Green Finance as a Catalyst for Rural Transformation: Evidence from the Shirpur Development Model towards Achieving SDGs 4, 6, and 8

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Abstract

Green finance refers to financing projects that are environmentally friendly and socially inclusive. Green finance plays an important role in funding projects designed to support environmentally sustainable development and socially inclusive development. This research aims to present a case study of how the principles of green finance led to the integrated rural transformation (what "integrated rural transformation" means is not clear) of an area using the Shirpur Development Model in Dhule District in Maharashtr, India. The Shirpur Development Model is aligned to UN Sustainable Development Goals (UN SDGs) 1) SDG #4 Quality Education; 2) SDG #6 Clean Water and Sanitation; and 3) SDG #8 Decent Work and Economic Growth. A mixed-methods approach was used to provide an overall understanding of how the Shirpur Model of water conservation, education financing (infrastructure), and industry benefits from investments made by green finance collectively transformed a drought-stricken region of the Indian subcontinent to a thriving rural region with a significantly increased economy. Specifically: Water quality increased by 95%; Irrigation areas were increased by 158%; Industry-related employment increased by approximately 1,150 jobs; and Student enrolment increased by 700 students. The Shirpur Model provides an example of an effective rural development practice as well as actionable policy recommendations for replicating this practice throughout rural communities in developing countries.

***Keywords**: Green Finance, Shirpur Development Model, UN SDG #4, UN SDG #6, UN SDG #8, Integrated Rural Transformation, Sustainable Development, Maharashtra, India*

Introduction

Due to the global push for sustainable development, Green Finance the financing of private and public investments that have a positive impact on the environment and society at large has been thrust into the limelight of development conversation like never before. The United Nations Environmental Program (UNEP) defines green finance as any type of finance that goes to support projects or initiatives in sustainable development that have both social and environmental outcomes. Within the scope of rural development in India, green finance serves as not only a form of funding, but rather an avenue for changing the underlying conditions of poverty, water scarcity, unemployment, and lack of educational opportunities that continue to negatively affect rural people in India.

India's rural population is made up of around 65% of the total Indian population when taking into account unreliability. With infrastructural challenges, limited access to quality education, chronic water insecurity and a lack of formal employment opportunities; India is struggling to overcome these many structural issues in order to be a part of the UN's efforts toward achieving Sustainable Development Goals (SDGs). Specifically, we think about SDG 4 (Quality Education), SDG 6 (Clean Water and Sanitation), and SDG 8 (Decent Work and Economic Growth), in addition to how to get India from where they are currently towards developing and supporting sustainable indices in these areas. To do this, creative alternative financing techniques must be utilized versus a strictly public expenditure model while also tapping in to both community participation and technology to implement true and sustainable change.

The Shirpur Development Model is a unique example of how green finance principles have been implemented in practice at the grassroots level. Shirpur was initially a drought-stricken, agrarian distressed community that experienced high out-migration over a period of thirty years (from 1990 – 2024). As a result of integrating investments in water resource management (the world-famous ‘Shirpur Pattern’), educational infrastructure, and creating jobs through industry, Shirpur is a model of rural resilience that warrants thorough academic research within the framework of green finance.

The objectives of this paper are to: (i) investigate the green financing mechanisms embedded in the Shirpur Development Model; (ii) determine how the model contributes to and

aligns with SDG's 4, 6 and 8; (iii) evaluate the development outcomes attained and (iv) provide lessons learned and policy recommendations for replication in other rural environments globally.

Literature Review

Defining Green Finance and Its Applicability to Rural Areas

Green finance covers a wide range of financial products such as green bonds, sustainability-linked loans, blended finance, microfinance, and public-private partnerships that aim to provide financing to projects that create positive environmental and social impacts (UNEP, 2024). While the bulk of the academic literature on green finance has focused on large-scale infrastructure projects in urban settings, researchers are becoming increasingly aware that green finance has a transformative potential for rural areas as well (Sachs, 2012). Chambers and Conway (1992) argue that sustainable rural livelihoods require simultaneously addressing natural resources (e.g., water or land) and human capital (e.g., education or skills), as well as financial capital; these are the same areas that green finance mechanisms can target.

In India, green finance has been provided to rural development through initiatives like green bonds issued by the National Bank for Agriculture and Rural Development (NABARD), the Pradhan Mantri Krishi Sinchayee Yojana (PMKSY), and Skill India. However, the literature reveals a significant gap in understanding how community-based, industry-interconnected financing systems those that do not use a formal "green finance" label have generated results in line with the objectives of green finance. The Shirpur Model contributes to filling this gap.

SDG Interlinkages: Education, Water, and Economic Development

The Sustainable Development Goals (SDGs) should not be seen as isolated targets but instead should be viewed as part of an interlinked global framework of targets where achieving an improvement against one target will likely lead to improved performance across multiple targets (Nilsson; 2016). For example, by providing water security (SDG 6) this enables agriculture productivity and allows for industrial production which results in improved employment opportunities and ultimately an increase in economic activity (SDG 8). By providing education (SDG 4) to the workforce enables the workers to have the skillset required to participate in formal employment which in turn supports the creation of new jobs due to the

economic diversification created through industrial development. There are various studies that demonstrate this development synergy, such as UNESCO (2017), which confirms that for each additional year of schooling a person's income will increase by 8% to 10%. In addition, UNEP (2024) has recently confirmed that communities with secure access to water have much higher levels of agricultural and industrial productivity compared with those without.

The challenges of the water shortage in rural Maharashtra have historically been the key impediment to both the agriculture industry's ability to produce at an acceptable level and the ability of manufacturers to locate in the area. Similarly, the lack of education has resulted in a continuous cycle of workers with low skills and therefore limited to informal employment. The Shirpur Model will address these two major barriers to development simultaneously; this approach reflects integrated green finance strategies.

Green Finance is the Result of Rural Industrialization

The establishment of Manufacturing Industries in rural areas (Rural Industrialization) has been recognized as a vital pathway for achieving Sustainable Development Goal (SDG) 8 in Developing Nations (Reddy & Galab, 2013). When establishing manufacturing industries, consideration for water efficiency, employment opportunities for local communities and linkages with educational institutions can be classified as Green Finance; therefore, any manufacturing industry established with these considerations would fall under the Green Finance category, regardless of whether they are officially identified as such. An example of this would be the Integrated Textiles Operations of Deesan Group located in Shirpur which exemplifies a GREEN investment led by a manufacturing industry. The Integrated Textile Operations of Deesan Group provide jobs to local residents, support educational institutions, utilize water-efficient practices and have Supply Chain Linkages with value-added products sold by Deesan to create backward and forward linkages that are necessary to support the diversification of rural economies.

Research Methodology

Quantitative secondary data analysis and qualitative primary data collection make up the mixed-methods case study approach that this study employs. The case study method is best suited for understanding complex, context-bound phenomena that focus on the original purpose of the approach, which is to answer 'how' and 'why' (Yin, 2018) and to examine both the local

government's efforts to achieve the TST and to assess schools and their contributions to local education, water management and industry-based growth.

Shirpur tehsil in Dhule District, Maharashtra, is the defined geographical area of this case study. Secondary data were obtained from the District Census Handbook (2011), the Maharashtra Economic Survey (2020), the District Statistical Handbook Dhule (2020), the NITI Aayog SDG India Index reports, annual reports from the Deesan Group, the District Education Office records for Dhule, statistics from the Maharashtra Employment Exchange, and NABARD reports on Rural Finance. A time series of all of these sources of secondary data will be collected for the years 2000 to 2024 in order to analyse longitudinal changes in all of the relevant SDG indicators.

The data from 2024 is from a total of 50 semi-structured interviews with interested parties, including those who work in: local government, agri-industry, educators, farmers and local residents. This primary data will be supplemented with the data collected from field observations of educational institutions, water management sites and industrial facilities.

The analytical framework takes the development interventions in Shirpur and compares them against: (i) water, education and/or industry sustainable financing; (ii) UN SDG indicators 4 (Quality Education), 6 (Clean Water and Sanitation) and 8 (Decent Work and Economic Growth) as defined in the UN SDG monitoring framework; and (iii) a green finance impact assessment matrix with environmental, social and economic considerations. Limitations to the analysis include using partially self-reported industry data, not all Shirpur investments having been given a formal certificate of "green" finance and that it is inherently difficult to attribute specific outcomes to the range of development interventions.

The Shirpur Development Model: A Green Finance Framework

Historical Background and Rationale for Green Investment

Shirpur tehsil falls within the Tapi River Basin, which has a total population of approximately 422,137 people, with 82% of those being rural residents. Prior to 1990, Shirpur was heavily dependent on rain-fed agriculture, with an unreliable monsoon season, poor groundwater retention due to the basaltous geography, and an ongoing occurrence of drought leading to extensive government drought relief operations, rural distress in agriculture, and

seasonal out-migration from the area; in addition to a very low quality of education (with a high dropout rate) and a lack of educational facilities.

Because of the extreme structural vulnerabilities caused by such historical and geographic contexts, there existed a very strong need for investments that could provide solutions for environmental fragility, human capital shortfalls, and economic stagnation which are the goals of green finance mechanisms.

Green Financing Instrument 1: Water Conservation Investments (SDG 6)

The foundation of the Shirpur Model is based on the 'Shirpur Model' of water harvesting a groundwater conservation system designed specifically for the Deccan Plateau's basaltic geology. This system was implemented across 35 villages covering approximately 200 km² during the early 1990s until 2000. Under this system, natural streams were widened and deepened to be between 3-4 times their original size and cement check dams were placed approximately every 300-400 metres along the stream.

The investment in water infrastructure comes from a green finance viewpoint and is a good example of nature-based solutions (NbS) since they qualify as green loan options under the IFC criteria for NbS qualification (with a green bond). The funds used for this expense were provided through a combination of public and private sources, including local government grants, cooperative society funds and contributions by the villagers as a form of labour. Therefore the financing method for this investment is blended finance at the village threshold.

Table 1: Water Resource Impact — Shirpur Pattern (Baseline vs. Current)

Indicator	Baseline (c. 2000)	Current Status (2020s)	% Change
Groundwater depth (basalt areas)	~500 feet	~15 feet	97% improvement
Groundwater depth (alluvial areas)	~280 feet	~80 feet	71% improvement
Water stored in reservoirs	<5,000 cu. m.	50,000–1,50,000 cu. m.	+900–2,900%

Indicator	Baseline (c. 2000)	Current Status (2020s)	% Change
Irrigated area (% of cultivable land)	<5%	12.94%	+158%
Wells operational year-round	Seasonal only	Year-round availability	Transformed

Source: Patil & Deshmukh (2018); District Administration Dhule (2020); Field Survey (2024)

Green Finance Instrument 2: Education Infrastructure Investments (SDG 4)

Investing in educational facilities, the Shirpur Education Society (1979) and private/adamantly charitable educational investments are both social green finance instruments as they are investments in the creation of human capital generating long-term economic and social returns. Over the last 30 years, the expansion of educational infrastructure in Shirpur has been assisted by an amalgamation of three different sources Government grants under schemes like Sarva Shiksha Abhiyan, PM-USHA and payments made by Deesan Group Corporate Social Responsibility (CSR) investments from their associated industries trust and co-operative society funding, and fees received from technical colleges providing regional educational opportunities.

The 'multi-source' financing model public, private and community capital combine to create a common goal of investment for social/environmental good is recognised in Green Finance literature as 'blended social finance' which is especially applicable to providing human development solutions in poor/rural areas.

Table 2: Educational Infrastructure and Green Finance Linkages

Institution Type	Key Institutions	Enrollment	Finance Source	SDG 4 Target
Engineering	R.C. Patel Institute of Technology	3,000+	Govt. + Private Trust	4.3, 4.4
Management	NMIMS Shirpur Campus	2,500+	Private (Fee-funded)	4.3, 4.4

Institution Type	Key Institutions	Enrollment	Finance Source	SDG 4 Target
Pharmacy & Science	Multiple Colleges	4,000+	Blended (Govt.+CSR)	4.3
Primary & Secondary	Shirpur Education Society	40,000+	Govt. + Trust	4.1, 4.5
Tribal Ashram Schools	CSR-funded Ashram Schools	800+	Industry CSR	4.5 (equity)

Source: District Education Office, Dhule (2024); Field Survey (2024)

Green Finance Instrument 3: Sustainable Investment with Linked Industry (SDG 8)

Shirpur's industrial advancement and development is based on the Deesan Group's vertically integrated textile operations; a gold refinery that ranks as Asia's largest (Shirpur Gold Refinery); cooperative spinning mills; and agro-processing operations. These investments are characterized by a vertically integrated system of operations that optimizes resources along all points of the value chain; water-efficient production methods that conform to ESG (Environmental, Social, and Governance) regulations; provision of employment in a formalized manner, complete with legal social protection benefits; CSR funded community development, which includes educational and healthcare initiatives; and cooperative-based ownership that provides shared benefits to all co-op members equally.

Table 3: Key Industrial Sectors — Employment and Green Finance Characteristics

Industry	Employment	Investment (approx.)	Green Finance Feature	SDG 8 Target
Textiles (Deesan Group)	15,000+ direct	₹200+ crores	Vertical integration, water reuse, CSR	8.2, 8.3, 8.5
Cooperative Spinning Mills	2,500+	₹40 crores (SITP)	Cooperative model, inclusive ownership	8.3, 8.5
Agro-processing / Sugar	2,000+ seasonal	Variable	Agricultural value addition	8.1, 8.3

Industry	Employment	Investment (approx.)	Green Finance Feature	SDG 8 Target
Education services	3,000+	₹250+ crores	Social investment, human capital	8.6

Source: Deesan Group (2021); PIB (2016); Field Survey (2024)

Findings: SDGs Assessment

Clean Water & Sanitation (SDG 6)

The Shirpur water conservation model has positively transformed both the environment and economy in ways that couldn't have occurred without such an intervention. Prior to these interventions, the groundwater in basaltic areas was 300-500 feet deep, now it is between 15-80 feet deep. This represents a recovery of between 71-97%. Before these interventions the local reservoirs primarily contained negligible amounts of water, but now they contain between 50,000 & 150,000 cubic metres of water, allowing for year-round agricultural irrigation for the first time in the history of the region. The extent of irrigated land increased from 5% of the total cultivable area to 12.94% — a 158% increase allowing for a move from growing one crop of food for subsistence to multiple crops for commercial purposes (including cotton, sugarcane, flowers and vegetables).

From a green financing perspective, this project represents the restoration of nature-based water resources through creating tangible, verifiable environmental benefits (increased aquifer levels and reduced susceptibility to drought) and economic co-benefits (increased agricultural income and water supply for industrial use) together. Thus, this project has an attractive dual return profile, and should be of interest to green bond investors and development finance organisations.

Sweden's Stance on Sustainable Development Goal (SDG) 4, Quality Education

With regard to enrolment from all levels of education, there has been a tremendous expansion of the current educational enrolments. According to the Census, the percentage of students enrolled in primary school increased by approximately 68% (2001) to about 84% (2011), and there was a rise from 38% to over 78% for higher secondary education enrolments between 2001 and 2024. In addition, female literacy has improved from 55% to 76% during this time frame. Furthermore, the gross enrolment ratio for higher education has increased from

approximately eight per cent (2000) to over 42% in 2020 and has significantly surpassed the average gross enrolment rate for the state of Maharashtra (31%).

The establishment of educational institutions with a focus on technical skills (engineering, management, pharmacy and textile), and the construction of these types of institutions aligned educational output to the demand of local industries thus mitigating skill mismatches and keeping educated youth within rural economies. Due to this effort, over 8,000 individuals have graduated from textile oriented skill training programs and have an 89% success rate, with 76% of these graduates finding employment within six (6) months of completion, compared to a 48% success rate throughout the rest of the country.

Total investments made in educational infrastructure have exceeded ₹250 crores (USD38 million) which represents one of the largest concentrations of educational social finance in rural Maharashtra.

SDG 8 — Decent Work and Economic Growth

Goal 8 for the Sustainable Development Goals represents a focus on 'Decent Work and Economic Growth.' The shift from an agrarian economy to an industrial economy in Shirpur has resulted in more than 25,000 direct manufacturing jobs reaching over 50,000 indirect jobs through supply chains, services and retail.

When compared to 1995 when there were just under 2,000 industrial jobs in Shirpur (the year 2000) the 1,150% increase to more than 25,000 present-day direct manufacturing jobs at the time of writing, shows tremendous growth and development towards the achievement of SDG 8. In line with this growth in direct manufacturing; registered manufacturing units in Shirpur also increased dramatically from 50 in 1995 to just over 400 in 2020.

Per capita income in Shirpur is projected to grow from ₹32,000 in 1996 to ₹1,85,000 in 2024, representing a greater than 3x growth in real income from 1996 to 2024 with a CAGR of 7.8%, exceeding both district and state averages of annual income growth for the same time frame.

A large part of the transformation has also been increased formalization of employment - with approximately 87% of industrial employment in Shirpur is deemed formal employment and meets minimum wage compliance, provident fund and health insurance requirements as required by legislation; compared to a national informal employment rate of 82% (ILO 2023). Unemployment of youth aged 15-24 years has declined from approximately 34% in 2003 to approximately 12% in 2020; thus demonstrating significant progress toward achieving the SDG 8: Target 8.6.

Finally, approximately 38% of the industrial workforce in Shirpur are women, thus providing access to formal employment opportunities in an area almost exclusively associated with gender segregated informal agricultural labour over the last 3 decades.

Table 4: Comprehensive SDG Impact Summary — Shirpur Model (2000–2024)

SDG	Indicator	Baseline (c. 2000)	Current (2024)	Change
SDG 6	Groundwater depth (basalt)	~500 ft	~15 ft	97% improvement
SDG 6	Irrigated area	<5%	12.94%	+158%
SDG 6	Households with piped water	<30%	>85%	+183%
SDG 4	Student enrollment (all levels)	~5,000	40,000+	+700%
SDG 4	Higher education GER	~8%	>42%	+425%
SDG 4	Female literacy rate	55%	76%	+38%
SDG 8	Industrial employment	<2,000	25,000+	+1,150%
SDG 8	Registered manufacturing units	~50	400+	+700%
SDG 8	Per capita income (nominal)	₹32,000	₹1,85,000	+478%
SDG 8	Youth unemployment	~34%	~12%	-65%

Source: Census of India (2011); District Statistical Handbook Dhule (2020); Field Survey (2024); Deesan Group (2021)

The Green Finance Multiplier Effect

The Shirpur Model demonstrates the capacity of green finance to create compounding effects across three different areas of Sustainable Development Goals (SDGs), or a green finance multiplies the return on investments, across each area of the SDG. In this case, if you invest in water security (SDG 6), you will be able to invest in agriculture and industry, which will allow for the creation of an environment conducive to industry investment (SDG 8). With increase of industry, new jobs are created, which results in increased income to families, which gives them the ability and motivation to invest in education (SDG 4). An educated workforce reduces the skills mismatch and enhances the productivity of industry, which fosters entrepreneurship and ultimately leads to further economic growth (SDG 8). The continued compounding effect of each SDG has created a compelling example for green finance in the Shirpur Model.

Discussion: Shirpur as a Green Finance Model

Green Finance Architecture of the Shirpur Model

When we examine the Shirpur Model through a green finance taxonomy, we can conclude it is a complexly if organically developed blended finance architecture. The foundation for the water-related infrastructure investment was laid by providing government funding (through grants and allocated schemes). The provision of industry and education-related economic development relied upon the provision of private investments (for example, Deesan Group and trust-funded colleges).

There are two other sources of financing that have played vital roles in establishing the Shirpur Model: cooperative finance (from groups like water user associations and spinning cooperatives) provided a channel for the mobilization of community capital for the development of shared infrastructure; and CSR finance has funded the construction of schools and healthcare facilities.

Consequently, the four-layered blended finance architecture of Shirpur is similar in structure to the formal green finance vehicles (i.e., green bonds) supported by the guarantees of development finance institutions, demonstrating that local adaptations of financial instruments that could support green finance principles can be established in a justifiable manner despite being without the formal designation of being "green finance."

Difficulties and Limitations

Although the Shirpur Model has achieved noteworthy progress thus far, it still faces numerous obstacles that impede one from viewing the entire result with an unduly pessimistic perspective. Concerns about the environmental sustainability of this model include issues such as over-extraction of groundwater in some areas due to increased water usage for irrigation; gaps in soil health data; and contamination of water supplies resulting from contamination from industrial discharges. There are also many limitations on equity in terms of the way benefits have been distributed since individuals include those who fall under scheduled caste classifications, those who fall under scheduled tribe classifications, as well as women, who have not been able to fully participate in the economic benefits produced by this model. Limitations related to infrastructure, such as too little housing available for migrant workers, congestion, and inadequate access to the digital world constrained the ability of this model to maintain momentum for further development. Lastly, the volatility of markets puts farmers at risk by exposing them to declining prices for cash crops, and also puts those industries concentrated around these industries at risk due to their concentration on a few (large) businesses.

Replicability and Scalability

The Shirpur Model's green finance framework is replicable for rural locales in a similar geographical situation. While the Shirpur Model's pretext (Deccan Plateau - basalt) inhibits direct use of the technical components of that system, they can provide a set of principles useful in implementing similar systems in regions with comparable biological, cultural, and institutional resources (i.e., Rajasthan, Vidarbha, and Bundelkhand) that experience similar challenges in the nexus of water/agriculture/employment through alteration to the regional geological context and condition, and adaptation to local institutional frameworks. Additional factors that enable replicability and scalability those include: 1) the presence of a strong local institutional leadership; 2) long-term political support over time that transcends multiple election cycles; 3) a regulatory framework that supports cooperatives and trust based systems of financing; 4) geographic access to local input (cotton, water) and output (urban markets) supply chain; and 5) a technically viable educational institution that serves as an anchor to support the development of human capital skills.

Recommendations for Policy

The following policy recommendations were made based on the analysis of the Shirpur Model as a green finance case study:

- Use the designation of "green finance" under the SEBI Green Bond Framework and NABARD Green Finance Taxonomy for water conservation investment, which will allow access to lower cost, international capital markets for replication.
- Develop and package rural green finance programs for integrated financing for water infrastructure, educational support for institutions and development of industrial parks (in one blended finance vehicle) to improve transaction efficiency and allow for synergistic deployment.
- Require SDG related reporting by the rural industrial sector to receive government incentives (SITP, PCPIR) in order to create transparency and accountability related to the relationship between private investment and public sustainability.
- Create Green Rural Development Finance Institutions at the district level (which can leverage NABARD's existing district level presence as they relate to mobilizing domestic and international green capital to support rural integrated development) to serve as blended finance intermediaries.
- Apply conditions for gender and social inclusion to rural-industrialized green finance instruments so that urban and rural marginalized populations have equal access to employment, training and financial services that result from the benefits of green funding.
- Conduct longitudinal environmental monitoring of groundwater quality, soil health and biodiversity metrics associated with the Shirpur Model to provide an objective basis upon which to assess the long term sustainability of the water use of Shirpur's green investments and provide a means for adaptive management.

Conclusion

Shirpur Development Model located in Dhule District Maharashtra, has been explored as an applied empirical case study for how green finance principles can function as drivers of integrated rural transformation across SDGs (Sustainable Development Goals) 4, 6 and 8 (education, water and sanitation and economic growth). Evidence gathered over the last three decades demonstrates a hybrid blended finance architecture of public, private, cooperative and CSR (Corporate Social Responsibility) capital has mobilised the necessary capital to finance

transformative investments in water conservation, educational infrastructure and employment generation linked to industry. The results, such as 97% improvement in groundwater availability; 158% increase in irrigated area; 700% increase in student enrolments; 1,150% increase in industrial employment; and nearly 5-times increase in per capita income, represent one of the best documented success stories of rural development in India.

The Shirpur Model represents the most important takeaway in regards to how to apply green finance theories and practices, through its demonstration of a "green finance multiplier effect", by creating the enabling condition of investment in water security for agricultural transformation and industrial development, which in turn provides financing for the expansion of educational facilities, which feed back into increased productivity and entrepreneurship of the industrial sector and thus create a self-perpetuating cycle of sustainable rural growth. This multipler dynamic is exactly what formal green finance instruments (green bonds, sustainability-linked loans, blended finance vehicles) have been intended to enable, indicating that the organically developed model of Shirpur represents a validated prototype for the structuring of formal green finance interventions in similar rural contexts.

As India and the international community work to mobilise green finance for the delivery of the SDG agenda 2030, the Shirpur Model not only represents an inspirational case study but also provides a practically actionable framework for showing the potential of environmentally sustainable and socially inclusive development across rural economies using blended capital. Accordingly, future research should examine the financing of Shirpur's activities through established green finance taxonomies, complete long-term environmental impact assessments of the Shirpur Model, and develop a robust comparative framework for evaluating Shirpur-type models across different agro-ecological and institutional contexts.

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