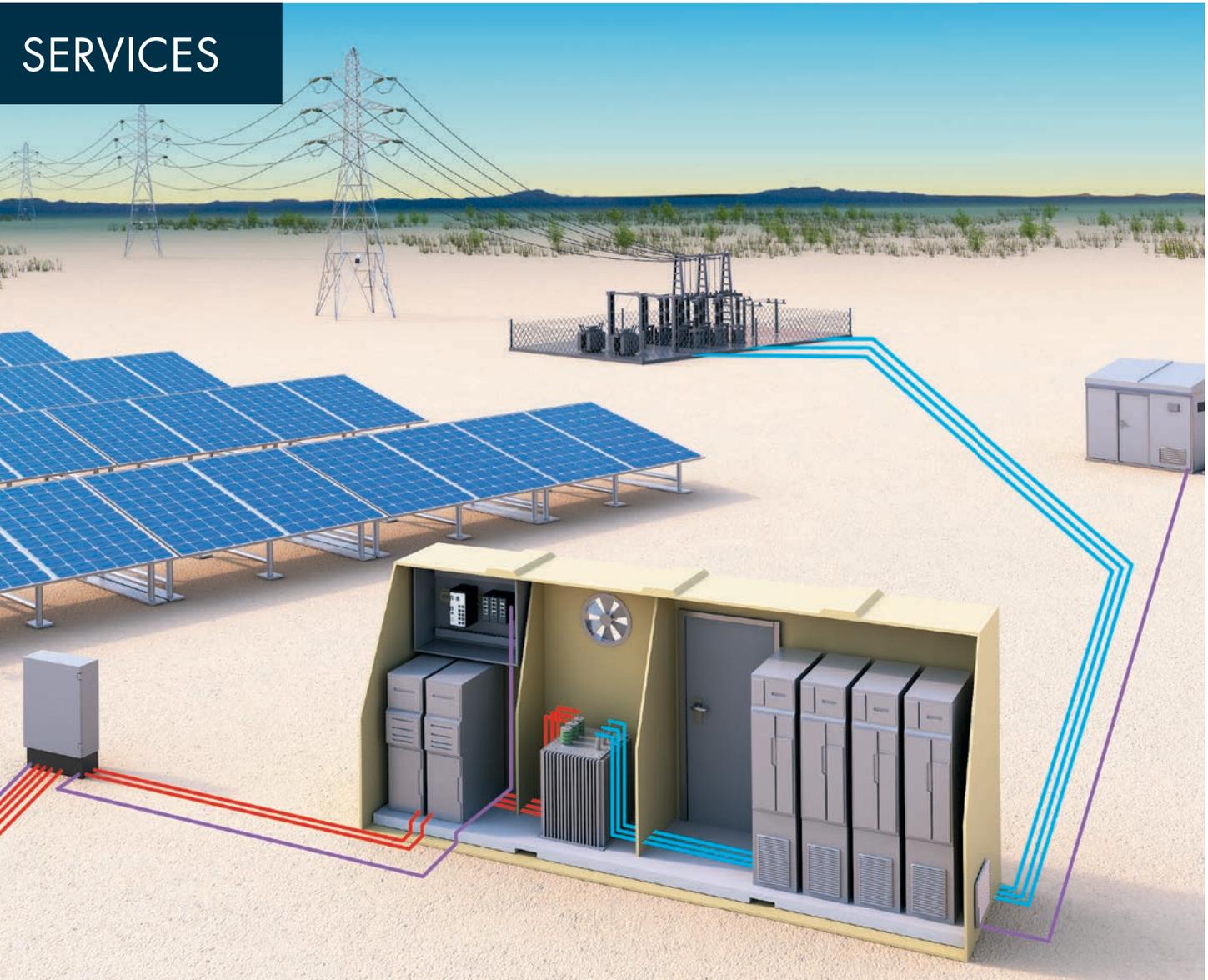


Single-core or three-core medium voltage cables up to 30 kV with large Cu- and Al-conductor cross-sections link the Solar Farms to the high voltage network by

transmitting the high current capacity output from the transformers to the public power distribution grid at which the cable circuits are usually buried in trenches directly in ground. MV-cables are designed, manufactured & tested acc. to IEC 60502-2 standard (further standards on request). Cables may be produced alternatively with XLPE, PVC, EPR insulation and armoring by copper wire screen/tape, lead sheath, aluminium/steel wire or steel/aluminium tape as well as PVC, PE, HFFR (halogen-free) outer sheath with fire retardancy acc. to IEC 60332-3 CAT A,B,C and being resistant against uv + ozone radiation, oil and termites & rodents.

In special cases at laying in harsh or rocky ground Nexans provides shock-proof type XLPE-cable solutions with improved mechanical impact resistance during the cable life-time provided by an increased PE-outer sheath

SERVICES



thickness and special reinforced PE-compound which is comparable with an armoured cable together with a high flexibility by a reduced insulation thickness. The new design of this time-proven cable boosts "admissible intensity" (current capacity in amperes) some 7% to increase billable output compared with a traditional direct buried cable. For further savings, less energy is lost through the Joule Effect. This contributes to a 12% lower impact on global warming. They are also extremely easy to strip, and come with appropriate accessories and junction boxes

> Nexans received a gold medal award from ADEME (French Environment and Energy Management Agency) and from the French Ministry of the Environment, for this "eco-designed cable" in recognition for the work performed for environmentally enhanced performance.

Enhanced MV-AC cable installation



Operators are looking for CAPEX savings and are therefore increasingly burying MV-AC cables (up to 60kV) to link Solar Farms to the MV network to meet environmental concerns and climatic conditions. Nexans new direct-buried cables are laid directly in the trench and then immediately buried, thus saving time and cost, since no sand has to be added to the bed.

A particular challenge for the project owner is to reduce CAPEX & OPEX while ensuring long-term cable system security. In-line straight joints, as installed hand-made by jointing team, may result in a potential weakness in the MV cable system, and elimination of joints altogether with point-to-point circuits have been seen as the most effective solutions. Nexans provides long-length single core cables associated with innovative installation methods, combining a fully-integrated drum carrier, cable binding and laying solution. This enables the 3x1 core cables to be continuously

laid together with the fiber optic and earthing cables. This unique one-step cable installation solution reduces the number of drums, jointing sections and joints and on-site installation days. It also generates tangible installation cost savings while reducing/eliminating the number of potential service interruption during plant operation.

> Cable drums, accessories and junction boxes are all managed logistically as a single system.

Cabinets for MV connectors



To house standard MV connectors in a tight and secure underground enclosure, Nexans offers robust watertight cabinets that allow connectors to be

easily disconnected if required, and makes it possible for operators to isolate part of their network while re-energizing the other part. Also, special connector kits allow them to perform tests, not only on connectors, but also on critical equipment and cables once everything is interconnected.

> Integrated sensors can help the operator manage the network by providing key data, including voltage, current and cable temperature.

Transformers



With a simple or multiple winding wire design, these transformers make it possible to step up voltage and connect several PV panel strings to the grid.

They are not only highly efficient, they are also able to function flawlessly in harsh operating conditions and at high ambient temperatures. Transformers can be integrated in a complete prefabricated solution within a protective shelter to house solar inverters, medium-voltage switchgears, monitoring systems and in/out cabling. Project engineering is made easier with pre-tested factory equipment, while After Sales Support assures long operational life.

> As part of the NOOR Ouarzazate mega solar project in Morocco, Nexans provided a complete transformer substation for the country's solar energy agency. We also integrated third-party equipment, including cooling, low-voltage panels and monitoring, and handled logistics and onsite installation.

KEYLIOS® data solutions for network control

LANactive Industry solution: managed industrial Ethernet switches and cabling for mission-critical data network infrastructures



Ethernet networks provide an intelligent platform for PV sub-systems, like monitoring control, maintenance, IP video surveillance and security. Our industrial

Ethernet switches allow to create standardized and highly reliable data network infrastructure in harsh environments of Smart Grid sites and ensure optimal transmission quality, redundancy, security, interoperability and easy maintenance. LANactive Industry solution includes the Ethernet switches, copper and fibre cabling, including its industrial variant and DIN-rail mounted connectivity, switches configuration and acquaintance software and a full range of support services.

> KEMA/DNV-GL proved Nexans industrial Ethernet switches compliance to IEC 61850 (3, 6, 7-1, 7-2, 7-3, 7-4, 8-1, 9-1) which is key to enable standardized universal data communication between various field devices of electrical grid infrastructures and managements SCADA, which significantly improves the efficiency of power generation, distribution and consumption infrastructures.

Fiber optic cables



To assure high data transmission capacity (from solar array to distant control centers), Nexans' Uni or Multitube, Uni or Multi bundle cables can be installed in

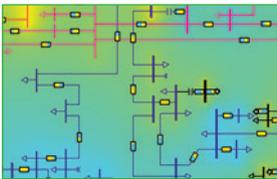
conduits, micro-conduits or directly buried. They are also waterproof and rodent-resistant. These cables can meet ultra-severe safety and fire norms and offer Electromagnetic Compatibility (EMC) in energy-dense areas.

> Nexans' full range of FO connectors, patch cords, splicing frames for individual fiber management are fully adaptable to distance and network configuration, and can be preconnectorized. The tough plastic cabinets are both shock resistant and heat/cold resistant, and are submersible down to four meters.





KEYLIOS® services for sustainability and reliability



PV Array network design optimization

Based on state-of-the-art simulation tools developed by its Research Center, Nexans provides

engineering support for co-designing and optimizing PV array networks. This makes it possible to assess installation conditions: single cables, groups of cables, overhead, buried. Secondly, it allows us to examine various heat sources: Joule losses from current load (stationary, transient, harmonic content), screen currents, and dielectric losses in insulations. Thirdly, we look at external heat sources, like cables in contact with hot surfaces, or mutual heating from adjacent cables. Finally, we analyze overall climatic conditions, mainly soil and air temperatures, sun radiance and wind patterns.

> By being able to simulate internal network and external conditions, Solar Farm customers can thus choose cables which perfectly match the specificities of each cable link and the entire PV array network.

Harnesses



Because solar plant expansion has given rise to a massive rollout, it is essential to reduce installation time while reducing the risk of failure during routine

operations. In areas with high labor costs, the provision of factory-fitted and tested harnesses for LV-DC cables has proven to be a cost-efficient solution. To ensure highest quality, the crimping process is fully compliant with IEC 603252.

> Nexans harness services include appropriate packaging and just-in-time delivery onsite.

Life Cycle Assessment (LCA) Services



Nexans evaluates the environmental impact of its products using Life Cycle Assessment. This standardized methodology allows us to quantify the

impact of the different life cycle steps of a product (manufacturing, distribution, installation, use and end of life) in accordance with various environmental indicators such as global warming, resource depletion, acidification of soils and water or energy consumption. The results are then communicated through an Environmental Product Declaration, compliant with the ISO 14025 standard called PEP (Product Environmental Profile). This allows customers to accurately quantify the environmental impact of their product or entire system.

> The first PEPs were developed for the Energyflex® range of PV products. They were recently updated to cover Energyflex® Plus and Energyflex® Plus SL range. Nexans is the only cable manufacturer to provide an environmental declaration for its PV products.

Cable End of Life Management

The Photovoltaic Array Low Voltage Cables and Medium Voltage Cables keep a value even when reaching end of life. When the plant dismantling has to be anticipated, Nexans values, recycles and manages the cable waste. They are recycled in an Environment classified Unit, subsidiary of Nexans Group, European specialist of cable grinding in partnership with the Suez Environment Group, RecyCâbles which is ISO 14001 compliant.

> Following a one-off request from Technord, a major installer, a long-term partnership has been settled through a frame agreement covering the take-back and recycling of surplus cables from all the Technord Group's subsidiaries.

NEXANS' KEYLIOS® FOR SUSTAINABLE PV ENERGY

GLOBAL EXPERTISE

As the world's leading cable manufacturer, we have a unique geographical, industrial and commercial presence in all markets. We also work closely with the entire chain of solar players, including panel and junction manufacturers, systems integrators, wholesalers, installers and project developers.

LOCAL PRESENCE

Nexans is increasingly a "glocal" company, combining global reach with sensitivity to local production needs and solar projects. Operating

on all continents, we are able to follow installers, project developers and OEMs everywhere, often working with local resources to organize technology transfers and training.

TECHNICAL EXPERTISE

With a long acquired expertise in cable design, materials, standards, and technology, we have continued to expand our offer, moving from being a product supplier to being a responsive provider of solutions and services, backed up by the R&D resources of our Nexans Research Center (NRC).

Nexans brings energy to life through an extensive range of cables and cabling solutions that deliver increased performance for our customers worldwide. Nexans' teams are committed to a partnership approach that supports customers in four main business areas: Power transmission and distribution (submarine and land), Energy resources (Oil & Gas, Mining and Renewables), Transportation (Road, Rail, Air, Sea) and Building (Commercial, Residential and Data Centers). Nexans' strategy is founded on continuous innovation in products, solutions and services, employee development, customer training and the introduction of safe, low-environmental-impact industrial processes.

In 2013, Nexans became the first cable player to create a Foundation to introduce sustained initiatives for access to energy for disadvantaged communities worldwide.

Nexans is an active member of Europacable, the European Association of Wire & Cable Manufacturers, and a signatory of the Europacable Industry Charter. The Charter expresses its members' commitment to the principles and objectives of developing ethical, sustainable and high-quality cables.

Nexans, acting for the energy transition, has an industrial presence in 40 countries, commercial activities worldwide, is employing close to 26,000 people and generating sales in 2016 of 5.8 billion euros. Nexans is listed on Euronext Paris, compartment A.

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