Reforming Renewable Energy Businesses through Artificial Intelligence

ISBN: 978-1-943295-26-5

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Artificial Intelligence (AI) is the new normal for the 21st century. There is no denying the fact that modern technology is embedded with any possible available form of AI. But the key is to ensure judicious and contemplative use of AI. Traditional knowledge systems of the North-Western Himalayas encourage employing various forms of renewable energy. AI can play a crucial role in steering the local businesses that survive on the local sources of energy. This can improve the livelihood opportunities, assuring sustained sustainable livelihoods for the local population.

Keywords: Artificial Intelligence; North-Western Himalayas; Traditional Knowledge Systems; Renewable Energy; Sustainable; Livelihood.

1. Introduction

AI integration into various industrial domains such as agriculture, healthcare, manufacturing, etc., promises a high productivity and efficiency. AI in its different forms such as Machine Learning, Internet of Things, robotics, etc., tend to improve and fasten processing and services(Bali, 2025). Though AI integration creates high-skilled jobs but it also induces the risks of job displacement, where semi-skilled labour are forced to abandon their work as AI can work much better and faster (Kumar Amit, 2021). Also, there are ethical issues, where the personal information and confidential data are at stake (Bali, 2025).

This leads the discussion to the point where introspection is required regarding ethical and just use of the artificial intelligence. Contemplative use of AI will enable its applications in scenarios that are most befitting with regards to improving performance and services. At the same time, there should be adequate human management and control on the usage of AI. This can enhance the livelihood opportunities in the vulnerable and fragile locations.

The Indian Himalayan Region constitutes the states of Uttarakhand, Himachal Pradesh, Ladakh, Jammu and Kashmir, Arunachal Pradesh, Mizoram and Assam. These regions have certain geographical limitations and fragilities (R. C. Sharma et al., 2008). Owing to these vulnerabilities, people of the region have developed certain Indigenous Knowledge Systems that encourage appropriate use of natural resources, that helps in creating ecological balance (Tsering et al., 2015). Renewable energy in the form of solar energy, biomass, watermills, etc. is employed to support lives and livelihood (Lohan & Sharma, 2012). The present study aims to highlight how AI in its varying forms can positively impact the usage of traditional renewable energy technologies in the Himalayas and thrive the local businesses that depend on these traditional practices.

2. Traditional Renewable Energy Technologies

Amongst the all-available renewable energy sources, Gharats, or traditional watermills are particularly found in the Himalayan regions. This is so because of the principle of operation of the traditional watermills, that requires conversion of kinetic energy of water into mechanical energy (Leiro et al., 2015). There is huge availability of water resources in the Himalayas in the form of glaciers, rivers, rivulets, streams, etc. So, these water resources are used to operate the Gharats. The water from these resources is diverted towards the Gharat, where the water falls through a height on the turbine beneath the Gharat, thus providing the required mechanical energy. The Gharats are being used in the Himalayas since ancient times, generally to obtain flour and grinded pulses and spices (Bhatt et al., 2021).

The major products from a traditional Gharat are flour and grinded spices. Recent studies have shown that the traditional watermills can be upgraded to support various other operations, besides just grinding(S. K. Agarwal, n.d.). So, the Gharats can be used to perform various operations, resulting in different kinds of products that can satisfy various markets (K. Sharma et al., 2025). Gharats can also be converted to hybrid energy sources, where it can be used in combination with other renewable energy sources such as solar, biomass, wind, etc,

The present discussion is quite crucial for the Himalayan communities and the hill economy. The Himalayan regions are facing migration at a greater scale due to lack of employment opportunities. The villages in these regions are turning into ghost villages as there is zero population in such villages (M. Agarwal et al., 2023). But if the Gharats in the Himalayan villages are upgraded to improve their performance and for performing multiple operations, this can boost the hill economy providing large scale employment opportunities to the Himalayan people (Kothari et al., n.d.).

3. Challenges Faced by Renewable Energy Businesses due to Lack of AI

Gharats, or traditional watermills have been the chief source of livelihood generation for the Himalayan people. Industrialisation and increased connectivity led to many changes which forced people to abandon the Gharats (R. C. Sharma et al., 2008).

- There are generally one or two Gharats in a single village, usually located outside the village near to a natural water stream. The paths to the Gharats are usually difficult. So, people starting feeling difficulty in carrying loads of grains to the Gharats for grinding purposes. They started preferring market-bought flour or using modern flour mills (Leiro et al., 2015).

Other Scenario: Through mapping and imagery analysis, Gharats that existed on difficult terrains could be mapped and a system could be established to ease the load of the people preferring to use Gharat-milled flour.

- At various locations, the water levels in the reservoirs associated with the Gharats have been so low that it is not possible to operate Gharats at such levels of water. It is also believed that development of large hydroelectric power plants have changed the river courses that earlier fed the Gharats (Bhatt et al., 2021).

Other Scenario: AI-based sensors can easily access real time data associated with the level of water in different streams feeding the Gharats. If this could have been accessed two decades back, many nature-based solutions could have been used to revive the rivers.

- Gharats were a symbol of communal harmony and cooperation. Though owned by particular individuals, Gharats were considered the property of the entire village, with people voluntarily assisting in construction, repair and maintenance of the Gharats (R. C. Sharma et al., 2008).

Other Scenario: AI could have created a network of Gharats present at certain locations like railway operates its railway network. These could have also led to product-based association of the Himalayan people depending on their needs and requirements.

4. Role of AI in Reforming Renewable Energy Businesses

As mentioned in the previous section, a Gharat, or a traditional watermill is a renewable energy source that is used to obtain flour and spices. Since, a Gharat utilises only the kinetic energy of water from the natural water resources, the speed of grinding in a Gharat is lower as compared to the speed of grinding grains in modern flour mills (Vashisht, 2012). This lower speed in a Gharat provides a specific taste, texture and flavour that is much superior to market bought flour. Gharat flour is much more nutritional as well as healthier (Gélinas et al., 2004).

The flour obtained from the Gharat is locally known as 'cold flour' due to involvement of very low amount of heat involved in the grinding operation in a Gharat. Also, due to the presence of a turbine below the structure of Gharat, the flour floor remains cool as the floor is constantly cooled by the water reaching the turbine. Thus, Gharat provides a high-quality product in the form of flour. Different kinds of flour can also be obtained from the Gharat depending on the requirements of the region. Similarly, various spices such as turmeric, black pepper, nutmeg, cinnamon, bay leaves can be grinded in a Gharat.

Studies have indicated that at some locations in the Himalayas, people are maintaining fish farms, bee farms, poly-farm houses nearby the Gharats and the Gharat systems are utilised for the same. Various other operations such as weaving, dying, oil extraction, etc., are performed using Gharats(S. K. Agarwal, n.d.; K. Sharma et al., 2025). Thus, Gharat is a renewable energy technology that can steer various operations and businesses.

Locals in the Himalayan region depend on the traditional systems such as Gharats for their survival. Despite challenges and facing the risk of extinction of such traditional methods, locals are struggling to revive their source of livelihood. Artificial Intelligence can be used to empower the such traditional renewable energy systems. Some of the AI applications for revolutionizing Gharats are mentioned below.

- **Mapping and Imagery Analysis:** Since, Gharats are generally scattered at remote locations, AI can be used for mapping and imagery analysis of the Gharats. The number of Gharats are gradually declining, thus AI can be used to create Gharat network for all the Gharats in a single district, or a block.
- **Internet of Things (IOT):** Real time data from various Gharats can be used to obtain information of various kinds and quantities of products that are being manufactured at various locations. This can strengthen the businesses as cumulative amounts of products can be sold, benefitting the stakeholders at different locations.

Figure 1 *Internet of Things Benefit Renewable Energy Business*

Figure 1 pictorially explain how real time data can benefit the local businessmen and Gharat owners to sell their products and earn profit. It shows that data regarding different products produced in varying quantities at various locations can be

accessed by the AI systems, which can collect the respective products and sell them in the required quantities to the customers.

Figure 1 depicts just three Gharats but AI can actually connect large number of Gharats in a district or a block depending on the operations being performed and products being manufactured at different Gharat locations

- **Disaster Management:** Depending on Gharat locations, various Gharats are often destroyed by the floods. Thus, AI systems can used to predict disasters such as floods, earthquakes, etc., and AI-driven early warning systems can help reduce the damage and destruction.
- **Nature-based Solutions (NbS):** Gharats at some locations are not able to operate due to lower level of water in various natural water resources, or complete change in the river courses that usually feed the Gharats. Intelligent systems with the help of various nature-based solutions can help revive the dying rivers and reservoirs.
- **Monitoring:** AI-powered drones can be used to monitor Gharats and their related infrastructure and provide real time data to the concerned authorities for proper monitoring and control.

Figure 2 describes the various applications of AI in reforming Gharats-based businesses in the Himalayan regions.

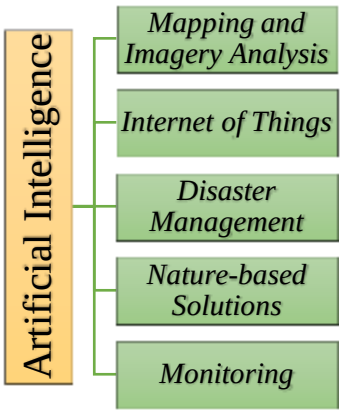

Figure 2 *AI Reforming Gharat-based Businesses*

5. Conclusion

Considerable number of studies have been discussing the ethical use of the AI. There have been debates concerning proper management and control of the AI-powered technologies. The present discussion highlights one of the examples, where AI can substantially contribute and derive the hill economy, that usually stumbles due to vulnerabilities and fragilities of the Himalayas. AI can help hill communities to utilise the natural environment and natural resources in an efficient manner. In the early times, Gharats were a thread to bind communities. Same can be achieved through AI where the communities connect and thrive through a common central node of the Gharats. This is also beneficial for the ecology of the Himalayas which cannot bear the exploitation involved in the modern construction and industrialization. Renewable energy sources based on the traditional knowledge systems of the hill communities can sustainably sustain the local population, while maintaining the ecological balance. AI can empower these systems for efficient operation, providing economic benefit from the local processes and products.

6. References

1. Agarwal, M., Sharma, M., & Shekhar Ganesha, S. (2023). Gharat – A sustainable source of livelihood. Materials Today: Proceedings, xxxx. https://doi.org/10.1016/j.matpr.2023.04.015
2. Agarwal, S. K. (n.d.). Re-energizing Watermills for Multipurpose Use and Improved Rural Livelihoods. https://doi.org/10.1659/0276
3. Bali, S. (2025). International Journal of Legal Studies and Social Sciences [Ijlsss]. International Journal of Legal Studies and Social Sciences, 3(1), 314–322. https://ijlsss.com/wp-content/uploads/2025/08/44.-Sharvika.pdf
4. Bhatt, A., Rana, D., & Lal, B. (2021). Gharat: an environment friendly livelihood source for the natives of western Himalaya, India. Environment, Development and Sustainability, 23(12), 18471–18487. https://doi.org/10.1007/s10668-021-01455-4
5. Gélinas, P., Dessureault, K., & Beauchemin, R. (2004). Stones adjustment and the quality of stone-ground wheat flour. International Journal of Food Science and Technology, 39(4), 459–463. https://doi.org/10.1111/j.1365-2621.2004.00804.x
6. Kothari, V., Bisht, Y., Society, H., & Ratan Tata Trust, S. (n.d.). Enabling Appropriate Technologies for Water Management and Improved Livelihoods in the Remote Uttarakhand.
7. Kumar Amit. (2021). Artificial Intelligence and Its Impact on Jobs in India. Research and Information System for Developing Countries, 104, 1–12.
8. Leiro, A. E., Paredes, L. D., & Lentz, M. A. (2015). Assessing Gharats of the Kamand Valley.

9. Lohan, S. K., & Sharma, S. (2012). Present status of renewable energy resources in Jammu and Kashmir State of India. Renewable and Sustainable Energy Reviews, 16(5), 3251–3258. https://doi.org/10.1016/j.rser.2012.02.011
10. Sharma, K., Sharma, V., & Arora, N. (2025). GHARATS (WATERMILLS): SUSTAINABLE ENERGY SOURCES OF THE HIMALAYAS. Book of Extended Abstracts of the 41st IAHR World Congress– Innovative Water Eng. for Sustainable Development, June, 5–8.
11. Sharma, R. C., Bisht, Y., Sharma, R., & Singh, D. (2008). Gharats (watermills): Indigenous device for sustainable development of renewable hydro-energy in Uttrakhand Himalayas. Renewable Energy, 33(10), 2199–2206. https://doi.org/10.1016/j.renene.2007.12.023
12. Tsering, G., Nimasow, G., & Dai Nimasow, O. (2015). Chuskor: an indigenous watermill for sustainable resource utilization by the Monpa tribes of Arunachal Pradesh, India. In Source: Current Science (Vol. 109, Issue 2). https://about.jstor.org/terms
13. Vashisht, A. K. (2012). Current status of the traditional watermills of the Himalayan region and the need of technical improvements for increasing their energy efficiency. Applied Energy, 98, 307–315. https://doi.org/10.1016/j.apenergy.2012.03.042