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EFFICIENT AND CLEAN WINTER HEATING BY GROUND-SOURCE
ENERGY HEAT PUMP IN NORTHERN CHINA
- AN EMERGING GREEN INDUSTRY OF INTEGRATED HEATING AND COOLING

北方冬季地能热泵高效清洁取暖

热冷一体化新兴绿色产业

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Exclusive Interview — Wang Jiyang
本刊独家专访——汪集暘

中國地熱能

CHINA GEOTHERMAL ENERGY



恒有源科技发展集团有限公司
EVER SOURCE SCIENCE & TECHNOLOGY DEVELOPMENT GROUP CO.,LTD.

恒有源科技发展集团有限公司简介

恒有源科技发展集团有限公司（简称“恒有源科技”）数十年来专注于供暖和制冷两个产业融合而成的热冷一体化产业创新。这是叠加热冷一体化系统的能源替代和产品不断创新的结果。在北方供暖地区同一系统实现了热冷一体化的暖保证、冷足够的地能生态供暖，而新质生产力已经将传统供暖是“送温暖，让百姓温暖过冬”的福利保证事业，升级换代成新时期地能生态供暖的“冬暖夏凉、日常有热水”的升级形态。在提高百姓生活水平同时实现了产业创新，让供暖行业在享受居民电价条件下（相当于燃煤供暖的成本），可降低传统供暖50%左右的能耗，依然保证原有的面积的正常取暖；且使用区域无燃烧、零排放；推动率先实现2060年的国家减碳目标。

浅层地能主要指来源于地下15-150米深的恒温层及附近区域的浅层低温地热能。电驱动热泵循环搬运因地制宜采集的地能，保证房间温度在18-26℃可调节。再没有必要依靠高温燃烧解决这个温度范围的供热问题了。避免了高温燃烧存在的能源安全的隐患和造成环境污染的风险。

恒有源科技的地能生态供暖因地制宜地采集低温地热能，热稳定性强、热源温度不受昼夜和四季更迭的气温变化的影响。恒有源科技依据地质透水率等条件，在保持水质的同时，环保高效地采集地能，为热泵工作提供了可靠的低温热源。

地能生态供暖技术相较于传统燃烧供暖，实现了“三个替代”：

- 1. 能源的替代：**以量大面广的地能替代了传统化石能源；
- 2. 产品的替代：**以安全高效、使用寿命长的热泵替代了传统锅炉；
- 3. 取暖热能获取方式的替代：**通过电力驱动热泵“搬运”低温的地热能，替代利用高温燃烧获得的取暖热能。这是实现了供暖能源按品位科学分类。利用地能生态供暖是能源匹配取暖温度的道德用能。

恒有源科技发展集团的地能生态供暖技术，全面覆盖城镇的集中供暖和一家一户的自采暖，它是零碳可再生的清洁供暖的向前发展。

恒有源科技发展集团以技术和质量保证产品创新，以专注“暖保证、冷兼有”的地能生态供暖的产业创新为己任。在专业化布局集中供暖热泵、自采暖热泵和地能采集器的生产基地的业务拓展中愿与有担当的企业合作共同发展，携手保证和区域推广地能生态供暖产业创新的成果，打造专业的大数据运维服务平台，确保有效服务客户提高百姓的生活品质。

我们的员工行为准则：

- 安全第一，标准当家；
- 扎扎实实打基础，反反复复抓落实；
- 负责任做每件事，愉快工作每一天。

我们的追求：

- 人与自然的和谐共生。



恒有源科技发展集团有限公司
EVER SOURCE SCIENCE & TECHNOLOGY DEVELOPMENT GROUP CO., LTD.

Corporate Profile of Ever Source Science & Technology Development Group Co., Ltd. (HYY)

For decades, Ever Source Science & Technology Development Group Co., Ltd. (HYY) has been dedicated to industrial innovation in integrated heating and cooling systems. Through continuous advances in energy substitution and product innovation, HYY has developed a Geo-energy Ecological Heating system that combines heating, cooling, and domestic hot water supply within a single energy solution.

In northern China's heating regions, HYY's integrated system utilizes shallow geo-energy resources to provide reliable heating in winter and effective cooling in summer. This innovation has elevated traditional heating services beyond their conventional role of simply keeping residents warm during the winter season, creating a modern energy solution that delivers warmth in winter, cooling in summer, and a continuous supply of domestic hot water throughout the year.

While improving living standards, HYY's technology also drives industry-wide innovation. Operating under residential electricity pricing, with operating costs comparable to conventional coal-fired heating, the system can reduce energy consumption by approximately 50% compared with traditional heating methods while maintaining the same heating capacity. The entire heating area operates without fuel combustion and produces zero direct emissions, contributing to the achievement of China's national carbon-neutrality goals.

Shallow geo-energy refers primarily to low-temperature geothermal energy stored within and around the underground constant-temperature zone, typically located at depths of 15 to 150 meters below the surface. Through electrically driven heat pumps, this renewable thermal energy is efficiently transferred and utilized to maintain comfortable indoor temperatures ranging from 18° C to 26° C. This approach eliminates the need to generate moderate-temperature heating through high-temperature combustion processes, thereby avoiding associated energy security risks and environmental impacts.

HYY's Geo-energy Ecological Heating system is designed according to local geological conditions and efficiently harnesses low-temperature geothermal energy. Unlike conventional heating sources, the underground thermal environment remains highly stable and is largely unaffected by day-night temperature fluctuations or seasonal climate changes. By optimizing energy collection based on geological permeability and hydrogeological conditions while preserving groundwater quality, HYY provides a reliable and sustainable low-temperature heat source for heat-pump operation.

Compared with traditional combustion-based heating systems, HYY's Geo-energy Ecological Heating technology achieves three fundamental transformations:

- 1. Energy Substitution:** Utilizing geothermal energy, namely low-temperature thermal energy below 25° C collected from underground constant-temperature layers, to replace traditional fossil fuels.
- 2. Product Substitution:** Replacing traditional boilers with safe, highly efficient, and long-service-life heat pumps.
- 3. Substitution of Heat Acquisition Method:** Using electricity to drive heat pumps to "transfer" geothermal energy, replacing the acquisition of heat through the high-temperature combustion of fossil fuels in boilers. This represents the scientific and ethical utilization of ecological energy for heating, achieving properly matched heating temperatures while ensuring combustion-free and zero-emission heating throughout the heating area.

HYY's Geo-energy Ecological Heating technology is applicable to both centralized district heating systems and individual household heating solutions, providing a practical pathway toward renewable, low-carbon, and sustainable heating development.

Guided by technology leadership and quality excellence, HYY remains committed to advancing Geo-energy Ecological Heating solutions that guarantee reliable heating while also providing cooling capability. Through the development of specialized manufacturing bases for district-heating heat pumps, residential heat pumps, and geo-energy collection systems, HYY actively seeks partnerships with responsible organizations to jointly promote the adoption of innovative clean-heating technologies.

Together with its partners, HYY is building a professional big-data-based operation and maintenance platform to ensure efficient system management, superior customer service, and continuous improvements in quality of life for communities served by Geo-energy Ecological Heating.

Three Codes of HYY Staff Conduct:

- Safety first, standards prevail.
- Build a solid foundation and ensure thorough implementation.
- Be responsible in every task, and work happily every day.

Our Pursuit:

- Harmonious coexistence between humanity and nature.



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ООО «Хэн Ю Юань Технолоджиз Дивелопмент Груп Лтд»

ООО «Хэн Ю Юань Технолоджиз Дивелопмент Груп Лтд» (сокращённо «Хэн Ю Юань Технолоджиз») на протяжении десятилетий специализируется на инновационном развитии интеграции двух отраслей – отопления и охлаждения, формируя единую термо-холодильную систему. Это является результатом энергетической замены и непрерывных инноваций продукции на основе совмещённой системы термо-холодильной интеграции.

В северных регионах Китая, где требуется отопление, эта единая система обеспечивает экологичное геотермальное отопление с гарантированным теплом и достаточным холодом, реализуя принцип «тепло зимой, прохлада летом». Новые производительные силы уже превратили традиционное отопление из социальной благотворительной миссии – «дарить тепло, чтобы люди могли согреться зимой» – в новую концепцию экологичного геотермального отопления нового времени: «зимой тепло, летом прохлада, а в повседневной жизни – горячая вода».

Повышая уровень жизни населения, компания одновременно осуществляет промышленные инновации. Отопительная отрасль получает возможность работать по льготному тарифу на электроэнергию для населения (что сопоставимо по стоимости с отоплением на угле), сокращая при этом традиционное энергопотребление на отопление примерно на 50%, сохраняя полноценное теплоснабжение существующих площадей. Зоны использования системы характеризуются отсутствием горения и нулевым уровнем выбросов, что способствует ускоренному достижению национальной цели по сокращению выбросов углерода к 2060 году.

Неглубокая геотермальная энергия в основном относится к низкотемпературному геотермальному теплу, извлекаемому из слоя постоянной температуры и прилегающих зон на глубине от 15 до 150 метров. Электрический тепловой насос с циркуляционным приводом перекачивает и использует геотермальную энергию, собранную в соответствии с местными условиями, обеспечивая возможность регулирования температуры в помещении в диапазоне от 18 до 26 градусов. Это устраняет необходимость полагаться на высокотемпературное сжигание топлива для решения проблемы теплоснабжения в данном температурном диапазоне, а также позволяет избежать скрытых опасностей энергетической безопасности и рисков загрязнения окружающей среды, связанных с высокотемпературным сжиганием.

Экологичное геотермальное отопление компании ООО «Хэн Ю Юань Технолоджиз Дивелопмент Груп Лтд» обеспечивает целенаправленный сбор низкотемпературной геотермальной энергии в зависимости от местных условий. Источник тепла отличается высокой стабильностью, его температура не зависит от суточных и сезонных колебаний температуры воздуха. Компания ООО «Хэн Ю Юань Технолоджиз Дивелопмент Груп Лтд», учитывая такие параметры, как водопроницаемость грунта, осуществляет экологически чистое и эффективное извлечение геотермальной энергии с сохранением качества воды, обеспечивая тем самым надёжный низкотемпературный источник тепла для работы тепловых насосов.

По сравнению с традиционным отоплением на основе сжигания топлива, экологичная геотермальная технология отопления обеспечивает «три замены»:

- 1. Замена источника энергии:** широкодоступная и повсеместная геотермальная энергия заменяет традиционное ископаемое топливо.
- 2. Замена продукта:** безопасный, высокоэффективный и долговечный тепловой насос заменяет традиционный котёл.
- 3. Замена способа получения тепла для отопления:** электрический тепловой насос «перекачивает» низкотемпературную геотермальную энергию, заменяя тепло, получаемое при высокотемпературном сжигании. Это позволяет научно классифицировать энергию для отопления по её качеству. Использование экологичного геотермального отопления является этичным использованием энергии, при котором источник энергии соответствует требуемой температуре отопления.

Экологичная геотермальная технология отопления компании ООО «Хэн Ю Юань Технолоджиз Дивелопмент Груп Лтд» полностью охватывает как централизованное отопление в городах и посёлках, так и индивидуальное отопление в отдельных домах. Это поступательное развитие чистого, возобновляемого и безуглеродного отопления.

Компания ООО «Хэн Ю Юань Технолоджиз Дивелопмент Груп Лтд» обеспечивает инновации продукции на основе технологий и качества, ставя своей миссией промышленные инновации в области экологичного геотермального отопления, ориентированного на «гарантированное тепло с дополнительным охлаждением». В рамках специализированного развёртывания производственных баз по выпуску тепловых насосов для централизованного отопления, тепловых насосов для индивидуального отопления и коллекторов геотермальной энергии компания выражает готовность к сотрудничеству с ответственными партнёрами для совместного развития, обеспечения и регионального продвижения результатов промышленных инноваций в области экологичного геотермального отопления, создания профессиональной платформы эксплуатации и обслуживания на основе больших данных, а также эффективного обслуживания клиентов и повышения качества жизни населения.

Наши принципы поведения для сотрудников:

Безопасность превыше всего, стандарты – наш приоритет;

Добросовестно закладывать фундамент, настойчиво добиваться выполнения задач;

Ответственно подходить к каждому делу, с радостью работать каждый день.

Наше стремление:

гармоничное сосуществование человека и природы.

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人物专访

——汪集暘院士



人物简介

汪集暘，男，1935年出生，江苏吴江人，地热、水文地质学家，中国科学院院士，国际矿产资源科学院院士，国际欧亚科学院院士。现任中国科学院地质与地球物理研究所研究员、国家地热能中心技术委员会名誉主任、中国科学院广州能源研究所首席科学家、中国石油大学（华东）地热与可再生能源研究中心主任、香港中文大学名誉教授、中国地源热泵产业联盟名誉理事长。曾任国际热流委员会（IHFC）委员、国际地热协会（IGA）主席团成员，荣获李四光地质科学奖、何梁何利基金科学与技术进步奖、刘光文科技成就奖。汪集暘长期从事地热理论和应用研究。

工作经历：1956年毕业于北京地质学院（现中国地质大学）水文与工程地质系，获学士学位；同年留校任教至1958年。1958年至1962年赴莫斯科地质勘探学院学习，获苏联地质矿物学副博士学位（等同 PhD）。1962年至1999年在中国科学院地质研究所历任助理研究员、副研究员、研究员、地热研究室主任等职。1979年至1981年担任美国弗吉尼亚理工大学访问教授、美国地质调查所（USGS）高级客座研究员。1999年至今任中国科学院地质与地球物理研究所研究员。长期致力于地热学、水文地质学的基础理论与应用研究，尤其在大地热流、岩石圈热结构、中低温地热系统等方向贡献卓著。建立了中国特色的地热研究体系，绘制中国首幅大地热流分布图，提出“东高西低，南高北低”的大地热流宏观分布特征。提出中国地热资源形成分布的构造—热背景理论，划分中国五种岩石圈热结构类型（如华北“冷壳热幔”、青藏高原“热壳热幔”）。系统研究中低温对流型地热系统，指导东南沿海等地热供暖、发电工程。

汪集暘院士现任国家地热能中心技术委员会名誉主任、中国地源热泵产业联盟名誉理事长、中科院广州能源研究所首席科学家，虽已步入耄耋之年，依旧坚守地热科研与产业推广一线，为我国地热产业高质量发展躬身践行、建言献策。汪院士一生致力于推动地能替代化石能源，助力热泵高效清洁供暖制冷产业健康发展，也是最早心系《中国地热能》杂志的地质科学家之一。早在2014年杂志创刊（彼时刊名定为《中国地能》）之际，汪院士便特意发来题词，寄予深切厚望。此次应允本刊专访，他围绕地热科研初心、产业发展现状、未来布局愿景等话题，分享了真挚而深刻的行业见解。

本刊访谈组：您早年留学归国后，便扎根地热与水文地质研究，当初是什么契机让您选定地热，并且坚持了一辈子？

汪集暘院士：我1962年从苏联学成回国，当时我国的地热研究几乎是一片空白，连一张完整的大地热流分布图都无法完成，基础研究领域完全处于起步阶段。能源是国家发展的根基命脉，那时候国内能源供给主要依赖煤炭、石油等化石能源，长期使用不仅引发了日益严重的环境污染问题，化石资源本身也面临枯竭危机，而地热是蕴藏在地下的清洁能源，储量丰富、用之不竭，堪称大地馈赠人类的绿色宝藏。

尤其是近年来快速发展的浅层地热，相比深部地热开发难度低，全国范围内分布广泛，开发利用便捷，更能直接对接民生需求，兼顾供暖与制冷两大核心用途，是真正能惠及百姓的清洁能源。我这辈子始终坚信，做科研绝不能闭门造车，必须扎根国家最迫切的发展需求，把论文写在祖国的大地上。就这样，从绘制第一张热流分布图起步，深耕地热研究一晃就是六十余年。看着地热从当初无人

关注的冷门小众学科，一步步成长为国家“双碳”战略的重要支撑力量，我内心满是欣慰，打心底里认定，这辈子选准这条科研路，走得值、走得对。

本刊访谈组：您一直大力推动浅层地热开发利用，在您看来，浅层地热相比其他可再生能源，核心优势是什么？它在我国能源转型中扮演着怎样的角色？

汪集暘院士：浅层地热的核心优势可以浓缩为“稳、广、净”三个字，这是风能、太阳能难以比拟的。风能发电依赖风力条件，太阳能利用受制于光照强度，遇上阴雨天气、夜间无光或是风力不足，就无法稳定出力，属于典型的“靠天吃饭”，能源供给间歇性极强。而浅层地热截然不同，地下数米至数百米的地层温度全年保持恒定，无论外界是酷暑三伏还是严寒数九，供冷供暖都能持续稳定运行，从不间断，供给可靠性极高。

其次，浅层地热分布范围极广，无论南北城乡、平原山区，全国各地几乎都具备开发潜力，完美适配建筑供暖、制冷场景，直接对接老百姓的日常生活需求。我国北方地区长期依赖散煤供暖，烟囱排放导致空气浑浊、雾霾频发，污染严重且碳排放量高，浅层地热正是替代散煤、实现清洁供暖的最优方案。

在“双碳”目标的大背景下，绝不能将浅层地热视作无关紧要的补充能源，它是建筑领域低碳转型的主力清洁能源，能够切实降低我国对化石能源的依赖，大幅改善大气环境质量，是能源转型进程中最接地气、见效最快的关键抓手，战略地位不可替代。

本刊访谈组：您在浅层地热研究和推广过程中，攻克了哪些关键难题？这些成果对我国地热产业发展有哪些里程碑式的意义？

汪集暘院士：早年开展浅层地热研究，遇到的首个核心难题就是“家底不清”。全国地下地热资源储量、分布规律、地层导热性能等基础数据完全空白，研究工作如同摸黑前行。我们团队常年奔赴野外，走遍大江南北，逐个区域开展实地勘探，一点点收集整理数据，最终摸清了全国浅层地热的赋存规律与核心热导率参数，建立起我国自主的浅层地热资源评价体系，填补了这项核心基础空白，为后续所有产业推广工作筑牢了根基。

第二个难题是技术水土不服，国外成熟技术无法直接照搬。我国幅员辽阔，南北方地质条件、气候环境差异极大，国外引进的热泵技术适配性极差。为此我们推动自主研发，在中关村诞生了我国拥有完全自主知识产权的地能热泵换热系统，这套系统最大的优势在于换热过程不消耗地下水资源，完全贴合我国国情，避免了水资源浪费与地层破坏。

除此之外，我们还牵头推动建立浅层地热开发利用的行业标准与规范，彻底改变了此前行业发展无章可循、无序混乱的局面，推动产业从粗放无序走向规范有序。这些工作看似基础，却有着里程碑式的意义，直接推动浅层地热从纯理论研究落地到实际工程应用，从少数试点项目逐步迈向规模化推广，为我国地热产业打下了坚实的理论与技术根基，也让国际学界看到了中国地热开发的核心实力，彻底摆脱了过去跟跑国外的被动局面。

本刊访谈组：“双碳”目标提出后，地热产业迎来新机遇，您认为未来浅层地热的发展方向是什么？深部地热和浅层地热该如何协同发展？

汪集暘院士：“双碳”目标为地热产业发展吹来东风，未来浅层地热要牢牢把握规模化、智能化、综合化三大发展方向。规模化，就是跳出大城市局限，向县域、乡村全面延伸，覆盖民用住宅、学校、医院等各类公共建筑，让地热惠及更多人群；智能化，就是依托大数据、物联网技术，实现地热系统精准调控、智能运维，无需人工全程值守也能高效运行，提升系统能效；综合化，就是与光伏、储能等其他清洁能源融合，打造多能互补系统，最大化发挥各类清洁能源的优势。

深部地热资源储量更为庞大，属于国家战略能源，但开发技术难度大、前期投入高，适合长远战略布局；浅层地热见效快、普惠性强，能快速落地惠及民生、削减碳排放，二者是互补共生关系，绝非相互替代。未来要坚持“浅、中、深并举”的发展思路，浅层聚焦民生应用，快速实现减碳降污、改善民生；深部聚焦技术攻关，做好战略能源储备，形成梯级开发、协同发力的产业格局，最大化释放地热资源的综合价值。

本刊访谈组：在您深耕地热领域数十年的视角下，浅层地热能开发利用的核心价值究竟是什么？

汪集暘院士：浅层地热的核心价值，远不止单纯的能源供给，而是生态价值、民生价值、战略价值的三重叠加，这也是它区别于其他清洁能源的核心特质。

从生态价值来看，浅层地热是典型的低碳、零碳能源，开发利用过程几乎不产生废气、废水、废渣，无需燃烧化石能源，能大幅削减碳排放与大气污染物排放，是守护绿水青山、助力实现“双碳”目标的硬核手段，彻底破解了长期以来能源发展与环境保护相互矛盾的难题。

从民生价值来看，它精准贴合老百姓最基本的冷暖需求，供暖制冷稳定舒适，后期运维成本低廉，城乡通用、老少皆宜。既能根治北方农村散煤

供暖的污染顽疾，又能补齐南方冬季无集中供暖、夏季制冷能耗偏高的民生短板，是真正普惠大众的“暖心能源”，让清洁能源的红利实实在在落到千家万户。

从战略价值来看，浅层地热是我国自主可控的本土资源，分布广泛、不依赖进口，不受国际能源局势波动影响，是筑牢国家能源安全底线的重要支撑。同时，它能带动上游勘探、中游设备制造、下游工程运维全产业链发展，创造大量就业岗位，助力乡村振兴，实现生态、民生、经济三大效益协同统一，这也是其最核心、最不可替代的价值所在。

本刊访谈组：您不仅是科研大家，还培养了大批地热领域的青年人才，对于现在投身地热、尤其是浅层地热研究的年轻学者和从业者，您有什么寄语和建议？您对地热发展的愿景是什么？

汪集暘院士：地热是实打实的朝阳产业，未来发展前景无比广阔，年轻人选择投身这个领域，是选对了方向、很有眼光。这里我给年轻学者和从业者三句由衷的建议：

第一，务必扎根实践，杜绝纸上谈兵。地热研究从来不是坐在办公室里核算数据、研读论文，离不开野外实地勘探、工程现场实操，要多跑一线工地、多接触真实地层，把书本理论与实际应用深度结合，才能做出真正有用、贴合需求的科研成果。

第二，坚守科研初心，耐得住寂寞。无论是科研攻关还是产业推广，都不是一朝一夕就能见效的，不可能一蹴而就，要沉下心打磨技术、深耕行业，摒弃急功近利的心态，唯有长期坚守，才能收获实实在在的成效。

第三，胸怀家国大局，紧盯国家需求。做科研不能单纯为了发表论文，要聚焦实用科研、攻克实用技术，把个人成长融入国家能源事业发展与“双碳”战略布局之中，才能真正实现个人价值。

我希望年轻人敢闯敢试、勇于突破，全力攻克行业卡脖子技术，把我国地热事业推向新的高度，让清洁能源惠及更多百姓。

我这辈子的愿景很朴素，就是让地热走进千家万户，彻底破解清洁供暖制冷的民生难题。未来五到十年，我期望浅层地热能成为城乡建设供冷供暖的主流方式，北方地区彻底告别散煤供暖污染，冬日常驻洁净蓝天；南方地区也能用上舒适低碳的地热空调，摆脱冬季湿冷、夏季闷热的困扰。同时，我期待我国建成完整的浅层地热全产业链，技术水平领跑全球，行业标准走向世界，把地热打造成亮眼的“中国名片”。

地热是大地赐予我们的绿色财富，我们必须合理开发、妥善利用，既要守护好绿水青山，也要筑牢国家能源安全底线，这是我们这代地学人的使命，更是代代地热人需要传承下去的责任。

以新质生产力推动首都经济高质量发展

本刊编辑部综合报道

1月26日上午，市政协十四届四次会议举行“大力发展新质生产力，扎实推动首都经济高质量发展”专题座谈会，委员们踊跃发言，绿色、智能、科技、协同等成为关键词。

“北京目前已率先实现全域清洁供暖，空气质量改善有目共睹。这期间，新质生产力催生了以浅层地能替代化石能源、以无燃烧替代燃烧供暖的绿色产业。”会上，来自特邀界别的市政协委员、中国恒有源发展集团董事局主席徐生恒就推动绿色供暖产业发展提出建议。

徐生恒介绍，地能是地下低于25℃的低温热能，属于无燃烧供暖，与传统燃烧供暖的方式有本质区别。“地能热泵供暖是跨部门、跨行业的系统换代工程。”为此，他建议完善跨部门政策协同机制与标准体系，制定更加高效的专项审批办法，助力地能热泵供暖规模化发展。徐生恒还建议，明确地能热泵供暖收费政策与补贴标准，“尤其是针对农村地区，制定村民更新地能热泵产品的补贴政策，让绿色供暖惠及更多百姓”。

来自科技界别的市政协委员、京东方科技集团股份有限公司执行副总裁冯莉琼就加快人工智能与高端制造深度融合提出建议。她谈到，北京高端制造企业集聚、创新资源富集，具备走在前列、打造全国乃至全球样板的基础与责任。冯莉琼建议，围绕“人工智能+制造”设立分层分类专项支持计划，对企业智能化基础设施建设给予补贴支持；

引导企业优先接入并参与共建北京市统筹推进的十万卡级国产智算集群，加速工程化落地。同时，探索“市级产业基金+专项资金”组合，支持行业大模型与智能体等关键能力研发，形成可持续投入机制。

“一个好案例胜过一沓文件。”冯莉琼建议，打造北京“人工智能+制造”标杆案例库，形成示范效应，并鼓励将经市场验证的自主创新AI产品与服务纳入采购与推广目录，加速优秀产品规模化应用。

来自民建界别的市政协委员、中央财经大学金融学院教授郭田勇就构建科技金融体制提出建议。

“当前，新一轮科技革命和产业变革正在加速重构全球创新版图、重塑全球经济结构。通过金融手段引导资本投向前沿技术和关键领域，有利于优化产业结构、提高生产效率、创造新的产业增长点。”郭田勇建议，银行应在科技金融体系中发挥更加积极的作用，以服务科技创新为战略任务，为科技型企业提供全生命周期综合金融服务。

“科技型企业普遍经历种子期、初创期、成长期、成熟期等发展阶段，具有投资风险高、回报周期长等特点。”郭田勇表示，银行可在政策支持及合规框架下，通过设立金融资产投资公司的方式，开展股权投资，支持科技型企业发展。

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深耕浅层地热能 领航清洁 供暖新赛道——恒有源以 技术创新与模式革新赋能 地能生态供暖产业高质量发展

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在“双碳”战略纵深推进、“十五五”规划全面开局，以及2026年4月22日中共中央办公厅、国务院办公厅《关于更高水平更高质量做好节能降碳工作的意见》落地实施的关键节点，地热能作为清洁低碳、稳定可靠的可再生能源，正迎来政策加持、市场扩容、技术迭代的历史性发展机遇。恒有源科技发展集团有限公司作为国内浅层地热能供暖领域的先行者，深耕行业多年，始终以原创技术为内核、标准化建设为抓手、模式革新为动力，长期专注于浅层地热能采集原创技术的产业化发展，所推广的暖保证、冷兼有的“地能生态供暖”取得了研发和应用的系列成果，是新时期继高碳高污染的传统供暖、低碳低污染的清洁供暖发展阶段之后形成的零碳再生的清洁供暖的升级形态。集团致力于在中国北方冬季取暖地区，因地制宜采集浅层地能（热）替代化石能源，大力推广与燃煤成本相当的“地能生态供暖”热冷系统一体化新兴产业，以生态用能、道德用能践行能源革命与民生保障，

为服务国家能源安全新战略、更高水平更高质量推进节能降碳、实现碳达峰碳中和目标贡献企业力量。

一、时代背景：顶层政策叠加，地热能迎来黄金发展期

2026年是“十五五”规划开局之年，也是我国迈向碳达峰目标的攻坚之年。《中华人民共和国国民经济和社会发展第十五个五年规划纲要》明确提出，要加快构建清洁低碳安全高效的新型能源体系，建设能源强国，积极推进光热发电和地热能利用，提高终端用能电气化水平，推动能源消费绿色化低碳化。

《关于更高水平更高质量做好节能降碳工作的意见》进一步作出顶层部署，强调一以贯之坚持节约优先方针，将节能降碳贯穿经济社会发展全过程各方面，统筹节能降碳与能源绿色转型，严格控制化石能源消费，深入推进减煤控油，积极推动存量

燃煤锅炉、工业窑炉清洁替代与散煤替代，因地制宜推进非化石能源供热替代，加强建筑节能降碳与清洁取暖改造，推进零碳园区建设与“以绿制绿”模式发展，为地热能产业指明刚性需求与发展方向。

在国家政策引领下，北京、河北、山西、山东、河南、重庆等省市纷纷将地热能纳入“十五五”重点发展方向，推动地能与风、光、生物质等多能互补、融合发展。随着《中华人民共和国能源法》施行、《中华人民共和国可再生能源法》修订完善、《推动热泵行业高质量发展行动方案》等政策接续发力，叠加零碳园区、新能源+产业等配套激励，地热能开发利用潜力加速释放。预计到2030年，我国地热能利用在一次能源消费中占比将达到3%，成为新型能源体系建设的核心支撑之一。

浅层地热能分布广、储量大、清洁环保、稳定可靠，尤其适配北方冬季清洁供暖需求。在“十五五”规划与节能降碳最新政策双重驱动下，浅层地热能产业步入规模化、标准化、智慧化、高质量发展的黄金时期。

二、技术引领：原创核心技术，铸就地能生态供暖

技术创新是地热能产业高质量发展的核心引擎。恒有源立足北京中关村科创高地，持续深耕技术研发，攻克行业共性关键难题，原创研发了“地下水100%回灌单井循环换热”地能采集技术，是适配浅层地热能开发的核心技术，适用于透水性适宜的地质条件，从根本上破解传统地热开发中地下水回灌难、热平衡难维持、水资源不可持续等瓶颈，实现环保效益与能效水平的双重突破，成为企业立足行业的核心竞争力。

新质生产力催生的北方冬季“地能生态供暖”取暖技术与传统供暖相比，实现了“三个替代”：

1、能源替代：以地能（采集来自地下恒温层低于25度的低温热能）替代传统化石能源；

2、产品替代：以安全高效、使用寿命长的热泵替代传统锅炉；

3、取暖热能获取方式替代：通过电力驱动热泵“搬运”地能，替代锅炉高温燃烧化石能源，是匹配对口取暖温度、供暖区域无燃烧、零排放的科学利用生态能源取暖的道德用能。

新质生产力“地能生态供暖”通过集成创新三大供暖系统，构建全谱系、高适配产品体系，可全面满足北方地区冬季自采暖和集中供暖的需求，践行了2016年中央财经领导小组会议上提出的“能源生产和消费革命、农村生活方式革命”及“居民可承受”的要求。具体包含：

1、地能热泵环境系统（适用于城乡集中供暖）：面向城乡集中供暖，满足大型社区、公共建筑、产业园区规模化供暖需求，支撑区域能源集中供应与高效管控；

2、地能热宝系统（适用于农村散户自采暖）：面向农村散户清洁取暖，实现独立计量、分间控温，精准匹配农村用能需求，助力乡村振兴与散煤替代；

3、分布式地能冷热源站系统：适配统一规划、分期投入场景，兼顾灵活性与经济性，助力区域供暖统筹布局。

三大系统供热量覆盖5.6kW-2,500MW，供暖面积覆盖40m²-5,000万m²，全方位满足新时代北方清洁供暖、建筑节能降碳、零碳园区建设等多元需求。集团秉持“技术领先、标准当家、产品安全、服务保证”理念，拥有机电工程施工总承包、机电专业承包、维修清洗等全流程完备资质体系，并参编多项国家、地方及团体标准，以技术合规与标准引领支撑产业规范发展。

三、模式创新：三商战略协同，构建全链条产业生态

抢抓“十五五”地热能规模化发展机遇，恒有源创新实施“三商”发展战略，打造市场化、多元化、可持续的产业生态，打通技术下沉、市场拓展、价值共享通道：

1、县级地能采集区域代理商：聚焦北方供暖核心区域，授权推广原创地能采集技术产品，打通技术落地“最后一公里”；

2、地能热泵项目独家代理商：依托成熟产品与工程经验，赋能代理商快速复制、高效落地；

3、区域发展合作商：联动产业链上下游，构建“设备供应、工程施工、运维服务”一体化全链条合作生态。

为保障“三商”战略落地，集团组建专项服务团队，提供技术培训、项目对接、资质支持、售后保障等全周期服务，并配套完善标准协议，规范合作流程、明晰权责利益，形成公平、共赢、可持续的合作格局。

业务布局方面，构建“产品+工程+运维+服务”多元协同格局，境内业务覆盖技术服务、产品销售、项目运维、工程施工、租赁等板块，结构均衡。集团坚守“供暖是必需品，要在最恶劣气候条件下，确保把党的温暖送到千家万户”的供暖理念，通过专业化运维与大数据平台保障，高效管理大量机房、主机与采集井，服务数千户居民，以优质服务树立行业口碑。

四、数字赋能：智慧转型升级，提质增效助力节能降碳

紧跟产业数字化、智能化浪潮，恒有源主动推进数字赋能，布局两大核心板块，以数智化驱动产业提质增效：

1、打造暖冷工业品超市：提升供应链协同效率；

2、上线热泵维修线上平台：实现客户报修、抢单派单、维修监督、收费回访、绩效兑现全流程线上化，推动运维服务向智能化、便捷化、高效化转型。

数字化转型深度契合节能降碳的最新要求，通过大数据分析 with 智能调控，实现地能热泵系统的精准能效管理，进一步降低能耗与碳排放，为地热能产业的智慧化、精细化发展提供可复制路径。

五、展望未来：锚定“双碳”目标，共筑绿色能源新未来

“十五五”时期，我国将全面实施碳排放总量和强度双控制度，推进碳考核、行业碳管控、企业碳管理、项目碳评价、产品碳足迹等制度落地。地热能作为稳定可靠的可再生能源，将在新型能源体系建设与节能降碳工作中承担更重要使命。

恒有源将始终秉持发展地能生态供暖热冷一体化新兴绿色产业使命，以原创技术为核心、三商战略为引擎、数字化转型为支撑，深度对接国家“十五五”能源规划与更高水平更高质量节能降碳工作要求，全力服务碳达峰碳中和大局。未来，集团将持续优化境内布局、聚焦核心业务、提升运营效率；持续深耕研发、推动技术创新与标准升级；持续拓展市场、让更多区域与用户用上清洁、高效、经济、安全的地能生态供暖服务。

在推进更高水平更高质量节能降碳、建设清洁低碳安全高效新型能源体系的征程上，恒有源将与行业同仁携手并进，共推地能生态供暖产业高质量发展，为实现人与自然和谐共生的中国式现代化贡献坚实力量。

闪光的足迹——武强院士 2025 年的履职调研

本刊编辑部

2025 年，全国政协委员、中国工程院院士、中国矿业大学（北京）内蒙古研究院院长武强立足能源绿色低碳转型核心使命，聚焦浅层地热能开发利用开展全国多地履职调研，深挖浅层地热能分布式应用优势，结合内蒙古农村牧区地域特点提出落地推广方案，并形成两会提案推动科研成果转化。本文梳理武强院士全年调研历程，展现其以地热技术破解能源转型难题、助力传统能源大区绿色升级的履职实践与行业担当。

一、调研开篇：锚定地热赛道，破解转型痛点

能源绿色低碳转型是我国实现“双碳”目标的核心抓手，浅层地热能作为储量大、分布广、清洁稳定的可再生能源，是破解城乡供暖制冷能耗高、化石能源依赖度大的关键路径。2025 年，武强院士紧扣国家能源战略部署，以全国政协委员与能源领域专家的双重身份，将履职调研重心聚焦浅层地热能开发利用，足迹遍布全国各大能源省区，深入一线摸清资源禀赋、技术瓶颈与应用场景，探寻能源产业高质量发展的务实路径。

据内蒙古新闻联播报道，武强院士通过 2025 年密集调研得出核心结论：地表以下 200 米范围内、水温低于 25℃ 的浅层地热能，具备极强的实用推广价值。依托 1-2 口勘探井搭配成熟热泵技术，即可实现建筑供暖、制冷、生活热水“三联供”，整套系统无需大范围管网联网，运维便捷、投入可控，高度适配内蒙古地广人稀的农村牧区地理特征，既能精准满足农牧民生产生活用能需求，又能赋能特色农业提质增效，为边疆地区能源清洁替代提供了可行方案。

二、深耕一线：全域调研积淀，凝练技术思路

武强院士长期深耕能源绿色低碳转型与化石能源高效利用领域，2025 年的履职调研坚持问题导向、实地为先，从京津冀都市圈到齐鲁大地，从山城重庆到内蒙古能源产区，全方位考察浅层地热能的城市建筑、乡村民生、产业配套中的应用成效，积累了大量一手数据与实践经验。

2025年秋季，武强院士在北京四季青镇开展的浅层地热能供暖专项调研，让其对该技术的民生价值与推广潜力有了更深刻的认知。此次调研重点考察浅层地热能替代煤炭、天然气等化石能源的实际效果，聚焦能源高效利用、减污降碳协同增效核心目标，进一步验证了浅层地热能“低成本、零污染、易推广”的技术优势，也坚定了其将成熟经验向内蒙古等能源大区推广的决心。

“浅层地热能是指地面以下 200 米以浅、水温低于 25℃ 的地热资源，通过专用热泵系统，可实现一套设备同步解决建筑供暖、制冷与生活热水供应，兼具经济性与环保性。”两会召开前夕，武强院士仍在细化浅层地热能应用技术方案，系统梳理重庆、山东、京津冀等地区城乡应用的成功案例与技术参数，结合内蒙古资源禀赋与用能特点，优化适配性开发模式，形成完善的提案素材，全力推动科研成果从实验室走向田间地头、牧区民居。

三、靶向发力：立足内蒙古，赋能能源转型升级

内蒙古作为我国传统能源大区，兼具丰富的可再生能源资源，在新型能源体系建设中肩负重要使命。武强院士在调研中指出，内蒙古幅员辽阔、居住分散，恰恰契合浅层地热能分布式开发、无需大联网的技术特性，推广应用前景广阔。通过简易钻井工程搭配成熟热泵技术，就能高效开发地下 200 米以内的浅层地热资源，既解决农牧民冬季供暖、夏季制冷的刚需，又能拓展温室种植、畜牧养殖等特色农业用能场景，助力乡村振兴与能源转型双向赋能。

2025 年，武强院士的调研足迹延伸至鄂尔多斯风光能源基地、蒙西电网枢纽等重点区域，全程见证能源产业全生命周期智能化变革进程。依托中国矿业大学（北京）内蒙古研究院的科研平台优势，他不仅推动浅层地热能技术落地攻坚，还同步助力智能矿山装备应用、煤炭清洁高效利用、矿区生态修复等重点工作，构建传统能源与清洁能源协同发展的新格局。

“内蒙古在传统能源提质、清洁能源开发方面均走在全国前列，下一步要借助 AI 等智能技术赋能，优化可再生能源开发规模与布局速度，让地热等清洁能源成为能源转型的核心动能。”武强院士表示，将把 2025 年履职调研成果转化为务实提案，持续推动浅层地热能内蒙古农村牧区规模化推广，助力传统能源大区打造绿色低碳能源新样板，为全国可再生能源多元化利用提供示范经验。

四、履职初心：以地热之光，照亮转型之路

从都市建筑到牧区毡房，从科研院所到能源一线，2025 年武强院士的履职足迹，镌刻着能源专家的责任担当与政协委员的为民初心。他以浅层地热能突破口，打通科研成果与民生应用的最后一公里，既破解了边疆地区清洁用能难题，又为我国地热产业分布式发展、全域化推广提供了实践参考。未来，随着相关提案落地与技术迭代，浅层地热能必将在能源绿色转型中发挥更大作用，书写清洁低碳、安全高效能源体系建设的新篇章。

封闭换热地能采集器地能 热宝变频多联机系统 低温 极端工况供暖的实验研究

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摘要：封闭换热地能采集器是一种新型的浅层地能采集装置^{[1]、[2]}，地能热宝变频多联机是一种性能稳定、节能环保的热泵产品。为研究封闭换热地能采集器与地能热宝变频多联机匹配的系统在低温极端工况下的运行稳定性等性能参数，作者借助北京香山别墅已有建筑为实验测试平台，通过现场实测获取运行数据，结果表明：地能采集装置运行稳定可靠、机组节能性好、供暖温度满足设计温度要求；地能热宝变频多联机可适配多种建筑场景的供暖需求，具备良好的极低温工况适应能力，无需针对低温极端环境另行开发专用地能热宝机型，有效降低了产品研发与配套改造成本，为前景广阔的新产品规模化推广与应用提供了良好的技术支撑。

关键词：低温极端工况；封闭换热地能采集器；地能热宝变频多联机；节能低碳

1 前言

1.1 研究背景

浅层地热能作为清洁可再生能源，结合热泵技术应用于建筑供暖，具有运行稳定、节能减排等突出优势，可有效替代化石能源，是推动可再生能源规模化应用、构建绿色低碳供热体系的重要路径，也是未来绿色建筑发展的核心方向之一。

封闭换热地能采集器不取地下水、无需回灌，相较于传统 U 型地埋管换热器，具备单位延米换热量大等优点。而地能热宝变频多联机可实现室内机独立启停、室温灵活调节，能依据房间供暖需求动态调节换热量，进一步提升系统节能效益，可广泛适配学校、办公楼、酒店、别墅等分散式供暖应用场景。

1.2 研究现状

封闭换热地能采集器是一种新型的单井循环换热装置，文献^[2]对该装置的技术特点进行了介绍，未见有相关的实验研究情况，特别是针对其低温极端工况下运行稳定性缺乏研究。文献^[3]提出了我国浅层地热能成因类型大地分区方案，指出浅层地热能开发利用适宜区的常温层原始温度介于

5~10℃，受该温度区间下限影响，热泵机组实际运行时供水温度易降至 5℃以下，而现行《水（地）源热泵机组》GB/T19409-2013 规定的最低运行工况为 5℃，致使实际低温运行工况与现有标准设定工况存在明显偏差。

基于上述研究不足，本文聚焦封闭换热地能采集器与地能热宝变频多联机组合系统，针对低温极端工况开展实验研究，为该类供暖系统的规模化推广提供参考与支撑。

1.3 名词定义

低温极端工况：指冬季制热模式下，热泵机组热源侧进水温度低于国标规定最低工作温度 5℃、降至 0℃及以下的极限运行工况，综合文献 [4]、[5] 及实际地源热泵工程运行特征，本实验将低温极端工况下地埋管进入机组的防冻液温度设定为 -5℃ ±3℃。本次测试覆盖供暖季室外低温时段。

1.4 研究内容

本文研究内容如下：

(1) 研究封闭换热地能采集器地能热宝变频多联机系统在热源侧进水温度 -5℃ ±3℃工况下的运行稳定性等性能参数。

- (2) 分析地能热宝变频多联机的节能性能。
- (3) 实测室内供暖温度达标情况。

2 实验系统搭建

2.1 实验地点概况

实验地点设于北京香山别墅，建筑为地下一层、地上三层结构，地上三层建筑面积约 446m²。冬季采暖室外计算温度取值为 -9℃，室内设计采暖温度按舒适采暖标准设定为 20℃；建筑冬季总采暖热负荷为 23.2kW，采暖热负荷指标约 52W/m²。

场地地层自上而下划分为：地表至 50m 深度范围内为回填土与岩土层，50m 以下为基岩。

2.2 系统构成

系统主要由封闭换热地能采集器、二次循环模块、补水定压产品、地能热宝变频多联机组成。封闭换热地能采集器有效深度为 47 米，系统冰点温度约 -18℃。系统配置表见表 1，系统示意图见图 1。

表 1：系统配置表

序号	模块名称	参数
1	封闭换热地能采集器	井深 47 米，外管径 194mm。设计满足低温极端工况条件。
2	二次循环模块	流量 6m³/h、扬程 17m、功率 1300W。
3	补水定压产品	膨胀水箱 0.25m³。
4	二次网配件	DN50 钢管连接件。
5	地能热宝变频多联机	①室外机制热量 30kW、功率 7.8kW；制冷量 28kW、功率 6.2kW。 ②室内机为 9 台 3.75kW 卧机。
6	三次网配件	铜管、分歧管、装饰管。
7	电气配件	电源箱 20A（380V）、配套电缆、信号线。

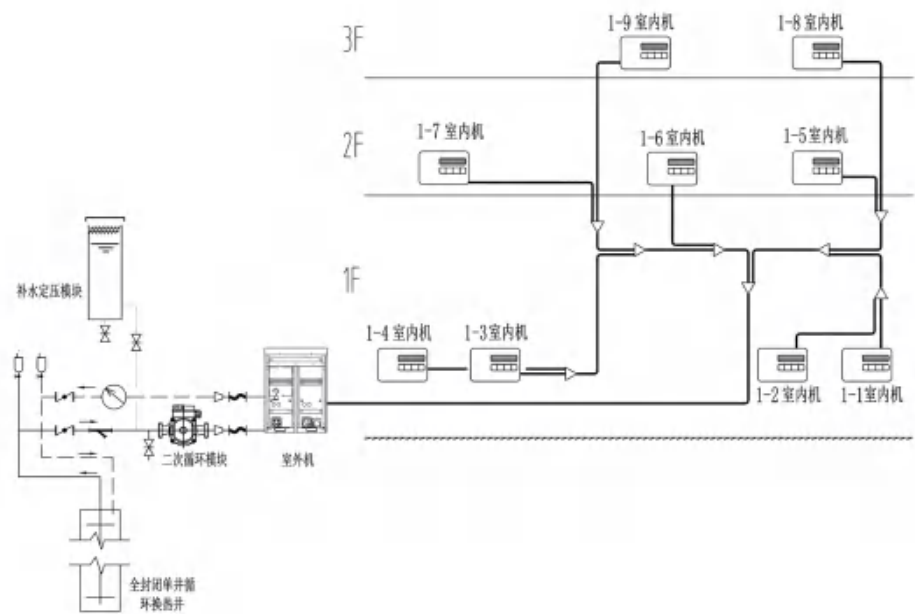


图 1

2.3 封闭换热地能采集器

封闭换热地能采集器井壁管为钢管，采用一次跟管成井和钻井底部密封技术，形成高效的全封闭换热采集器，示意图如图 2 所示，其中“1”为内管，“2”为外管。现场施工图见图 3。

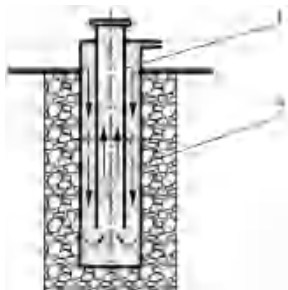


图 2



图 3

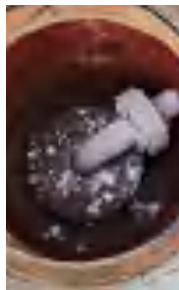


图 4

封闭换热地能采集器井壁管为钢管，施工采用一次跟管成井和钻井底部密封技术，形成高效的全封闭换热采集器。在单井换热管（外管）中安装导水管（内管），导水管底部与单井换热管连通，井底采用“密封宝”密封，井口安装简易装置，形成独立封闭循环回路。循环介质（水与乙二醇混合液）沿外管与内管之间的环形空间向下流动，与周围岩土换热升温后，经内管返回机组。该结构相较于传统 U 型地埋管换热器，单位延米换热量更大，有利于浅层地热能的推广应用。封闭换热地能采集器井室如图 4 所示。

2.4 地能热宝变频多联机

2.4.1 工作原理

地能热宝变频多联机以水（地）源作为冷热源，依靠变频压缩机驱动制冷剂闭式循环，采用单台室外主机搭配多台室内机的形式，构成一拖多空气调节设备。冬季制热工况下，系统从地层土壤／地下水中汲取低位清洁能源热能，经变频压缩机做功升温后，向室内空间输送供暖热量；机组可依据室内实时负荷变化，动态调节压缩机运行频率与系统冷媒循环流量，实现各室内机独立分区控温、按需精准供能。

2.4.2 产品特点

该产品将地源热泵技术与直流变频多联技术深度融合，具有操作灵活、精准控制、安装便捷等优势，集成了地源机组高效节能与多联机组灵活可控的双重特点。图5为现场主机安装图、图6为现场室内机安装图。



图 5



图 6

3 实验方案

3.1 测试布点

测试布点见表 2。

表 2：测试布点表

序号	项目	分项	记录频次／方式	仪表安装位置
1	室外环境温度	室外环境温度	连续测量	院子西侧外墙
2	地源侧温度	封闭换热地能采集器供、回水温度	连续测量	采集井供、回水管
3	室内温度	室内房间温度（共 7 个测点）	连续测量	各房间桌上，距地面高约 1.2m
4	电量	热泵系统总电量	手动记录	系统配电箱
5	功率	水泵功率	手动记录	钳形电流表现场测量并记录
6	水流量	地能换热介质流量	手动记录	机组总供、回水管
7	补水罐液位	补水罐液位检测	目测	花坛西北角
8	机组参数	供水温度、回水温度、蒸发温度	连续测量	地能热宝变频多联机组
9	冰点温度	冰点温度	手动测量	冰点测量仪

注：按照《公共建筑节能检测标准》JGJ/T177-2009 要求布置室内温度点，室外测点避免太阳直射以保证环境温度的真实性。

3.2 测试仪表参数

测试仪表精度参数见表 3。

表 3：测试仪表精度参数

序号	仪表名称及型号	精度
1	温度计（RC-4HC、RC-4）	在 -20℃ ~40℃测温范围内，精度为 ±0.5℃；其余 ±1℃。
2	电量表	精度等级 1 级，额定电流 Ib~Imax（标定电流至最大电流）：±1.0%
3	水表	允许最大误差 ±2%
4	钳流表	±1.0%FS（满量程）
5	冰点测量仪	示值误差 ±0.5℃
6	机组温度传感器	±0.1℃

3.3 测试时间

2025 年 12 月 8 日－2026 年 3 月 10 日，共计 93 天。

3.4 测试项目

测试项目包括：室外温度、室内房间温度、封闭换热地能采集器供／回水温度及水流量、地能热泵变频多联机系统耗电量、补水罐液位、机组参数。

3.5 数据处理方法

(1) 系统及机组运行功率

测试周期内用电量除以测试时长，得到运行平均功率；用仪表测量循环水泵电流并计算循环水泵功率，室内机功率采用机组标示的额定功率。机组运行平均功率 = 系统平均功率－循环水泵功率－室内机功率。

(2) 机组制热量

地源侧换热量计算公式：
 $Q_g(kW)=1.163\times qV(m^3/h)\times \Delta t(^{\circ}C)$ ；

●qV 为水表测试所得的平均水流量

●Δt 为机组入、出水温差

(3) 单位面积耗电量

单位面积耗电量 = 系统总消耗电量／建筑面积。

4 实验结果与分析

4.1 实验结果

(1) 室外温度：最高 19.2℃，最低 -13.4℃，平均 1.5℃。温度曲线见图 8。

(2) 封闭换热地能采集器供、回水温度：

●供水温度见图 9：最高 -3℃，最低 -8.2℃，平均 -6.5℃。

●回水温度见图 10：最高 -4.1℃，最低 -8.5℃，平均 -7.7℃。

(3) 室内房间温度：7 个测点平均温度 21.1℃。各房间温度详见表 4。

(4) 水流量：测试期间 5 次测量平均值为 5.4 m³/h。

(5) 系统耗电量及功率：93 天总耗电量 14955 kWh，系统平均功率 6.7 kW，机组平均功率 5.9 kW。

(6) 定压补水罐液位：测试期间液位无明显变化。

(7) 机组参数：平均供水温度 -4℃，平均回水温度 -5.7℃；冷媒蒸发温度最高 -7.1℃，最低 -9.4℃。

(8) 循环介质冰点温度：实测约 -18℃，低于最低室外环境温度。

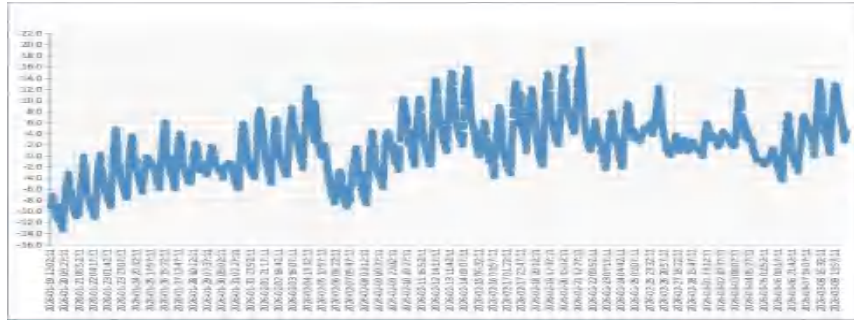


图 8

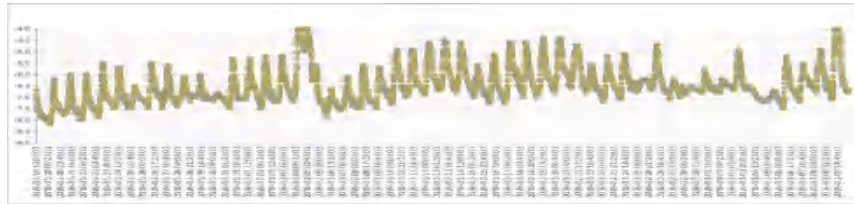


图 9

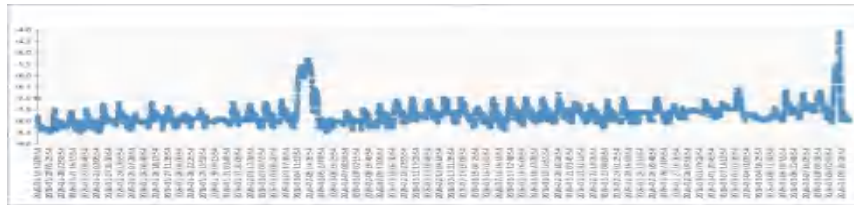


图 10

表 4: 室内温度测试表 (温度/℃)

房间 温度	餐厅	棋牌室	二层 南卧室	二层 东北卧室	二层 西北卧室	三层 南卧室	三层 北卧室
最高温度	25.3	30	32.4	28.5	27.4	29.5	28.9
最低温度	16	11.7	17	19.32	16.6	13.4	16.3
平均温度	19.4	20	21.9	23.4	21.2	20.9	20.8

4.2 实验分析

(1) 系统运行工况分析

测试时间内, 封闭换热地能采集器供水平均温度 -6.5°C , 满足设定的 $-5^{\circ}\text{C} \pm 3^{\circ}\text{C}$ 工况条件。期间, 室外平均温度 1.5°C , 最低实测温度 -13.4°C , 最低温度发生在 2026 年 1 月 20 日早晨 7 点。查询 2025 年至 2026 年海淀区供暖季历史气象数据, 最低温度为 -13°C (2026 年 1 月 20 日)。表明测试期间覆盖了所在区域供暖季低温时段。

(2) 机组运行情况分析

对机组运行工况及封闭换热地能采集器供、回水温度进行分析，有两个时段水温出现了明显上升，第 1 个出现在 2026 年 2 月 4 日，主要原因为室外温度上升明显，此阶段供、回水有温差，机组压缩机以低频率运行；第 2 个出现在 3 月 9 日，主要原因为室外温度上升，室内温度也上升明显，供、回水基本无温差，机组到温停机。由供水温度变化曲线可知，机组运行正常，未出现故障停机的情况。

(3) 定压补水罐液位分析

定压补水罐液位无明显变化，表明系统循环流体（水与乙二醇混合液）无渗漏，封闭换热地能采集器钻井底部密封技术在冬季极端工况条件下密封可靠。

(4) 室外环境温度对封闭换热地能采集器温度影响分析

拟合室外环境温度与封闭换热地能采集器供水温度曲线如图 11 所示。其中蓝色曲线为室外环境温度，黄色曲线为封闭换热地能采集器供水温度；黑色横线分别为室外环境平均温度 1.5℃温度线、封闭换热地能采集器供水平均温度 -6.5℃温度线。A、B、C 三处分别对应测试期间室外环境温度出现的三个低温特征点。从曲线特征可以看出：尽管封闭换热地能采集器供水温度随室外环境温度走低略有下降，但整体变化幅度极小。室外环境温度的低温波动，对封闭换热地能采集器供水温度降幅的影响可忽略不计。

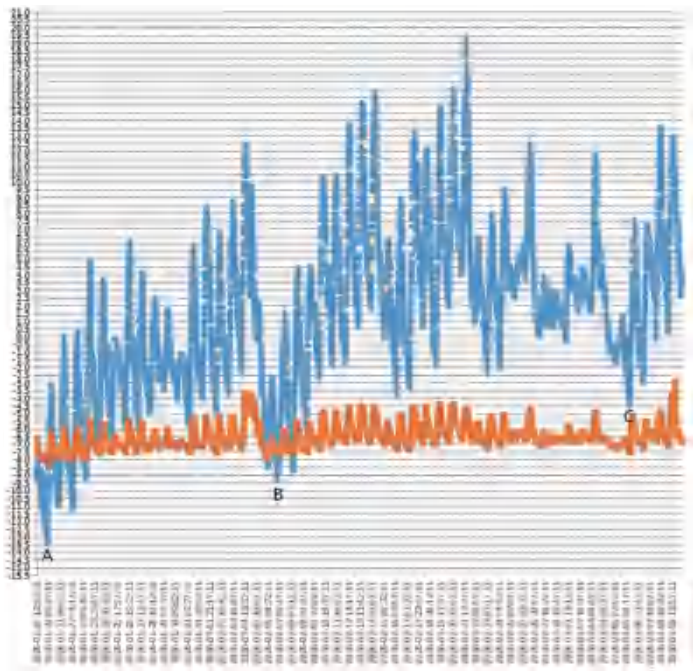


图 11

(5) 耗电量分析。93 天系统总耗电量 14955kWh, 单位面积耗电量为 33.5kWh/m²。

(6) 性能参数。测试性能参数见表 5。

表 5：测试性能参数

序号	参数	单位	测试值	备注
1	地源侧平均换热量	kW	10	延米换热量为 212.8W/m
2	系统平均制热量	kW	15.3	
3	机组平均 COP	kW/kW	2.6	
4	系统 COP	kW/kW	2.3	
5	机组平均功率	kWh	5.9	内机 + 外机功率
6	系统平均功率	kWh	6.7	内机 + 外机 + 水泵功率

结合市场调研情况来看，市面风机盘管型低温空气源热泵名义工况 COP 为 2.4 ~ 2.5；地能热宝变频多联机在极端低温工况下平均 COP 可达 2.6，能效水平优于低温空气源热泵名义工况性能。地能热宝变频多联机名义工况 COP 达 3.85，节能优势突出。

(7) 室内供暖温度情况分析

测试期间，室内 7 个测温布点平均温度为 21.1℃，满足设计标准及室内供暖温度要求。其中棋牌室最低室温偏低，主要受西侧大门频繁开启、机组设定供暖温度偏低双重因素影响，三层南卧室最低室温偏低，原因是测试期间存在人为手动关停室内机的操作。

2025 - 2026 年供暖季北京未出现达到或接近近十年历史极端低温的天气。北京市近 10 年极端低温为 -19.6℃（出现于 2021 年 1 月 7 日）；2025 - 2026 供暖季北京最低气温为 -12.6℃，出现在 2026 年 1 月 21 日（数据来源：北京市气象台）。因此，本次测试所得室内供暖平均温度仅代表本供暖季气象工况下的系统运行水平。

5 结论与展望

5.1 结论

(1) 运行稳定性：系统在 93 天极端工况测试中全程无故障停机、无保护动作。定压补水罐液位无变化，验证了井底密封可靠性。室外低温波动对地埋管供水温度影响极小，热源稳定性优异。

(2) 节能性：极端工况下机组实测 COP 为 2.6，优于低温空气源热泵名义工况能效，结合无需除霜等优势，具有显著的节能效益。

(3) 供暖效果：测试期间室内平均温度 21.1℃，满足室内温度 20℃设计目标，系统可在极端工况下保证供暖效果。

5.2 展望

建筑领域是热泵应用最主要的场景，但当前热泵在建筑供暖领域渗透率不足 5%^[6]。水（地）源热泵供暖作为新兴的节能低碳产业，具有显著的经济效益和社会效益，应用潜力较大。封闭换热地能采集器不受地质条件限制，单位延米换热量优于传统 U 型地埋管；封闭换热地能采集器地能热宝变频多联机系统不仅节能优势显著，还可在极端工况下持续稳定供暖，无需针对极端低温环境另行开发专用机型，有效降低了产品研发与配套改造成本，在学校、办公、酒店、别墅等分散式供暖场景中具有良好的推广应用前景。

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封闭换热地能采集器

作者：王学志

一、概述

封闭换热地能采集器是一种先进的浅层地热能采集技术。该技术采用单一钻井孔和完全封闭的循环回路，通过置于井内的专用换热管道与浅层地下的岩土体进行充分的热交换，从而实现稳定、高效且环境友好的热能持续提取。其钻井深度一般在400米以内。整套系统具有结构设计简洁、工程施工周期较短、初期投资较低、长期运行安全可靠等突出优点，非常适用于各类建筑的冬季供暖、夏季制冷以及全年生活热水供应等多种需求，是构建现代绿色低碳建筑能源系统的优选技术方案之一。

二、结构与工作原理

在换热井内安装单井换热管，其内部设同轴导水管，导水管底部与单井换热管下部连通，井底用“密封宝”组件密封，井口装简易控制装置，共同构建独立密闭的循环换热回路。

在循环泵驱动下，低温循环介质（通常为水或防冻液）沿单井换热管与导水管间的环形空间（以下简称：环空）向下流至井底，过程中通过金属管壁与周围地层岩土热交换，吸收地层热量升温。到达井底后，介质折返进入导水管内腔，向上回流至地面。升温介质回地面后，进入热泵机组设备，向建筑供热系统释热。降温后的介质再被泵入环空，开始新循环，形成连续、稳定、高效的封闭式热能采集循环。

该过程中，循环介质在密封管道内运行，与地下水不接触，对当地地下水资源和地质环境无负面影响。

三、主要技术特点

1、取热不取水，生态友好性

取热过程中，换热介质不接触地下水、不接触岩土体，彻底避免了地下水的开采与回灌操作，不会扰动和破坏天然含水层结构。

2、单井占地面积非常小

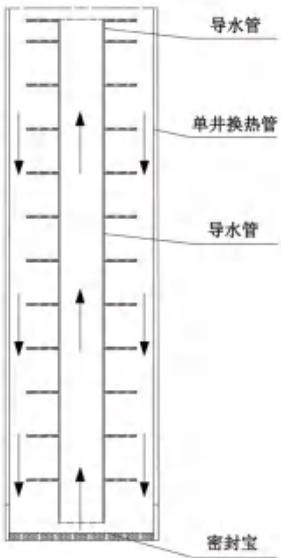
整套系统仅需一个钻孔井位，占地面空间少，特别适合在土地资源紧张的城区、已建住宅小区、校园、医院等场所进行部署应用。

3、闭式循环系统运行稳定可靠

系统内部为密闭洁净环境，杜绝了因水质引起的结垢、腐蚀或堵塞等问题，设备使用寿命长，日常维护工作量小。

4、浅层施工便捷高效

钻井深度浅，所需施工周期短，总体工程造价较低，施工技术难度不大。



四、技术适用条件说明

本技术主要适用于大地表层（一般 400 米以内）的浅层地热能开发利用项目。通常要求项目所在地的地层岩土具备良好的导热性能，且地下水位相对稳定。该技术特别适合于城市各类新建或改造建筑、大型住宅社区、公共建筑（如商场、办公楼、学校）的清洁供暖与空调项目。尤其是在法规明令禁止开采地下水、对生态环境保护要求严格的生态敏感区域、城市建成区以及水资源重点保护区，本技术展现出了不可替代的优势。

五、与其他技术的对比分析

1、与传统地下水地源热泵系统对比

传统地下水地源热泵系统必须开采地下水作为热源，使用后还需进行回灌，常常面临回灌困难、可能引起地下水水质污染、导致地下水位下降等多种风险。而本技术采用全封闭循环，不取水、不回灌，从根源上规避了所有与水文地质相关的问题，系统运行更为稳定可靠，后期运维管理更加简单，项目报批流程也更为便捷。

2、与普通浅层地埋管地源热泵系统对比

传统的水平或垂直地埋管系统需要钻凿数量众多的换热孔，占地面积大，施工布局复杂，对场地要求高。相比之下，本技术单口井的换热能力更强，所需钻孔数量大幅减少，占地面积更小，施工速度更快，可设计性强，在相同供热／制冷规模下，具有更优的综合经济性。

3、与空气源热泵系统对比

空气源热泵系统受气候影响大，运行能耗波动大，长期运行成本偏高；本技术能耗稳定、节能率更高，无气候限制，兼顾冷暖双供，综合运行成本更低，环保效益、长期经济效益优于空气源热泵。

六、节能效益综合分析

将封闭换热地能采集器与高效地源热泵系统相结合，系统综合能效比（COP）通常可以达到 3.5 至 4.5 甚至更高，这一性能指标远高于常规的空气源热泵。

七、全面环境影响分析

1、对水环境的影响

系统全程为全封闭循环，彻底避免了地下水的抽取、回灌以及与地下水直接接触，因此对项目所在区域的地下水文环境、水质及水位不产生任何干扰或影响，从根本上消除了地下水污染、渗漏或水位下降等潜在环境风险。

2、对大气环境的影响

系统运行无任何化石燃料燃烧过程，因此不产生烟尘、二氧化硫（SO₂）、氮氧化物（NO_x）、粉尘以及二氧化碳（CO₂）等大气污染物。

八、社会效益

浅层地热能作为一种清洁可再生能源，在实际应用中能够有效替代煤炭、天然气等传统化石能源，从而大幅减少二氧化碳及其他污染物的排放量，有助于改善区域大气环境质量，提升居民生活舒适度与健康水平。

此外，该技术的推广应用还大力促进了当地能源结构向清洁化、低碳化方向转型，为绿色建筑发展与低碳社区建设提供了可靠的技术支撑，具有明显的示范引领效应和广泛的社会效益。这一发展方向完全符合国家关于清洁能源推广与可持续发展的政策导向，对推动生态文明建设与实现“双碳”目标具有积极意义。

恒有源全面推进融媒体宣传体系建设 赋能浅层地热能清洁能源品牌高质量发展

作者：何天悦

2026年是恒有源科技发展有限公司（以下简称“恒有源”）落地标准化巩固发展战略的关键之年。紧扣国家“双碳”战略目标与北方地区清洁取暖发展大势，集团在持续深耕浅层地热能技术研发、标准化体系建设与市场规模化推广的同时，将企业宣传工作重心全面向网络传播与融媒体建设倾斜。通过搭建全媒体传播矩阵、打造优质品牌内容、强化专业团队建设、创新内容传播形式，全方位构建与企业标准化发展战略相匹配的品牌宣传体系，持续扩大中关村原创浅层地热能采集技术的行业影响力与社会认知度，为“地能热泵无燃烧高效取暖”技术的全国推广筑牢品牌根基。

一、顶层设计先行，构建全维度全媒体传播矩阵

立足企业标准化全国推广的核心战略，集团对现有宣传渠道进行系统性梳理与整合，形成了以“以专业期刊为根基、官方平台为核心、主流社交新媒体为延伸”的立体化传播矩阵。

目前，集团可稳定运营的宣传平台涵盖一家平面专业媒体《中国地热能》杂志，以及九大网络传播平台，包括恒有源官方网站、微信公众号、新浪微博、抖音、快手、小红书、哔哩哔哩、微信视频号、今日头条。实现了从行业垂直受众到社会大众

的全维度覆盖，打通了技术理念、产品价值、品牌形象从行业端到市场端、用户端的传播链路，为企业标准化产品与代理合作模式的全国推广搭建了完善的渠道体系。

二、扎根一线场景，以真实产品力打造品牌核心内容

集团始终以产品真实性能与用户真实体验作为品牌宣传的核心，用一线场景的实证内容传递技术价值。2026年1月9日，集团组建四个专项工作组，在全年气温最低的三九天，先后回访了北京市海淀区罗家坟村、海淀区西闸村、丰台区留民营村、河北定州吴羊平村四大核心项目，与终端用户面对面沟通交流，同步拍摄纪实类短视频内容。

本次回访特意选定三九天开展，核心是以极端低温环境下的系统真实运行效果及用户体验，验证恒有源核心产品的性能优势。回访相关内容聚焦“地能热宝”产品“热保证、冷兼有、费用低”的核心价值，以农户真实使用体验为核心，打造有温度、有说服力的品牌内容，相关视频已在新浪微博等平台正式发布。

（三九天回访相关视频：搜索关键词“地能热宝”，或在小红书，抖音、微博、微信视频号等平台，搜索“恒有源集团”账号。）

三、权威背书赋能，联动主流媒体扩大行业影响力

以核心技术与标杆项目为根基，集团通过权威专家认证与主流媒体联动，提升品牌公信力。2026年2月10日，全国政协委员、中国工程院院士、中国矿业大学（北京）内蒙古研究院院长武强一行，实地走访调研恒有源浅层地热能供暖标杆项目。

调研期间，武院士首先深入北京市海淀区罗家坟村农户家中，与村民亲切沟通，详细了解室内供暖温度、使用成本、日常操作等实际情况，高度评价了恒有源“地能热宝”产品在农村地区的规模化应用，为村民冬季取暖带来的便利与生活品质的提升。随后，武强一行走访了已安全稳定运行26年的集中供暖标杆项目——北京市海淀区外国语实验学校项目，与校领导开展座谈交流，深入调研系统长期运行的稳定性、经济性与环保效益。

本次调研邀请香港大公报记者全程随行采访，记者分别对武强院士、项目农户与学校负责人进行深度专访，全面梳理恒有源原创技术与标准化产品在不同应用场景的落地成效，相关视频新闻已通过大文国际微信视频号等平台正式发布，实现了行业权威声音与主流大众媒体的联动传播，进一步扩大了企业品牌的社会影响力。

四、强化内功建设，完善融媒体人才培养与组织保障

为适配融媒体时代的传播规律，集团同步推进宣传人才队伍建设与组织体系完善，为宣传工作的长效发展筑牢根基。2026年1月22日，集团特邀资深融媒体专家靳智伟，开展主题为“社交媒体的算法和我们的对策——中国恒有源发展集团有限公司新媒体策略”的专项培训。培训围绕社交媒体传播逻辑、算法机制、企业新媒体运营策略等核心内容展开，全面提升了集团员工对融媒体传播的认知水平，帮助团队精准把握新媒体时代的传播机遇，明确了企业融媒体宣传的工作方向与实施路径。



香港大公报记者对武强院士等进行采访



海淀外国语实验学校项目走访照片



海淀区罗家坟村农户家进行走访照片

2026年2月，集团正式成立融媒体工作小组，对企业网络媒体传播资源进行系统性梳理，建立标准化的内容创作、审核、发布全流程管理体系。同时，小组借助春节节点，发起全国各区域员工短视频创作传播活动，充分调动一线员工的传播积极性，形成全员参与的品牌传播氛围，有效扩大了企业品牌的传播覆盖面。3月，将公司春季检修人员的专业操作、设备的运行情况等生动且真实的内容，通过拍摄系列视频和直播的方式，向外界展示公司的专业实力和严谨态度，获万余浏览量，引发行业同仁与用户群体的广泛关注与好评。



万博商厦项目春检工作前安全交底



全国工商联项目春检直播现场

五、创新内容形式，打造多元化品牌传播内容体系

围绕品牌传播核心目标，集团持续推进宣传内容的创新升级，打造适配不同传播平台、不同受众群体的多元化内容矩阵。2026年1月，集团特邀原北京电视台资深摄影记者，量身打造企业品牌宣传短片，全面展现企业技术实力、项目成效与品牌理念，目前短片已通过今日头条平台正式发布。

2026年3月，集团进一步深化内容创新，携手专业短剧制作团队，以“讲好恒有源的供暖故事”为核心主题，启动系列主题短剧的拍摄制作工作。系列短剧通过具象化、故事化的内容形式，生动展现浅层地热能清洁取暖技术的应用价值与民生意义，打破行业技术与大众之间的认知壁垒。目前系列短剧第一集已完成拍摄工作，进入后期制作阶段，待正式上线后，将推动“高效清洁取暖”的品牌理念实现更广泛的大众传播。

六、未来展望构建全维度全媒体传播矩阵

2026年开年以来，恒有源以融媒体宣传体系建设为抓手，实现了品牌宣传工作从渠道搭建、内容创作、团队建设到组织保障的全链条升级，不仅全面提升了企业品牌的行业影响力与社会认知度，更与企业标准化、规模化发展的核心战略深度同频，为全国区域代理与项目合作模式的推进提供了强有力的品牌支撑。

未来，恒有源将持续深耕浅层地热能清洁能源领域，以中关村原创的单井循环换热核心技术为根基，以标准化产品体系为核心，以融媒体宣传体系为桥梁，持续讲好中国清洁取暖的创新故事，推动“地能热泵高效清洁取暖”技术的全国规模化推广，加速热冷一体化新兴绿色产业发展，为国家“双碳”战略目标的实现、北方地区清洁取暖事业的高质量发展持续贡献核心力量。

关于神奇的浅层地下恒温层

作者：老马

一、什么是浅层地下恒温层

地球表面的温度分布并非均匀一致，而是随着深度变化呈现出明显的分层特征。主要分为三层：外热层（变温层）、常温层（恒温层）和内热层（增温层）。其中，恒温层就是位于外热层下方、内热层上方的过渡地带，也是我们最常利用的浅层地下热资源和冷资源的所在层位。

外热层是最靠近地表的一层，深度通常在 0-30 米左右，其热量主要来自太阳辐射，会随着纬度、季节、昼夜、植被覆盖等因素剧烈变化——夏天被太阳晒得发烫，冬天则会随着地表降温而变冷，甚至出现冻结现象。随着深度增加，太阳辐射的影响会逐渐减弱，到了一定深度，地表温度变化对它的影响几乎可以忽略不计，此时地下温度就会稳定在一个固定值，这个深度范围就是恒温层。

恒温层的深度和温度并非固定不变，会因地域不同而有差异。一般来说，我国北方地区恒温层深度较深，约 15-30 米，温度较低，比如哈尔滨的恒温层温度约 3.5℃；南方地区恒温层深度较浅，约 5-15 米，温度较高，比如厦门的恒温层温度可达 21℃，但其核心特点始终不变——全年温度稳定，波动范围较小。此外，恒温层的温度还会受到岩土体热物性、地下水流动等因素的轻微影响，但总体保持恒定状态。

二、恒温层与浅层地能的开发利用

恒温层最宝贵的价值，在于它储存了丰富的浅层地能。浅层地能是指地表以下一定深度范围内（主要是恒温层及附近区域），岩土体、地下水等介质中储存的热能，是一种清洁、可再生、储量巨大的新型能源，而恒温层正是浅层地能最稳定、最易开发利用的载体。

与煤炭、石油等化石能源相比，浅层地能具有无可比拟的优势：它分布广泛，几乎遍布全球各地，无需长途运输；清洁无污染，开发利用过程中不会产生废气、废水、废渣，也不会破坏臭氧层，能有效减少温室气体排放；可再生性强，恒温层的热能主要来自太阳辐射的和地球内部的散热，只要合理开发，就能实现永续利用。此外浅层地能的能量密度稳定，不受季节、天气变化的影响，能为人类提供持续稳定的能源支持。

我国的浅层地能资源十分丰富，据调查，全国 336 个地级以上城市的浅层地热能年可开采量折合标准煤达 7 亿吨，其中超过 80% 的省会城市都适合浅层地能开发利用。目前，浅层地能的开发利用主要集中在建筑供暖、制冷、生活热水供应等领域，尤其在城市建筑中应用广泛——通过地能热泵系统，将恒温层中的热量提取出来，为住宅、商场、办公楼等建筑提供舒适的室内环境，既节能又环保，对推动绿色低碳城镇化发展、缓解冬季雾霾具有重要意义。浅层地能将帮助我们实现零碳再生的清洁供暖的高级形态——“地能生态供暖”。

值得注意的是，恒温层的热物性参数（如导热系数、比热容等）是影响浅层地能开发利用的关键因素，不同岩性的岩土体，其导热性能不同，会直接影响热能的传递效率和开发成本。准确地确定这些参数，建立地温场预测模型，能为浅层地能的科学开发提供精准依据，降低工程成本，提高开发效率。

三、为什么恒温层既能作为热源又能作为冷源使用？

很多人会好奇，地能热泵系统为什么能实现“一机两用”，既能在冬天供暖，又能在夏天制冷？其实，这一神奇功能的核心，正是利用了恒温层“冬暖夏凉”的恒定温度特性，再结合热泵的能量搬运功能，实现了热能的高效转移和利用，其本质就像一个“地下热能搬运工”。

地能热泵系统主要由三部分组成：地能采集器（埋于恒温层）、热泵主机和室内末端系统（风机盘管、地暖管等），其中地能采集器是连接恒温层与热泵主机的关键，依靠其内部循环流动的传热介质，实现与恒温层岩土体的热交换。其供暖和制冷的工作过程的差别，本质上只是能量传递方向的切换。

冬季供暖时，地表空气温度较低（通常低于 0°C ），而恒温层的温度较高（如北京 15°C ）。此时，地能采集器中的循环介质会吸收恒温层岩土体中的热量向热泵供热，因为热源温度远高于空气温度所以制热效率高。夏季制冷时空气温度较高（通常超过 30°C ），而恒温层的温度依然保持稳定，热泵系统将室内的热量输送到地能采集器中，最终将热量释放到恒温层的岩土体。恒温层此时相当于

“天然冷库”。由于这个“冷库”的温度较低且容量十分巨大，所以制冷效率高还可以规避通常制冷引起的“热岛”效应。

浅层地下恒温层，这个隐藏在我们脚下的“神奇宝库”，不仅揭示了地球内部的热平衡规律，更为人类应对能源危机、实现绿色发展提供了重要支撑。随着浅层地能开发技术的不断进步，恒温层的价值将被进一步挖掘，未来，它将走进更多家庭和企业，为我们的生活带来更清洁、更舒适、更可持续的能源体验，让地球的“体温”成为滋养人类发展的不竭的资源。

Interview with Academician Wang Jiyang



Profile

Wang Jiyang, born in 1935 in Wujiang, Jiangsu Province, is a renowned geothermal and hydrogeological scientist, Academician of the Chinese Academy of Sciences, Academician of the International Academy of Mineral Resources Sciences, and Academician of the International Eurasian Academy of Sciences. He currently serves as Research Professor at the Institute of Geology and Geophysics, Chinese Academy of Sciences; Honorary Director of the Technical Committee of the National Geothermal Energy Center; Chief Scientist at the Guangzhou Institute of Energy Conversion, Chinese Academy of Sciences; Director of the Geothermal and Renewable Energy Research Center at China University of Petroleum (East China); Honorary Professor at The Chinese University of Hong Kong; and Honorary Chairman of the China Ground Source Heat Pump Industry Alliance.

He previously served as a member of the International Heat Flow Commission (IHFC) and the Board of Directors of the International Geothermal Association (IGA). He has received numerous honors, including the Li Siguang Geological Science Award, the Ho Leung Ho Lee Foundation Award for Scientific and Technological Progress, and the Liu Guangwen Award for Scientific and Technological Achievement. Academician Wang has devoted his life to theoretical and applied research in geothermal science.

Professional Experience: In 1956, he graduated from the Department of Hydrogeology and Engineering Geology at Beijing Geological Institute (now China University of Geosciences) with a bachelor's degree and remained there as a faculty member until 1958. From 1958 to 1962, he studied at the Moscow Geological Prospecting Institute, where he earned the Soviet Candidate of Sciences degree in Geology and Mineralogy, equivalent to a PhD.

From 1962 to 1999, he served successively as Assistant Researcher, Associate Researcher, Research Professor, and Director of the Geothermal Research Division at the Institute of Geology, Chinese Academy of Sciences. From 1979 to 1981, he was Visiting Professor at Virginia Tech in the United States and Senior Visiting Research Scientist at the United States Geological Survey (USGS). Since 1999, he has been Research Professor at the Institute of Geology and Geophysics, Chinese Academy of Sciences.

Over the decades, Dr. Wang has dedicated himself to fundamental and applied research in geothermal science and hydrogeology, making outstanding contributions in terrestrial heat flow, lithospheric thermal structure, and medium- and low-temperature geothermal systems. He established a geothermal research framework with Chinese characteristics, completed China's first terrestrial heat flow map, and proposed the macroscopic distribution pattern of terrestrial heat flow in China as "higher in the east and lower in the west, higher in the south and lower in the north".

He also proposed the tectonic-thermal background theory for the formation and distribution of geothermal resources in China and classified five types of lithospheric thermal structures, including the "cold crust, hot mantle" structure in North China and the "hot crust, hot mantle" structure on the Qinghai-Tibet Plateau. His systematic research on medium- and low-temperature convective geothermal systems has guided geothermal heating and power generation projects in China's southeastern coastal regions.

Dr. Wang currently serves as Honorary Director of the Technical Committee of the National Geothermal Energy Center, Honorary Chairman of the China Ground Source Heat Pump Industry Alliance, and Chief Scientist at the Guangzhou Institute of Energy Conversion, Chinese Academy of Sciences. Despite his advanced age, he remains active on the front lines of geothermal research and industrial promotion, continuing to contribute tirelessly to the high-quality development of China's geothermal industry through both practice and advocacy. Throughout his life, Academician Wang has been committed to promoting the replacement of fossil fuels with geothermal energy and advancing the healthy development of efficient and clean heat-pump-based heating and cooling industries. He was also among the earliest geological scientists to support China Geothermal Energy magazine. As early as the magazine's inaugural launch in 2014, when it was titled China Geothermal Energy, Dr. Wang specially sent a calligraphic inscription expressing his sincere hopes and expectations for the publication. In this exclusive interview, he shared heartfelt and insightful perspectives on his original aspirations in geothermal research, the current development of the industry, and his vision for the future.

Interview Team: After returning to China from your studies abroad, you devoted yourself to geothermal and hydrogeological research. What originally inspired you to choose geothermal research and remain committed to it throughout your life?

Dr. Wang: When I returned to China from the Soviet Union in 1962, geothermal research in China was almost entirely blank. At that time, we could not even produce a complete terrestrial heat flow map, and the entire field of fundamental research was still at a very early stage.

Energy is the foundation and lifeline of national development. Back then, China relied primarily on fossil fuels such as coal and oil for its energy supply. Long-term dependence on these resources not only caused increasingly serious environmental pollution, but also raised concerns over resource depletion. Geothermal energy, however, is a clean energy resource stored beneath the earth's surface. It is abundant, renewable, and truly a green treasure bestowed upon humanity by the earth itself.

In recent years, shallow geothermal energy in particular has developed rapidly. Compared with deep geothermal resources, shallow geothermal energy is easier to develop, widely distributed across the country, and more convenient to utilize. More importantly, it directly addresses people's everyday needs by providing both heating and cooling, making it a truly people-oriented clean energy source.

I have always believed that scientific research must never be detached from reality. Researchers must stay rooted in the country's most urgent development needs and write their papers on the land of the motherland. Beginning with the compilation of China's first terrestrial heat flow map, I have devoted more than sixty years to geothermal research.

Seeing geothermal energy evolve from a little-known niche discipline into an important pillar supporting China's "Dual Carbon" strategy brings me great satisfaction. Deep in my heart, I firmly believe that I chose the right path and that this lifetime of dedication has been worthwhile.

Interview Team: You have consistently promoted the development and utilization of shallow geothermal energy. In your view, what are its core advantages compared with other renewable energy sources, and what role does it play in China's energy

Dr. Wang: The core advantages of shallow geothermal energy can be summarized in three words: stability, accessibility, and cleanliness. These are advantages that wind and solar energy cannot easily match.

Wind power depends on wind conditions, while solar energy relies on sunlight intensity. During cloudy weather, at night, or when wind conditions are weak, these energy sources cannot provide stable output. They are highly intermittent and heavily dependent on natural conditions.

Shallow geothermal energy is fundamentally different. Temperatures in underground strata, ranging from several meters to several hundred meters below the surface, remain stable throughout the year. Regardless of whether it is extremely hot or bitterly cold outside, geothermal systems can continuously provide reliable heating and cooling without interruption. Their energy supply reliability is exceptionally high.

In addition, shallow geothermal energy is widely distributed. Whether in northern or southern China, urban or rural areas, plains or mountainous regions, almost every part of the country has development potential. It is perfectly suited for building heating and cooling applications and directly meets people's daily living needs.

For a long time, northern China has relied heavily on scattered coal burning for winter heating. The resulting chimney emissions have caused severe air pollution, frequent smog, and high carbon emissions. Shallow geothermal energy is precisely the optimal solution for replacing scattered coal use and achieving clean heating.

Under the broader context of China's "Dual Carbon" goals, shallow geothermal energy should never be regarded as a minor supplementary energy source. It is in fact one of the primary clean energy sources for low-carbon transformation in the building sector. It can substantially reduce China's dependence on fossil fuels, significantly improve atmospheric environmental quality, and serve as one of the most practical and effective approaches in the energy transition process. Its strategic importance is irreplaceable.

Interview Team: During your research and promotion of shallow geothermal energy, what major challenges did you overcome? What milestone significance have these achievements had for China's geothermal industry?

Dr. Wang: In the early stages of shallow geothermal research, the first major challenge was simply the lack of basic knowledge. There was virtually no reliable data regarding geothermal resource reserves, distribution patterns, or the thermal conductivity characteristics of underground strata. Research work at that time was like moving forward in complete darkness.

Our team spent many years conducting field investigations across the country. We traveled extensively throughout China, carrying out on-site exploration region by region and gradually collecting and organizing data. Eventually, we identified the occurrence patterns and key thermal conductivity parameters of shallow geothermal resources nationwide and established China's own shallow geothermal resource evaluation system. This filled a critical foundational gap and laid the groundwork for all subsequent industrial development efforts.

The second major challenge involved adapting technologies to China's actual conditions. Mature foreign technologies could not simply be copied and applied directly in China. China has vast territory and significant differences in geological and climatic conditions between the north and south, making imported heat pump technologies poorly suited in many cases.

As a result, we strongly promoted independent technological innovation. In Zhongguancun, China developed its own geothermal heat pump heat exchange system with completely independent intellectual property rights. One of the system's greatest advantages is that the heat exchange process does not consume groundwater resources, making it fully compatible with China's national conditions while avoiding groundwater waste and geological damage.

In addition, we led efforts to establish industry standards and technical specifications for the development and utilization of shallow geothermal energy. This fundamentally changed the previous situation in which the industry lacked clear standards and developed in a disorderly manner. The industry gradually moved from extensive and unregulated development toward standardized and orderly growth.

Although these efforts may appear foundational, they carry milestone significance. They directly promoted the transition of shallow geothermal energy from purely theoretical research into practical engineering applications and from limited pilot projects to large-scale commercialization. They also established a solid theoretical and technical foundation for China's geothermal industry and demonstrated China's core strengths in geothermal development to the international academic community, enabling China to move beyond merely following foreign technologies.

Interview Team: Since the introduction of the "Dual Carbon" goals, the geothermal industry has entered a new stage of opportunity. In your opinion, what is the future direction of shallow geothermal energy development? How should deep and shallow geothermal resources develop in coordination?

Dr. Wang: The "Dual Carbon" goals have created tremendous opportunities for the geothermal industry. In the future, shallow geothermal energy development should firmly focus on three major directions: large-scale deployment, intelligent operation, and integrated development.

Large-scale deployment means expanding beyond major cities into counties and rural areas, covering residential buildings, schools, hospitals, and various public facilities so that geothermal energy can benefit a broader population.

Intelligent operation means utilizing big data and Internet of Things technologies to achieve precise control and smart operation and maintenance of geothermal systems, enabling highly efficient operation without the need for constant manual supervision.

Integrated development means combining geothermal energy with photovoltaics, energy storage, and other clean energy systems to establish multi-energy complementary systems that maximize the advantages of different clean energy sources.

Deep geothermal resources are even more abundant and represent strategic national energy resources. However, their development involves greater technical challenges and higher initial investment costs, making them more suitable for long-term strategic planning.

Shallow geothermal energy, by contrast, delivers rapid results and broad public benefits. It can quickly improve people's livelihoods and reduce carbon emissions. The two should therefore be viewed as complementary and mutually supportive rather than mutually substitutive.

In the future, development should follow a coordinated approach that advances shallow, medium-depth, and deep geothermal resources simultaneously. Shallow geothermal energy should focus on practical livelihood applications and rapid carbon and pollution reduction, while deep geothermal energy should focus on technological breakthroughs and strategic energy reserves. Together, they can form a coordinated industrial structure that maximizes the comprehensive value of geothermal resources.

Interview Team: From your decades-long perspective in the geothermal field, what do you believe is the core value of shallow geothermal energy development and utilization?

Dr. Wang: The core value of shallow geothermal energy goes far beyond energy supply alone. Its significance lies in the integration of ecological value, social value, and strategic value. This is also what fundamentally distinguishes it from other clean energy sources.

From an ecological perspective, shallow geothermal energy is a typical low-carbon or even near-zero-carbon energy source. Its development and utilization generate almost no waste gas, wastewater, or solid waste. Because it does not require fossil fuel combustion, it can significantly reduce carbon emissions and air pollutants. It is therefore a powerful tool for protecting ecological environments and advancing the realization of the "Dual Carbon" goals.

From a social perspective, shallow geothermal energy directly addresses people's most fundamental needs for heating and cooling. It provides stable and comfortable indoor environments while maintaining relatively low long-term operation and maintenance costs. It is suitable for both urban and rural areas and benefits people of all ages. It can effectively solve the long-standing pollution problems caused by scattered coal heating in northern rural regions, while also addressing the lack of centralized heating in southern China during winter and reducing excessive cooling energy consumption during summer. It is truly a people-centered form of clean energy that delivers tangible benefits to millions of households.

From a strategic perspective, shallow geothermal energy is a domestically controlled indigenous resource. It is widely distributed throughout China, does not rely on imports, and is not affected by fluctuations in international energy markets. It therefore plays an important role in safeguarding national energy security.

At the same time, shallow geothermal energy can stimulate the development of the entire industrial chain, including upstream exploration, midstream equipment manufacturing, and downstream engineering operation and maintenance. It creates large numbers of jobs, supports rural revitalization, and promotes the coordinated development of ecological, social, and economic benefits. This is precisely its most essential and irreplaceable value.

Interview Team: You are not only a leading scientist but also a mentor to many young geothermal professionals. What advice would you offer to today's young scholars and practitioners engaged in geothermal research, especially shallow geothermal energy? What is your vision for the future of geothermal development?

Dr. Wang: Geothermal energy is truly a sunrise industry with tremendous future potential. Young people who choose to devote themselves to this field have made a wise and forward-looking choice.

I would like to offer three sincere pieces of advice to young scholars and practitioners.

First, stay rooted in practice and avoid empty theorizing. Geothermal research is never accomplished solely by reading papers and analyzing data in an office. It requires extensive field investigation and practical engineering experience. Young researchers should spend more time at project sites and in real geological environments, combining theoretical knowledge with practical applications in order to produce research outcomes that genuinely meet societal needs.

Second, remain true to the original purpose of scientific research and learn to endure loneliness. Whether in research or industrial promotion, meaningful results cannot be achieved overnight. It takes patience, persistence, and long-term dedication. One must avoid the mentality of seeking quick success and instead focus on refining technologies and deeply cultivating the industry over time.

Third, maintain a strong sense of national responsibility and focus closely on the country's needs. Scientific research should not exist solely for publishing papers. Researchers should focus on practical technologies and real-world challenges, integrating their personal development with the advancement of China's energy sector and the national "Dual Carbon" strategy. Only in this way can one truly realize personal value.

I hope young people will be courageous in exploration and innovation, boldly tackling key technological bottlenecks and pushing China's geothermal industry to new heights so that clean energy can benefit even more people.

My lifelong vision is actually very simple: to bring geothermal energy into every household and fundamentally solve the livelihood challenges associated with clean heating and cooling.

Within the next five to ten years, I hope shallow geothermal energy will become a mainstream solution for heating and cooling buildings in both urban and rural areas. I hope northern China will completely eliminate pollution caused by scattered coal heating and enjoy clear blue skies throughout winter. I also hope southern China will benefit from comfortable and low-carbon geothermal air conditioning systems, free from the damp cold of winter and the oppressive heat of summer.

At the same time, I hope China will establish a complete shallow geothermal industrial chain, achieve globally leading technological capabilities, and bring Chinese industry standards to the international stage, making geothermal energy a distinguished Chinese contribution to the world.

Geothermal energy is a form of green wealth bestowed upon humanity by the earth. We must develop and utilize it responsibly and scientifically. We must not only protect our green mountains and clear waters, but also strengthen the foundation of national energy security. This is the mission of our generation of geoscientists and a responsibility that future generations of geothermal professionals must continue to carry forward.

Promoting High-Quality Development of the Capital's Economy through New Quality Productive Forces

Comprehensive Report by the Editorial Department

On the morning of January 26, the Fourth Session of the 14th Beijing Municipal Committee of the Chinese People's Political Consultative Conference (CPPCC) held a special forum on "Vigorously Developing New Quality Productive Forces and Solidly Promoting the High-Quality Development of the Capital's Economy". During the meeting, committee members actively shared their views, with green development, intelligence, technology, and coordination emerging as key themes.

"Beijing has already taken the lead in achieving citywide clean heating, and the improvement in air quality is evident to all. During this process, new quality productive forces have fostered a green industry that replaces fossil fuels with shallow geothermal energy and replaces combustion-based heating with non-combustion heating", said Shengheng Xu, Member of the Beijing Municipal CPPCC from the Specially Invited Sector and Chairman of the Board of China HYY Development Group, while offering suggestions on advancing the green heating industry.

Shengheng Xu explained that geothermal energy refers to low-temperature thermal energy below 25° C stored underground, and that geothermal heating fundamentally differs from traditional combustion-based heating because it involves no combustion process. "Geothermal heat pump heating is a system-wide transformation project that spans multiple departments and industries", he said. He therefore proposed improving cross-departmental policy coordination mechanisms and standard systems, as well as establishing more efficient specialized approval procedures to support the large-scale development of geothermal heat pump heating.

Shengheng Xu also suggested clarifying heating fee policies and subsidy standards for geothermal heat pump systems. "Particularly in rural areas, subsidy policies should be introduced to support residents in upgrading geothermal heat pump products, allowing green heating to benefit more people", he said.

Liqiong Feng, Member of the Beijing Municipal CPPCC from the Science and Technology Sector and Executive Vice President of BOE Technology Group Co., Ltd., offered suggestions on accelerating the deep integration of artificial intelligence and high-end manufacturing.

She noted that Beijing possesses strong foundations and responsibilities for becoming a national and even global model due to its concentration of high-end manufacturing enterprises and abundant innovation resources. Fengliqiong Feng proposed establishing tiered and categorized special support programs centered on "Artificial Intelligence + Manufacturing", including subsidy support for enterprises building intelligent infrastructure. She also recommended guiding enterprises to prioritize access to and participation in the jointly developed domestically produced intelligent computing cluster with a capacity of 100,000 computing cards, which is being coordinated and advanced by Beijing Municipality, in order to accelerate engineering implementation.

At the same time, she suggested exploring a combined mechanism of "municipal industrial funds plus special-purpose funds" to support the research and development of industry-specific large models and intelligent agents, thereby establishing a sustainable investment mechanism.

"One successful case is more convincing than a stack of documents", Liqiong Feng said. She proposed creating a benchmark case library for "Artificial Intelligence + Manufacturing" in Beijing to generate demonstration effects, while also encouraging independently developed AI products and services that have been validated by the market to be included in procurement and promotion catalogs in order to accelerate the large-scale application of outstanding products.

Tianyong Guo, Member of the Beijing Municipal CPPCC from the China Democratic National Construction Association sector and Professor at the School of Finance, Central University of Finance and Economics, offered suggestions on building a science and technology finance system.

"At present, a new round of technological revolution and industrial transformation is accelerating the restructuring of the global innovation landscape and reshaping the global economic structure. Guiding capital toward frontier technologies and key sectors through financial means will help optimize industrial structures, improve production efficiency, and create new industrial growth drivers", Tianyong Guo said.

He suggested that banks should play a more active role within the science and technology finance system by treating support for technological innovation as a strategic mission and providing technology enterprises with comprehensive financial services throughout their entire life cycles.

"Technology enterprises generally go through stages such as seed stage, start-up stage, growth stage, and maturity stage, and they are characterized by high investment risks and long return cycles", Tianyong Guo said. He added that, within the framework of policy support and regulatory compliance, banks could support the development of technology enterprises by establishing financial asset investment companies and conducting equity investments.

(Source: Beijing Daily, published on January 27, 2026. Reporter: Xuening Chen.)

Deepening the Development of Shallow Geothermal Energy and Leading a New Track for Clean Heating – HYY Empowers the High-Quality Development of the Geothermal Ecological Heating Industry through Technological Innovation and Model Innovation

Author: Yang Mingzhong

At a critical stage marked by the in-depth advancement of China's "Dual Carbon" strategy, the full launch of the 15th Five-Year Plan period, and the implementation of *the Opinions on Further Improving Energy Conservation and Carbon Reduction at a Higher Level and with Higher Quality* issued on April 22, 2026 by the General Office of the CPC Central Committee and the General Office of the State Council, geothermal energy, as a clean, low-carbon, stable, and reliable renewable energy source, is embracing historic development opportunities driven by stronger policy support, expanding markets, and accelerating technological iteration.

As a pioneer in China's shallow geothermal heating sector, Ever Source Science & Technology Development Group Co., Ltd. has cultivated the industry for many years. Taking original technologies as its core, standardized development as its foundation, and model innovation as its driving force, the company has long focused on the industrialization of original shallow geothermal energy extraction technologies. The promoted "geo-energy ecological heating" system, which guarantees heating while also providing cooling, has achieved

a series of research, development and application results. It represents an advanced form of zero-carbon, renewable clean heating in the new era, following the development stages of traditional high-carbon, high-pollution heating and low-carbon, low-pollution clean heating.

The Group is committed to utilizing shallow geothermal energy according to local conditions in northern China's winter heating regions to replace fossil fuels. It vigorously promotes the emerging integrated industry of "Geothermal Ecological Heating" heating-and-cooling systems at costs comparable to coal-fired heating. Through ecological and responsible energy utilization, HYY actively practices the energy revolution and safeguards public well-being, contributing corporate strength to the implementation of China's new national energy security strategy, the advancement of higher-level and higher-quality energy conservation and carbon reduction, and the realization of the carbon peaking and carbon neutrality goals.

I. Era Background: Strong National Policies Bring Geothermal Energy into a Golden Period of Development

The year 2026 marks the opening year of the 15th Five-Year Plan period and also a decisive year for China's progress toward carbon peaking goals. *The Outline of the 15th Five-Year Plan for National Economic and Social Development of the People's Republic of China* clearly proposes accelerating the establishment of a clean, low-carbon, safe, and efficient modern energy system, building China into a strong energy nation, actively promoting solar thermal power generation and geothermal energy utilization, improving the electrification level of end-use energy consumption, and advancing the green and low-carbon transformation of energy consumption.

The Opinions on Further Improving Energy Conservation and Carbon Reduction at a Higher Level and with Higher Quality further establishes top-level policy arrangements. It emphasizes consistently prioritizing energy conservation, integrating energy conservation and carbon reduction throughout the entire process of economic and social development, coordinating carbon reduction with green energy transformation, strictly controlling fossil fuel consumption, continuously reducing coal and oil use, actively promoting the clean replacement of existing coal-fired boilers and industrial kilns, advancing non-fossil-energy heating substitution according to local conditions, strengthening building energy conservation and clean heating renovation, and promoting the construction of zero-carbon industrial parks and the development of the "green electricity for green manufacturing" model. These measures have provided clear demand orientation and development direction for the geothermal industry.

Guided by national policies, Beijing, Hebei, Shanxi, Shandong, Henan, Chongqing, and many other provinces and municipalities have incorporated geothermal energy into key development priorities during the 15th Five-Year Plan period, promoting integrated and complementary development between geothermal energy and other clean energy sources such as wind, solar, and biomass.

With the implementation of the *Energy Law of the People's Republic of China*, the continued revision and improvement of the *Renewable Energy Law of the People's Republic of China*, and the rollout of policies such as the *Action Plan for Promoting the High-Quality Development of the Heat Pump Industry*, together with supporting incentives for zero-carbon industrial parks and "new energy plus industry" models, the potential for geothermal energy development and utilization is being rapidly released. It is expected that by 2030, geothermal energy utilization will account for 3 percent of China's primary energy consumption and become one of the core pillars supporting the construction of a modern energy system.

Shallow geothermal energy features wide distribution, abundant reserves, environmental friendliness, and stable reliability, making it particularly suitable for northern China's clean winter heating needs. Driven by both the 15th Five-Year Plan and the latest energy conservation and carbon reduction policies, the shallow geothermal industry is entering a golden era of large-scale, standardized, intelligent, and high-quality development.

II. Technological Leadership: Original Core Technology Creates Geothermal Ecological Heating

Technological innovation is the core engine driving the high-quality development of the geothermal industry. Based in Beijing's Zhongguancun innovation hub, HYY has continuously invested in technological research and development and tackled common key industry challenges. The company independently developed the "100% Groundwater Reinjection Single-Well Circulation Heat Exchange" geothermal energy extraction technology. It is a core technology adapted to shallow geothermal energy development, applicable to geological conditions with suitable permeability, fundamentally solving long-standing bottlenecks in traditional geothermal development such as groundwater reinjection difficulties, challenges in maintaining thermal balance, and unsustainable water resource utilization.

This technology has achieved dual breakthroughs in environmental protection and energy efficiency and has become HYY's core competitive advantage in the industry.

Driven by new quality productive forces, the "Geothermal Ecological Heating" technology for northern winter achieves "three substitutions" compared with traditional heating:

1. Energy Substitution: utilizing geothermal energy, namely low-temperature thermal energy below 25° C collected from underground constant-temperature layers, to replace traditional fossil fuels;

2. Product Substitution: replacing traditional boilers with safe, highly efficient, and long-service-life heat pumps;

3. Substitution of Heat Acquisition Method: using electricity to drive heat pumps to "transfer" geothermal energy instead of obtaining heat through the high-temperature combustion of fossil fuels in boilers. This represents the scientific and responsible use of ecological energy for heating, ensuring matched heating temperatures while achieving combustion-free and zero-emission heating throughout supply areas.

Driven by new quality productive forces, "Geothermal Ecological Heating" has established a comprehensive and highly adaptable product system through the integrated innovation of three major heating systems, fully meeting both decentralized and centralized winter heating needs in northern China. It also fulfills the requirements proposed at the 2016 meeting of the Central Financial and Economic Leading Group regarding the "Energy Production and Consumption Revolution", the "Rural Lifestyle Revolution", and "Affordable Heating for Residents".

The three systems include:

1. Geothermal Heat Pump Environmental System (for urban and rural centralized heating): designed for centralized urban and rural heating, meeting large-scale heating demands for residential communities, public buildings, and industrial parks while supporting centralized regional energy supply and efficient management;

2. Geothermal Energy Thermal Unit System (for decentralized rural household heating): designed for rural clean heating, enabling independent metering and room-by-room temperature control while precisely matching rural energy needs and supporting rural revitalization and scattered coal replacement;

3. Distributed Geothermal Cooling and Heating Source Station System: suitable for unified planning and phased investment scenarios, balancing flexibility and cost efficiency while supporting coordinated regional energy supply planning.

The three systems together provide heating capacities ranging from 5.6 kW to 2,500 MW and cover heating areas from 40 square meters to 50 million square meters, comprehensively meeting the diverse needs of clean heating, building energy conservation and carbon reduction, and zero-carbon industrial park development in northern China during the new era.

Upholding the philosophy of "technology leadership, standards-oriented development, product safety, and service assurance", HYY possesses a complete qualification system covering general contracting for electromechanical engineering construction, specialized electromechanical contracting, maintenance and cleaning services, and other full-process capabilities. The company has also participated in the drafting of numerous national, regional, and industry standards, supporting standardized industry development through technological compliance and standards leadership.

III. Model Innovation: The "Three-Partner Strategy" Builds a Full-Chain Industrial Ecosystem

To seize the opportunities arising from the large-scale development of geothermal energy during the 15th Five-Year Plan period, HYY has innovatively implemented its "Three-Partner Strategy", creating a market-oriented, diversified, and sustainable industrial ecosystem while opening channels for technology deployment, market expansion, and shared value creation.

The strategy includes:

1. County-Level Regional Agents for Geothermal Energy Extraction: focusing on core heating regions in northern China and authorizing the promotion of original geothermal extraction technology products to solve the "last-mile" challenge of technology implementation;
2. Exclusive Agents for Geothermal Heat Pump Projects: leveraging mature products and engineering experience to enable partners to rapidly replicate and efficiently implement projects;
3. Regional Development Partners: integrating upstream and downstream industrial chain resources to establish a full-chain cooperation ecosystem covering equipment supply, engineering construction, and operation and maintenance services.

To ensure the effective implementation of the "Three-Partner Strategy", HYY has established dedicated service teams providing full-cycle services including technical training, project coordination, qualification support, and after-sales guarantees. At the same time, the company has developed comprehensive standard agreements to regulate cooperation procedures and clarify responsibilities, rights, and interests, thereby forming a fair, mutually beneficial, and sustainable cooperation framework.

In terms of business operations, HYY has established a diversified collaborative structure integrating "products, engineering, operation and maintenance, and services". Domestic business operations cover technical services, product sales, project operation and maintenance, engineering construction, and equipment leasing, forming a balanced business structure.

The Group adheres to the heating philosophy that "heating is a necessity, and even under the harshest climatic conditions, warmth must reach every household". Through professional operation and maintenance systems and big-data management platforms, HYY efficiently manages large numbers of equipment rooms, host units, and geothermal extraction wells while serving thousands of households, establishing a strong industry reputation through high-quality services.

IV. Digital Empowerment: Intelligent Transformation Enhances Quality, Efficiency, and Energy Conservation

Closely following the trend of industrial digitalization and intelligent transformation, HYY has actively promoted digital empowerment by developing two core business segments to drive industrial upgrading through digital intelligence:

1. Establishing an Industrial Supermarket for Heating and Cooling Equipment: realizing centralized management of product release, sales, and inventory to improve supply chain coordination efficiency;
2. Launching an Online Heat Pump Maintenance Platform: enabling fully digitalized processes for customer repair requests, order dispatching, maintenance supervision, service fee tracking, customer follow-up, and performance evaluation, thereby promoting operation and maintenance services toward greater intelligence, convenience, and efficiency.

The company's digital transformation deeply aligns with the latest requirements for energy conservation and carbon reduction. Through big-data analysis and intelligent regulation, HYY achieves precise energy efficiency management of geothermal heat pump systems, further reducing energy consumption and carbon emissions while providing a replicable pathway for the intelligent and refined development of the geothermal industry.

V. Looking Ahead: Advancing toward the "Dual Carbon" Goals and Building a Green Energy Future Together

During the 15th Five-Year Plan period, China will fully implement systems controlling both total carbon emissions and carbon intensity while advancing carbon assessment mechanisms, industry carbon regulation, enterprise carbon management, project carbon evaluation, and product carbon footprint systems.

As a stable and reliable renewable energy source, geothermal energy will undertake an increasingly important mission in the construction of China's modern energy system and the advancement of energy conservation and carbon reduction.

HYY will continue to uphold its mission of developing the emerging green industry of integrated geothermal ecological heating and cooling systems. Taking original technologies as its core, the "Three-Partner Strategy" as its engine, and digital transformation as its support, the company will deeply align with China's 15th Five-Year energy planning and the national requirements for higher-level and higher-quality energy conservation and carbon reduction, fully contributing to the realization of the carbon peaking and carbon neutrality goals.

Looking forward, HYY will continue optimizing its domestic business layout, focusing on core businesses, and improving operational efficiency. It will continue deepening research and development, promoting technological innovation and standards upgrading, and expanding market coverage so that more regions and users can enjoy clean, efficient, economical, and safe geothermal ecological heating services.

On the journey toward achieving higher-level and higher-quality energy conservation and carbon reduction and building a clean, low-carbon, safe, and efficient modern energy system, HYY will continue working hand in hand with industry partners to advance the high-quality development of the geothermal ecological heating industry and contribute solid strength to the realization of Chinese modernization characterized by harmonious coexistence between humanity and nature.

Shining Footprints – Academician Wu Qiang's 2025 Research and Public Service Initiatives

China Geothermal Energy Editorial Department

In 2025, Wu Qiang, Member of the National Committee of the Chinese People's Political Consultative Conference (CPPCC), Academician of the Chinese Academy of Engineering, and President of the Inner Mongolia Research Institute of China University of Mining and Technology (Beijing), focused on the core mission of promoting a green and low-carbon energy transition. Centering his research on the development and utilization of shallow geothermal energy, he carried out extensive field investigations across multiple regions of China, explored the advantages of distributed shallow geothermal applications, proposed practical implementation plans tailored to the geographical characteristics of rural and pastoral areas in Inner Mongolia, and transformed research findings into policy proposals submitted during the Two Sessions. This article reviews Mr. Wu's year-long research journey, highlighting his dedication to using geothermal technology to address energy transition challenges and support the green upgrading of traditional energy-producing regions.

I. Beginning the Research Journey: Focusing on Geothermal Energy to Address Transformation Challenges

The green and low-carbon energy transition is a key pathway for China to achieve its "Dual Carbon" goals. As a renewable energy source characterized by abundant reserves, wide distribution, cleanliness, and stability, shallow geothermal energy represents an important solution to the high energy consumption

associated with urban and rural heating and cooling, as well as the heavy dependence on fossil fuels.

In 2025, Academician Wu Qiang, leveraging his dual roles as both a CPPCC member and an energy expert, concentrated his research efforts on the development and utilization of shallow geothermal energy. His research activities extended across major energy-producing provinces and regions nationwide, where he conducted on-site investigations into resource endowment, technical bottlenecks, and practical application scenarios, seeking pragmatic pathways for the high-quality development of the energy industry.

According to reports by Inner Mongolia News Broadcast, Academician Wu Qiang reached a key conclusion through his intensive investigations in 2025: shallow geothermal energy located within 200 meters below the surface and with water temperatures below 25°C possesses significant practical value for widespread application.

With only one or two exploration wells combined with mature heat pump technology, the system can simultaneously provide building heating, cooling, and domestic hot water. The complete system requires no large-scale pipeline network connections, offers convenient operation and maintenance, and involves controllable investment costs. It is particularly well suited to the vast and sparsely populated rural and pastoral regions of Inner Mongolia. The technology can accurately meet the energy needs of local farmers and herders while also supporting the upgrading

and efficiency improvement of characteristic agricultural industries, thereby providing a practical solution for clean energy substitution in border regions.

II. Deep Engagement on the Front Line: Extensive Research and Refinement of Technical Approaches

Mr. Wu has long been deeply engaged in the fields of green and low-carbon energy transition and the efficient utilization of fossil energy resources. His 2025 research activities adhered to a problem-oriented and field-based approach. From the Beijing-Tianjin-Hebei metropolitan region to Shandong Province, from Chongqing to Inner Mongolia's major energy-producing areas, he comprehensively investigated the application effectiveness of shallow geothermal energy in urban construction, rural livelihoods, and industrial support systems, accumulating extensive firsthand data and practical experience.

In the autumn of 2025, Mr. Wu conducted a special investigation into shallow geothermal heating projects in Sijiqing Town, Beijing. This research further deepened his understanding of the technology's value for improving people's livelihoods and its broad potential for future application.

The investigation focused on the practical effects of replacing coal, natural gas, and other fossil fuels with shallow geothermal energy. Centered on the goals of efficient energy utilization and coordinated pollution and carbon reduction, the study further verified the technical advantages of shallow geothermal energy, including low cost, zero pollution, and ease of large-scale deployment. It also strengthened his determination to promote mature application models in major energy-producing regions such as Inner Mongolia.

"Shallow geothermal energy refers to geothermal resources located within 200 meters below the surface and with water temperatures below 25°C. Through specialized heat pump systems, a single integrated system can simultaneously provide building heating, cooling, and domestic hot water, combining both economic and environmental benefits", Mr. Wu explained.

Even on the eve of the Two Sessions, Mr. Wu continued refining technical solutions for shallow geothermal applications. He systematically reviewed successful urban and rural case studies and technical parameters from Chongqing, Shandong, and the Beijing-Tianjin-Hebei region. Based on Inner Mongolia's resource conditions and energy consumption characteristics, he optimized suitable development models and compiled comprehensive proposal materials to accelerate the transition of research outcomes from laboratories to rural fields and pastoral residences.

III. Targeted Efforts: Rooted in Inner Mongolia to Empower Energy Transformation and Upgrading

As one of China's traditional energy-producing regions, Inner Mongolia also possesses abundant renewable energy resources and shoulders important responsibilities in the development of China's modern energy system.

During his investigations, Mr. Wu pointed out that Inner Mongolia's vast territory and dispersed population distribution align particularly well with the distributed development characteristics of shallow geothermal energy systems, which do not require extensive network interconnection. This creates broad prospects for large-scale application.

By combining relatively simple drilling projects with mature heat pump technology, shallow geothermal resources within 200 meters

below the surface can be efficiently utilized. Such systems can meet farmers' and herders' practical needs for winter heating and summer cooling while also expanding energy application scenarios for characteristic agriculture, including greenhouse cultivation and livestock breeding. In this way, the technology supports both rural revitalization and energy transformation.

In 2025, Mr. Wu's research activities extended to key regions such as the Ordos wind and solar energy base and the western Inner Mongolia power grid hub, where he observed the intelligent transformation of the entire energy industry chain.

Relying on the research platform advantages of the Inner Mongolia Research Institute of China University of Mining and Technology (Beijing), he not only promoted the practical implementation of shallow geothermal technologies, but also supported work related to intelligent mining equipment applications, the clean and efficient utilization of coal resources, and ecological restoration in mining areas, thereby helping establish a new development pattern characterized by coordinated advancement between traditional energy and clean energy.

"Inner Mongolia is already at the forefront of both traditional energy upgrading and clean energy development nationwide. The next step is to leverage intelligent technologies such as AI to optimize the scale and deployment pace of renewable energy development, allowing clean energy sources such as geothermal energy to become core driving forces for energy transformation", Wu Qiang stated.

He also emphasized that the outcomes of his 2025 research activities would be transformed into practical policy proposals to continuously promote the large-scale deployment of shallow geothermal energy in rural and pastoral areas of Inner Mongolia, helping traditional energy-producing regions establish new models for

green and low-carbon energy development while providing valuable demonstration experience for the diversified utilization of renewable energy across China.

IV. Original Aspiration in Public Service: Illuminating the Path of Transformation through Geothermal Energy

From urban buildings to pastoral yurts, from scientific research institutions to front-line energy projects, Mr. Wu's 2025 research and public service journey reflects both the responsibility of an energy expert and the people-centered commitment of a CPPCC member.

By taking shallow geothermal energy as a breakthrough point, he helped bridge the "last mile" between scientific research achievements and practical applications benefiting people's daily lives. His work not only addressed the challenge of clean energy utilization in border regions, but also provided practical reference models for the distributed development and nationwide expansion of China's geothermal industry.

Looking ahead, as relevant proposals continue to be implemented and technologies further evolve, shallow geothermal energy is expected to play an even greater role in China's green energy transition and contribute to a new chapter in the development of a clean, low-carbon, safe, and efficient modern energy system.

Experimental Investigation of a Closed-Loop Heat-Exchange Geothermal Energy Collector – Ground Energy Heat Treasure Variable-Frequency Multi-Split System for Heating under Extreme Low-Temperature Conditions

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Abstract: The Closed-loop Heat Exchange Geothermal Energy Collector is a new type of shallow geothermal energy collection device, while the Ground Source Energy Treasure Variable Refrigerant Volume (VRV) System is a heat pump product that is stable, energy efficient, and environmental friendly. In order to invest stability and performance of a Closed-loop Heat Exchange Geothermal Energy Collector and Ground Source Energy Treasure VRV system under extremely low temperature conditions, an existing villa building in Beijing's Xiangshan area was used as the experimental platform, and collect operational data through on-site measurements. The result indicates that the geothermal energy collection is stable and reliable, the unit demonstrates excellent energy-saving performance, and the heating supply temperature meets the design requirements. The Ground Source Energy Treasure VRV system can satisfy the heating demands of various building scenarios and exhibits strong adaptability to extremely low-temperature operating conditions. Therefore, there is no need to develop specialized Ground Source Energy Treasure models for severe cold environments, effectively reducing product development and retrofit costs. These findings provide strong technical support for the large-scale promotion and application of this promising new technology.

Keywords: Extremely low-temperature conditions; Closed-loop Heat Exchange Geothermal Energy Collector; Ground Source Energy Treasure Variable Refrigerant Volume (VRV) System; Energy conservation and low-carbon development.

1 Introduction

1.1 Research Background

As a clean and renewable energy resource, shallow geothermal energy has attracted increasing attention for building heating applications when combined with a heat pump. It offers advantages including stable operation, high energy efficiency, and reduced carbon emissions. Its utilization can effectively replace fossil fuels, promoting the large-scale application of renewable energy and the creation of green, low-carbon heating systems. Consequently, shallow geothermal energy is considered one of the key technologies for sustainable building development.

The Closed-loop Heat Exchange Geothermal Energy Collector does not need to extract groundwater and therefore eliminates the reinjection of it. Compared with traditional U-tube ground heat exchangers, it provides a higher heat exchange capacity per unit borehole length. Meanwhile, the Ground Source Energy Treasure VRV System enables independent operation of indoor units and can flexibly control the room temperature. The heating output can be adjusted dynamically according to room-specific heating demands, further improving the overall energy efficiency of the system. As a result, the technology is well suited for decentralized heating applications in schools, office buildings, hotels, villas, and other building types.

1.2 Current Research Status

The Closed-loop Heat Exchange Geothermal Energy Collector is a novel single well circulation heat exchange device. Previous research^[2] introduced its technical characteristics; however, few experimental studies have been reported regarding its practical performance, particularly under extremely low-temperature operating conditions. Research on its operational stability in such conditions remains limited. Another article^[3] proposed a geologically based zoning scheme for the occurrence and classification of shallow geothermal resources in China and point out that the undisturbed ground temperature in suitable shallow geothermal development regions generally ranges from 5°C to 10°C. Under actual operating conditions, the lower limit of this temperature range may cause the supply temperature on the heat source side of a heat pump system to drop below 5°C. However, the current Chinese standard (GB/T 19409-2013) specifies a minimum operating temperature of 5°C. Therefore, there is a significant discrepancy between actual low-temperature operating conditions and the conditions defined by the current standard.

To address these research gaps, this study investigates a combined heating system consisting of a Closed-loop Heat Exchange Geothermal Energy Collector and a Ground Source Energy Treasure VRV System. Experimental tests were conducted under extremely low-temperature conditions to evaluate the system's performance and provide technical support for its large-scale application.

1.3 Definition of Nouns

Extremely Low-Temperature Operating Conditions: Refers to a winter heating condition in which the inlet temperature on the heat source side of the heat pump unit falls below the minimum operating temperature of 5°C specified by the national standard and reaches 0°C or lower. Based on References^{[4][5]} and the actual operating characteristics of ground-source heat pump projects, the antifreeze solution temperature entering the heat pump unit from the ground heat exchanger was maintained at $-5^{\circ}\text{C} \pm 3^{\circ}\text{C}$ during the experiments. The test period covered outdoor low-temperature conditions throughout the heating season.

1.4 Research Objectives

The objectives of this study are as follows:

- (1) To investigate the operational stability and performance characteristics of the combined Closed-loop Heat Exchange Geothermal Energy Collector-Ground Source Energy Treasure VRV System under a heat-source-side inlet temperature of $-5^{\circ}\text{C} \pm 3^{\circ}\text{C}$.
- (2) To evaluate the energy-saving performance of the Ground Source Energy Treasure VRV System.
- (3) To measure indoor heating temperatures and check whether they meet design requirements.

2 Experimental System Setup

2.1 Overview of the Experimental Site

The experiment was conducted in a villa located in Xiangshan, Beijing. The building consists of one basement level and three above-ground floors, with a total above-ground floor area of approximately 446 m². The outdoor temperature for winter heating was -9°C, and the indoor design heating temperature was set at 20°C according to thermal comfort standards. The total winter heating load of the building was 23.2 kW, corresponding to a heating load index of approximately 52 W/m².

The geological profile of the site is divided into the following strata from top to bottom: fill and soil-rock layers extend from the ground surface to a depth of 50 m, while bedrock is encountered below 50 m.

2.2 System Configuration

The experimental system mainly consists of a Closed-loop Heat Exchange Geothermal Energy Collector, a secondary network circulation module, a make-up water and pressure-maintenance unit, and a Ground Source Energy Treasure VRV System. The effective depth of the Closed-loop Heat Exchange Geothermal Energy Collector is 47 m, and the freezing point of the system is approximately -18°C. The system configuration is shown in Table 1, and the schematic diagram of the system is shown in Figure 1.

Table 1. System Configuration

NO.	Module	Specifications
1	Closed-Loop Heat-Exchange Geothermal Energy Collector	Borehole depth: 47 m; outer casing diameter: 194 mm. Designed to operate under extreme low-temperature conditions
2	Secondary Circulation Module	Flow rate: 6 m ³ /h; head: 17 m; power: 1,300 W
3	Water Make-Up and Pressure Stabilization Unit	Expansion tank volume: 0.25 m ³
4	Secondary Loop Accessories	DN50 steel pipe fittings and connectors
5	Ground Energy Heat Treasure Variable-Frequency Multi-Split System	① Outdoor unit: heating capacity 30 kW, power consumption 7.8 kW; cooling capacity 28 kW, power consumption 6.2 kW ② Indoor units: nine 3.75 kW horizontal concealed units
6	Tertiary Loop Accessories	Copper pipes, branch pipes, and decorative piping
7	Electrical Accessories	20A (380V) power distribution box, associated power cables, and signal cables

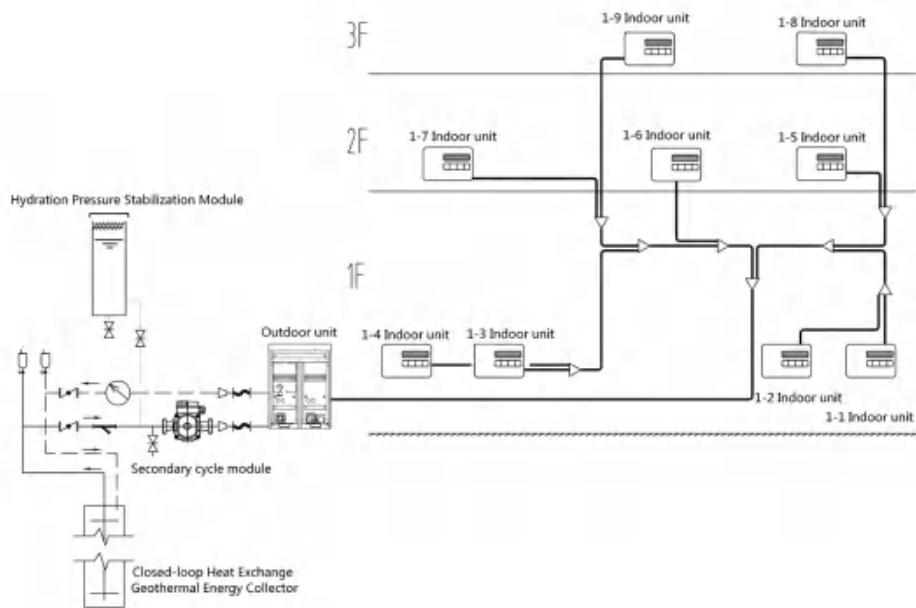


Figure 1

2.3 Closed-loop Heat Exchange Geothermal Energy Collector

The Closed-loop Heat Exchange Geothermal Energy Collector utilizes a steel casing and employs one-step casing installation together with borehole-bottom sealing technology to form a highly efficient closed-loop heat exchange collector, as shown in Figure 2, where “1” represents the inner pipe and “2” represents the outer pipe. The field installation is shown in Figure 3.

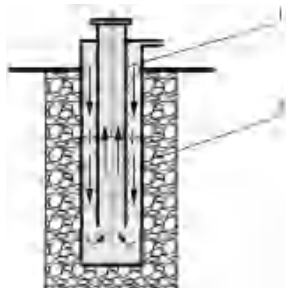


Figure 2



Figure 3



Figure 4

The collector is constructed using a steel casing and a one-step casing installation method combined with borehole-bottom sealing technology, which forms a highly efficient fully enclosed heat exchange collector. An inner water-conveying pipe is installed inside the single-well heat exchange pipe (outer pipe). The bottom of the inner pipe is connected to the outer pipe, while the borehole bottom is sealed using a proprietary sealing device. A simple wellhead assembly is installed to form an independent closed-loop circulation circuit. The circulating fluid (a water-ethylene glycol mixture) flows downward through the annular space between the outer and inner pipes. After absorbing heat from the surrounding soil and rock formations, the warmed fluid returns to the heat pump unit through the inner pipe. Compared with traditional U-tube ground heat exchangers, this configuration provides a higher heat exchange capacity per unit borehole length, which is beneficial for the wider application of shallow geothermal energy. The collector chamber is shown in Figure 4.

2.4 Ground Source Energy Treasure VRV System

2.4.1 Operating Principle

The Ground Source Energy Treasure VRV System uses water or geothermal energy as the heat source and sink. A variable-frequency compressor drives a closed refrigerant cycle, and one outdoor unit is connected to multiple indoor units to form a multi-split air-conditioning and heating system. During winter heating operation, the system extracts low-grade thermal energy from the surrounding soil or groundwater. After being upgraded through the vapor-compression cycle, the heat is transported to

indoor spaces for heating. The system dynamically adjusts compressor frequency and refrigerant flow rate according to real-time indoor load variations, enabling independent zone temperature control and precise on-demand heat supply for individual indoor units.

2.4.2 Product Features

The Ground Source Energy Treasure VRV System integrates ground-source heat pump technology with DC inverter VRV technology. It combines the high energy efficiency of ground-source heat pumps with the flexibility and precise control of VRV systems. The product offers flexible operation, accurate temperature regulation, and convenient installation, making it suitable for a wide range of building heating applications.

The Ground Source Energy Treasure VRV System integrates ground-source heat pump technology with DC inverter VRV technology. It combines the high energy efficiency of ground-source heat pumps with the flexibility and precise control of VRV systems. The product offers flexible operation, accurate temperature regulation, and convenient installation, making it suitable for a wide range of building heating applications. The outdoor unit and indoor unit installations are shown in Figures 5 and 6, respectively.

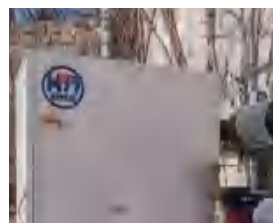


Figure 5



Figure 6

3 Methodology

3.1 Measurement Layout

The measurement layout is shown in Table 2.

Table 2. Measurement and Monitoring Plan

NO.	Item	Sub-item	Recording Frequency/ Method	Instrument Location
1	Outdoor Environment	Outdoor air temperature	Continuous measurement	West exterior wall of the courtyard
2	Ground Source Side Temperature	Supply and return water temperatures of the Closed-Loop Heat-Exchange Geothermal Energy Collector	Continuous measurement	Supply and return pipes of the geothermal energy collector
3	Indoor Temperature	Indoor air temperature (7 measurement points)	Continuous measurement	On tables in each room, approximately 1.2 m above the floor
4	Electricity Consumption	Total electricity consumption of the heat pump system	Manual recording	System power distribution box
5	Power	Pump power consumption	Manual recording	Measured and recorded on-site using a clamp meter
6	Water Flow Rate	Flow rate of the geothermal heat-exchange medium	Manual recording	Main supply and return pipes of the unit
7	Make-Up Water Tank Level	Water level of the make-up water tank	Visual inspection	Northwest corner of the flower bed
8	Unit Operating Parameters	Supply water temperature, return water temperature, and evaporation temperature	Continuous measurement	Ground Energy Heat Treasure Variable-Frequency Multi-Split Unit
9	Freezing Point Temperature	Freezing Point Temperature	Manual recording	Freezing Point Meter

Note: According to the requirements in the Chinese standard Standard for Energy Efficiency Inspection of Public Buildings (JGJ/T 177-2009), the indoor temperature measurement points were arranged in accordance, and the outdoor temperature sensors were positioned to avoid direct solar radiation, ensuring representative measurements of ambient air temperature.

3.2 Instrument Specifications

The accuracy specifications of the testing instruments are shown in Table 3.

Table 3. Uncertainties of Measuring Instruments

NO.	Instrument and Model	Uncertainties
1	Temperature Data Logger (RC-4HC, RC-4)	$\pm 0.5^{\circ}\text{C}$ within the temperature range of -20°C to 40°C ; $\pm 1.0^{\circ}\text{C}$ outside this range
2	Electricity Meter	Accuracy Class 1.0; $\pm 1.0\%$ over the rated current range (I_b – $I_{\max}$)
3	Water Meter	Maximum permissible error: $\pm 2.0\%$
4	Clamp Meter	$\pm 1.0\%$ of full scale (FS)
5	Freezing-Point Meter	Indication error: $\pm 0.5^{\circ}\text{C}$
6	Unit Temperature Sensor	$\pm 0.1^{\circ}\text{C}$

3.3 Testing Period

December 8th, 2025–March 10th, 2026, covering a total period of 93 days.

3.4 Test Parameters

The monitored parameters included: outdoor air temperature, indoor room temperature, supply and return water temperatures of the Closed-loop Heat Exchange Geothermal Energy Collector, circulating fluid flow rate, electricity consumption of the Ground Source Energy Treasure VRV System, make-up tank water level, and operating parameters of the unit.

3.5 Data Processing Methods

(1) System and Unit Operating Power

The average system operating power was obtained by dividing the total electricity consumption during the test period by the corresponding operating time. The circulating water pump power was calculated based on current measurements, while the indoor unit power consumption was taken as the rated

value specified by the manufacturer. The average operating power of the heat pump unit was calculated as:

Average unit power = Average system power – Water pump power – Indoor unit power

(2) Heating Capacity of the Unit

The heat transfer rate on the ground-source side was calculated using the following equation:

$$Q_g(\text{kW}) = 1.163 \times qV(\text{m}^3/\text{h}) \times \Delta t(^{\circ}\text{C})$$

● qV is the average flow rate measured by the water meter

Δt is the temperature difference between the inlet and outlet water of the unit

(3) Electricity Consumption per Unit Floor Area

The electricity consumption per unit floor area was calculated as:

Electricity consumption per unit floor area = (Total system electricity consumption)/(Building floor area)

4 Results and Analysis

4.1 Experimental Results

(1) Outdoor air temperature: the maximum temperature was 19.2°C, the minimum temperature was -13.4°C, and the average temperature was 1.5°C. The temperature profile is shown in Figure 8.

(2) Supply and return water temperatures of the Closed-loop Heat Exchange Geothermal Energy Collector:

● The supply water temperature is shown in Figure 9: the maximum value was -3°C, the minimum value was -8.2°C, and the average value was -6.5°C.

● The return water temperature is shown in Figure 10: the maximum value was -4.1°C, the minimum value was -8.5°C, and the average value was -7.7°C.

(3) Indoor temperature: the average temperature of the seven measurement points was 21.1°C. Detailed data are presented in Table 4.

(4) Flow rate: the average value of five measurements during the test period was 5.4 m³/h.

(5) Electricity consumption and power: the total electricity consumption during the 93-day test period was 14,955 kWh. The average system power was 6.7 kW, and the average unit power was 5.9 kW.

(6) Water level of the pressure-maintenance make-up tank: no significant change in liquid level was observed during the test period.

(7) Unit operating parameters: the average supply water temperature was -4°C, and the average return water temperature was -5.7°C. The refrigerant evaporation temperature ranged from -9.4°C to -7.1°C.

(8) Freezing point of the circulating fluid: the measured freezing point was approximately -18°C, which was lower than the minimum outdoor temperature recorded during the test period.

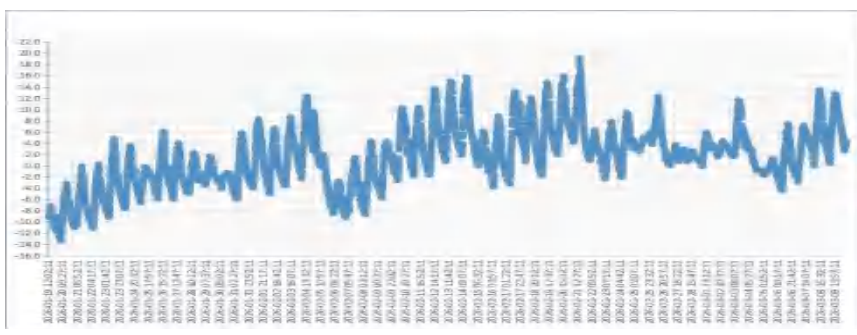


Figure 8

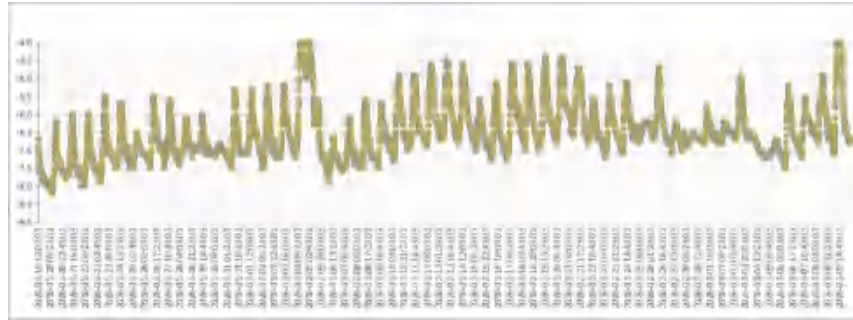


Figure 9

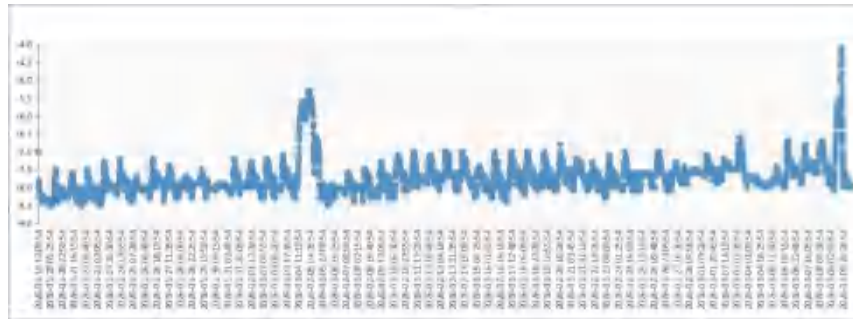


Figure 10

Table 4: Indoor Temperature Measurements (°C)

Room Temp	Dining Room	Recreation Room	Second-Floor South Bedroom	Second-Floor Northeast Bedroom	Second-Floor Northwest Bedroom	third-Floor South Bedroom	third-Floor North Bedroom
Maximum Temperature	25.3	30	32.4	28.5	27.4	29.5	28.9
Minimum Temperature	16	11.7	17	19.32	16.6	13.4	16.3
Average Temperature	19.4	20	21.9	23.4	21.2	20.9	20.8

4.2 Experimental Analysis

(1) Analysis of System Operating Conditions

During the test period, the average supply water temperature of the Closed-loop Heat Exchange Geothermal Energy Collector was -6.5°C , meeting the target operating condition of $-5^{\circ}\text{C} \pm 3^{\circ}\text{C}$. The average outdoor temperature was 1.5°C , while the minimum recorded temperature was -13.4°C , occurring at 7:00 am on January 20th, 2026. According to historical meteorological data for the 2025-2026 heating season in Haidian District, the minimum temperature during the heating season was -13°C on 20 January 2026. This indicates that the test period covered the low-temperature conditions of the local heating season.

(2) Analysis of Unit Operation

Analysis of the unit operating conditions and the supply and return water temperatures revealed two periods during which water temperatures increased significantly. The first period occurred on February 4th, 2026 and was primarily caused by a noticeable increase in outdoor temperature. During this period, a temperature difference still existed between the supply and return water, and the compressor operated at a relatively low frequency. The second period occurred on March 9th, 2026, when both outdoor and indoor temperatures increased substantially. The temperature difference between the supply and return water approached zero, so the unit shut down after reaching the set temperature. The supply water temperature profile indicates that the unit operated normally throughout the test period without any fault-related shutdowns.

(3) Analysis of Make-up Tank Water Level

No significant change in the water level of the make-up tank was observed during the test period. This indicates that no leakage occurred in the

circulating fluid loop and confirms the reliability of the borehole-bottom sealing technology under extreme winter operating conditions.

(4) Influence of Outdoor Temperature on Collector Temperature

The relationship between outdoor temperature and the supply water temperature of the Closed-loop Heat Exchange Geothermal Energy Collector is illustrated in Figure 11. The blue curve represents outdoor air temperature, while the yellow curve represents the collector supply water temperature. The black horizontal lines indicate the average outdoor temperature (1.5°C) and the average supply water temperature (-6.5°C), respectively. Points A, B, and C correspond to three characteristic low-temperature events during the test period. The results show that although the supply water temperature decreased slightly with decreasing outdoor temperature, the overall variation remained very limited. Therefore, the influence of outdoor temperature fluctuations on the collector supply water temperature can be considered negligible.

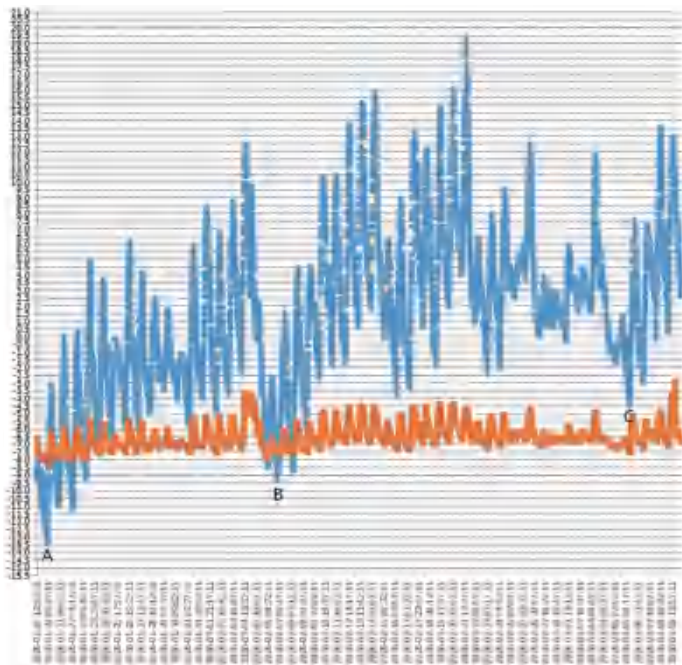


Figure 11

(5) Analysis of Electricity Consumption

The total electricity consumption during the 93-day test period was 14,955 kWh, corresponding to an electricity consumption of 33.5 kWh/m².

(6) Performance Analysis

The measured performance parameters are summarized in Table 5.

Table 5: Measured System Performance Parameters

NO.	Parameter	Unit	Measured value	Remarks
1	Average Ground-Source Heat Exchange Capacity	kW	10	Heat exchange rate per meter of borehole depth: 212.8 W/m
2	Average System Heating Capacity	kW	15.3	–
3	Average Unit COP	kW/kW	2.6	–
4	System COP	kW/kW	2.3	–
5	Average Unit Power Consumption	kWh	5.9	Indoor and outdoor units combined
6	System average power	kWh	6.7	units, outdoor unit, and circulation pump combined

According to market survey results, the nominal COP of low-ambient-temperature air-source heat pumps with fan-coil terminals is typically between 2.4 and 2.5. In this study, the Ground Source Energy Treasure VRV System achieved an average COP of 2.6 under extremely low-temperature conditions, outperforming the nominal performance of low-temperature air-source heat pumps. Furthermore, the nominal COP of the unit reaches 3.85, demonstrating significant energy-saving potential.

(7) Analysis of Indoor Heating Performance

During the test period, the average temperature of the seven indoor measurement points was 21.1°C, satisfying the design heating temperature requirement of 20°C. The lower minimum temperature in the south bedroom on the third floor resulted from manual shutdown of the indoor unit during the test period.

It should be noted that Beijing did not experience temperatures approaching the historical extreme lows recorded during the past decade in the 2025-2026 heating season. According to the Beijing Meteorological Observatory, the lowest temperature recorded in Beijing over the past decade was –19.6°C on January 7th, 2021, whereas the minimum temperature during the 2025–2026 heating season was –12.6°C on January 21th, 2026. Therefore, the indoor temperature results obtained in this study represent the system performance only under the meteorological conditions of the 2025-2026 heating season.

5 Conclusions and Future Prospects

5.1 Conclusions

(1) Operational stability: No fault shutdowns or protective actions occurred during the 93-day test period. The stable water level in the make-up tank verified the reliability of the borehole-bottom sealing technology. Outdoor temperature fluctuations had minimal influence on the supply water temperature, demonstrating excellent heat-source stability.

(2) Energy efficiency: The measured COP of the unit reached 2.6 under extremely low-temperature conditions, exceeding the nominal performance of low-temperature air-source heat pumps. Together with its frost-free operation, the system demonstrates considerable energy-saving benefits.

(3) Heating performance: The average indoor temperature during the test period reached 21.1°C, satisfying the design requirement of 20°C and demonstrating that the system can maintain effective heating under extreme operating conditions.

5.2 Future Prospects

Buildings represent the primary application sector for heat pump technology; however, the current penetration rate of heat pumps in building heating remains below 5%. As an emerging low-carbon heating technology, water-source and ground-source heat pumps offer significant economic and environmental benefits and possess substantial development potential. The Closed-loop Heat Exchange Geothermal Energy Collector is not constrained by groundwater availability and provides a higher heat exchange capacity per unit borehole length than conventional U-tube ground heat exchangers. Moreover, the combined Closed-loop Heat Exchange Geothermal Energy Collector

– Ground Source Energy Treasure VRV System offers both significant energy-saving benefits and reliable heating performance under extremely low-temperature conditions, eliminating the need for specialized units designed specifically for severe cold climates. Therefore, the system has strong potential for widespread application in decentralized heating scenarios such as schools, office buildings, hotels, and villas.

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Closed-loop Heat Exchange Geothermal Energy Collector

Author: Wang Xuezhi

I. Overview

The closed-loop heat exchange geothermal energy collector is an advanced shallow geothermal energy extraction technology. This technology utilizes a single borehole and a fully closed circulation loop. Specialized heat exchange pipes installed within the borehole exchange heat with shallow underground rock and soil formations, thereby achieving stable, efficient, and environmentally friendly continuous heat extraction.

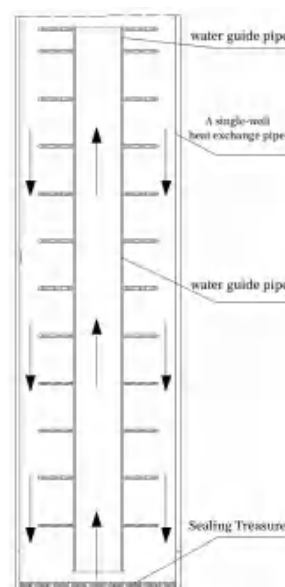
The drilling depth is generally within 400 meters. The overall system features a simple structural design, a short construction period, relatively low initial investment, and long-term safe and reliable operation. It is highly suitable for winter heating, summer cooling, and year-round domestic hot water supply in various types of buildings, making it one of the preferred technical solutions for modern green and low-carbon building energy systems.

II. Structure and Working Principle

A single-well heat exchange pipe is installed inside the heat exchange well, with a coaxial water guide pipe arranged within it. The bottom of the water guide pipe is connected to the lower section of the single-well heat exchange pipe. The bottom of the well is sealed with a "Sealing Treasure" assembly, while a simple control device is installed at the wellhead. Together, these components form an independent closed-loop circulation heat exchange system.

Driven by a circulation pump, the low-temperature circulating medium, usually water or antifreeze, flows downward through the annular space between the single-well heat exchange pipe and the water guide pipe toward the bottom of the well. During this process, heat exchange occurs between the medium and the surrounding geological strata through the metal pipe wall, allowing the medium to absorb geothermal heat and gradually increase in temperature.

After reaching the bottom of the well, the medium changes direction and enters the inner cavity of the water guide pipe, flowing upward back to the surface. Once returned to the surface, the heated medium enters the heat pump unit and releases heat into the building heating system. The cooled medium is then pumped back into the annular space to begin a new cycle, forming a continuous, stable, and efficient closed-loop geothermal energy extraction process.



Throughout the entire operation process, the circulating medium remains inside sealed pipes without direct contact with groundwater, thereby avoiding any adverse impact on local groundwater resources or the geological environment.

III. Main Technical Features

1. Heat Extraction without Water Extraction, Environmentally Friendly

During the heat extraction process, the heat exchange medium does not come into contact with groundwater or geological formations. The system completely avoids groundwater extraction and reinjection operations and does not disturb or damage the natural aquifer structure.

2. Extremely Small Footprint for a Single Well

Only one borehole is required, occupying minimal land area. The technology is particularly suitable for densely populated urban areas, existing residential communities, campuses, hospitals, and other locations where land resources are limited.

3. Stable and Reliable Closed-Loop Operation

The internal environment of the system remains closed and clean, effectively eliminating scaling, corrosion, and blockage caused by water quality issues. As a result, the equipment enjoys a long service life and requires relatively little routine maintenance.

4. Convenient and Efficient Shallow Construction

The drilling depth is relatively shallow, the construction period is short, the overall project cost is comparatively low, and the technical implementation difficulty is relatively manageable.

IV. Technical Applicability Conditions

This technology is primarily suitable for shallow geothermal energy development and utilization projects involving shallow underground formations, generally within 400 meters below the surface. It typically requires geological formations with good thermal conductivity and relatively stable groundwater conditions.

The technology is especially suitable for clean heating and air-conditioning projects in urban new construction and renovation projects, large residential communities, and public buildings such as shopping malls, office buildings, and schools.

In areas where groundwater extraction is strictly restricted, ecologically sensitive regions with high environmental protection requirements, densely built urban districts, and key water resource protection zones, this technology demonstrates particularly significant advantages.

V. Comparative Analysis with Other Technologies

1. Comparison with Traditional Groundwater-Source Heat Pump Systems

Traditional groundwater-source heat pump systems require groundwater extraction as a heat source and subsequent reinjection after use. Such systems often face challenges including difficult reinjection, risks of groundwater contamination, and declines in groundwater levels.

In contrast, the closed-loop heat exchange geothermal energy collector adopts a fully closed circulation system that requires neither groundwater extraction nor reinjection. It fundamentally avoids hydrogeological issues, resulting in more stable and reliable operation, simpler long-term management, and more convenient project approval procedures.

2. Comparison with Conventional Shallow Buried-Pipe Ground-Source Heat Pump Systems

Traditional horizontal or vertical buried-pipe systems require large numbers of boreholes, occupy extensive land areas, involve complicated layouts, and impose high site requirements.

By comparison, the closed-loop heat exchange geothermal energy collector provides stronger heat exchange capacity per single well, significantly reduces the required number of boreholes, occupies less land, enables faster construction, and offers greater design flexibility. Under the same heating and cooling scale, it delivers superior overall economic performance.

3. Comparison with Air-Source Heat Pump Systems

Air-source heat pump systems are heavily affected by climatic conditions, resulting in fluctuating energy consumption and relatively high long-term operating costs.

In contrast, this technology maintains stable energy consumption and higher energy efficiency without being significantly affected by climate conditions. It supports both heating and cooling functions while offering lower overall operating costs and superior environmental and long-term economic performance compared with air-source heat pumps.

VI. Comprehensive Energy Efficiency Analysis

When combined with high-efficiency ground-source heat pump systems, the closed-loop heat exchange geothermal energy collector can achieve a system coefficient of performance (COP) generally ranging from 3.5 to 4.5 or even higher. This level of performance is significantly superior to that of conventional air-source heat pump systems.

VII. Comprehensive Environmental Impact Analysis

1. Impact on the Water Environment

The system operates entirely within a closed circulation loop and completely avoids groundwater extraction, reinjection, and direct contact with groundwater. Therefore, it produces no disturbance or impact on the local groundwater hydrological environment, groundwater quality, or groundwater levels.

The technology fundamentally eliminates potential environmental risks such as groundwater contamination, leakage, and groundwater level decline.

2. Impact on the Atmospheric Environment

The system operates without any fossil fuel combustion and therefore produces no atmospheric pollutants such as smoke dust, sulfur dioxide (SO₂), nitrogen oxides (NO_x), particulate matter, or carbon dioxide (CO₂).

VIII. Social Benefits

As a clean and renewable energy source, shallow geothermal energy can effectively replace traditional fossil fuels such as coal and natural gas in practical applications. In doing so, it significantly reduces carbon dioxide emissions and other pollutant emissions, helps improve regional air quality, and enhances residents' living comfort and health conditions.

At the same time, the promotion and application of this technology strongly supports the transformation of local energy structures toward cleaner and lower-carbon systems. It provides reliable technical support for green building development and low-carbon community construction while generating strong demonstration effects and broad social benefits.

This development direction fully aligns with China's national policy orientation for clean energy promotion and sustainable development and contributes positively to the advancement of ecological civilization and the achievement of the "Dual Carbon" goals.

HYY Comprehensively Advances Integrated Media Communication System Construction

Empowering the High-Quality Development of the Shallow Geothermal Clean Energy Brand

Author: He Tianyue

The year 2026 marks a critical stage for Ever Source Science & Technology Development Group Co., Ltd. (HYY) in implementing and consolidating its standardized development strategy. Closely aligning with China's "Dual Carbon" strategic goals and the broader trend toward clean heating development in northern China, the Group has continued to deepen its efforts in shallow geothermal technology research and development, standardized system construction, and large-scale market promotion. At the same time, it has shifted the primary focus of its corporate communications toward online dissemination and integrated media development.

By establishing an all-media communication matrix, creating high-quality branded content, strengthening professional team development, and innovating content dissemination methods, HYY is comprehensively building a brand communication system aligned with its standardized development strategy. Through these efforts, the Group continues to expand the industry influence and public recognition of Zhongguancun-originated shallow geothermal technologies, laying a strong brand foundation for the nationwide promotion of "non-combustion high-efficiency heating through geothermal heat pumps".

I. Advancing Top-Level Design to Build a Comprehensive All-Media Communication Matrix

Based on the core strategy of promoting standardized development nationwide, the Group has systematically reviewed and integrated its existing communication channels, forming a multidimensional communication matrix centered on "professional journals as the foundation, official platforms as the core, and mainstream social media platforms as extensions".

At present, the Group operates one professional print media platform, China Geothermal Energy magazine, as well as nine major online communication platforms, including the HYY official website, WeChat Official Account, Sina Weibo, Douyin, Kuaishou, Xiaohongshu, Bilibili, WeChat Channels, and Toutiao.

This communication matrix achieves comprehensive coverage ranging from specialized industry audiences to the general public, establishing a complete communication chain that connects technological concepts, product value, and brand image from the industry level to the market and end-user level. It also provides a comprehensive channel system supporting the nationwide promotion of the Group's standardized products and agency cooperation models.

II. Rooted in Real-World Scenarios and Building Core Brand Content through Authentic Product Performance

The Group has consistently regarded authentic product performance and real user experience as the core of its brand communication efforts, using firsthand application scenarios to demonstrate the value of its technologies.

On January 9, 2026, HYY organized four dedicated working teams to conduct return visits during the coldest period of winter, known as the "Sanjiu" period, to four major project sites: Luojiafen Village in Haidian District, Xizha Village in Haidian District, Liuminying Village in Fengtai District, and Dingzhou Village in Hebei Province. Team members engaged in face-to-face communication with end users while simultaneously filming documentary-style short videos on site.

The return visits were intentionally conducted during the coldest winter period in order to verify the actual operating performance and user experience of HYY's core products under extreme low-temperature conditions.

The resulting content focused on the core values of the "Geothermal Thermal Unit" product, namely "heating assurance, integrated cooling capability, and low operating cost". By centering on the genuine experiences of rural household users, the Group created brand content that is both persuasive and emotionally engaging. Related videos have already been officially released on platforms including Sina Weibo.

(Related videos from the winter return visits can be found by searching for the keyword "Geothermal Thermal Unit", or by searching for the "HYY Group" account on platforms such as Xiaohongshu, Douyin, Weibo, and WeChat Channels.)

III. Empowering Brand Credibility through Authoritative Endorsements and Mainstream Media Collaboration

Building upon its core technologies and benchmark projects, the Group has strengthened brand credibility through endorsements from authoritative experts and cooperation with mainstream media organizations.

On February 10, 2026, Wu Qiang, Member of the National Committee of the Chinese People's Political Consultative Conference (CPPCC), Academician of the Chinese Academy of Engineering, and President of the Inner Mongolia Research Institute of China University of Mining and Technology (Beijing), led a delegation to conduct field investigations at HYY's benchmark shallow geothermal heating projects.

During the investigation, Academician Wu first visited rural households in Luojiafen Village, Haidian District, Beijing, where he engaged in friendly conversations with local residents and carefully learned about actual indoor heating temperatures, operating costs, and daily system operation conditions. He highly praised the large-scale application of HYY's "Geothermal Heating Device" products in rural areas and recognized the improvements they have brought to winter heating convenience and quality of life for local residents.

The delegation subsequently visited the Beijing Haidian Foreign Language Shiyuan School project, a benchmark centralized heating project that has operated safely and stably for 26 years. There, the delegation held discussions with school leadership and conducted in-depth research on the system's long-term operational stability, economic efficiency, and environmental benefits.

The investigation invited reporters from Ta Kung Pao Hong Kong to conduct full-process coverage. Journalists carried out in-depth interviews with

Academician Wu Qiang, project users, and school representatives, comprehensively documenting the practical implementation results of HYY's original technologies and standardized products across different application scenarios.

Related video news reports have since been officially released through platforms including the Takung Media International WeChat Channels account. The project successfully achieved coordinated dissemination between authoritative industry voices and mainstream public media, further enhancing the Group's social influence and brand recognition.



Interviews Conducted by Reporters from Hong Kong Ta Kung Pao with Academician Wu Qiang and Others



Photographs from the Site Visit to the Haidian Foreign Language Shiyan School Project



Photographs from Household Visits in Luojiafen Village, Haidian District

IV. Strengthening Internal Capabilities and Improving Integrated Media Talent Development and Organizational Support

To better adapt to the communication landscape of the integrated media era, the Group has simultaneously advanced the development of its publicity talent team and the improvement of its organizational system, laying a solid foundation for the long-term development of corporate communications.

On January 22, 2026, the Group invited senior integrated media expert Zhiwei Jin to conduct a special training session titled "Social Media Algorithms and Our Strategies – New Media Strategies for China HYY Development Group Co., Ltd." The training focused on key topics including social media communication logic, algorithm mechanisms, and corporate new media operation

strategies. It comprehensively enhanced employees' understanding of integrated media communication, helped the team accurately grasp communication opportunities in the new media era, and clarified the direction and implementation path for the Group's integrated media publicity efforts.

In February 2026, the Group officially established an Integrated Media Working Group to systematically organize and integrate the company's online media communication resources while establishing a standardized full-process management system covering content creation, review, and publication.

At the same time, leveraging the Spring Festival holiday period, the Working Group launched a nationwide short-video creation and communication campaign involving employees from various regional branches. This initiative fully mobilized frontline employees' enthusiasm for participation in brand communication, fostering a company-wide atmosphere of active engagement in brand promotion and effectively expanding the reach of the corporate brand.

In March, the Group further showcased the company's professional strength and rigorous working standards to the public through a series of videos and livestreams featuring the professional operations of the company's spring maintenance personnel and the real-time operating conditions of its equipment. The related content attracted more than ten thousand views and received widespread attention and positive feedback from industry professionals and user communities alike.



Pre-Work Safety Briefing for the Spring Inspection of the Wanbo Commercial Building Project



Livestream Scene of the Spring Inspection for the All-China Federation of Industry and Commerce Project

V. Innovating Content Formats and Building a Diversified Brand Communication Content System

Centered on its core brand communication objectives, the Group has continued to advance the innovation and upgrading of its publicity content, creating a diversified content matrix tailored to different communication platforms and audience groups.

In January 2026, the Group specially invited a senior former cameraman and reporter from Beijing Television Station to produce a

customized corporate brand promotional film. The short film comprehensively showcases the company's technological capabilities, project achievements, and brand philosophy. It has now been officially released through the Toutiao platform.

In March 2026, the Group further deepened its content innovation efforts by collaborating with a professional short-drama production team. Centered on the theme of "telling HYY's heating story well", the Group officially launched the production of a series of themed short dramas.

Through vivid and story-driven content formats, the series aims to present the practical value and social significance of shallow geothermal clean heating technology in a more accessible and engaging way, helping bridge the gap between industry technologies and public understanding.

At present, filming for the first episode of the series has been completed and has entered the post-production stage. Once officially released, the series is expected to further expand public awareness and communication of the brand concept of "non-combustion high-efficiency heating".

VI. Future Outlook

Since the beginning of 2026, HYY has used the construction of its integrated media communication system as an important strategic driver, achieving a comprehensive upgrade of its brand communication efforts across the entire chain, including channel development, content creation, team building, and organizational support.

These efforts have not only significantly enhanced the company's industry influence and public recognition, but have also closely aligned with the company's core strategy of standardized and large-scale development, providing strong brand

support for the advancement of nationwide regional agency cooperation and project partnership models.

Looking ahead, HYY will continue to deepen its commitment to the shallow geothermal clean energy sector. Rooted in Zhongguancun-originated single-well circulation heat exchange core technology, centered on standardized product systems, and supported by its integrated media communication platform, the company will continue telling the story of China's clean heating innovation.

At the same time, HYY will continue promoting the large-scale nationwide application of "non-combustion high-efficiency heating through geothermal heat pumps", accelerate the development of the emerging integrated heating-and-cooling green industry, and contribute sustained core strength to the realization of China's "Dual Carbon" strategic goals and the high-quality development of clean heating across northern China.

On the Remarkable **Shallow Underground Constant-Temperature Layer**

Author: Lao Ma

I. What Is the Shallow Underground Constant-Temperature Layer?

The temperature distribution beneath the Earth's surface is not uniform. Instead, it exhibits distinct stratification characteristics that vary with depth. It is generally divided into three layers: the external thermal layer (variable-temperature layer), the constant-temperature layer, and the internal thermal layer (temperature-increasing layer). Among them, the constant-temperature layer is the transitional zone located beneath the external thermal layer and above the internal thermal layer. It is also the layer where the shallow underground thermal resources and cold resources utilized in "ground energy ecological heating" are situated.

The external thermal layer is the layer closest to the Earth's surface, typically extending to a depth of approximately 0–30 meters. Its heat mainly originates from solar radiation and fluctuates significantly with latitude, season, day and night cycles, and vegetation coverage. In summer, it becomes heated by solar exposure, while in winter it cools along with surface temperatures and may even freeze.

As depth increases, the influence of solar radiation gradually weakens. At a certain depth, surface temperature fluctuations become negligible, and underground temperatures stabilize at a relatively constant value. This depth range is known as the constant-temperature layer.

The depth and temperature of the constant-temperature layer are not fixed and vary by region. In general, northern China has a deeper constant-temperature layer, usually between 15 and 30 meters, with relatively lower temperatures. For example, the constant-temperature layer in Harbin is approximately 3.5°C. In southern China, the layer is generally shallower, usually between 5 and 15 meters, and temperatures are relatively higher. In Xiamen, for instance, the temperature of the constant-temperature layer can reach approximately 21°C.

However, the defining characteristic of the constant-temperature layer remains unchanged: its temperature remains stable throughout the year with only minimal fluctuations. In addition, the temperature of the constant-temperature layer may also be slightly affected by factors such as the thermal properties of rock and soil and groundwater movement, though overall it remains in a relatively constant state.

II. The Constant-Temperature Layer and the Development and Utilization of Shallow Geothermal Energy

The greatest value of the constant-temperature layer lies in its abundant storage of shallow geothermal energy. Shallow geothermal energy refers to thermal energy stored within rock, soil, groundwater, and other underground media at certain depths below the Earth's surface, primarily within and around the constant-temperature layer. It is a clean, renewable, and abundant new energy resource, and the constant-temperature layer serves as the most stable and easily exploitable carrier of shallow geothermal energy.

Compared with fossil fuels such as coal and petroleum, shallow geothermal energy possesses unmatched advantages. It is widely distributed and available in nearly all regions of the world without the need for long-distance transportation. It is clean and non-polluting, generating no waste gas, wastewater, or solid waste during development and utilization, while also causing no damage to the ozone layer and effectively reducing greenhouse gas emissions.

Shallow geothermal energy is also highly renewable. The thermal energy within the constant-temperature layer primarily originates from solar radiation and heat dissipation from the Earth's interior. As long as it is developed responsibly, it can be sustainably utilized over the long term.

In addition, shallow geothermal energy maintains stable energy density and is not significantly affected by seasonal or weather changes, allowing it to provide continuous and stable energy support for human society.

China possesses extremely abundant shallow geothermal energy resources. According to surveys, the annual exploitable quantity of shallow geothermal energy in 336 prefecture-level and above cities nationwide is equivalent to approximately 700 million tons of standard coal. More than 80 percent of provincial capital cities are suitable for shallow geothermal energy development and utilization.

At present, the development and utilization of shallow geothermal energy are mainly concentrated in building heating, cooling, and domestic hot water supply, particularly in urban buildings. Through geothermal heat pump systems, heat from the constant-temperature layer is extracted to provide comfortable indoor environments for residential buildings, shopping malls, office buildings, and other facilities. This approach is both energy-efficient and environmentally friendly and plays an important role in promoting green and low-carbon urbanization and mitigating winter smog pollution.

It is worth noting that the thermophysical parameters of the constant-temperature layer, such as thermal conductivity and specific heat capacity, are key factors affecting the development and utilization of shallow geothermal energy. Different geological formations and rock-soil compositions possess different thermal conductivity characteristics, which directly influence heat transfer efficiency and development costs.

Accurately determining these parameters and establishing geothermal field prediction models can provide precise support for the scientific development of shallow geothermal energy, reduce engineering costs, and improve development efficiency.

III. Why Can the Constant-Temperature Layer Serve as Both a Heat Source and a Cooling Source?

Many people wonder why geothermal heat pump systems can achieve dual functionality, providing heating in winter and cooling in summer. The core reason lies in the stable "warm in winter and cool in summer" temperature characteristics of the constant-temperature layer. Combined with the heat transfer function of heat pumps, this enables efficient transfer and utilization of thermal energy. In essence, the system functions like an "underground thermal energy transporter".

A geothermal heat pump system mainly consists of three components: the geothermal energy collector buried within the constant-temperature layer, the heat pump unit, and the indoor terminal system such as fan coil units or radiant floor heating pipes.

Among them, the geothermal energy collector serves as the key connection between the constant-temperature layer and the heat pump unit. Through the circulating heat-transfer medium inside the collector, heat exchange occurs with the surrounding underground rock and soil formations. The difference between the heating and cooling processes essentially lies only in the direction of energy transfer.

During winter heating operation, surface air temperatures are relatively low, often below 0°C, while the temperature within the constant-temperature layer remains comparatively high. In Beijing, for example, the temperature is generally around 15°C. Under these conditions, the circulating medium inside the geothermal collector absorbs heat from the underground rock and soil and transfers it to the heat pump system. Because the underground heat source temperature is significantly higher than outdoor air temperature, heating efficiency is correspondingly high.

During summer cooling operation, outdoor air temperatures may exceed 30°C, while the temperature of the constant-temperature layer remains stable. The heat pump system transfers indoor heat into the geothermal energy collector, which ultimately releases the heat into the underground rock and soil formations of the constant-temperature layer.

At this stage, the constant-temperature layer functions as a "natural cooling reservoir." Because this underground "cooling reservoir" maintains relatively low temperatures and possesses enormous thermal storage capacity, cooling efficiency is extremely high while also helping avoid the "urban heat island effect" commonly associated with conventional cooling systems.

The shallow underground constant-temperature layer, this remarkable hidden treasure beneath our feet, not only reveals the thermal equilibrium principles of the Earth's interior but also provides important support for humanity in addressing energy challenges and achieving green development.

As shallow geothermal energy development technologies continue to advance, the value of the constant-temperature layer will be further unlocked. In the future, it will enter more homes and businesses, bringing cleaner, more comfortable, and more sustainable energy experiences to daily life and transforming the Earth's natural "body temperature" into an inexhaustible resource supporting human development.

敬告读者

《中国地热能》是由中国地热能出版社主办，首都科技发展战略研究院、北京工业对外经贸促进会、中国地热与温泉产业技术创新战略联盟、中国热冷一体化清洁能源研究院协办的科技期刊，双语半年刊。我们的办刊宗旨是为政府制定能源政策提供参考建议；为地能开发企业提供宣传平台；为设计者、大众提供交流空间；推广浅层地热能利用经验，展示应用实例。

我们始终不忘读者的期待，用心用力办好期刊。毫无疑问，优化空气、节能减排、治理雾霾是当前摆在全体中国人民面前一个重大课题，我们希望《中国地热能》这本小小的期刊能够为攻克这一难题贡献微薄之力。

立足长远，着眼当前，在继承中创新，在变革中发展。自创刊以来，期刊一直得到了业内专家学者和广大读者的热情支持，在此致以我们的衷心感谢。大家的关注是我们的追求，大家的支持是我们的动力。让我们携手共进，共同打造《中国地热能》的美好明天。

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Editor's Note

"China Geothermal Energy" is a scientific journal sponsored by China Geothermal Energy Publishing House, and co-organized by the Capital Science and Technology Development Strategy Research Institute, the Beijing Industrial Foreign Trade Promotion Association, the China Geothermal and Hot Spring Industry Technology Innovation Strategic Alliance, and the China Thermal and Cold Integrated Clean Energy Research Institute. It is a bilingual semi-annual publication. Our mission is to provide meaningful proposals to policymakers in the energy sector, to offer a promotional platform for geothermal energy development enterprises; to create a communication channel for providers and consumers; and to showcase the good practices and applications of shallow geothermal energy for efficient heating.

We always strive to constantly improve the journal, so as to live up to the expectations of our readers. Undoubtedly, optimizing air quality, energy conservation and emission reduction, and smog control are significant challenges facing all Chinese people today. This journal, "China Geothermal Energy" is designed with the hope of making its contribution to overcoming these challenges.

Looking towards the future while staying focused on the present, we strive to innovate and evolve in our practices. Since its establishment, our journal has received tremendous support from industry experts, scholars, and readers, for which we are sincerely grateful. Your attention is our treasure, and your support serves as our motivation. Let us join hands and work together to shape a brighter future for "China Geothermal Energy".

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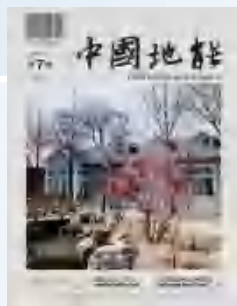
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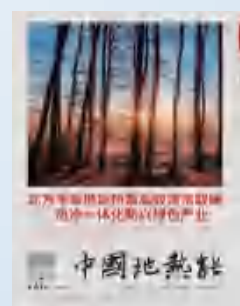
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CHINA GEOTHERMAL ENERGY







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