Energy

SinoTrough: Innovative Solar Technology for a Sustainable Energy System in China

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SinoTrough: 面向中国可持续能源系统的创新型太阳能技术

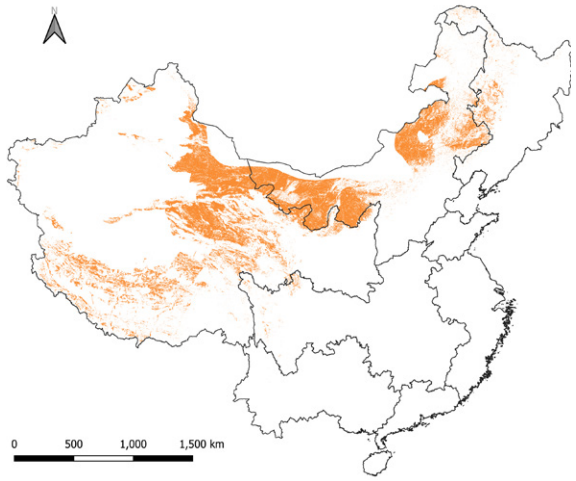
来自德国弗朗霍夫太阳能研究所 Gregor Bern博士、夏宁梓和Francisco Torres Sartori的客邀文章

Unlike fossil fuels, concentrating solar power (CSP) plants can generate clean and cost-effective electricity. Concentrating solar collectors, such as a parabolic trough, convert heat generated by sunlight into electricity. In sunny regions, they supply renewable electricity on demand by using large thermal storage facilities. In an energy market highly penetrated by fluctuating renewable energies such as wind power and photovoltaics without storage, CSP with thermal storage contributes to flexibility of the electricity system and helps maintain grid balance. These thermal storage facilities allow for the generation of electricity whenever needed and thus support a non-fluctuating renewable energy provision by also taking into account possible time gaps between the availability and demand of energy. On top of that, thermal storage also allows the generation of electricity even at night-time when the sun is not shining. Therefore, CSP represents a promising technology to support China in its ambitious goals to peak CO_2 emissions before 2030 and subsequently reach carbon neutrality by 2060.

Demand in solar thermal power plants and solar collectors has been growing around the world, and especially in China. In response to the rising demand, the German-Chinese SinoTrough project focuses on the development of collector systems to further increase the efficiency and reliability of the technology and reduce production costs. The project aims at developing an innovative parabolic trough collector to fit the needs of the Chinese market and energy system. In addition, the project takes into consideration the resilience needed to adjust to the harsh environmental conditions in Northwest China as well as the socio-economic adaptation to the Chinese market.

The SinoTrough project is funded by the German Federal Ministry of Education and Research (BMBF) as part of the “CLIENT-II Funding Initiative”. Fraunhofer Institute for Solar Energy Systems (ISE) in Germany serves as the network coordinator and scientific partner, providing research on the Chinese energy market,

与化石燃料相比，光热发电能够生产更加清洁并划算的电力。例如槽式集热器等光能集热器可以将太阳光中的热能转化为电力，在阳光充足的区域可以通过大型储热设施根据需求生产可再生电力。当能源市场被大量如无储能功能的风能或光伏这一类不稳定的能源占据时，具备储热功能的光热发电可以增加电力系统的灵活性，同时有助于维持电网的供求平衡。这些储热设施使得电厂可以在有需要时随时发电，因此针对需求和可用性之间的时间差提供了一种稳定的可再生能源。更重要的是，储热使得发电可以在没有光照的夜晚进行。这一切使得CSP可能成为中国实现其雄心勃勃的目标的助力，即在2030年达到二氧化碳排放峰值并到2060年实现碳中和。



Orange dots depict areas deemed suitable for the installation of CSP power plants in the northern and northwestern regions of Mainland China
中国大陆适合建光热发电站的地点由橘黄色圆点标注，集中在华北、西北地区
Source / 图片来源: Fraunhofer Institute for Solar Energy Systems ISE

中国乃至全球对光热发电站和光热集热器的需求都在持续增长。面对这些不断上涨的需求，中德合作的SinoTrough项目专注发展集热器系统，提高该技术的效率以及可靠性，并降低生产成本。该项目旨在为中国市场和能源系统专门研发一种创新型槽式集热器，考虑到了集热器对中国西北地区严峻环境条件的适应性，以及针对中国市场所需的社会经济方面的调整。

the role of CSP in its energy system, social acceptance in the relevant regions, as well as the socio-economic impacts on the Chinese market. In parallel, the German company sbp sonne is developing the innovative parabolic trough collector, while the Chinese company RoyalTech will build a prototype in Northwest China demonstrating the technological improvement. In the end, Fraunhofer ISE and the Chinese Academy of Science will measure and assess the collector's performance on site.

After successful development and product launch in China, the goal is to enable the newly developed SinoTrough collector to be offered to further markets around the world, thus contributing to the transformation of the global energy system and climate mitigation. Possible transfer markets include the Middle East, North Africa, and South America.

Community and market acceptance

The SinoTrough project aims to make sure that relevant communities and market participants can voice their opinions and offer valuable feedback during its implementation. Fraunhofer ISE is studying the socio-economic acceptance in addition to the technical performance by involving stakeholders in this process. These studies could offer a key perspective for investors and policy makers to analyze the values of CSP projects especially when considering system integration of the technology. With such consideration, two online surveys are currently open to investigate the market and community acceptance respectively. The market acceptance questionnaire targets key stakeholders on the CSP supply chain in China such as engineering, procurement and construction (EPC), component manufacturers and investors, while the community acceptance questionnaire is designed for long-term residents in Inner Mongolia, Gansu, and Qinghai Province. Contributions are very much appreciated and will help make the SinoTrough project a success for the involved partners, the respective communities and the Chinese market. To further engage relevant stakeholders and increase social acceptance, a workshop will be organized in the late summer of this year to introduce the SinoTrough project and present results from the technological and socio-economic research.

Impact on economic development and electricity grid optimization

The method of input-output analysis and the Jobs and Economic Development Impacts (JEDI) for CSP Model are used for assessing the potential economic impacts

该项目由德国联邦教育与研究部的 "CLIENT-II基金计划" 资助。德国弗朗霍夫太阳能研究所 (Fraunhofer ISE) 担任组织协调并作为科研伙伴，对中国能源市场、光热发电在该系统中的角色、相关地区的社会接受程度以及项目对中国市场的经济影响进行研究。与此同时，德国施莱希伯格曼合伙人太阳能有限公司 (sbp sonne) 负责研发槽式集热器，而中国常州龙腾光热科技股份有限公司则负责在中国西北地区建设展示改进技术的原型。弗朗霍夫太阳能研究所与中国科学院将对集热器的性能进行现场测量和评估。

在成功研发并在中国发布产品后，最终目标是使得新研发出的SinoTrough集热器同样可以用于其他市场，以此为全球能源系统转化以及减缓气候变化做出贡献。潜在的转移市场有中东、北非以及南美洲。

社区和市场接受程度

SinoTrough项目希望确保相关社区和市场能够表达他们的想法、能够被听见。弗朗霍夫太阳能研究所在研究技术性能之外还在研究相关社会经济接受程度，并让利益相关者参与到这个过程内。这方面的研究可以为投资方和政策制定者提供一个用来评估光热发电项目价值的关键角度，尤其是考虑到如何将这项技术融合到电力系统之中。考虑到这一点，现在有两份分别用来研究市场接受度和社区接受度的线上调查问卷等待填写。市场接受度调查问卷目标群体是中国光热发电供应链中的主要利益相关者，如工程总包、零部件生产商、投资方等，而社区接受度调查问卷是为长居内蒙古、甘肃、青海省的居民设计的。如果您符合以上条件，愿意填写相关问卷，我们将不胜感激！您的参将帮助SinoTrough成为一个对相关合作伙伴、社区和中国市场来说都成功的案例。为了能够进一步加强利益相关者的参与并提高社会接受度，今年夏末我们将会举办一场研讨会，来介绍SinoTrough项目以及技术方面还有社会经济方面研究的成果。

对经济发展和电网优化的影响

项目的潜在经济影响分析使用了投入产出分析法以及光热储能发电(CSP)就业和经济发展模型(JEDI)。根据初步分析的估计，一座运用SinoTrough技术的50 MW的示范电厂在常年运作中可以创造243个工作岗位，其中44个来自电厂，77个来自供应链，122个来自诱导效应。在这样的一座电厂二十五年的运行期内，通过该电厂、当地供应链以及家庭消费其工资收入可产生约4.32亿美元的经济产出。

of the project. Primary analysis estimates that a 50 MW demonstration plant using SinoTrough technologies would create 243 jobs, out of which 44 are onsite, 77 from the supply chain, and 122 as induced effects during annual operation. Over a lifetime of 25 years, such a plant would approximately generate 432 million USD of economic output, taking into the account revenue created from the local supply chain, and household spending of employment income, in addition to the plant itself.

In order to pave the way for a higher share of renewable energy in the power grids of the future, a model region in China was investigated based on prerequisites deemed necessary for a successful implementation of this initiative. The Fraunhofer ISE simulation tools Entigris and ColsimCSP were used to identify the potential of a storable and plannable technology for power generation aimed at strengthening the Chinese grid and meeting rising energy supply demands in the long term. As a result, suitable areas for CSP installation in China were identified through an assessment of technical potentials, which are predominantly located in northwestern and northern regions. The expansion of an inter-regional transmission grid and installed capacity of renewables were subsequently predicted under a reference scenario and a High Renewable Energy Share Scenario (HighRES). In both scenarios, greenhouse gas emissions in China would peak by 2030. Yet, in the reference scenario, the share of renewables in the electricity mix only reaches 38 percent, whereas in the HighRES scenario, the share of renewables comprises 50 percent. As a result, the analysis suggests that the HighRES scenario would require twice as much grid infrastructure compared with the reference scenario to enhance inter-regional connectivity.

The results underline how different technologies should be combined to identify and implement the most beneficiary power supply for a society. Costs and benefits of investment in 24/7 electricity generation, grid stability and local impact of technological advancements on employment must be considered together. Enhanced grid capacity allows for the efficient distribution of energy from the regions of generation to serve the high power demand of the economic hubs located in the southeast of the country, while storage technologies enable filling the gaps between the supply and demand curves. The right combination of wind, hydropower, photovoltaic and CSP with suitable storage technologies, in synergy with an expanded electricity grid, will support China on its path towards carbon neutrality.

为了给采用更高比例可再生能源的未来能源系统铺好前路，我们为中国大陆地区建模分析了前提条件，运用弗朗霍夫太阳能研究所的模拟工具Entigris和ColsimCSP，来鉴定一项可储能、可规划的技术有多大的潜能可以在长期改善中国能源供应以及电网。作为结果，我们通过分析技术潜力确认了中国适合建造光热发电站的地区，主要集中在西北和华北地带。我们还在参考场景和可再生能源高比例的场景下预测了跨区域输电网的扩张情况和可再生能源的装机容量。两种场景中，中国都会在2030年达到温室气体排放峰值。参考场景中，可再生能源供电量占总量38%，可再生能源高比例场景中该比例则占到50%。分析显示，高比例场景所需的电网基础设施是参考场景的两倍，以此来增加区域之间的连通性。

这些结果强调了应该如何结合不同的技术来为一个社会鉴定并实施益处最大的供电方式：二十四小时供应电力所带来的投资成本和收益、电网稳定性和科技进步对当地就业的影响应该同时被参考。提高电网容量可以使发电区域和东南的用电地区之间的能源供应更加有效，而正确结合风能、水能、光伏和光热储能发电，加上一个强大的电网将会助力中国在迈向碳中和的道路上继续前进。

以下是市场调查问卷和社区调查问卷的二维码：

BMBF-Project Office "Clean Water"
德国联邦教育研究部（BMBF）"清洁水" 创新研究项目办公室

The BMBF-Project Office "Clean Water" at Tongji University Shanghai, which was implemented to support the Water Research Cooperation between BMBF and the Chinese Ministry of Science and Technology and its projects in July 2012 (introduced in previous Econet Monitors), supports all CLIENT II-projects in China.

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自2012年7月起，位于上海同济大学的BMBF "清洁水" 项目办公室协助 BMBF 与 中国科技部 之间的水研究合作（详见Econet旧刊介绍），以及所有与中国合作的CLIENT II-研究项目。

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