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Green Building 绿色建筑特刊

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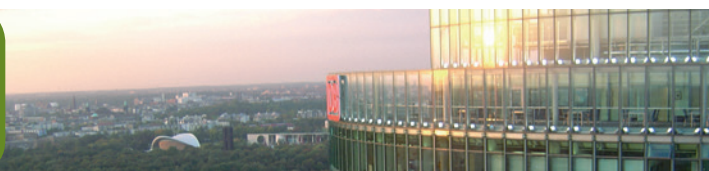
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Green Building



Chinese Cities Transforming Towards Carbon Neutrality – An Overview of Recent Political and Economic Developments

中国城市的碳中和转型：近期政策及经济发展概述

Urbanization lies at the heart of China's economic rise. In the beginning of the country's reform and opening-up era, less than a fifth of the population lived in cities. Meanwhile, the share has jumped up to more than 60 percent. Inevitably, the industrial and residential complexes formed in urban areas also contribute greatly to China's ever-growing carbon footprint. Cities now consume 85 percent of the total national energy supply and are responsible for around 70 percent of total national energy related CO₂ emissions. Yet, over the next three decades, estimations project that another 250 million people will become urban dwellers. As a matter of fact, the carbon emission pathway of China's cities will determine the success of the national dual carbon targets – peaking carbon emissions before 2030 and achieving carbon neutrality by 2060.

Five-Year Plan envisions new-type cities

To promote low-carbon urban development, the central government in Beijing envisions the construction of so-called new-type cities. The 14th Five-Year Plan, promulgated in March 2021, emphasizes the integration of green rings, green corridors, green wedges, and greenways in urban planning. The plan also promotes ecological restoration and green building as well as prioritizing urban public transportation. More specifically, the plan targets constructing or refurbishing around 1,000 public urban parks across the country until 2025.

On top of that, the Ministry of Housing and Urban-Rural Development (MOHURD) issued the sector-specific “14th Five-Year Plan for the Development of Building Energy Efficiency and Green Building” in March of this year. The plan aims to limit the total annual consumption of primary and secondary energy in building operations to 115 million tons of standard coal in 2025. It also specifies a set of requirements regarding the management of green buildings operations, encouraging the establishment of corresponding management platforms as well as using

城市化是中国经济崛起的核心。在中国改革开放初期，只有不到五分之一的人口居住在城市。如今这一比例已跃升至60%以上。在城市地区形成的工业和住宅综合体也不可避免地造成了中国不断增长的碳足迹。目前，城市的能源消耗占全国能源供应总量的85%，占与能源相关的二氧化碳排放总量的70%左右。据估计，在未来30年内还会有2.5亿人成为城市居民。事实上，中国城市的碳排放路径将决定2030年前达到碳排放峰值，2060年前实现碳中和的国家双碳目标的成功与否。

五年规划设想新型城市

为促进低碳城市发展，中央政府对建设所谓的新型城市进行了设想。2021年3月颁布的《第十四个五年规划》强调将绿环、绿廊、绿楔和绿道纳入城市规划。规划还促进生态修复和绿色建筑，并优先发展城市公共交通。规划还设立了更加具体的目标，到2025年在全国新建、改扩建1000个左右体育公园。



China's 14th Five-Year Plan targets constructing or refurbishing around 1,000 public parks until 2025

中国的《第十四个五年规划》设立了到2025年新建、改扩建1000个左右体育公园的目标

Source / 图片来源: David Stanley

此外，住房和城乡建设部于今年3月发布了针对特定行业的《“十四五”建筑节能与绿色建筑发展规划》。

information and communications technology (ICT) for real-time monitoring and analysing energy consumption and indoor air quality.

Moreover, MOHURD published a new set of mandatory national standards for energy conservation and renewable energy use in buildings which came into effect in April of this year. Through these standards, the designated energy consumption of newly constructed houses and public buildings is lowered by 30 and 20 percent respectively, compared to the previous national standards implemented since 2016. The MOHURD document also requires feasibility reports, construction plans and initial designs of new buildings to include a calculation of energy consumption, renewable energy use and carbon emissions.

However, these policies need to be further adapted to local urban conditions. Launching low-carbon city pilot projects has been a main tool of Chinese policymakers in this regard. Since 2010, at least 87 cities and provinces have explored routes to low-carbon development by saving energy in industry and limiting emissions from buildings, transportation and agriculture. While there has been no comprehensive official evaluation of the program, research of the Chongyang Institute of Finance of Renmin University indicates that by the beginning of last year more than 80 pilot cities and provinces had proposed carbon peaking targets, of which 42 aimed to reach the peak by 2025. Furthermore, urban emission profiles vary greatly depending on cities' industrial layout. The Renmin University study found that service-based, industrial, agricultural and mixed-economy cities with both strong service and industry sectors all have different carbon reduction paths. Remarkably, bringing down emissions in the building sector becomes more and more crucial for low-carbon development as urban economies move away from traditional carbon-intensive industries and towards the service sector. The megacities on China's east coast are at the forefront of this shift.

Shanghai is a leader among China's cities on the path to decarbonization

The city of Shanghai, currently struggling against a local Covid outbreak, has positioned itself as a leader in China's urban decarbonization efforts. In January 2021, the Shanghai city government announced to reach carbon peak during the period of the 14th Five-Year Plan. Currently, the city emits around 200

该规划旨在2025年将建筑运行一次二次能源消费总量限制在1.15亿吨标准煤。文件还对完善绿色建筑运行管理提出了要求,鼓励建设绿色建筑智能化运行管理平台,充分利用现代信息技术,实时监测和分析能源消耗以及室内空气质量。

此外,住房和城乡建设部还发布了一套新的强制性国家标准《建筑节能与可再生能源利用通用规范》,于今年4月生效。这一标准要求中,新建居住建筑和公共建筑的平均设计能耗水平分别比2016年以来执行的节能设计标准降低了30%和20%。这份文件还要求新建建筑的可行性报告、建设方案和初步设计文件包括建筑能耗、可再生能源利用以及建筑碳排放的分析报告。

然而,这些政策需要进一步适应当地的城市条件。在这方面,启动低碳城市试点项目一直是中国的政策决策者采取的主要方法。自2010年以来,至少有87个省市通过节约工业能源和限制建筑、交通和农业排放,探索了低碳发展道路。尽管尚未对该项目进行全面的官方评估,但中国人民大学重阳金融研究院的一项研究表明,截至去年年初,已有80多个试点省市提出了碳达峰目标,其中42个省市旨在到2025年达到碳排放峰值。此外,城市碳排放情况因城市的工业布局而异。重阳金融研究院的这一研究发现,服务业和工业都繁荣发展的服务型、工业型、农业型和混合经济型城市有不同的碳减排路径。值得注意的是,随着城市经济从传统的碳密集型产业转向服务业,降低建筑业的排放对于低碳发展变得越来越重要。中国东部沿海的大城市处于这一转变的最前沿。



Shanghai strives to reach its carbon peak during the period of the 14th Five-Year Plan

上海力争在“十四五”期间实现碳达峰

Source / 图片来源: Giulio Jiang

上海是脱碳道路上的“先行者”

正处于抗击当地新冠疫情当中的上海市将自己定位为中国城市脱碳道路上的“先行者”。2021年1月,

million tons of carbon a year. Industry, transportation and buildings each account for an estimated 45 percent, 30 percent and 25 percent of total emissions, according to research by the World Resources Institute. The share of building emissions is already higher than the average among Chinese cities, which lies around 22 percent. However, the share may still increase significantly: In so-called developed nations, industrial emissions peaked, and subsequently emissions from transport and buildings became a bigger challenge for decarbonization. For instance, buildings account for 70 percent of total emissions in New York.

Shanghai's new green building schemes take up the challenge. The municipality is building five city "sub-centres" on its outskirts. In April last year, the city government issued the "14th Five-Year Plan New City Environmental Quality and New Infrastructure Special Program", ruling that buildings in those sub-centres must use green building standards, and that ultra-low energy buildings are to be encouraged.

Research from the International Council for Local Environmental Initiatives – Local Governments for Sustainability (ICLEI), focusing on Shanghai's Changning district, also found that improving energy efficiency in existing buildings can bring substantial emissions savings. This is especially the case for commercial buildings, where energy use is often tens of times that of government or residential buildings.

Moreover, Shanghai started monitoring energy use in some large public buildings in 2009. On screens at monitoring centres and online, building owners and the city government can track the real-time usage of key building infrastructure such as air-conditioning and lighting to increase energy efficiency. The monitoring scheme now covers more than 2,000 public buildings.

The role of building-integrated photovoltaics

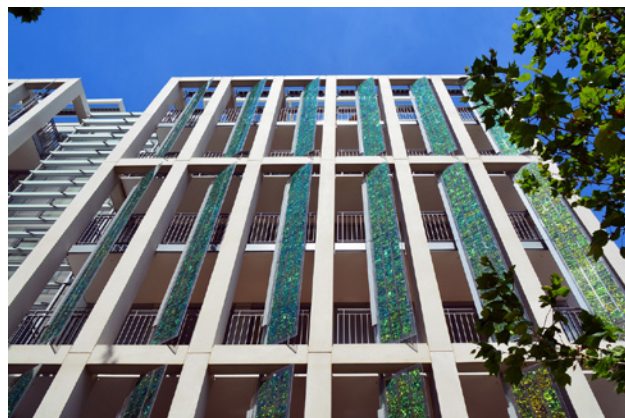
However, the urban energy transition cannot only rely upon building energy savings – the greatest barrier on the path to carbon-neutral cities is on the supply side. As long as urban grids continue running largely on fossil fuels, decarbonization is out of reach. One strategy to shift the electricity supply towards renewable energies includes building-integrated photovoltaics (BIPV). In the middle of last year, the Chinese National Energy Administration (NEA) issued a policy to encourage the installation of on-

上海市政府宣布在“十四五”期间实现碳达峰。目前, 该市每年的碳排放约达2亿吨。根据世界资源研究所的研究, 工业、交通和建筑分别占上海总排放量的45%、30%和25%。建筑排放的份额已经高于中国城市的平均水平, 约为22%。然而, 这一比例可能仍会大幅增加: 在发达国家, 工业领域的碳排放量达到峰值后, 来自交通和建筑领域的碳排放就成为脱碳的更大挑战。例如, 建筑占纽约碳排放量总值的70%。

上海市以新的绿色建筑方案迎接这一挑战。该市正在郊区建设五个新的城市“副中心”。去年4月, 上海市政府发布了《“十四五”新城环境品质和新基建专项方案》, 规定这些“副中心”的新建建筑100%执行绿色建筑标准, 并鼓励超低能耗建筑。

国际地方政府环境行动理事会 (ICLEI) 针对上海长宁区开展的研究也表明, 提高现有建筑的能效可以大幅减少碳排放。商业建筑尤其如此, 其能耗通常是政府或居住建筑的十数倍。

此外, 上海于2009年开始监测一些大型公共建筑的能耗情况。在监测中心的屏幕和网上, 业主和政府都能够看到建筑空调、照明等主要用能系统的实时能耗, 以提高能源效率。这一监测平台目前覆盖了超过2000栋公共建筑。



Building-integrated photovoltaics significantly expands solar PV surface area

光伏建筑一体化显著扩大太阳能光伏表面积

Source / 图片来源: Images George Rex

光伏建筑一体化的作用

然而, 城市能源转型不能仅仅依赖于建筑节能——城市通往碳中和道路上的最大阻碍在于供给侧。只要城市电网继续大量使用化石燃料, 脱碳就遥不可及。将电力供应转向可再生能源的战略之一是光伏建筑一体化 (BIPV)。去年年中, 中国国家能源局 (NEA) 发布了一项鼓励安装分布式发电的政策, 要求试

site distributed energy generation by requiring pilot counties, cities and districts to allocate at least half of Party and government building rooftop areas to solar PV, as well as 40 percent of other public and at least 30 percent of industrial and commercial building rooftop areas. In the first half of 2021, distributed solar PV installations amounted to 7.65 gigawatts, accounting for close to 60 percent of solar PV addition, according to the NEA.

The potential of BIPV for low-carbon urban development was also highlighted by recent studies of the International Renewable Energy Agency (IRENA) as a part of the “Energy Solutions for Cities of the Future” project. The project is supported by the International Climate Initiative (IKI), led by the German Federal Ministry for Economic Affairs and Climate Action (BMWK) in cooperation with the Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV). One report within the project focuses on the Wuzhong District of Suzhou city as a case study to explore pathways towards net-zero emissions. In Wuzhong, electricity typically accounts for two-thirds of total energy consumption of buildings. Therefore, BIPV can play an important role in decarbonizing the building sector. At the same time, it could alleviate constraints on local renewable energy supply as BIPV significantly expands available surface area for solar PV electricity generation. This is particularly true for an area with high-rise buildings, where rooftop areas generally represent a small portion of the building envelope. With façade-integrated PV, the building can generate not only more electricity but also produce a much more balanced output than rooftop PV systems alone. This is due to PV panels on façades being able to generate electricity at smaller solar altitude angles than rooftop panels.

Notably, the new 14th Five-Year Plan for the green building sector also targets electrification as a strategy to reduce direct greenhouse gas emissions from buildings: By 2025, electricity shall account for more than 55 percent of building energy consumption. Along with this shift, BIPV solutions may become more and more widespread across China.

In the multitude of development pathways, each Chinese city finds itself on a different stage of transformation towards carbon neutrality. Green building technologies already greatly contribute to China’s urban decarbonization efforts, and they are set to become even more essential on this journey.

点县(市、区)将至少50%的党政机关建筑屋顶面积、40%学校、医院、村委会等公共建筑屋顶面积和30%工商业厂房屋顶面积分配给太阳能光伏安装。据国家能源局称,2021上半年,分布式太阳能光伏装机达到765万千瓦,占太阳能光伏新增量的近60%。

作为“未来城市能源解决方案”项目的一部分,国际可再生能源署(IRENA)最近的研究也强调了光伏建筑一体化在低碳城市发展中的潜力。该项目由德国联邦经济与气候保护部(BMWK)领导的国际气候倡议(IKI)与德国联邦环境、自然保护、核安全与消费者保护部(BMUV)合作支持。该项目的一份报告以苏州市吴中区为例,探讨实现净零排放的途径。在吴中区,电力通常占建筑总能耗的三分之二。因此,光伏建筑一体化可以在建筑行业脱碳方面发挥重要作用。同时,随着光伏建筑一体化显著扩大太阳能光伏发电的可用面积,可以缓解当地可再生能源供应的限制。对于有高层建筑的区域来说尤其如此,因为屋顶区域通常只是建筑围护结构的一小部分。与屋顶光伏系统相比,建筑立面的集成光伏系统不仅可以产生更多的电力,还可以有更平衡的输出。这是因为,相比于屋顶板,建筑立面上的光伏板能够在更小的太阳高度角下发电。



The case study of Suzhou’s Wuzhong district provides valuable insights for urban decarbonization pathways
苏州市吴中区的案例研究为城市脱碳路径提供了有价值的参考
Source / 图片来源: 罗布泊 (Luo Bubo)

值得注意的是,《“十四五”建筑节能与绿色建筑发展规划》还将电气化作为减少建筑直接温室气体排放的策略:到2025年,电力消费应占建筑能耗的55%以上。随着这一转变,光伏建筑一体化解决方案可能在中国越来越广泛。

在众多的发展路径中,每个中国城市都处于向碳中和转型的不同阶段。绿色建筑技术已经为中国的城市脱碳努力做出了巨大贡献,并将在碳中和转型过程中变得更加重要。

From Energy Efficiency to Carbon Neutrality

A contribution by Thilo Cunz, German Energy Agency (dena)

从超低能耗建筑到零碳建筑

来自德国能源署Thilo Cunz的客邀文章

More than one third of global energy consumption and CO₂ emissions comes from buildings. Following the 2015 Paris Climate Agreement, all countries turned to develop their building stock towards carbon neutrality as a part of their climate protection strategies, aiming to limit the rise in mean global temperature to 1.5 °C. Buildings constitute the single largest energy-consuming sector and the emission reduction costs are quite low compared to other sectors.

Climate-neutral buildings

In four steps, each with a similar impact largely regardless of local conditions, it is possible to reduce the CO₂ emissions in building construction and operation:

- To less than 50 percent, through more energy efficiency of building envelopes, building services and technical appliances (so-called low-carbon or energy efficient building)
- To less than 25 percent, through renewable energy use and generation, preferably on site (zero-carbon building in operation)
- To less than 12.5 percent, through material-efficient and largely carbon-free new construction (zero-carbon building throughout the life cycle)
- To 0 percent, through more renewable energy generation than use (zero-carbon building, so-called energy plus)

Due to manifold interactions between all components, the reduction of energy consumption comes first. The far reduced energy demand is then possible to be covered by employing renewable energy sources, preferably on site. In respect of the whole building life cycle, even carbon embodied in building materials needs to be reduced. Finally, remaining emissions need to be compensated, e.g., through some extra renewable energy generation.

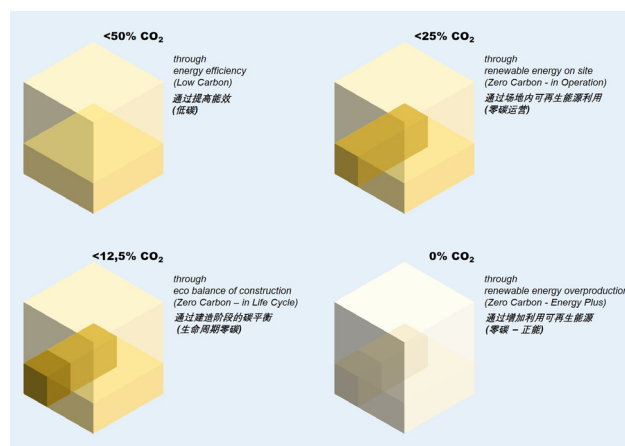
The German Energy Agency (dena) is a nationally and internationally active think tank aiming to drive the

全球超过三分之一的能源消耗与二氧化碳排放来自于建筑产业。自2015年巴黎协定之后，全球各国都为实现气候中和出台了相应的气候保护战略与框架。为实现将本世纪全球气温升幅控制在1.5°C内的目标，建筑领域的碳中和在这些气候保护战略与框架中起着不可替代的作用。众所周知，建筑产业是能耗和碳排放最大的产业。然而，和其他产业相比，建筑产业降低碳排放的成本是相对较低的。

建筑碳中和

结合当地的不同情况，通过以下四步，可以降低建造与运营过程中产生的碳排放。

- 通过外围护结构、技术设备、物业管理三个方面提高建筑的能源效率，使建筑达到低碳(低能耗)的水平。从而将建筑的能耗与碳排放降低至普通建筑的百分之五十左右。
- 通过尽可能在场地内利用可再生能源并生产电能，使建筑达到零碳运营的水平。从而将建筑的能耗与排放降低至普通建筑的百分之二十五左右。
- 通过选取含碳量低的建材以及采用低碳的建造手段使建筑达到全生命周期零碳。从而将建筑的能耗与排放降低至普通建筑的百分之十二点五左右。
- 在建筑运营过程中通过可再生能源产生的电量大于其自身的能耗需求，从而达到真正意义的零碳(正能建筑)。



In four steps, it is possible to achieve carbon neutrality of buildings in operation and throughout the whole life cycle
通过四个步骤在建筑领域达到运营及全生命周期碳中和

energy transition. Since 2008, dena is present in China to exchange experiences and support the necessary transition in construction on building, district and city level. Among others, dena since then has initiated or completed nearly 50 low-carbon projects of various building categories in 4 Chinese climate zones and 12 provinces.

Proven basic concept and process

Following the urge of the Chinese economy to achieve the climate goals, dena has improved its Sino-German low-carbon building certification system towards a Sino-German zero-carbon building in-operation certification. The energy-efficient passive building concept again forms the basis for the new system. It is supported by proven quality management components throughout the whole planning and construction process, such as trainings and coaching for planners and craftsmen, plan reviews, on-site visits and final acceptances – extended by some additional features.

Using renewable energy sources

The path to carbon neutrality in operation includes using renewable energy. Within the framework of an energy concept, a set of local renewable energy sources will be considered, such as photovoltaic, solar thermal heat, environmental cooling or heating, geothermal cooling or heating, water cooling or heating, wind power, biomass, hydrogen and others.

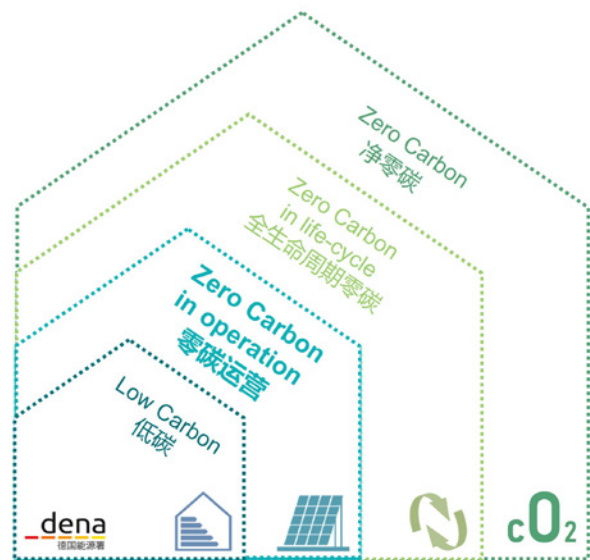
The property line serves as a first system boundary. Renewable energy should be generated directly on site as far as possible. The second choice is using locally available environmental-friendly energy, such as waste heat from industry, carbon neutral district heating or cooling and local water for water heat pumps. Green electricity from the grid may complete the energy mix to achieve carbon neutrality in operation.

Certification for zero-carbon in operation

The new dena certificate is awarded to zero-carbon buildings in operation. After a pre-calculation in the planning phase and the completion of construction, accompanied by a quality assurance process, a zero-carbon certificate is issued at the time of building completion. However, performance must be confirmed by real energy consumption data and reliable information on energy use. A metering and monitor-

首先通过各种途径降低建筑的自身运营能耗。其次，通过利用可再生能源，尤其是场地内的可再生能源，满足建筑的运营能耗需求。就整个建筑生命周期而言，应降低建筑全生命周期如建材等的碳足迹。最终利用如额外的可再生能源发电等手段，对剩余的碳排放进行抵偿。

德国能源署(dena)是全德范围以及全世界范围，以能源转型为己任的智库单位。自2008年以来，德国能源署便启动了中德就建筑，城区与城市层面的交流与合作工作。至今，德国能源署在中国正在参与或已经完成了近五十个不同类型的低碳建设项目。这些项目分布于中国的12个省(直辖市)，跨越了4个气候带。



Different dena certifications can be issued to low-carbon and zero-carbon buildings

德国能源署针对低碳建筑与零碳建筑的认证

基本概念和流程

针对中国为实现碳中和目标而产生的迫切需求，我们在原有的中德低碳建筑认证体系的基础上进行升级，推出了中德零碳建筑运营认证体系。该新体系仍以高能效被动式建筑为基础，并将通过多年实践检验的德国能源署质量保证服务体系贯穿整个项目从规划到施工的全过程。通过对设计单位与施工单位进行培训，设计图纸审核，施工现场检查以及最终现场验收等环节来确保建筑的品质。

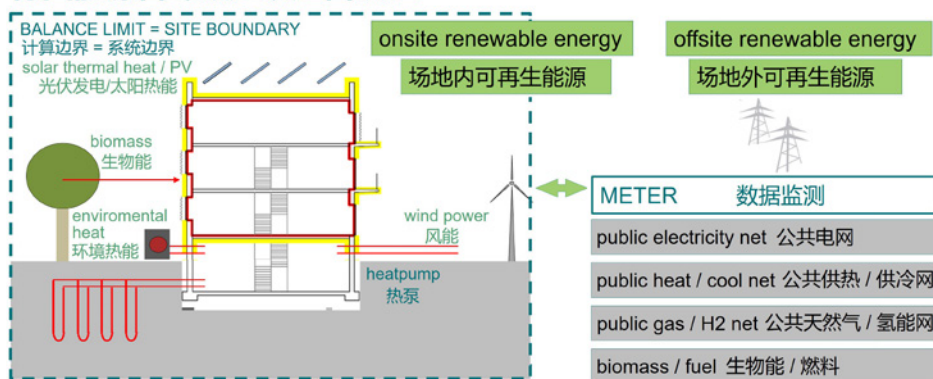
利用可再生能源

对于可再生能源的利用是实现建筑零碳运营的重要环节。在能源概念的框架内所涉及的可再生能源通常为光伏、太阳能热、环境冷/热能、地热/冷能、水冷/热能及风能、生物能，氢能等。

BUILDING

DENA ZERO-CARBON IN OPERATION CERTIFICATION

德国能源署零碳建筑运营认证



An overview of system boundaries for on-site and off-site renewable energy supply
可在再生能源的系统边界

ing concept also forms part of the certification requirements, including the equipment and a process for data generation, documentation and delivery. In case that the performance does not match the expectations, data will help to identify necessary adjustments for the technical system and user behaviour. Pre-certification following the successfully completed building construction will be updated every three years, based on an annual data evaluation process using data collected on a monthly basis.

The concept of carbon neutral building operation offers advantages on several levels. Far reduced energy consumption and the usage of largely renewable energy sources contributes significantly to climate protection and marks a first step towards global climate neutrality, envisioned to be achieved around the year 2050. Due to reliable construction quality, it offers improved user comfort along with stable thermal conditions and high air quality in a long-term perspective. Carbon neutrality will also strengthen the market position of investors and operators, and increase the value of their sustainable real estate portfolio. Even if investment cost might be slightly higher, life cycle cost will be clearly lower due to lower energy and CO₂-related expenses.

The local adaptation of a proven international concept requires some adjustments to the China-specific situation. This is an exciting part of the implementation process and will be developed from project to project in collaboration with all participating parties, such as authorities, investors, planners, manufacturers and users as well as dena and its local Chinese partners. We are looking forward to this great challenge!

建筑地块的边界可被定义为可再生能源的系统边界。应尽可能选择利用地块内也就是场地内的可再生能源。其次应尽量考虑邻里地块所能够提供的可再生能源或环境友好型能源如附近工业产生的余热，低碳排放的集中供暖或供冷，或利用毗邻的水源作为冷热源。通过接入绿电对建筑产生的碳排放进行抵偿是最后一步选择。

零碳建筑运营认证

新发布的德国能源署零碳认证主要针对运营阶段的零碳排放。在设计阶段经过计算确保建筑满足运营碳要求，并且通过德国能源署质量保证服务在设计与施工阶段对建筑品质的保障，在项目竣工通过验收后，会颁发零碳建筑竣工认证。然而，在运营过程中是否确实能够达到零碳运营标准，则必须通过对一定时间的建筑运营能耗数据的监测进行验证。因此，对于能耗数据的统计与监测工作也是认证工作不可缺少的环节。其中包括数据收集，记录整理与提交等环节。在建筑能耗指标不符合预期的零碳标准时，监测数据将作为设备优化与使用者行为优化的依据。能耗监测的数据收集整理以月为单位。如对年能耗的监测数据满足零碳运营标准，则为该项目颁发的运营零碳认证，该认证有效期为三年。

零碳建筑运营认证概念的提出在多个层面能够起到积极的作用。随着能源消耗的大幅减少和可再生能源的大量使用，它对气候保护做出了重大贡献，是建筑领域向2050年全球气候中和这个宏伟目标迈出的第一步。从长远来看，其为使用者提供了一个高舒适度的，温度恒定，空气质量较高的室内环境。对于开发单位和物业管理单位而言，通过零碳认证将加强他们的市场地位和房地产投资价值 and 可持续性。即使投资成本可能略高，但由于能耗和相关的运营费用较低，从而使生命周期的总经济成本明显降低。

国际概念的本土化需要根据当地的具体情况进行一些调整。这是实施过程中令人振奋的部分。它需要所有参与者如政府、开发商、设计单位、施工单位，使用者以及德国能源署和他们的中国合作伙伴的共同努力，从项目入手，不断地改进。我们期待着这个伟大的挑战!

Sustainable Support for German Building Expertise in China

德国建筑节能经验在中国发展的长期支持

China's industrial development and rapid urbanization have led to a surge in energy demand during the past years. China currently holds a share of about 24 percent of global energy consumption. With the announcement of the 14th Five-Year Plan (2021-2025) in March of last year, the government set out to cut China's energy intensity by an additional 13.5 percent as well as reduce carbon intensity by 18 percent until 2025. The building sector makes up more than a fifth of national primary energy demand and will play a pivotal role in achieving the government's ambitious energy efficiency targets.

As German companies, particularly in the field of green building and energy efficiency, enjoy a stellar reputation for their high-quality technical products and expertise across the globe, they are provided with promising market opportunities for their sustainable building technologies and services in China.

Aiming to support especially small and medium-sized enterprises (SMEs) to tap into such opportunities in China and other countries, the German Federal Ministry for Economic Affairs and Climate Action (BMWK) established the Energy Solutions Initiative in 2003. In the context of the initiative, AHK Greater China has successfully organized business trips to China as well as a wide range of fact-finding missions to Germany to promote Sino-German partnership concerning energy efficiency. Through business trips, including one-day symposia, German enterprises receive an opportunity to explore the business environment and market potential in China as well as to present their technologies and solutions to Chinese decision-makers and stakeholders. Individual business-to-business matchmaking meetings and company visits form another integral part of the trip. Participating German companies receive a comprehensive target market analysis based on the topic of the program. Building on measures of previous years, AHK Greater China organizes two digital business trips in China in 2022.

From March 22 to 25, AHK Greater China hosted a digital delegation in Hong Kong for German SMEs active in the market of building energy efficiency, bringing together German companies with industry peers in Hong Kong. The business trip took place in light of

过去几年中国的工业发展以及快速城镇化导致的持续性建筑激增使能源需求大幅增加。目前,中国约占全球能源消耗的24%。去年公布的第十四个五年规划(2021-2025)显示,政府致力于到2025年将中国单位GDP能耗再降低13.5%,并将单位GDP二氧化碳排放量降低18%。中国的建筑行业占一次能源需求的五分之一以上,将在实现其雄心勃勃的节能目标方面发挥关键作用。

德国企业凭借全球著称的高质量技术产品和专业知识,尤其是在绿色建筑和能效领域,可以在中国的可持续建筑技术及服务方面获得具有前景的市场机会。



At the end of March, AHK Greater China hosted a digital business delegation in Hong Kong for German SMEs active in the building energy efficiency market

三月底,德国海外商会联盟·大中华区在香港举办了一次专门面向活跃于建筑能效领域的德国中小企业的线上考察访问

Source / 图片来源: barnyz

为了帮助德国企业,尤其是中小型企业,在中国和其他国家获得这些机会,德国联邦经济与气候保护部(BMWK)于2003年发起了德国能源解决方案倡议。在这项倡议的框架下,德国海外商会联盟·大中华区已经成功组织了一系列赴德考察以及来华商务考察代表团,以支持中德伙伴关系在能效领域的发展。通过这些包含为期一天的研讨会在内的考察访问,德国企业可以了解中国的商业环境和市场潜力,并可以向中国的决策者和其他利益相关方展示他们的先进技术和解决方案。个性化的B2B对接以及公司拜访也是行程不可或缺的一部分,参访德企还可以免费获得相应主题的详尽的目标市场分析报告。基于过去几年的措施,德国海外商会联盟·大中华区将在2022年组织两次线上商务考察访问。

Hong Kong's ambitious energy saving and construction plans.

Based on the "Energy Saving Plan for the Built Environment 2015-2025+", the city administration aims to reduce energy intensity in the building sector by 40 percent until 2025 compared with the level of 2005. The plan focuses on promoting the climate-friendliness of public sector facilities according to common efficiency standards such as BREEAM or LEED. One of the most important projects is a ten-year development plan for hospitals with an investment volume equivalent to EUR 24 billion. In addition, the largest shopping mall in the metropolis is currently built on 350,000 square meters of land on the state-operated airport site. EUR 500 million is available for the expansion of the Science Park and Cyberport innovation centers, and the government recently approved over EUR 58 million for the Lantau Tomorrow Vision mega-project, envisioning the construction of an entire new city on an artificially raised island with up to 400,000 apartments. These projects offer numerous opportunities for suppliers of construction technology such as thermal insulation, facades, low-energy houses or prefabricated components.

Moreover, AHK Greater China will host a digital business trip in Shanghai from August 28 until September 2 of this year. Under the topic of "Energy efficiency in buildings for climatic zones with hot humid summers and cold winters", it strives to support German companies in initiating business on the Chinese market.

The trip is organized against the background of new developments in building energy efficiency in mainland China: Energy-saving construction is becoming more and more important to the Chinese government, as shown by more ambitious energy efficiency targets and sustainable building criteria. According to the Chinese Ministry of Housing and Urban-Rural Development (MOHURD), demand for energy efficiency investments in the construction sector is expected to rise continuously. The focus is on more environmentally friendly new buildings and low-energy projects, and increasingly also on energy retrofitting of existing buildings. At the same time, however, the real energy standards of buildings lag far behind of what is technically and economically feasible. Due to Germany's high energy efficiency standards, German companies are therefore particularly apt to provide their solutions on the Chinese market.

3月22日-25日,德国海外商会联盟·大中华区在香港特别行政区举办了一次专门面向活跃于建筑能效领域的德国中小型企业的线上考察访问,它将德国公司与香港的同行聚集在一起。此次商务考察访问在香港设定的宏伟的节能和建设计划背景下举行。

根据“香港都市节能蓝图2015-2025+”,香港的目标是到2025年将建筑行业的能源强度较2005年降低40%。该计划的重点是根据BREEAM或LEED等通用效率标准,促进公共设施的气候友好性。最重要的项目之一是面向医院的十年发展计划,投资额达240亿欧元。此外,这座大都市最大的购物中心目前建在机场,占地约35万平方米。5亿欧元用于香港科学园和数码港创新园区和社群的扩建,政府最近批准了超过5800万欧元用于“明日大屿愿景”项目,设想在一个人工岛上建设一座拥有40万套公寓的全新城市。这些项目为隔热、外墙、低能耗房屋或预制构件等建筑技术供应商提供了许多机会。

此外,德国海外商会联盟·大中华区还将于今年8月28日至9月2日在上海举办在线商务考察访问。以“夏热冬冷地区的建筑能效”为主题,本次在线考察访问将致力于支持德国公司在中国市场开展业务。



The business trip from August 28 to September 2 will focus on "Energy efficiency in buildings for climatic zones with hot humid summers and cold winters"

8月28日至9月2日的商务考察访问将以“夏热冬冷地区的建筑能效”为主题
Source / 图片来源: Asian Development Bank

此次考察访问在中国大陆建筑节能新发展的背景下举办:节能建筑对中国政府来说有着越来越重要的意义,这体现在其更加宏伟的节能目标和更加严格的可持续建筑标准上。据中国住房和城乡建设部称,预计建筑行业的能效投资需求将持续增长。重点是更加环保的新建筑和低能耗项目,并越来越多地对现有建筑进行节能改造。然而,与此同时,建筑物的实际能源标准远远落后于技术和经济上可行的标准。由于德国的高能效标准,德国公司因此尤其适合在中国市场提供解决方案。

Urban Renewal in Chinese Cities: Sino-German Learnings for an Environmentally and Socially Sustainable Development

A contribution by Claudia Sanders, Network for Architecture Exchange NAX

中国城市更新：中德环境和社会可持续发展专题交流分享

来自NAX建筑网络交流平台Claudia Sanders的客邀文章

China's urbanization rate has gone through the roof, so to speak: It has increased from roughly 50 percent in 2011 to 63 percent in 2021. Combined with the ambitious goal of the Chinese government to reach carbon neutrality in 2060, urban regeneration really is the only sustainable strategy to address these challenges. However, only in recent years have Chinese cities begun to seriously implement urban renewal goals and guidelines. For the last 50 years, the Chinese way of urban redevelopment has been large-scale demolition and new construction, with little regard for cultural or architectural heritage, the preservation of communities or resource efficiency. This has started to change slowly with the release of the New Urbanization Plan by the Chinese State Council in 2014. During this current phase of urban redevelopment, municipalities have implemented a more cautious, diversified and gradual urban planning strategy. For German building experts, who have a long history of bilateral cooperation with China, this shift in strategy opens up new opportunities on the Chinese market. Over the last decades, German architects and engineers have gained much experience with urban renewal projects, both nationally and internationally. They argue that the existing building stock should be regarded as a temporary resource depot. A sustainable urban development strategy should therefore optimize the life cycle of buildings and reduce the use of non-renewable resources.

During the Sino-German City Lab, held by the Network for Architecture Exchange NAX in October 2021, German and Chinese architects, planners, city officials and industry experts exchanged experiences on regeneration projects and on how bilateral cooperation could aid the sustainable urban renewal efforts in China. The findings which emerged from these discussions could act as guidelines and thinking points for future urban renewal strategies in China.

可以说，中国的城镇化率正在急速上升：该数字已从2011年的约50%升至2021年的63%。与此同时，中国政府确定了2060年实现碳中和的宏远目标。在此背景下，城市再生是应对该领域挑战的唯一可持续战略。然而，直到最近几年，中国城市才开始认真贯彻落实城市更新目标和指导方针。过去50年里，中国的城市重建一直采取大规模拆除和新建的方式，很少考虑文化或建筑遗产、社区保护或资源效率因素。中国国务院于2014年印发《国家新型城镇化规划》，此后这种情况开始逐步改变。在当前的城市重建阶段，市政部门实施了更加审慎、多样化、循序渐进的城市规划战略。对于与中国有着长期双边合作历史的德国建筑专家来说，这种战略转变为中国市场打开了新的机遇之窗。过去几十年里，德国建筑师和工程师在国内和国际城市更新项目中积累了丰富经验。他们认为，应当把既有建筑存量视为临时资源库。因此，城市可持续发展战略应当优化建筑物的生命周期，减少不可再生资源的使用。



Xi'an Dahua mill factory renovation

西安大华纱厂改造

Copyright / 图片来源: Keyao Wang & Zhijian Workshop

在2021年10月由“建筑交流网络”NAX主办的“中德城市实验室” (Sino-German City Lab) 项目期

Urban Regeneration as a key factor for social and environmental sustainability in cities

Urban quarters which have organically developed over a long period of time are more resilient than newly developed areas. “Breaking up social structures is expensive. It’s hidden costs that city governments will feel the pinch of down the line. However, if existing social structures are preserved, people who have lived in an area for 20 or 30 years will often help each other, which reduces the need for social help” says Hieronimus Nickl, CEO of Munich and Beijing based architectural office Nickl + Partner.

Addressing the abandonment of mono-functional compounds in China and elsewhere

In view of newly emerging ways of working and living, huge business-only and residential-only districts do not meet the needs of contemporary society anymore. Developers, municipalities and urban planners need to come up with ideas on how to convert and reuse these structures sustainably. However, Joachim Wendt, Partner at the Schneider+Schumacher architectural office, also sees potential in China’s tendency to build big: “Compared to the buildings that we have in Germany, Chinese buildings are often planned with a lot more, let’s say, air within them. The additional volume does give you more flexibility and the opportunity to refurbish and reuse them.”

Participatory planning processes are key for the success of urban regeneration

“Participatory processes can be frustrating because they take a lot of time, but one will gain much more acceptance in the project and therefore a kind of social sustainability one might not be able to achieve otherwise” says Wolfram Putz, Partner at the German architectural practice GRAFT. In turn, this will reduce long-term costs for maintenance – since residents will take better care of the infrastructure – and support the development of a resilient urban quarter with a tight social fabric. In Germany, there is a specialized profession that emerged in recent years to lead the necessary multi-stakeholder communication and engagement. In Beijing, efforts in this direction are also being taken with the appointment of community “responsibility officers” in local

间, 中德两国的建筑师、规划师、城市官员及行业专家交流了他们在再生项目方面的经验, 并探讨了双边合作如何助力中国开展可持续城市更新工作。与会者通过讨论得出的一系列结果, 这些结果可以作为中国未来城市更新战略的指导方针和思考点:

城市再生是实现城市社会和环境可持续发展的一个关键因素

经历长期有机发展的城市小区比新开发的地区更具韧性。“打破社会结构的代价高昂。这是隐性成本, 城市政府将深切感受到这方面的压力。然而, 如果现有社会结构得到保护, 在一个地区生活了20或30年的人们往往会守望相助, 从而减少对社会帮助的需求。”尼克及合伙人建筑事务所 (Nickl + Partner) CEO 海罗尼莫斯·尼克尔 (Hieronimus Nickl) 表示, Nickl + Partner总部位于慕尼黑, 在北京设有分公司。

城市再生可以成为解决中国及其他国家和地区大规模废弃单一功能化合物的有效工具

随着新兴工作和生活方式的出现, 庞大的纯商务区 and 纯居住区已经不能满足当代社会的需求。开发商、市政部门和城市规划师需要想方设法, 以可持续的方式改造和再利用这些建筑物。然而, 施耐德+舒马赫建筑事务所 (Schneider+Schumacher) 合伙人约阿希姆·温特 (Joachim Wendt) 认为中国大兴土木的趋势蕴藏着很大潜力: “与德国建筑相比, 中国建筑在规划时往往会留出更多空间。额外的体积确实带来了更大的灵活性, 并有机会对建筑进行翻新和再利用。”

参与式规划过程是城市再生成功的关键

德国格拉夫特建筑事务所 (GRAFT) 合伙人沃夫莱姆·普兹 (Wolfram Putz) 说: “参与式过程可能会令人沮丧, 因为这类过程耗时长久, 但你会在项目中获得更高接受度, 从而实现传统方式下可能无法实现的社会可持续发展。”反过来, 这类过程将降低长期维护成本——因为居民将更好地照管基础

neighbourhoods, so-called hutong areas, who host participatory processes with residents.

Urban renewal projects need to find new ways to achieve financial sustainability

Oftentimes urban regeneration projects are funded by government subsidies. “And they are absolutely necessary. But relying on them can also be dangerous. It would be more sustainable to create a market for renovated, preserved buildings and quarters. How do you do that? You bring in the private caretaker, the dweller, the owner. If every hutong, every courtyard house is now owned by its former renter, you will see that those buildings are maintained without government subsidies” says Wolfram Putz of GRAFT.

Building climate-friendly and livable neighborhoods

These are only some of the learnings which have emerged during the discussions between German architects and Chinese city representatives in the lab. But they highlight the importance of sustainable urban renewal strategies when aiming for resilient and sustainable living conditions in the metropolises of the world. The findings also dispel the assumption that demolition and rebuilding is cheaper than the arduous regeneration of historic infrastructures. If German and Chinese partners combine their expertise, technologies and experience, they possess everything it takes to build climate-friendly and livable neighborhoods.

设施——并将支持建设社会结构紧凑的弹性城市小区。在德国，近年来出现了一种专业职业，负责组织多个利益相关方进行必要的沟通并发动他们积极参与。北京也在朝着这一方向努力，当地胡同任命了社区“责任人”，负责组织当地居民实施参与式过程。

城市更新项目需要找到实现财务可持续性的新方法

城市再生项目往往由政府提供补贴。“政府补贴不可或缺，但依赖政府补贴也可能导致危险。为完成改造、保存完好的建筑和住宅区建设一个市场会更具可持续性。如何做到这一点呢？将私人看管人、居住者、房主纳入其中。如果每条胡同、每座四合院现在都归以前的租户所有，这些建筑将会在没有政府补贴的情况下得到维护。”格拉夫特建筑事务所的沃夫莱姆·普兹表示。

建设气候友好型宜居社区

以上是德国建筑师和中国城市代表在实验室探讨过程中的一些心得体会，其中强调了可持续城市更新战略对于全球大都市创造弹性、可持续生活条件的重要性。这些发现还打消了这样一种假设，即拆除和新建建筑的成本比竭力实现历史基础设施的再生更低。中德两国的合作伙伴通过整合双方的专长、技术及经验，将能够为建设气候友好型宜居社区创造一切必要条件。

The Network for Architecture Exchange NAX is an initiative by the Federal Chamber of German architects and has been supporting German planners on their way abroad since 2002. It promotes the exchange of knowledge and experience between architects and engineers all over the world. The Sino-German City Lab is part of the project “Green China III” by the Network for Architecture Exchange. It is funded by the “Export Initiative Environmental Technologies” (EXI) of the Federal Ministry for the Environment, Nature Conservation and Consumer Protection (BMUV).

“建筑交流网络” NAX由德国联邦建筑师协会发起，自2002年起为德国规划师开拓海外业务提供支持。NAX致力促进世界各地建筑师和工程师之间的知识及经验交流。

“中德城市实验室”是“建筑交流网络”“绿色中国三”项目的一部分，由德国联邦环境、自然保护和消费者保护部的“环境技术出口倡议” (EXI) 提供资助。

City-Scale Digital Twin – Artificial Intelligence Empowers Smart Cities to Tackle Climate Change

A contribution by Fraunhofer Institute for Building Physics IBP

城市级数字孪生 — 人工智能为智慧城市赋能应对气候变化

来自弗劳恩霍夫建筑物理研究所IBP的客邀文章

In view of the increasing intelligence of urban infrastructure and the wide application of big data technology, whether in the formulation and implementation of carbon neutrality and carbon peaking, or in the refinement of urban management for the benefit of ordinary people, expectations are high for the implementation and operation of the digital twin City Information Model (CIM).

The Fraunhofer Innovation Platform (FIP) team actively introduced German AI and atmospheric modeling technologies, successfully explored the establishment and operation methods of the CIM model at urban scale, and further provided digital analysis, simulation and pre-diagnosis methods for various purposes.

In the fully renovated Shanghai Urban Planning Exhibition Hall, a huge model of Shanghai, the core exhibition item, showcases the digital transformation via an immersive and interactive 5D urban digital model.

Two research institutes of Fraunhofer provided professional technical support for the project. The Fraunhofer Institute for Factory Operation and Automation (IFF) was responsible for the development of the visual simulation system, and the Fraunhofer Institute for Building Physics (IBP) was responsible for the analysis and simulation of urban temperature, airflow and thermal comfort.

Urban climate simulations are fundamental to achieving carbon peaking and carbon neutrality. The Fraunhofer team conducted a city-scale climate simulation analysis as well as a region-specific temperature airflow analysis. Through simulation analysis, urban planning professionals can evaluate and visualize the impact of future strategies on urban heat island mitigation and climate change adaptation.

Fraunhofer IBP scientists first used the Weather Research and Forecasting Mode (WRF) to simulate the current and future climate of the whole urban area of Shanghai (an area of about 6,833 square kilometers) and analyzed typical summer-time situations. The digital model covered most of Shanghai city and surrounding areas and was initialized using the simu-

随着城市基础设施智能化程度的提升, 大数据技术的广泛应用, 无论是碳中和碳达峰的目标制定与实施, 还是让老百姓有获得感的精细化城市管理。人们对数字双城信息模型 (CIM) 的实施和运行寄予厚望。

弗劳恩霍夫“城市生态发展”创新平台团队积极引进落地德国人工智能和大气模拟技术, 成功探索了城市尺度的CIM模型建立、运行方法, 并进一步为各种目的提供数字化分析、仿真模拟以及预诊断手段。

在全面更新改造的上海城市规划展厅中, 作为核心展项的巨大的上海模型, 通过沉浸式互动的5D城市数字模型展示了数字化转型。



Digital sand table in Shanghai Urban Planning Exhibition Hall
上海城市规划展示馆数字沙盘
Copyright / 图片来源: SBA GmbH

弗劳恩霍夫研究院的两个研究所为该项目提供专业技术支持。弗劳恩霍夫工业自动化研究所负责开发可视化仿真系统。弗劳恩霍夫建筑物理研究所负责进行城市温度、气流和热舒适等方面的分析模拟。

城市气候模拟是实现碳达峰碳中和的基础。弗劳恩霍夫团队进行了包括全市范围的气候模拟以及特定区域的温度气流分析。通过模拟分析, 城市规划专业人员可以评估和可视化未来战略对缓解城市热岛和适应气候变化的影响。

弗劳恩霍夫建筑物理所团队首先使用天气分析和预测 (WRF) 软件对整个上海城区 (面积约为6833平方公里) 进行了现状和未来的气候模拟, 分析了夏季典型状况。该数字模型利用全球天气模型的模拟结果

lation results of a Global Weather Model. The WRF model uses three nested domains for the simulation.

Further, detailed 'microscale' climate simulations were conducted for two focus areas in the city: Bund (historic centre) and Jiading district. The simulations depicted a typical summer day in 2020 (current situation) and 2035 (future scenario). The 24-hours simulation period was within a 10-day period of the previously described whole-city simulation. These microscale simulations were carried out using the urban climate simulation software PALM-4U with a spatial resolution of 5.0 m x 5.0 m. Contrary to the WRF model, the PALM model requires detailed 3D geometric information about urban structures. The three-dimensional digital model of Shanghai was coupled with the whole-city meteorological model. Through simulation analysis, the change of urban microclimate in selected areas was studied in greater detail than that of the whole city to evaluate the level of comfort of urban spaces and to optimize energy conservation and emission reduction measures.

For future simulations both at city scale and district scale, the technical team utilised land use / land cover information consistent with the Shanghai 2035 master plan. Different future urban planning scenarios were studied, assessing the impact of factors such as the use of green roofs and highly reflective surfaces on urban carbon peaking and carbon neutralization. At district scale, the digital model can also evaluate the impact of building envelope thermal insulation and other energy-saving and environmental protection measures.

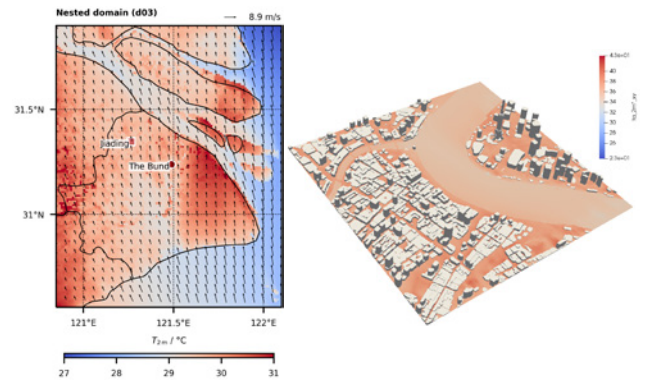
A number of standard meteorological variables (near-surface temperature, humidity and wind, urban heat island intensity) resulted from the simulations within all simulation grids. Some results of the study are displayed in the sketches of the city-wide simulation and district-scale simulation for The Bund. It was shown that the 2035 master plan can bring about a summer cooling of up to one degree Celsius (albeit not uniformly across the city).

This research reflects the great significance of atmospheric modeling and artificial intelligence technologies for complex urban systems in a megalopolis like Shanghai to cope with climate change, to achieve energy conservation and carbon reduction in the development stage, and to reconcile economic development with carbon peaking and carbon neutrality. This also exemplifies a new model of Sino-German applied science and technology cooperation.

进行初始化, 模拟覆盖了上海城市及周围大部区域并。WRF模型运用了三个嵌套模拟域进行仿真。

在此基础上, 对上海的两个重点区域进行了更详细的微尺度气候模拟。以外滩风貌区和嘉定新城为例, 模拟分析了2020年(现状)和2035年(未来情景)的一个典型夏日的状况。在上述全市域模拟的10天周期内进行24小时连续计算。

这些微观模拟使用了空间分辨率为5.0m x 5.0m的城市气候模拟软件PALM-4U。与WRF模型不同的是, PALM模型需要关于城市空间结构的更精细化三维几何信息, 利用上海的三维数字模型, 与大尺度气象模型耦合。通过模拟分析, 对选定区域的城市小气候的变化进行了比整个城市更详细的研究, 从而评估城市空间的舒适度、优化节能减排措施。



Average near-surface temperature and velocity fields from the city-wide simulation and near-surface air temperature at 2 pm in The Bund district (2020 situation)
 全市范围内模拟的平均近地表温度和速度场以及外滩地区下午2点的近地面空气温度 (2020年情景)
 Copyright / 图片来源: Fraunhofer IBP

在未来的城市规模和地区规模模拟中, 技术团队采用了与上海2035总体规划一致的土地利用/土地覆盖信息。研究了未来不同的城市规划场景, 并评估了诸如使用绿色屋顶和高反射表面等因素对城市碳峰值和碳中和的影响。在地区尺度上, 该数字模型还可以评估建筑围护结构隔热性能和其他节能环保措施的影响。

一系列典型的气象变量(近地表温度、湿度和风、城市热岛强度)被网格化模拟。部分结果显示在全市和外滩风貌区的模拟图中。结果显示2035总体规划可以带来高达1.0K的夏季降温(尽管在整个城市尚不均匀)。

这项研究很好地体现出大气模拟和人工智能技术在上海这样的超大都市复杂城市系统应对气候变化、在发展中实现节能减排、协调经济发展与碳峰值和碳中和方面的重要价值。这也是中德应用科技合作的新模式。

Rooftop Solar to Roll Out on China's Public Buildings

A contribution by Gao Baiyu

发展分布式光伏, 中国瞄准公共建筑屋顶

来自高白羽的客邀文章

On Tiananmen Square, China's very heart, an 850 square metre solar installation is in operation. The panels sit on the roof of the Great Hall of the People, generating 98,000 kilowatt hours (kWh) a year to run the building below. This is not a common arrangement. Nationally, next-to-no government or public buildings have rooftop solar installations.

In late June 2021, the National Energy Administration (NEA) published a notice on county-level trials of distributed solar power generation, designed to boost rooftop solar. This may prompt a new spurt in solar installations, on both public and private buildings, over the next five years. Statistics collected by industry media outlet BJX indicate 75 county-level governments have picked firms to install distributed solar and are set to start trials.

What is distributed power generation?

Unlike a coal-fired power station feeding the grid, distributed power is electricity generated on a smaller scale. The power can either be used by the home, office or other facility that produced it, sold to other users in the vicinity or sold to the grid. Distributed power generation has the potential to improve energy security, lower power costs and reduce CO₂ emissions.

The NEA notice encourages counties to sign up if they have appropriate rooftops, good grid access and the technical and financial capacity to roll out the programme. Electricity grid companies are expected to provide connections where possible, making upgrades if necessary, to ensure distributed solar power can be connected to the wider network.

To apply for the trial, at least half of the rooftops of a county's Party and government buildings needs to be suitable for solar installation, and 40% of other public buildings such as hospitals and schools. Liu

在中国的心脏——北京天安门广场上, 占地850平方米的光伏组件正在运行。这些光伏被安装在人民大会堂屋顶, 年发电量约9.8万度, 用以供给建筑内各项设施运作。但这样的场景并不常见, 在全国范围内的政府大楼或其他公共建筑上, 屋顶光伏的安装率低到几乎可以忽略。

为促进屋顶光伏的开发, 2021年6月底中国国家能源局下发了《关于报送整县(市、区)屋顶分布式光伏开发试点方案的通知》(后称《方案》), 或将在“十四五”期间激发电伏市场新的装机潜力。据统计, 截至目前, 已有75个县(区/市)敲定了整县分布式光伏的开发企业, 即将进行试点开发。

什么是分布式发电?

与为电网供电的燃煤发电站不同, 分布式发电是指规模较小的发电。该电力可供家庭、办公室或其他发电设施使用, 出售给附近的其他用户, 或出售给电网。分布式发电具有改善能源安全、降低电力成本以及减少二氧化碳排放的潜力。

《方案》提出, 试点应按照“宜建尽建”的原则, 鼓励具备可利用屋顶资源、电网接入和消纳条件良好、有实力推进试点项目建设的县(市、区)积极申报试点; 电网企业也应按照“应接尽接”的原则, 升级改造电网, 以保障分布式光伏大规模的接入需求。



To meet its climate goals, China needs to more than double its wind and solar power generation capacity in the coming decade
为达成气候目标, 中国的风电和光伏装机容量在未来的10年要翻一倍有余
Source / 图片来源: Alamy

Yiyang, deputy secretary general of the China Photovoltaic Industry Association, stated that solar power installations on the rooftops of Party and government, university and hospital buildings are rare, but the trials could change that.

Why promote distributed solar?

At the Climate Ambition Summit in December 2020, China set a couple of important goals for the year 2030. Non-fossil energy sources should account for about 25 percent of all primary energy consumption; and solar and wind power generation should reach over 1,200 GW. At the end of 2020, China had installed 281 GW of wind and 253 GW of solar power, making a total of 534 GW. To meet its 2030 goals, China needs to more than double its wind and solar power generation capacity in the coming decade. Solar power capacity needs to grow by 80 GW a year, according to Peng Peng, secretary general of the China New Energy Investment and Financing Alliance.

This is no easy task. Though growth in solar power farms, which account for the lion's share of solar capacity in China, had been rapid, it slowed in 2021. Peng points out that while it will be possible to build more solar farms to drive growth in solar capacity between 2021 and 2025, there will be a bottleneck in how much of it the grid can deal with. Solar power farms are mostly located in northern China while distributed solar suits the more developed eastern coast, where there is a lot of consumers, easier access to the grid and plenty of room for growth. "Distributed solar will have to account for half of new capacity, if annual growth in solar power is to go past 80 GW," said Peng.

At the end of 2020, distributed solar accounted for about 78 GW (30 percent) of the 253 GW of China's installed solar generation capacity, according to data from the country's National Energy Administration. Growth in distributed solar appears to be picking up in proportion to growth in solar farms. In the first half of 2021, about 13 GW of new solar power capacity was installed, 7.65 GW of that distributed solar.

《方案》对想要申报试点的县(市、区)的可利用屋顶面积提出了要求,党政机关建筑屋顶可安装光伏面积不得低于50%,其他公共建筑屋顶可用面积不低于40%。中国光伏行业协会副秘书长刘译阳提及,像党政机关、学校、医院、村委会等公共建筑的屋顶光伏装机量还很低,试点推进将促进这些单位的光伏安装量大幅增长。

为什么推分布式光伏?

在2020年12月的气候雄心峰会上,中国提出气候行动目标,要求到2030年,非化石能源占一次能源消费比重将达到25%左右,风电、光伏发电总装机容量将达到1200吉瓦以上。而截至2020年底,中国风光总装机容量为534吉瓦,其中包含风电281吉瓦、光伏253吉瓦。这意味着在10年间,中国的风电和光伏装机容量要翻一倍有余。新能源电力投融资联盟秘书长彭澎表示,为达成气候目标,光伏年均装机量的增长期望达到80吉瓦以上。



The recent notice of the National Energy Administration encourages counties to sign up for a rooftop solar development plan
国家能源局下发的这一《方案》鼓励县(市、区)积极申报屋顶分布式光伏开发试点

Source / 图片来源: Wikimedia, N509FZ

这对光伏行业来说并不轻松。2021年之前,集中式光伏发展迅猛,在光伏装机总量中占主导地位,但其发展步伐正慢慢放缓。彭澎指出,“十四五”前期还能依靠地面集中式光伏电站来拉动装机量,然而到了后期,随着电网消纳空间的减少,大规模地面电站消纳将成为集中式光伏发展关键的“卡脖子”因素。而相比主要分布在“三北”地区的集中式光伏,分布式光伏多分布在中东部经济发达地区,离电力消费端更近,消纳问题小,发展空间更大。“分布式市场至少要占到年新增市场的一半,光伏的年装机增长量才能突破80吉瓦。”她介绍说。

根据国家能源局数据计算,截至2020年底,在全国累计的253吉瓦光伏装机中,分布式光伏仅占30%,

Rely on rooftops, or innovation?

Over 20 GW of the 78 GW of distributed solar capacity is residential, and around 58 GW is generated on offices and industrial buildings. There are virtually no solar installations on the rooftops of public buildings. The new trials aim to fix that by boosting installations on Party and government buildings, universities and hospitals.

Liu Yiyang explained that public buildings are rarely covered with solar panels as they already enjoy relatively low electricity prices. If generating power costs about the same as taking it from the grid, building managers have little incentive to go for solar.

Investors will usually lease a rooftop, provide power to the building owner at a discount, and sell the remainder to the grid. But public buildings tend to be smaller than industrial and commercial buildings, meaning less excess electricity to sell. Also, the investors need to lease public building rooftops from the government, which means more red tape. Liu thinks the government needs to step in to coordinate this process, helping investors arrange grid connections, matching up rooftop solar providers with rooftop owners, and reducing investment costs. The government also needs to educate building owners and investors, increasing their eagerness to develop distributed solar and make better use of the public rooftops. "Before, the building owners didn't see a need, so even if a solar power firm came knocking, they wouldn't be interested. That roadblock is being cleared now."

Liu is enthusiastic about the business model: "For the solar power firms, generation from public buildings might be low, but it's reliable profit." Governments, hospitals and universities don't relocate every few years, and can be relied upon to pay their bills. Business and factory owners, in contrast, may use less electricity in a quiet period, or even close down. And if bills aren't paid, it's the investors that lose out.

Public buildings have only limited roof space. Peng Peng holds that a county government will only

约为78吉瓦。而2021年上半年，全国光伏新增装机13.01吉瓦，其中分布式光伏达到了7.65吉瓦，超过了集中式光伏的装机量，分布式光伏的发展速度正在加快。

靠公共屋顶还是靠模式创新?

在分布式光伏78吉瓦的累计装机容量中，户用光伏累计装机超过20吉瓦，工商屋顶累计装机估计在58吉瓦左右，党政机关建筑、学校、医院、村委会等公共建筑屋顶的光伏装机几乎可以忽略不计。而此次《方案》的推进，能大大促进这些单位的光伏安装量增长。

刘译阳解释说，公用屋顶的光伏覆盖率低，是因为公共建筑的电费相对较低，如果屋顶光伏电价和电网电价所差无几，业主没有节省电费的压力，就没有安装光伏的积极性。



The key to developing distributed solar is expansion on the rooftops of industrial, commercial and residential buildings

分布式光伏发展的核心是工商业和户用光伏

Source / 图片来源: Wikimedia, Xiaoxiaozhao (小小赵)

而对于投资方来说，一般选择租用建筑屋顶，按照业主已使用的光伏发电量收取折扣电费，并将多余的电量卖给电网。而公共建筑的屋顶可用面积相对于工商业厂房等建筑来说通常较小，这也意味着“余电上网”的并网难度更高。同时，企业还需要打通政府渠道以开发屋顶，这都会增加投资商的非技术成本。刘译阳认为，现在需要政府来协调这些资源，帮助投资方协调电网接入问题和供需方的资源对接问题，帮助企业降低投资成本。同时，政府也需要教育业主和投资方，提高他们发展分布式光伏的积极性，把公共建筑的光伏安装比例提高。“以前业主没有这个需求，所以即使光伏企业推荐，他们也不愿意装，现在我们就要把这个痛点和堵点打开。”

对于在公共屋顶上发展分布式光伏的商业模式，刘译阳非常看好：“对于光伏企业来说，公共建筑虽然电量较低，但收益稳定性很高。政府、医院、学校这

have control over several thousand square metres of rooftop space – ten thousand, at most. “Even if you reach the 50 percent coverage proposed by the NEA, that’s a limited amount of power generation.” She emphasized that the key to developing distributed solar is expansion on the rooftops of industrial, commercial and residential buildings.

Will these new trials promote that? She doesn’t expect to see the trials alone make much difference – it will depend largely on profitability.

Installations on industrial and commercial buildings are either entirely for the company’s own consumption, or excess generation is sold to the grid. Residential installations come in a third variety too – where all power generated is sold to the grid. On-site consumption is the most profitable process, as it removes the need to buy power from the grid at business rates. When power is sold to the grid, the benchmark coal power tariff is paid, which is lower. Li Hui, founder of Adzar Energy, a distributed solar solutions provider, said that in Shanghai large industrial companies pay 0.80 CNY per kWh during the day, which they can save by generating their own electricity. Power sold back to the grid earns 0.41 CNY per kWh.

In neither case are market mechanisms fully in play. Peng Peng points out that reform is required to generate more enthusiasm for distributed solar. The existing system, where sold power can only enter the grid, should be changed to allow generators to deal directly with nearby consumers. That, she says, would make distributed generation more profitable, reducing financing costs and bringing many more projects online.

Li Hui doesn’t expect the trials to have much impact on his business, saying that Adzar Energy specialises in distributed solar installations for industrial and commercial facilities on city outskirts, and has also worked on residential installations. Government-controlled rooftops primarily belong to state-owned enterprises or government institutions, he said.

But he does think the trials will make more building owners realize they have a social responsibility

类公共设施不可能过个三五年就搬家,也不会存在收不上电费的问题。”相比之下,工商业业主就可能因为经营不善而产生用电量下降甚至倒闭的问题,如果业主拖欠电费,投资商就会承担相应的损失。

值得注意的是,公共建筑的屋顶规模有限。彭澎指出,就一个县来讲,政府控制的屋顶只有几千平,至多上万平,“即便能(按照《方案》的要求)安装(公共建筑面积的)50%,我们觉得增量也是很有限的”。她强调,分布式光伏发展的核心还是工商业和户用光伏。

工商业和户用光伏能否在此次《方案》的推进下发展起来?彭澎认为试点政策的影响不大,工商业和户用要发展,关键取决于项目的盈利情况。

目前,工商业分布式光伏可选择“全部自发自用”和“自发自用、余电上网”两种模式,户用光伏再多一种“全额上网”的选择。“自发自用”模式对标的是工商业或户用电费价格,经济性相对较高;“余电上网”和“全额上网”模式则对标当地燃煤标杆上网电价,价格相对较低。亚坦能源科技(上海)有限公司的创始人李辉指出,就上海地区而言,大工业企业日间用电价在0.8元/度左右,这意味着自发自用一度电就能节省0.8元。而余电卖给电网的收购价则为0.41元/度左右。

然而,无论是“自用”还是“上网”,市场化程度都不高。彭澎指出,要提高开发分布式光伏的积极性,关键需要制度创新,要打开“隔墙售电”模式,放开分布式光伏电力的市场化交易,允许分布式能源项目将电力直接销售给周边的能源消费者,而不是必须低价卖给电网。“如果‘隔墙售电’模式打开,分布式项目的收益问题就能得到改善,融资成本会相应下降,符合投资人需求的电站也会大批涌现出来。”她说。

李辉也认为公司目前业务基本不受《方案》影响。他介绍说,亚坦新能专注于开发城市周边的工商业光伏项目,也曾做过户用的别墅项目,但这些业务都是政府控制不了的,政府把控的主要是国企单位和事业单位的屋顶。

李辉认为,《方案》最大的意义在于让自有屋顶的企业认识到自己有使用绿电、发展可再生能源的社会责任。除了对公共建筑屋顶的光伏安装面积进行了规定,《方案》也对工商业建筑和农村居民建筑屋顶设置了分布式光伏安装面积目标。“有了《方案》以后相当于是全民参与,所有的企业都知道我可能早晚要上光伏,原来觉得光伏收益不太高的客户也会

to generate green and renewable energy. The NEA's document sets targets for distributed solar installations on industrial and commercial buildings, and residential buildings in rural areas. Li said: "All companies will see that, sooner or later, they're going to end up with solar panels, and the government encouragement may mean those who saw it as unprofitable get on board. That means we can win new business as the policy rolls out."

Monopoly concerns?

Droves of local governments have applied to run trials, but small and medium-sized enterprises have some concerns. One commenter on the NEA website asked how the government would protect the interest of small-scale solar installers, who are at risk of being frozen out as county governments sign up with larger firms.

The NEA replied that trials should be run competitively, rather than as monopolies, and be marketed, with all suitable companies able and encouraged to participate in bidding.

The NEA also pointed out that local governments can choose whether and how many trials to run, and that there is no requirement to gain NEA approval. The reply also explained the government's role: it is to coordinate resources, rather than take over the entire process. The building owners should choose contractors freely, via the market. Also, the trials should not cause any ongoing approvals processes or grid connections to be paused or delayed.

The publicly available data so far shows that most local governments have opted to use state-owned enterprises to develop distributed solar. But as few such enterprises have previously done this in their own right, many are choosing to cooperate with private firms. "Currently I haven't heard of any local governments signing exclusive agreements which lock other firms out," said Li Hui.

This article was first published on the website www.chinadialogue.net

因为政府的推动而愿意去做，那我们就能顺应政策开拓新业务。”

整县推进是否会带来垄断问题？

《方案》下发后，地方政府的申报如火如荼，但中小企业却提出了自己的忧虑。有网友在中国能源局官方网站留言问道：各地如果曲解整县推进光伏政策，会出现垄断式承包的弊端，政府要如何保护小型安装承建商？

针对网友问题，国家能源局强调要在推进试点工作中做到“竞争不垄断”。要求试点工作坚持市场主导和充分竞争的原则，将各地屋顶分布式光伏开发市场向所有符合条件的企业开放，鼓励企业参与市场竞争，参加开发建设。



Installation of solar photovoltaic panels on the roof of the Hongqiao Railway Station in Shanghai

在上海虹桥火车站屋顶安装太阳能光伏板

Source / 图片来源: Jiri Rezac

此外，国家能源局还在回复中提出，各地可自行决定是否开展试点和开展多少试点，按申报要求来报送试点方案的县（市/区）均可自行实施方案、无需审批。回复也对政府所扮演的角色做了规定：政府重点工作是协调资源而非大包大揽、具体开发建设应该由屋顶产权单位按照市场化原则自主确定开发主体。同时，各地应保持工作连续性，不得以开展试点为由暂停、暂缓现有项目立项备案、电网接入等工作。

就目前各地公开信息来看，绝大多数县（市/区）选择由央企、国企来负责开发当地的分布式能源，但央企和国企此前独立开发分布式光伏较少，因此，也有不少央企、国企选择与民企协同合作。“目前还没有听说哪个地区跟哪个企业签了排他协议，导致其他企业进不去的”，李辉说。

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China Energy Web 中国能源网
china5e.com

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China Renewable Energy Society (CRES) 中国可再生能源学会
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dena.de

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creia.net

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CO2 Trade 二氧化碳交易
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