ATMOS

High-Accuracy Spectral Monitoring of Atmospheric Attenuation in Solar Tower Plants
Technology Transfer and Licensing Opportunity for China

Draft v1 - May 2026

Prepared for discussions with potential industrial partners in China. This document describes a technology transfer and licensing opportunity, not a service offering by CENER in China.

1. Executive summary

ATMOS is a patented measurement technology developed to quantify atmospheric attenuation of solar radiation in commercial solar tower plants. It directly measures the spectral loss between two measurement points observing the same illuminated target, enabling real-time assessment of the energy actually delivered by heliostats to the receiver over long slant ranges.

The technology addresses a growing need in large tower plants: atmospheric attenuation is a significant but often poorly measured source of performance uncertainty. As heliostat fields grow larger, the optical path between distant heliostats and the receiver can exceed one kilometre, making aerosols, water vapour, dust and scattering effects increasingly relevant for design, bankability and operation.

CENER is seeking a Chinese industrial partner to license the ATMOS patent and transfer the associated know-how. The partner would complete product adaptation and industrialization for the Chinese CSP market, manufacture or integrate the system locally, and exploit the technology commercially. CENER's role would be focused on technology transfer, know-how and agreed technical support during the transfer phase, not on providing long-term services in China.

2. Why atmospheric attenuation measurement matters

2.1 A major but poorly quantified loss

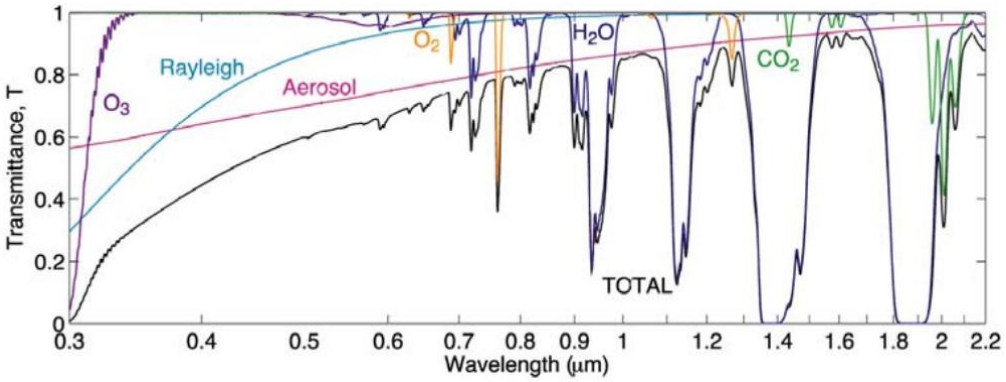
In tower plants, heliostats reflect solar radiation to a receiver located on top of a tower. During this path, part of the radiation is lost through scattering and absorption. The magnitude of this loss depends on atmospheric conditions and heliostat-to-receiver distance.

- Clear-day attenuation can be around 6% at a slant range of approximately 1.3 km.
- Hazy-day attenuation can approach 20% at the same distance.
- The variability can produce significant deviations between predicted and actual receiver input.
- Because this loss is site-specific and time-dependent, simplified assumptions are not enough for high-confidence performance assessment.

2.2 Spectral effects are critical

Solar radiation reaching the surface is distributed across ultraviolet, visible and near-infrared wavelengths. Nearly half of the energy is in the near-infrared range, where absorption by water vapour and CO2 can be significant. Broadband approaches that collapse the spectrum into a single value may miss relevant physical effects.

ATMOS measures attenuation across a broad spectral range, allowing operators and technology developers to distinguish between different atmospheric phenomena and understand how attenuation varies during the day.



Spectral distribution of solar irradiance and relevance of the near-infrared range for atmospheric attenuation.

2.3 Relevance for China

China is currently the most active market for new solar tower CSP deployment. The combination of large tower plants, long heliostat slant ranges and variable atmospheric conditions makes accurate attenuation measurement especially relevant for Chinese developers, EPCs, component suppliers and research-backed industrial companies.

3. Limitations of existing approaches

In many projects, atmospheric attenuation is estimated through standard models or broadband image-based measurements. These approaches are useful for preliminary work but have important limitations when the goal is to reduce uncertainty in large commercial tower plants.

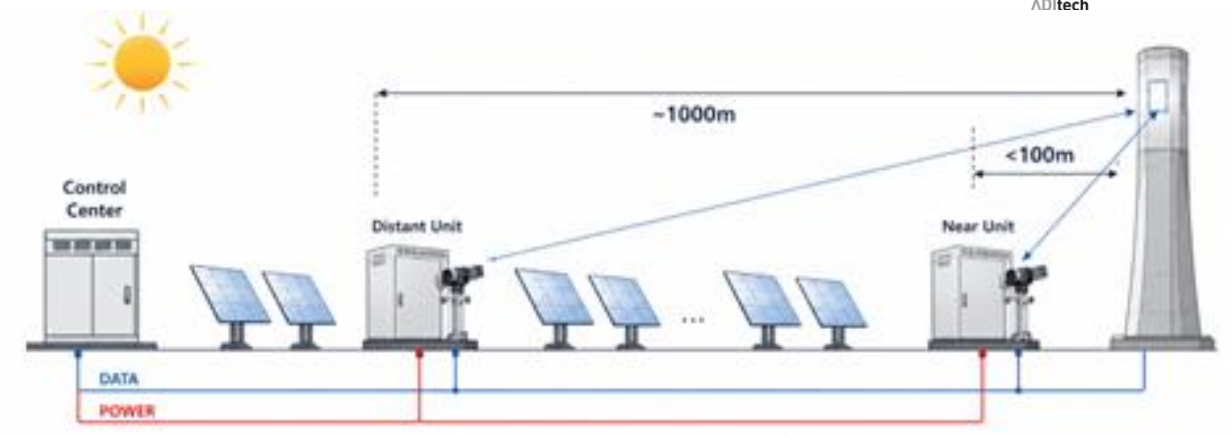
- Model-based estimates depend heavily on atmospheric assumptions that may not represent real site conditions.
- Broadband systems provide only one integrated value and lose wavelength-dependent information.
- Image-based approaches using vertical screens may not reproduce intraday spectral variations accurately.
- Infrared absorption bands can be neglected even though they affect a large share of the solar spectrum.
- Errors increase with distance, air mass and atmospheric variability.

4. The ATMOS solution

4.1 Concept

ATMOS compares the spectral power density measured by two units observing the same illuminated target: a near unit located close to the target and a distant unit located at a longer slant range. After calibration and background correction, the difference between both spectra provides the atmospheric attenuation profile along the path.

This differential measurement avoids relying only on assumptions about aerosols, water vapour or atmospheric turbidity. The result is a direct, real-time and spectrally resolved measurement of attenuation in the plant environment.



ATMOS architecture: near and distant spectral units observe the same target to infer real-time atmospheric attenuation.

4.2 Key technical characteristics

Parameter	Indicative value / description
Measurement principle	Differential spectral power density measurement between a near and a distant unit
Measured spectral range	Approximately 350-1650 nm
Absolute attenuation accuracy	Target accuracy below 1%
Relative attenuation accuracy	Approximately 0.5%
Typical measurement time	60-120 seconds
Configuration	Near unit, distant unit, illuminated target, calibration and background correction
Output	Spectral attenuation profile and real-time attenuation data

4.3 Main benefits

- Direct measurement instead of purely model-based estimates.
- Spectrally resolved information across visible and near-infrared wavelengths.
- Real-time monitoring suitable for changing atmospheric conditions.
- Improved plant design and heliostat field modelling for long slant ranges.
- Reduced uncertainty in performance assessment and operational diagnosis.
- Potential integration with plant monitoring, forecasting and digital performance tools.

5. Validation and maturity

ATMOS has progressed through laboratory proof of concept, field validation and pilot-oriented development. The technology has undergone prototype redesign, calibration improvements, real-time data processing and operational validation activities in relevant CSP environments.

For commercial discussions, the most accurate positioning is: field-validated patented technology ready for transfer to an industrial partner for final product adaptation, industrialization and local deployment.

- Prototype iterations have addressed optical stability, alignment, background correction and system robustness.
- Software improvements include real-time processing, online reporting, historical data storage and automatic exception tagging.

- The system has been developed specifically for solar tower applications and long-distance attenuation measurement.

6. Intellectual property

ATMOS is protected by patent rights and is available for licensing and technology transfer under agreed commercial terms.

Item	Details
International PCT publication	WO2020016466A1
International title	System for measuring in real time the atmospheric attenuation of electromagnetic radiation from at least one source and measurement method
International publication date	23 January 2020
China publication	CN111868516A; also identified in some records as CN111868516B after grant
Chinese title	一种用于实时测量来自至少一个源电磁辐射的大气衰减的系统和测量方法
China publication date	30 October 2020

7. Technology transfer opportunity for China

CENER's objective is to transfer ATMOS to a Chinese partner with the technical, industrial and commercial capacity to complete development, industrialize the product and exploit it in the Chinese CSP market. The cooperation should be structured around patent licensing, know-how transfer and a clear commercialization roadmap.

7.1 Ideal partner profile

- CSP tower plant developer, owner or EPC contractor.
- Heliostat field, solar receiver or CSP instrumentation supplier.
- Photonics, optical instrumentation or industrial monitoring company.
- Energy technology company with local manufacturing and integration capacity.
- Research-backed industrial group able to complete product development and commercial deployment.

7.2 Expected partner role

- Adapt the system to Chinese plant requirements and standards.
- Complete product engineering, industrialization and local manufacturing or integration.
- Develop the supply chain, installation approach, certification and maintenance concept.
- Commercially exploit the technology in China and any additional agreed territories.
- Provide local customer support, field deployment and market development.

7.3 CENER contribution

- Patent licensing under agreed conditions.
- Transfer of technical know-how, design rationale and validation background.
- Support during the agreed technology transfer phase.
- CSP tower expertise to help the partner position the technology correctly in the market.

8. Potential applications

- Design-stage characterization of atmospheric attenuation for large solar tower projects.
- Operational monitoring of attenuation events such as haze, dust, fog or variable aerosol conditions.
- Performance diagnostics when receiver input deviates from expected values.
- Improvement and validation of ray-tracing, optical and plant performance models.
- Support for bankability, resource assessment and technical due diligence.
- Integration into plant digital twins and forecasting platforms.

9. Proposed collaboration roadmap

Phase	Main objective
Phase 1	NDA, technical review, patent/license discussion and partner fit assessment
Phase 2	Transfer package definition, target product configuration and Chinese market requirements
Phase 3	Engineering adaptation, industrial design and local supply-chain definition
Phase 4	Pilot deployment or demonstration in a Chinese tower CSP environment
Phase 5	Commercial launch, deployment and royalty-based exploitation model

10. Conclusion

ATMOS addresses a real and growing source of uncertainty in solar tower CSP: the atmospheric attenuation of radiation travelling from heliostats to the receiver. Its key value lies in direct, real-time and spectrally resolved measurement, enabling better design, diagnosis and performance assessment for large heliostat fields.

For China, ATMOS represents a protected technology transfer opportunity: a Chinese partner can acquire access to CENER's patent and know-how, complete industrialization locally and build a differentiated product for the world's most active solar tower CSP market.