Financing sustainable energy transition in rural China

Barriers, policies, good practices from China and Europe

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Authors:

Yujie Ren	CENTRAL UNIVERSITY OF FINANCE AND ECONOMICS (CUFE)
Zixi Jin	CENTRAL UNIVERSITY OF FINANCE AND ECONOMICS (CUFE)
Yilei Fu	CENTRAL UNIVERSITY OF FINANCE AND ECONOMICS (CUFE)
Chun Xia-Bauer	Wuppertal Institute for Climate, Environment and Energy (WI)

Contact:
Chun Xia-Bauer, RurEnergy Project Coordinator, chun.xia@wupperinst.org

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1 Energy transition in rural China

1.1 The need for clean heating and energy retrofit in rural China

The pursuit of clean heating and energy retrofit stand as a cornerstone in China's sustainable energy transition and hold immense potential in realizing China's ambitious climate target. Notably, rural houses in China constituted a substantial portion of the overall building landscape, boasting a total building area of 23.3 billion m^2, which accounts for 34% of civilian buildings in the country. The energy consumption in rural houses reached 230 million tons of coal equivalent, representing 22% of the total energy consumption in civilian buildings. It resulted in 427 million tons of CO_2, contributing to 20% of the total emissions from civilian buildings. Thus, reducing energy consumption and carbon emissions of rural houses, is of paramount importance.

On the other hand, due to challenges such as limited access to district heating networks and inadequate thermal insulation in rural houses, rural areas face distinct disadvantages compared to urban districts in achieving optimal thermal comfort. Therefore, the implementation of energy retrofit and clean heating solutions in rural areas is crucial to enhancing the well-being of rural households.

1.2 How clean heating and energy retrofit has been promoted in rural China

The *2017 Report on the Work of the Government* marked a significant turning point by introducing the concept of clean heating for the first time. This initiative included, among others, the promotion of clean heating in northern China, transitioning three million households from heating with coal to electricity or gas.

In the same year, the *Clean Heating Plan in Northern China (2017 - 2021)* was jointly released by the National Development and Reform Commission and 10 ministries and commissions. This plan outlined specific steps to advance clean heating in the northern region, signifying a rollout of clean heating initiatives. Additionally, the Ministry of Environmental Protection unveiled *the 2017 Air Pollution Control Work Plan for Beijing-Tianjin-Hebei and Neighboring Areas*. This plan focused on managing coal use in the "2+26" cities within the region, addressing severe air pollution issues. The target for each city was to transition the heat source from coal to gas or electricity in 50,000 to 100,000 households within their jurisdiction, including rural areas, and phase out small coal-fired boilers. In the realm of energy retrofit, the national government issued the *Guiding Opinions on Accelerating the Modernization of Rural Houses*, emphasizing the critical role of energy retrofit in rural development. It sets energy efficiency as a key pillar for rural house design and construction and promotes rural energy transition. Various regions have adopted renewable heating solutions tailored to their local conditions.

Table 1 Local promotion of clean heat projects

Regions	Local promotion
Shandong Province	The 2018 *Comprehensive Evaluation of Geothermal Resources in Shandong Province* indicates local reserve of geothermal resources at 219.4 billion tce, which is about 47.7 times of the available coal resources in the province. Geothermal resources have been discovered in 17 cities. In June 2021, Lingcheng District of Dezhou City started using geothermal energy to heat an area of 71,000 m^2, saving about 1,536 tons of coal and reducing 3,829 tons of carbon emissions per year for clean heating.
Henan Province	The *14th Five-Year Plan for Modern Energy System, Carbon Peaking and Carbon Neutrality* sets the target of new geothermal heating capacity to at least 50 million m^2 by 2025. Zhengzhou, Luoyang and other cities along the Yellow River basin have favorable geological conditions and have implemented geothermal projects.
Jilin Province	With abundant land resources and a well-established livestock industry, Shulan City collects about 1.3 million tons of straw and agricultural by-product every year. It uses biomass fuel in its combined heat and power systems to provide clean heating to an area of 2.1 million m^2.
Tibet	The province with the most solar energy resources in China, long sunshine hours and high irradiation. The world's first large-scale solar energy for district heating project at the highest altitude with 100% operations guarantee by solar power.

Table 2 Local promotion of rural house energy retrofit

Regions	Local promotion
Liaoning Province	The *Implementation Plan for Accelerating the Modernisation of Rural Houses and Villages of Liaoning Province* states that by the end of 2023, eligible villages shall complete the planning process to enhance building design and construction, and to promote clean energy development in rural areas. Shenyang City, the provincial capital, has set out the target of retrofitting 28 villages from 2021 to 2023. “Coal to clean energy" and energy retrofit pilots have been implemented in six villages.
Guizhou Province	The *2021 Livable Rural House Retrofit Pilot Program of Guizhou Province* proposes to retrofit existing buildings by optimising indoor partition, and the construction quality of ground, wall, ceiling, kitchen, bathroom, electricity, ventilation and lighting. Dapu Village of Xingren City actively promotes rural house retrofit by replacing the conventional stoves to significantly improve indoor environment.

At present, the promotion of clean heating and energy retrofit of rural houses is highly dependent on governmental subsidies. Central government funding has played a pivotal role in advancing clean heating and energy retrofit initiatives for rural houses, with a substantial investment of 35.12 billion yuan (approx. 4.9 billion USD) allocated from 2017 to 2019. This funding initiative specifically targeted over 35 million households during the "13th Five-Year Plan" period (2016-2020). On the local level, in Henan, the investment for

clean heating pilots in Zhengzhou, Kaifeng, Hebi, and Xinxiang reached 46.14 billion yuan (approx. 6.41 billion USD), inclusive of 14.23 billion yuan (approx. 1.98 billion USD) in government funding. Similarly, Lanzhou City in Gansu Province executed 55 clean rural heating projects, with a total investment of 11.41 billion yuan (approx. 1.59 billion USD), including an annual central General overview of green financing for energy efficiency and clean heating in China government funding of 700 million yuan (approx. 97 million USD) for three years.[1]

While government funding plays a crucial role, it is insufficient for the sustained long-term implementation of clean heating and energy retrofit in rural areas. The imperative is to expand and diversify financial support, with green finance emerging as a pivotal player. During the 14th Five-Year Plan period (2021-2025), around 11.07 million households in rural areas are expected to transition their heating from using raw coal. This initiative will require a total investment ranging from 276.71 billion yuan (approximately 38.44 billion USD) to 387.39 billion yuan (approximately 53.82 billion USD).[2]

China foresees an increased need for diversified financing means in the future. Diversification encompasses various instruments, including but not limited to green credit, green bonds, green funds, and green public-private partnerships (PPPs). Nevertheless, green finance for clean heating encounters challenges such as high initial investment, long investment cycles, and perceived high risks. Additionally, a robust policy framework remains indispensable for effectively leveraging the role of green finance.

[1] China Coal Cap (2020) China Raw Coal Management Research Report 2020.

[2] Ibid.

2 General overview of green financing for energy efficiency and clean heating in China

2.1 Overall Development

Green financing in China has witnessed remarkable growth. As of the end of the first quarter of 2023, China's green loan volume reached 24.99 trillion yuan (approx. 3.47 trillion USD), reflecting a substantial 38.3% year-on-year increase, significantly outpacing the growth rate of all other loan types. The proportion of green loan balances to total loan balances surged to 11.08%, a notable increase of 7.68% compared to 2022. Notably, green loans directed towards infrastructure upgrades constituted 44.38% of the total, demonstrating a notable year-on-year increase of 34.2%.[3] However, green loans allocated to clean heating and energy retrofit projects have been relatively limited. At the local level, green loans have supported clean heating and energy retrofit projects in rural Henan and Gansu provinces, but progress has been limited. According to the assessment of financial ecosystem development conducted by IIGF, Gansu Province ranks 23rd and Henan Province ranks 17th among the 31 provinces in China, indicating relatively underdeveloped financial ecosystems. Nevertheless, both regions exhibit strengths in specific domains. For instance, Gansu Province is ranked 6th in policy promotion, while Henan Province holds the 9th position in market engagement.

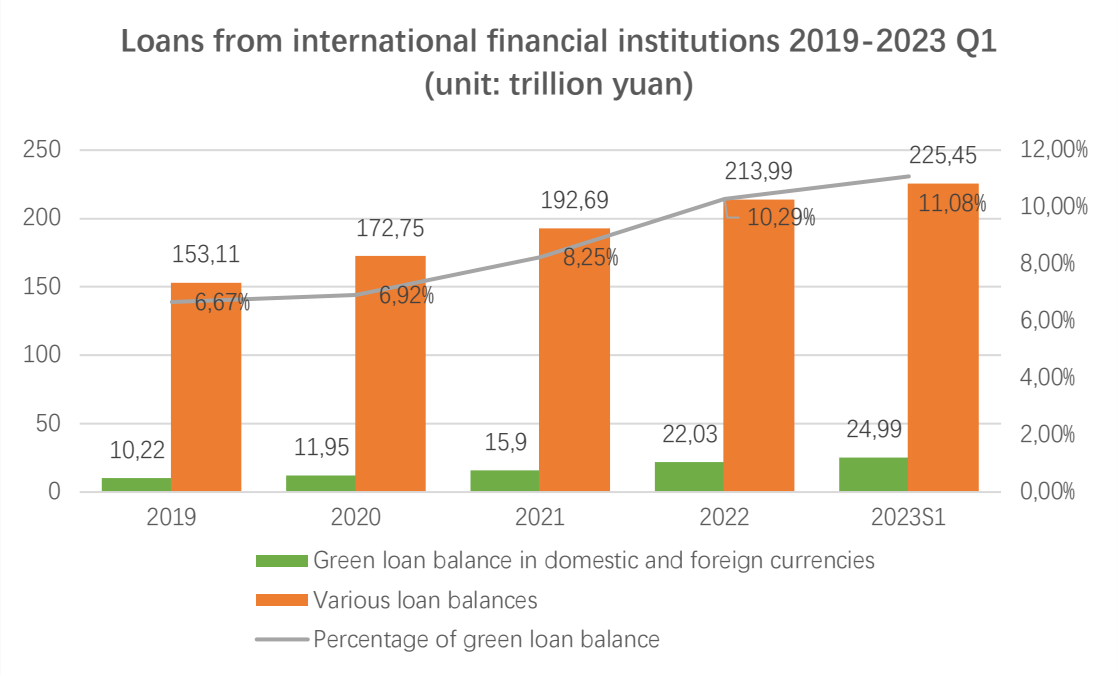

Figure 1 Loans distribution of international financial institutions 2019-2023 Q1 (source: People's Bank of China)

[3] People's bank of China (2023). Loans distribution of international financial institutions 2019-2023 Q1

2.2 Policy progress of green finance for rural clean heating and energy retrofit

Clean heating and energy retrofit for rural houses have been integrated into the domain of green finance. The *Green Industry Guidance Catalogue (2019)* and The *Green Bond Endorsed Project Catalogue (2021)* comprehensively cover various aspects of clean heating and energy efficiency retrofit, including production, services, and demand. Specifically, the following areas are highlighted:

- Energy conservation and environmental protection: Emphasis is placed on transforming boilers, furnaces, and other equipment, as well as recovering waste heat and pressure for power generation and heating.
- Clean energy utilization: This encompasses the utilization of wind, solar, biomass, geothermal, and nuclear energy, covering equipment manufacturing, operation management, and installation of heat pumps.
- Promotion of a green and circular animal husbandry model: Known as "breeding + biogas + growing + processing", this model utilizes manure and organic matter for agricultural fertilization, livestock feeding, and the production of biogas and biomass for efficient clean heating.
- Infrastructure enhancement: Efforts focus on improving energy efficiency in buildings and retrofitting rural houses to integrate them into the rural-urban heating system.

Local initiatives in Henan and Gansu primarily focus on green finance and inclusive finance to support clean heating and energy retrofit endeavours. In Henan Province, the release of *the Implementation Opinions on Accelerating the Establishment of an Initial Framework for a Green, Low-carbon, and Circular Economy* in August 2021 includes measures to promote green and low-carbon transformation in energy systems, encourage clean and combined heat and power for heating, and initiate large-scale projects such as straw biogas and bio-based natural gas. Additionally, it also aims to enhance green finance, encompassing green loans, green bonds, and green insurance, in alignment with the national Green Bond Endorsed Project Catalogue (2021). Similarly, Gansu Province introduced the *Implementation Plan on Accelerating the Establishment of an Initial Framework for a Green, Low-carbon, and Circular Economy* in the same month. This plan emphasizes enhancing the green and low-carbon energy system, maximizing the utilization of geothermal resources, and expanding rural clean heating supply, and establishing a supportive system for green finance. Inclusive finance measures to support rural revitalization, including sustainable energy transition, are also prominent in local policies, as evidenced by *Gansu's Several Measures on Financial Assistance for High-quality Development of the Real Economy* issued in May 2021. Additionally, the province implemented *the Assessment and Evaluation Measures for Financial Institutions to Serve Rural Revitalization*, aimed at increasing access to small and micro credits and encouraging investment in green infrastructure and environmentally friendly projects. Thus, exploring the synergies between inclusive financing and green financing is essential for driving the development of clean heating and energy retrofit in rural China from the consumer perspective.

2.3 Barriers of scaling up green finance for rural clean heating and energy retrofit

2.3.1 Rural Households

Rural households encounter significant obstacles due to their limited financial means and the lack of available financing options for implementing energy retrofitting and adopting clean heating solutions. The financial strain is evident in both the initial investments and ongoing operational expenses. For instance, project survey data from Henan and Gansu provinces show that a majority of rural households (85% and 68% respectively) are willing to allocate between 1,000 to 5,000 yuan (approx. 139 to 695 USD), far below the actual costs of retrofitting and clean heating installation. The other challenge lies in operational costs, as showcased by the "coal to gas" project in Zhengzhou. Based on data from the official website of China Resources Gas, residents pay 2.58 yuan/m^3 (approx. 0.36 USD/m^3) for the first 50 m^3 of gas per month, and 3.35 yuan /m^3 (approx. 0.47 USD/m^3) thereafter. Assuming a 100-m^2 rural house consumes 25 m^3 of gas per day, the monthly gas bill would amount to approximately 2,474 yuan (approx. 343 USD). If the heating period lasts for three months, the annual household heating costs could reach as high as 7,422 yuan (approx. 1,032 USD). [4] This poses a significant financial burden considering that the per capita disposable income of rural residents in 2021 was 18,931 yuan (approx. 2630 USD),[5] making it unrealistic for them to bear the operating costs of clean heating. On the other hand, residents have rather limited access to finance. According to project survey, 52.4% of respondents in Henan were unaware of any available financing channels, while 47.6% considered government subsidies insufficient. In Gansu province, 55% of respondents found government subsidies inadequate, and 40% expressed difficulties in obtaining bank loans due to complexity and stringent requirements.

2.3.2 Companies (manufacturers, service providers/project developers)

Rural clean heating and energy retrofit projects often lack appeal for private sector investment. First, these initiatives tend to be economically unattractive. The initial investment needed is significant, covering expenses like upgrading substations, high- and low-voltage cables, and equipment installation. For example, in coal-to-electricity heating projects, the investment in the power grid alone can soar up to 25,000 yuan (approx. 3473 USD) per single family, alongside costs for equipment purchase, installation, and ongoing operations. However, the potential returns on investment are often limited.[6] The second challenge lies in the design of government subsidies. Firstly, financial subsidies from the central government to pilot cities for clean heating in the northern areas do not account for local variations in baselines and thus retrofit demand, which can differ significantly among pilot cities, urban-rural junctions, towns, and new countryside areas. Subsidies are granted solely based on administrative levels. Secondly, the costs of different technologies have not been fully taken into account. Thirdly, variations in household income levels have not been adequately considered. As a result, in some regions, financial subsidies obtained by enterprises to implement collective retrofitting of rural houses may be limited, leading to lower investment returns. Thirdly, MSMEs implementing these projects often face challenges in accessing financing. The *Notice on the Organization of Applying for Clean Winter Heating Projects in Northern Areas*

[4] Official website information of Zhengzhou China Resources Gas Co., Ltd

[5] China Statistical Yearbook 2021

[6] Farmer Daily (26 Mar. 2021). The pathway towards decentralized clean heating in rural areas

issued in 2022 highlights the importance of considering local economic and social conditions, utilizing appropriate energy sources, and promoting energy efficiency in buildings. However, the variety of technologies presents a challenge for financial institutions in assessing project feasibility and providing green financing to MSMEs.

2.3.3 Financial Institutions

For financial institutions, the primary challenge lies in the source of repayment. Whether it's project loans for MSMEs or personal loans for households, there's often inadequate guarantee of repayment. Enterprises, lacking a sustainable business model for clean heating and energy retrofit projects, often rely on governmental subsidies or bundle financing with other profitable projects, increasing the risks for banks when providing loans. Secondly, there are limited financial products available for clean heating and energy retrofit in rural China. Currently, loans dominate as the primary financial product for such projects. The development of other financial products has been relatively slow, with only a few initiatives such as special bonds issued by Linyi City of Shandong Province in 2021 for district heating projects. Anji County in Zhejiang Province introduced the "green building loan for rural houses" in May 2020, pioneering the use of the Green Building Evaluation Standard to assess rural houses and determine interest rates and loan prime rates accordingly. Despite their success, such financial products remain largely experimental and confined to pilot projects. The third barrier is a lack of collaterals. Rural house energy retrofit projects lack collateral, thereby increasing the borrower's default risk. Additionally, enterprises' future receivables from clean heating projects, used as collateral, are frequently hindered by ineffective heating fee collection. Moreover, innovative mechanisms such as leveraging carbon allowances and credits as collateral still lack established schemes and procedures. The fourth challenge encountered by financial institutions is the difficulty in screening projects. National and local governments have not yet developed standardized guidelines for project compliance checks or energy-saving measurement standards for rural clean heating and energy retrofit initiatives. This makes it challenging for financial institutions to identify and assess potential projects.

3 Green finance practices for energy retrofit and clean heating in China and Europe

3.1 Green Loans

3.1.1 Clean heating pilot with green finance in Changzhi, Shanxi Province

As one of the pilot cities in the Beijing-Tianjin-Hebei air pollution corridor, Changzhi City in Shanxi Province launched a clean heating pilot program in 2018, bolstered by green finance. By October 2021, the total clean heating loans for the pilot program amounted to 286 million yuan (approx. 39.76 million USD) , showing a remarkable 184.2% increase compared to the previous year.[7] The success of the pilot program can be attributed to four key factors:

- **Standardised procedure**: The *Guidance on Financial Support for Rural Clean Heating Pilot in Changzhi City* mandates financial institutions to provide tailored services. Under the supervision of Changzhi Branch of the People's Bank of China (PBOC) [8] , Changzi Rural Commercial Bank developed the Standard Procedures for Clean Heating Loan Applications, outlining requirements for loan applicants, application processes, and post-issuance management. Regular updates of these procedures are available on the Enterprise Information Service Platform (www.cpbz.gov.cn) for public oversight.
- **Monetary policy:** The PBOC Changzhi County Sub-Branch provides preferential refinancing options to Changzi Rural Commercial Bank to facilitate lending for clean heating projects.
- **Financial products innovation**: Changzhi Rural Commercial Bank has introduced two specialized financial products, namely the "Electricity Loan" and "Biogas Loan," totalling 4.4 million yuan (approx. 611,628 USD) in lending, benefiting over 250 rural households with clean heating solutions. Additionally, they are exploring the utilization of special warrants and fixed assets from clean energy enterprises as collateral for the loans.
- **Information sharing:** The PBOC Changzhi Branch established an information platform for clean heating financing, effectively facilitating information sharing among the government, financial institutions, and enterprises. Contributions to the platform have been made by municipal and county-level governments, as well as six financial institutions and seven clean heating enterprises within Changzhi County.

3.1.2 German KfW on-lending loan program

The German government has been implementing funding programs to promote energy efficiency and renewable energies in buildings since the 1990s. The recently amended German Climate Change Act sets a legally binding target for the building sector to reduce greenhouse gas emissions by over 40%. To achieve this target, the Federal Funding for Efficient Buildings (BEG) program was established in 2021 as a key instrument. Under the BEG program, funding is available in the form of low-interest loans and direct investment grants. The German state-owned Bank for Reconstruction (Kreditanstalt für

[7] Changzhi Municipal People's Government: Supporting clean heating pilot with green finance

[8] PBOC oversees the monetary and fiscal regulations of China.

Wiederaufbau, KfW) is the major implementing organizations for the funding program. KfW operates on an on-lending approach, meaning it does not directly provide funding to final customers. Instead, it collaborates with intermediary financial institutions, mostly commercial or public banks. These intermediary banks assess the creditworthiness of customers and the viability of investments before on-lending KfW funds. Ultimately, KfW decides whether a specific loan application meets the criteria for promoting energy efficiency. While the loan risk remains with the on-lending bank, they receive an implementation margin within the KfW interest rate as compensation for their services.[9]

KfW implement governmental funding for systematic energy performance approach of both residential and non-residential buildings, i.e., purchasing or constructing a new energy efficient building/apartment and overall energy renovation[10]. Key features of KfW's energy-efficient building credits include:

- **High threshold for energy efficiency and sustainability.** The recently issued BEG has strengthened the eligibility criteria for energy performance to ensure that only the most energy-efficient buildings can receive funding. For residential buildings, new constructions must meet the *Efficiency House standard 40* [11] and be certified with the German *Sustainable Building Quality Seal* to qualify for funding. Energy retrofit projects are eligible for funding if they meet the *Efficiency House standard 85.*
- **Flexibility and low-interest rates.** For the annuity loan, the loan period is flexible, ranging from four to 30 years. The low interest rate is fixed for the first ten years of the loan period. Following this initial period, the KfW provides the customer with another interest rate option for a 10-year extension.
- **Repayment bonus tired to energy efficiency and renewable use**. It reduces the loan amount and shortens the repayment period. The higher the efficiency achieved in the renovation project, the greater the repayment bonus awarded to the owners. Additionally, owners are qualified for the bonus if their renewable heating system covers at least 65% of the building's energy needs. The maximum repayment bonus per housing unit is 37,500 EUR.
- **Support for planning and construction supervision**. For loan applications, KfW requires the owner to engage a qualified energy efficiency expert for project planning and construction supervision. The expert must then confirm that the project meets KfW's energy efficiency standards using online software provided by KfW. Additionally, KfW subsidizes these technical services, covering 50% of the eligible costs through an additional loan amount and repayment grant.[12][13]

[9] Hennes, D. R. (n.d.). Financing Energy Efficiency in the Residential Sector – Lessons Learnt from Germany and Emerging Economies. 39.

[10] Governmental funding can be provided for investing in both the whole-building energy efficiency projects and the individual measures. Another agency is responsible for funding individual measures.

[11] The term "Efficiency House" (Effizienzhaus) was introduced by the KfW as a benchmark for energy savings achieved, aligning with the general standards outlined in the German Buildings Energy Act (GEG) for both new constructions and existing buildings. These standards establish the minimum requirements for energy efficiency against which building projects are evaluated. Efficiency House Standard 40 signifies that a new or renovated building can only consume 40% of primary energy and have 55% of the transmission heat loss compared to a reference building.

[12] KfW (n.d.) Your promotion for new houses and condominium. https://www.kfw.de/inlandsfoerderung/Privatpersonen/Neubau/index-2.html

[13] KfW (n.d.) Existing Properties. https://www.kfw.de/inlandsfoerderung/Privatpersonen/Bestandsimmobilie/

3.1.3 Belgium Belfius Energy Efficiency Package

In Europe, many Energy Service Companies (ESCOs) face challenges in accessing suitable financing. Belfius Bank in Belgium addresses this obstacle by introducing dedicated financing solutions for ESCOs and their clients through the Belfius Energy Efficiency Package (BEEP). This comprehensive package offers financing options to various entities including companies, public authorities, educational institutions, and social profit organizations, encouraging investments in energy efficiency and renewable energy initiatives. Supported by the Private Finance for Energy Efficiency (PF4EE) instrument of the European Investment Bank (EIB), Belfius can provide businesses with up to EUR 75 million in loans to enhance energy efficiency. Additionally, Belfius has access to technical and financial expertise as part of the PF4EE initiative.[14]

Various financing products have been developed, including investment loans, leasing, and sales of receivables based on future energy savings. Sales of receivables, particularly relevant to ESCOs, allow their projects to be fully financed by the bank without impacting their balance sheet, enabling them to implement more projects. ESCOs guarantee the energy savings to clients, who then pay the bills to the bank. These loans are secured by the European Investment Bank's (EIB) PF4EE guarantee, covering up to 80% of their value.[15]

Belfius Bank has provided extensive support to ESCOs and their clients. They partially cover the energy audit costs for projects financed by them, ensuring high-quality energy savings documentation. Additionally, Belfius offers tailored advice on ESCO financing and Energy Performance Contract (EPC) contract development. They have also developed standardized EPC contracts to streamline ESCO financing transactions, reducing associated transaction costs. Moreover, Belfius collaborates with Eurostat authorities to align contracts with guidance on off-balance sheet treatment of EPC contracts, making energy efficiency projects more attractive for public sector clients.

Finally, recognizing the significance of an integrated approach to managing diverse tasks related to ESCO financing, Belfius Bank applied for the EIB's ELENA facility (European Local Energy Assistance). This funding will establish an in-house project development unit, serving as a comprehensive one-stop-shop to assist clients at every stage of their energy efficiency investment journey. [16]

Key messages:

- To incentivize customers to invest in ambitious energy efficiency measures, financing conditions can **be linked to the level of energy efficiency achieved**.
- Encouraging or even **mandating energy advice** conducted by qualified energy auditors as a prerequisite for loan approval, such as through an Individual Renovation Roadmap (iSFP), is crucial. This advice can identify energy savings potential and prevent lock-in effects, optimizing the benefits of supportive loan programs.

[14] European Investment Bank (EIB). (2016, December 8). Belgium: Two new EIB-Belfius agreements to foster smart and sustainable investment and climate action. European Investment Bank. https://www.eib.org/en/press/all/2016-325-belfius-and-eib-sign-two-new-agreements-to-foster-smart-and-sustainable-investment-and-combat-climate-change

[15] Ibid.

[16] PF4EE. (n.d.). Interview: Financing ESCO projects—Views from Belfius Bank in Belgium | EIB PF4EE Homepage. Retrieved 14 July 2022, from https://pf4ee.eib.org/news/interview-financing-esco-projects-views-belfius-bank-belgium

- Given their limited technical expertise in building energy efficiency and clean heating, **local banks should be granted access to technical support or encouraged to collaborate with qualified technical partners** who have already developed relevant services.
- Banks with experience in the energy efficiency field could explore offering **integrated service packages** to ESCOs to streamline ESCO financing, as seen in initiatives like Belfius' one-stop-shop.
- **Tailoring green loan products to diverse technologies and target groups** with varying characteristics and needs is essential. This approach involves designing products with customized interest rates, durations, and collateral assessments.
- Establishing an information and exchange platform would allow stakeholders to access information on green financing policies, financial products, and qualified projects. This platform would facilitate matchmaking between financial institutions and investors, effectively promoting green financing.

3.2 Green Funds

3.2.1 Henan coal-to-gas investment fund

Henan Tianlun Gas Group Co., Ltd. (hereinafter referred to as Tianlun Gas) collaborated with Henan Zhongyujin Holdings Equity Investment Management Co., Ltd. (hereinafter referred to as Yuzi Holdings) and Henan Yuzi Urban-Rural Integrated Development Co., Ltd to establish the Henan Yuzi Tianlun New Energy Investment Fund in 2018. The fund boasts a total capital contribution of 10 billion yuan (approx. 1.39 billion USD) from all partners, with Tianlun Gas contributing 4 billion yuan (approx. 556.03 million USD). With backing from national policy banks, the fund aims to mobilize 50 billion yuan (approx. 6.95 billion USD) from private capital for coal-to-gas clean heating projects in rural Henan Province.

A specialized project-oriented company was founded to lead investments in coal-to-gas initiatives, encompassing both upstream and downstream aspects of the natural gas industry. The initiative targets covering the initial expenses of transitioning to natural gas heating for over three million rural households by 2023. As of June 2022, substantial progress has been made, with the project spanning across more than 30 regions in Henan Province. The company has forged agreements with nearly three million households for the conversion, having completed installations for nearly two million households.

With Yuzi Holdings' robust credit standing and strong funding capabilities, coupled with Tianlun Gas's management expertise and exit strategies, the fund has steadily been expanding its operations. [17]

3.2.2 The Latvian Baltic Energy Efficiency Facility (LABEEF)

The Latvian Baltic Energy Efficiency Facility (LABEEF) is a pioneering fund designed to bolster ESCOs in executing renovation projects in multifamily buildings through energy performance contracting (EPC). It has transitioned into privately financed Building Energy Efficiency Facilities spanning Europe, now managed by Funding For Future (F3).[18]

Under LABEEF, the ESCO receives a loan for implementing energy efficiency projects from a commercial bank to cover the upfront investment costs. The loan agreement is

[17] ZhiTong Financial Information Technology: Tianlun Gas (01600) helps to set up coal to gas investment fund in Henan

[18] https://fcubed.eu

backed by LABEEF, which assumes the financing risks. After the measures are completed, measured, and monitored in a winter season, LABEEF forfeits the EPC contract and continues to collect the EPC receivables from the building owners through the commercial bank until the renovation investment is refinanced. In order to forfeiting, LABEEF collects loans from the European Bank for Reconstruction and Development (EBRD). For residents, instead of taking on a loan, their cost is limited to an increase in energy bills of about 15%. The ESCOs take the implementation risk of the projects.

LABEEF purchases only 80% of the discounted future cash flows from ESCOs. The rest 20% remains with the ESCOs. This model provides incentives to the ESCOs to renovate buildings with a low default payment risk and a high energy saving potential, and to use the highest standards of technical design as well as material and installation quality in their renovation projects. The typical savings of these projects range from 45% to 65%.[19][20]

Key messages:

- Green funds serve as a reliable source of long-term financing for building renovations. Key partners for these funds can include enterprises such as energy supply companies and real estate developers.
- Establishing a robust management structure with clearly defined roles, rules, and responsibilities is essential for ensuring the sustainability of these funds. Management functions encompass strategy development, project selection, operational oversight, internal monitoring, risk management, investment decisions, and exit strategies. Dedicated units should be established to fulfill these specific functions. Additionally, management should prioritize transparency for investors concerning fund utilization, investments, management practices, and associated risks.
- In the forfeiting setting, financial institutions have the option to purchase a portion of future receivables from ESCOs, effectively sharing risks with them. This arrangement incentivizes ESCOs to select buildings with high energy-saving potential and low default risks among building owners. Consequently, ESCOs are motivated to implement EPC projects with the highest technical standards.
- Policy support plays a crucial role in fostering the development of green funds. Measures such as tax incentives and risk-sharing mechanisms can encourage private investment in these funds.

3.3 Green Bonds

The Guidance on Strengthening Asset-Liability Management of State-owned Enterprises, introduced in September 2018, provides crucial support to state-owned enterprises, enabling them to leverage their stock assets for debt structure optimization and engage in asset-backed security business in accordance with legal guidelines. In November, the Tianfeng-Henan Energy Gas Supply Special Purpose Vehicle was inaugurated as China's pioneering coal-to-gas asset-backed security project. This initiative proactively aligns with the national agenda for structural reforms on the supply side while pioneering a new green model that integrates industry and finance in the energy

[19] Jörling, K., & Schäfer, M. (2018). LABEEF in Latvia Fact sheet (p. 22).

[20] Stancioff, N. (2017). LATVIAN BALTIC ENERGY EFFICIENCY FACILITY (LABEEF).

sector.

Asset-backed securities, an innovative financial product encouraged by recent policies and embraced by the market, leverage future cash flows and credit enhancement from underlying assets. Key stakeholders in this financial ecosystem include the original equity owner, the management body, and the investor. In this case, Henan Gas Group Limited serves as the original equity owner, entrusting Tianfeng Securities as the management body to establish the Tianfeng-Henan Energy Gas Supply Special Purpose Vehicle (SPV), with gas supply infrastructure tariffs from July to March each year spanning from 2018 to 2023 as the underlying assets. Tianfeng bolsters the bond's creditworthiness by securing certification from reputable third-party institutions. A robust credit rating is paramount for investors. The total issuance stands at 530 million yuan (approx. 73.67 million USD), with a priority-grade tranche named "Yu Gas 01-05" valued at 500 million yuan, which holds a AAA rating, signifying an exceptionally high level of creditworthiness.

Key messages:

- From a market perspective, asset securitization optimizes resource allocation, enhances financing channels, and fosters the deployment of financial products that directly benefit the real economy. Similarly, from the viewpoint of the original equity owner, such vehicles efficiently revitalize stock assets, reduce financing costs, and unlock fresh funding avenues.
- Introducing financing supported by future gas supply payments represents an innovative strategy to bolster creditworthiness. This approach can also be applied to rural clean heating projects, with heating cost payments serving as the backing.
- Individual clean heating and energy renovation projects often lack the scale necessary for green bond issuance. Aggregation is essential to reach the threshold required for trading on the capital market.
- Green bond issuers must establish clear sustainability criteria for projects included in the asset pool. Currently available standards for reference encompass China's Green Bond Support Project Catalogue, the China-EU Common Classification Catalogue for Sustainable Finance, and the ICMA Green Bond Principles. Additionally, financial institutions can utilize existing standards such as China's Green Building Standards and International Green Building Certifications, which delineate sustainable criteria for buildings.

3.4 Public-Private Partnership (PPP)

3.4.1 PPP for district heating in Henan

Clean heating and energy retrofit projects, primarily aimed at enhancing living standards, are predominantly spearheaded and supported by government initiatives, often through government procurement and subsidies. However, due to their extensive scale, multifaceted nature, prolonged timelines, and substantial funding requirements, these endeavours can strain government resources. Relying solely on government funding for project construction and operation may limit fiscal flexibility and stability to some extent.

private capital for clean heating and energy retrofit projects, emerges as a viable solution and has become increasingly prevalent across Henan and Gansu provinces. By fostering collaboration between the public and private

sectors, PPPs streamline project development and operation while alleviating the financial burden on the government.

In these provinces, numerous clean heating PPP projects have been initiated, offering easier cost control over construction and operation while benefiting a broad population. For instance, in the district heating project in Ruyang County, Henan Province, revenue primarily comes from heating fees. If the local heating price is lower than the fuel costs, the project receives a government subsidy to ensure a pre-tax return of 8%. In Henan and Gansu, clean heating PPP projects predominantly adopt a concession model with terms spanning 20-30 years. This ensures operational stability and project returns, facilitating the realization of long-term benefits for both the public and private sectors.

3.4.2 PPP for energy efficiency of the City of Ljubljana (Slovenia)

In 2018, the City of Ljubljana, the capital of Slovenia, finalized a PPP agreement with a consortium comprising Resalta and Petrol for the energy renovation of public buildings within the municipality. This marked the inception of the largest operational PPP for energy efficiency in South-East Europe. The scope of the project encompassed a diverse range of facilities, including sports halls, schools, kindergartens, administrative buildings, health centres, and other public amenities.

The executed measures comprised comprehensive upgrades, such as heating, ventilation, and air conditioning (HVAC) systems utilizing renewable energy sources, installation of energy-efficient interior lighting fixtures, replacement of windows and doors, facade refurbishments, and roof insulation. According to Resalta, the EUR 14.9-million initiative is projected to yield energy savings exceeding 8,000 MWh annually and curtail nearly 3,000 tons of CO2 emissions per year. A subsequent project has been implemented with a total investment of EUR 4.8 million, featuring similar measures and primarily targeting schools, kindergartens, sports centres, and municipal buildings. It is anticipated to achieve annual energy savings of 2,260 MWh and reduce CO2 emissions by 459 tons. [21]

Resalta and Petrol, the private partners, assumed responsibility for managing and maintaining the equipment and systems installed throughout the 15-year contract period. Together, they contributed 51% of the funding, with the remaining portion provided by the EU Cohesion Fund, the Republic of Slovenia, and the City of Ljubljana.

The PPP model offers the advantage of immediate energy cost savings for the city of Ljubljana, enabling it to repay the private partners over the 15-year contract period, with the city set to fully benefit from the achieved energy cost savings after the contract expires.[22]

[21] Build-Up. (2018): The largest Public-Private Partnership for energy efficiency in South-East Europe is now operational. https://www.buildup.eu/en/news/largest-public-private-partnership-energy-efficiency-south-east-europe-now-operational

[22] Spasić, V. (2018): Resalta completes largest public-private partnership for energy efficiency in South-East Europe. https://balkangreenenergynews.com/resalta-completes-largest-public-private-partnership-for-energy-efficiency-in-south-east-europe/

Key messages

- The combination of government funds and private capital enhances financing volume and efficiency, offering diverse return mechanisms. PPP is well-suited for projects like clean heating and energy retrofitting, aligning with their lengthy project cycles.
- A robust legal framework is essential for mitigating the risks inherent in PPP projects. The enactment of national legislation dedicated to PPPs, along with detailed implementation guidelines, is instrumental in substantially decreasing the risks associated with collaborations between government and social capital.
- The lack of standardization in PPP procedures for energy retrofit projects poses challenges for public authorities in conducting feasibility assessments and financial analyses. Without standardized procedures, relevant departments are unable to propose effective cooperation terms in advance or ensure consistent implementation throughout the project period. [23] Consequently, private investors may encounter a certain degree of uncertainty.
- Energy retrofits projects are mostly small scale, posing a significant challenge for PPP implementation. Aggregation is necessary to overcome this hurdle. In Europe, facilitator organizations aggregate numerous buildings with varying characteristics to attain a size conducive to financing.

[23] CECA. (2017): The role of PPP in promoting building energy efficiency

4 Designing Tailored Green Financing Products for Rural Energy Retrofit and Clean Heating Projects

Building upon established green finance practices in both China and Europe, this chapter introduces the design of three customized green financial products aimed at tackling the distinctive needs and challenges for promoting clean heating and energy retrofitting in China.

4.1 Green Loans

4.1.1 Government Procurement Loan

The Government Procurement Loan stands out as a specialized credit financing service extended by financial institutions to Small and Medium Enterprises (SMEs) that secure government procurement contracts. Leveraging future receivables from government procurement as collateral, this financial instrument caters to a diverse array of suppliers varying in qualifications and scales engaged in government procurement activities. Additionally, the loan can be extended to finance a wide range of products related to clean heating, encompassing heating equipment, clean energy apparatus, biomass processing machinery, and rural housing renovation materials like reinforced glass and insulation layers.

The terms of financing are primarily influenced by factors such as enterprise rating, the procurement contract, production and renovation scale, profitability, project duration, and payment deadlines. Among these factors, the procurement contract holds particular significance for the qualification of funding, the review of collateral, and the evaluation of repayment for Government Procurement Loans. Firstly, the procurement awarded to the applicant must be included in the government financial budget. Secondly, the applicant is required to pledge the future receivables from the government procurement contract as collateral. Lastly, the applicant must adhere to timely repayments as stipulated in the settlement period outlined within the government procurement contract.

The Government Procurement Loan offers a distinct advantage by leveraging government procurement contracts, streamlining the conventional credit process typically reliant on fixed asset collateral, and reducing transaction costs associated with financing. Additionally, with the advancements in information technology, the convergence of finance and technology proves increasingly advantageous. Many financial institutions are integrating Government Procurement Loans with government procurement clouds, procurement systems, and banking systems to establish Government Procurement e-Loans. This initiative aims to create an online platform facilitating bidirectional information exchange and supply-demand interactions. It streamlines processes such as pre-loan approvals, in-loan supervision, and post-loan management, fostering efficient and transparent financing practices.

4.1.2 Loans using Future Receivables as Collateral

This type of loan can be specifically tailored for clean heating projects by utilizing future receivables, such as heating fees, as collateral. However, compared to procurement loans above, the eligibility criteria for this product are more stringent, requiring highly qualified energy service companies with extensive experience, a well-defined business model, and a robust mechanism for collecting energy fees. For instance, in the case of rural

photovoltaic heating projects, the local grid company seeking a loan must fulfill two key conditions. Firstly, the borrower or pledger must possess an approved power grid operation license from the relevant governmental department, along with a valid business license issued by the industrial and commercial administrative department. Secondly, the local grid company must establish a designated account at the lending bank and enter into an agreement for fee collection on behalf of the bank. [24]

This loan type, utilizing future receivables, excels at aligning with the project operation cycle, repayment schedule, and payback cycle. The borrower's strong credit rating and the substantial scale of their projects ensure access to substantial low-interest financing. Moreover, due to the strength of the borrowers, there is significant potential for expanding supply chain financial services. These services, such as inventory financing and prepayment proxy payments, meet the needs of manufacturers, distributors, and other stakeholders across the supply chain, thereby promoting financial inclusion throughout both the upstream and downstream segments of the industrial chain.

4.1.3 Loans using Carbon Credits as Collateral

In this loan arrangement, the borrower utilizes carbon credits as collateral to secure funding. This innovative financial product is a cornerstone of China's carbon market pilots, primarily serving enterprises engaged in either carbon emissions or carbon sink activities. Given the limited scope of industries covered by the national carbon market and the temporary pause in the national voluntary emission reduction credits (CCER) market, regional carbon sink trading has emerged as a viable solution. This approach effectively caters to non-pilot carbon market regions or industries currently outside the carbon market's purview.

Presently, numerous regions across the country have successfully engaged in carbon sink trading activities tailored to their unique characteristics, leveraging local resources and industrial strengths. These projects encompass, for example, afforestation, forest management, and bamboo forest management initiatives. Verified forest carbon sink projects (FFCER) are eligible for trading on the local carbon market. As of June 2022, FFCER transactions have reached a volume of 3.78 million tons, amounting to 56.05 million yuan (approx. 7.65 million USD). Notably, on February 28, 2023, in Zhejiang Ningbo, a landmark transaction occurred, marking the inaugural nationwide blue carbon trading. Approximately 2340.1 tons of carbon sink volume were traded at a price of 106 yuan (approx. 14.73 USD) per ton.

Regional carbon sink trading and carbon financial product development involve several key steps: on-site surveys, carbon sink assessment methodologies, actual project development, trading, and financial innovation. Considering the Lanzhou biomass power plants as a case study of a carbon sink project, the initial step involves conducting on-site surveys to ascertain whether these projects exhibit sufficient concentration for effective aggregation, while also verifying their potential for emission reduction and economic benefits. Once the local biomass power generation project meets the necessary criteria, the next step involves developing a tailored carbon sink methodology specific to the project's characteristics. It defines conditions for eligibility, identifies baseline parameters, and outlines additional requirements for demonstrating the carbon sink project's effectiveness. It also delineates emission reduction and carbon measurement methods, along with monitoring procedures, thereby guiding and standardizing the

[24] Zhou Chunmei. Legal Recognition of Income Rights Pledge[EB/OL]. 2003. https://www.chinacourt.org/article/detail/2003/06/id/62742.shtml.

project's development process.

Following the formulation of the carbon sink methodology, a preliminary assessment is conducted to gauge the projected emission reductions achievable through the project. Subsequently, the project owner engages a consulting company to compile a Project Design Document (PDD) and submits an application to the national authority. A third-party organization verifies the carbon offset project. Upon approval, the project is officially registered. During the operational phase, the registered carbon sink project generates emission reductions, prompting the project owner to apply for verification based on the emission reduction monitoring report. Upon approval, the corresponding issuance of CCER is obtained, which can be traded within the local carbon market. Local financial institutions have the opportunity to innovate by creating carbon financial products specifically designed for carbon sink projects. They could explore the concept of using future receivables from carbon sinks as collateral for loans. A financing model could be developed that combines collateral based on spot market prices of carbon sinks with agreed long-term repurchase of carbon credits by the borrowers ("collateral+repurchase"), providing a feasible solution for this type of loan.

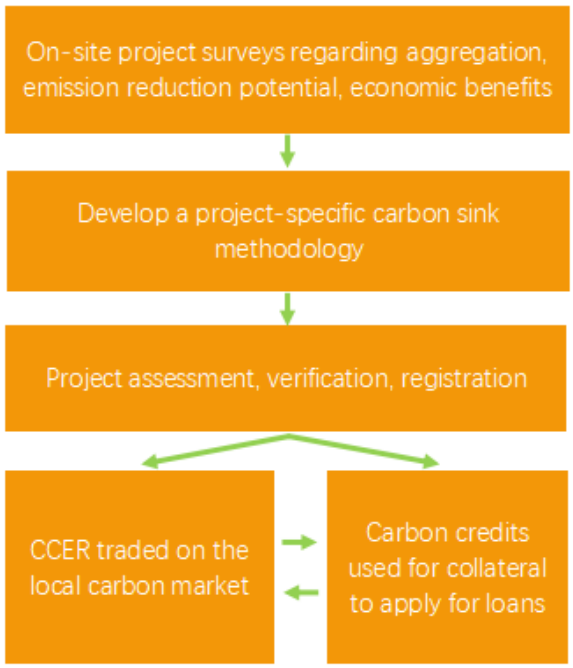

Figure 2 Key steps of regional carbon sink trading and carbon financial product development

In terms of product requirements, for projects with verified emission reductions and CCER issuance, enterprises can secure loans from banks by pledging tradable CCERs. The local carbon market will freeze these CCERs, after which the banks will disburse the loan accordingly. For projects approved but not yet verified for emission reductions, third-party agencies are involved. These agencies monitor and assess the anticipated emission reductions and carbon sink volume of the project, estimates its value, and provides the assessment documents to the bank. Upon verification by the bank and disclosure on the platform, the loan is disbursed.[25]

In terms of product advantages, this loan type not only unlocks the economic value of carbon sink resources but also enhances their financial versatility, thereby expanding financing channels for enterprises. The "collateral + repurchase" model transforms the repurchase of environmental rights into financing, mitigating the risk associated with carbon credit collateral for banks. It effectively addresses challenges such as the prolonged issuance cycle and difficulties in realizing the value of carbon sink assets.

[25] Qin, T., Du, Y., Chen, Y., et al. (2023). Comparison of Forestry Carbon Offset Pledge Loan Financing Models, Realistic Dilemmas, and Breakthrough Directions. Agricultural Economic Issues, 2023(01), 120-130. DOI:10.13246/j.cnki.iae.2023.01.006.

4.2 Green Bonds

4.2.1 Local government green bonds

Local government special bonds are financial instruments issued by provincial, autonomous regional, and municipal governments to fund public projects that yield specific returns. Repayment of these bonds occurs within a designated timeframe using funds or special revenues generated by the corresponding public projects. These bonds play a pivotal role in stimulating public investment and infrastructure development.[26]

Local government bonds are suitable for rural clean heating and energy efficiency projects due to their social welfare nature. Costs of these bonds is influenced by macro-level factors like the average yield of national bonds, as well as project-specific factors such as scale, investment direction, duration, and benefits.

In terms of product requirements, the application of local government special bonds in the field of rural clean heating and energy efficiency should ensure that the projects and scale are coordinated within the locally approved special debt limit by the State Council. The cash flow generated by projects should be reflected as government funds or special income, incorporated into the government fund budget management, and achieve revenue coverage for principal and interest.

In terms of product advantages, local government special bonds are encouraged and supported by national policies. They offer larger issuance quotas, longer financing periods, lower financing costs, and more rigorous risk supervision. Leveraging local government special bond funds can help stimulate and expand effective investment, promoting the stable operation of the local economy.

[26] Ministry of Finance. Notice on the Issuance and Management Measures of Local Government Special Bonds. 2015. http://www.gov.cn/gongbao/content/2015/content_2883246.htm.

Table 3 financial product design for rural clean heating and energy retrofitting

Product Types	Product Segments	Financed activities	Factors determining	Product Advantages	Product Requirements
Loans	Government procurement loan	Clean heating: Heating equipment manufacturing Clean energy equipment manufacturing Biomass processing and utilization Centralized heating retrofits Decentralized heating retrofit	Scale and benefits of production and retrofits Green building materials and green building rating Enterprise rating Project cycle and settlement period Procurement contract	Policy support Expanding financing channels for SMEs Reducing financing costs for SMEs Supporting new economy ventures with light assets Providing flexible and convenient processes	The applicant's procurement funds must be included in the government financial budget at the same level or above. The applicant must pledge the accounts receivable under the awarded government procurement contract. The applicant must be able to timely pay the procurement funds into the repayment account.
		Rural house energy retrofits: exterior wall insulation; windows			
	Loans using Future Receivables as Collateral	Large-scale promotion of clean heating (and rural house retrofits)	Scale and benefits of production and retrofits Green building materials and green building	Large loan amounts, preferential interest rates Future revenue as	Borrower with strong credit rating due to its industry advantages and high-quality assets, clear business model, and strong fee collection ability

			rating Enterprise rating Repayment mode Project period	guarantee, flexible Loan repayment period matches the fee collection period	
	Loans using Carbon Credits as Collateral	Biomass heating	Scale and benefits of production and retrofits Carbon emissions Enterprise rating Repayment mode Project period	Innovative assets Converting environmental benefits to economic benefits	Carbon sinks that meet the relevant methodological requirements Carbon sinks measured and disclosed before, during, and after the loan Local governments lead the establishment of regional carbon sink trading markets
Bonds	Local government special bonds	Large-scale promotion of clean heating (and rural house retrofits)	Project size, investment, cycle and profits Average yield of national bonds	Supported and encouraged by national policies, Larger issuance quotas, longer financing periods, lower financing costs, Rigorous risk control	The bond project and its scale within the special local debt limit approved by the national government. The cash flow generated by the project reflected as governmental funds or special income, incorporated into governmental fund management, and ensure revenue covers principal and interest

5 Conclusion

During the 13th Five-Year Plan period (2016-2020), China made significant progress in rural clean heating and energy retrofit, benefiting over 35 million households. With China's commitment to the "dual-carbon" goal, promoting clean heating and energy retrofit in rural areas has become integral to its development targets. Relying solely on subsidies will not suffice to meet its substantial funding requirements. Therefore, large-scale and diversified green finance to promote sustainable business models is imperative.

Currently, green finance has begun to drive transformation in rural areas of Henan and Gansu. However, challenges persist, including inadequate financial support and uneven regional development. From a policy standpoint, China's green finance initiatives encompass a wide range of areas related to clean heating and energy efficiency retrofitting in rural homes. Both Henan and Gansu are rolling out supportive policies for green finance and inclusive finance. Despite this, stakeholders - farmers, businesses (producers, service providers, and project developers), and financial institutions—are grappling with various internal and external barriers, hampering progress.

In practice, financial instruments have not yet made a significant impact on China's rural clean heating and energy retrofit projects. Although green loans are currently the primary option, their scope is limited. Additionally, there have been innovative initiatives involving green funds, green bonds, and green public-private partnerships. Looking ahead, financial institutions are encouraged to delve deeper into innovative and dedicated financial products. This includes exploring government procurement loans, loans using Future Receivables as Collateral, loans using Carbon Credits as Collateral, and local government special bonds. These initiatives hold the potential to greatly enhance the financing options available for rural clean heating and energy retrofit projects.

Project Consortium:

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