

Research Project of the Year: STEM

**"Development of Integrated
System Approach for Waste
to Useful Energy towards
Circular Economy"**

Project Team: Mr. Ashok Verghese, Project Head, Hindustan Institute of Technology and Science, Chennai , Dr. M. Jaikumar, Project Investigator, Hindustan Institute of Technology and Science, Chennai and Dr. J. Pradeep Bhasker, Co-Investigator, Hindustan Institute of Technology and Science, Chennai. Mr. Ashok Verghese, Pro Chancellor, Hindustan Institute of Technology & Science is the Project Head of the project titled "Development of Integrated System Approach for Waste to Useful Energy towards Circular Economy". He has several patents and numerous publications to his credit.

About the project: Hindustan Institute of Technology and Science (HITS), Chennai and Trier University of Applied Sciences (TUAS), Germany have forged a collaborative effort through the International Urban & Regional Cooperation (IURC) initiative to establish a sustainable quarter concept towards circular economy. This aims to integrate various renewable energy systems within the campus which includes a solar power plant to harness clean energy, a biogas plant that converts food waste into energy, and biofuel for the institute's transport fleet. Additionally, the initiative focuses on implementing energy-saving practices to further sustainability efforts. This holistic approach not only promotes eco-friendly operations but also fosters a culture of environmental consciousness within the academic community. The project serves as a pioneering model for the effective utilization of waste to energy systems as a copy template to the nearby village panchayats setting a precedent for sustainable development and fostering international cooperation in the field of environmental and social upliftment.

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1. Nominee or key personnel

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2. Submission title or project name

Project Name: “Development of Integrated System Approach for Waste to Useful Energy towards Circular Economy”

Funding Organisation: **International Urban & Regional Organisation (IURC – An EU Funded Programme)**

3. Project detailed note

Cities are growing and changing so fast that the expanding demography can mean more economic activity and wealth, but it can also mean added strain on energy, water, health, transport and housing facilities. This is why the European Union (EU) has launched a two-year programme, IURC International Urban and Regional Cooperation to promote international urban cooperation where Europe’s cities want to link up with other cities and regions of the world. In the present proposal of IURC, Hindustan Institute of Technology and Science, Chennai (HITS) contemplates to undertake a pilot study in the District of Chengalpet near the City of Chennai, Tamil Nadu along with the Trier University of Applied Sciences, Germany (TUAS) to launch bilateral and multilateral cooperation through city-to-city pairings for networking at global level to realize

measures for an ecologically sustainable and greener development. The City of Trier had already agreed to extend extensive support to the district of Chengalpet in the form of study visits and thematic networks which will help us realize the sustainable development goals and in turn will provide a substantial frame to apply for the European research funding to implement the project at a larger scale.

The project role of educational institutions (HITS & TUAS) as such would be the transfer of knowledge and technology, where the Trier University has already implemented a successful urban conversion project based on “Quarter concept” in one of its campuses. Hence, the present project proposal aims to study the feasibility of waste-to-energy conversion, hydrogen technologies and establishing a zero-emission region in HITS campus that would serve as the copy template in the selected region. The proposed project would involve field visit to the selected region, study the livelihood practices and waste management techniques carried out by the government, policies framed by the government, energy generation and affordability in the region, etc. and integrate novel hydrogen/waste technologies solutions as proposed by HITS and TUAS along with industry participation for establishing a zero-emission concept. A similar pilot concept would be established at HITS that would serve as Research and Innovation hub for implementing in the nearby regions.

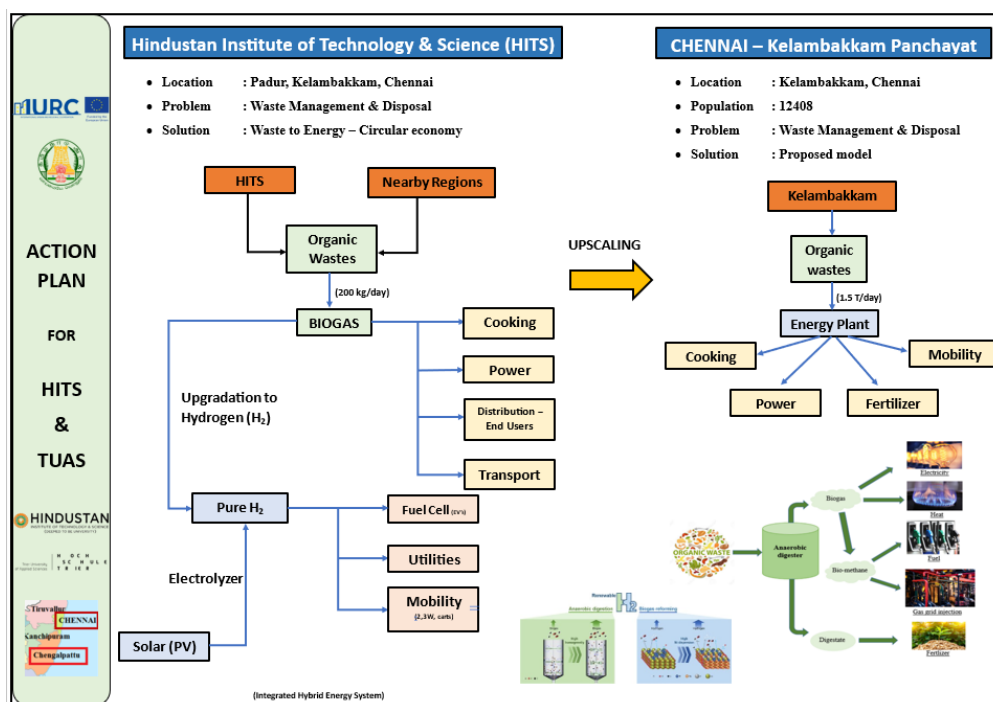
4. Edited submission

Hindustan Institute of Technology and Science (HITS), Chennai and Trier University of Applied Sciences (TUAS), Germany have forged a collaborative effort through the International Urban & Regional Cooperation (IURC) initiative to establish a sustainable quarter concept towards circular economy. This aims to integrate various renewable energy systems within the campus which includes a solar power plant to harness clean energy, a biogas plant that converts food waste into energy, and biofuel for the institute's transport fleet. Additionally, the initiative focuses on implementing energy-saving practices to further sustainability efforts. This holistic approach not only promotes eco-friendly

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5. Supporting Material (Attachments)

1. U-CAP Submission to IURC (Action Plan)



- **Explain the background to your project. Why was the research necessary and what were its primary objectives?**

- The necessity for this research project arose due to the escalating challenges associated with the rapid urbanization and industrialization in Che

nai and the broader Indian context. The inefficiencies in the existing waste management systems were leading to environmental degradation, health hazards, and resource wastage. Additionally, the growing energy demands required a shift towards renewable and sustainable energy sources to reduce reliance on non-renewable fossil

fuels, consequently mitigating the impact on climate change and environmental degradation.

The primary objectives of the project were as follows:

- Waste Management by implementing a holistic waste management system that focuses on effective waste segregation, recycling, and conversion of organic waste into valuable resources, thereby reducing the burden on landfills and preventing pollution.
 - Developing efficient biogas and biofuel generation processes from household waste, thus contributing to the production of clean and sustainable energy alternatives, while also reducing the carbon footprint and promoting a circular economy.
 - Sustainable Campus Development by Integrating the waste to energy project into the larger Sustainable Campus concept at HITS, aiming for a comprehensive approach to sustainability, encompassing waste management, energy conservation, and environmental stewardship.
 - Facilitating the exchange of expertise and technological know-how between Hindustan Institute of Technology and Science in Chennai and Trier University of Applied Sciences in Germany, fostering a cross-cultural collaboration for innovative solutions in the field of sustainable energy and waste management.
 - By achieving these objectives, the project aimed to serve as a model for other institutions and communities, encouraging the adoption of sustainable practices and technologies to mitigate environmental challenges and promote a greener, more sustainable future for urban development.
- **Describe what the work involved and what challenges arose.**

The Waste to Energy project at Hindustan Institute of Technology and Science in collaboration with Trier University of Applied Sciences involved a comprehensive range of activities, including research, technology implementation, infrastructure development, and community engagement.

Some of the key components of the work included:

- Detailed research was conducted to understand the composition of household waste in the Chennai area especially in Kelambakkam panchayat (nominated region), the potential for biogas and biofuel production, and the most suitable technologies for waste-to-energy conversion. Feasibility studies were carried out to assess the economic viability and environmental impact of the proposed project.
- Setting up the necessary infrastructure as a pilot demonstration for waste collection, segregation, and processing was a crucial aspect of the project. This included the installation of waste segregation units, biogas and biofuel production facilities, and the integration of these systems within the existing campus infrastructure.
- Implementing advanced technologies for efficient waste management and energy conversion required expertise in biogas production, biofuel refining, and waste treatment processes. Collaboration with experts from Trier University of Applied Sciences in Germany was essential to leverage their knowledge and experience in these areas.
- Urban Action Plan proposed to the Government by engaging the campus community and local residents was essential to ensure the success and sustainability of the initiative. Educational programs, awareness campaigns, and workshops were organized to educate people about the importance of waste management, renewable energy, and sustainable practices.

Challenges that arose during the course of the project included:

- Lack of awareness among the people regarding the importance and safety aspect of waste segregation. Garnering active participation and support from the campus community and local residents was challenging, as changing mindsets and habits related to waste management and energy consumption required persistent education and engagement efforts.

- Ensuring the long-term financial sustainability of the project, including the operational costs of the waste management system and the maintenance of the energy production infrastructure, required careful planning and resource allocation.

Despite these challenges, the collaborative efforts of the teams from Hindustan Institute of Technology and Science and Trier University of Applied Sciences aimed to overcome obstacles through innovative solutions and a commitment to the shared vision of sustainable development and environmental stewardship.

- **What did the results reveal and what are the potential wider benefits to society?**

Some of the key findings and benefits included:

- The implementation of advanced waste management techniques led to a significant reduction in the amount of organic waste sent to landfills, thereby reducing environmental pollution and health hazards associated with improper waste disposal.
- The successful conversion of household waste into biogas and biofuels provided a renewable energy source that could be utilized for various purposes, such as cooking, heating, and electricity generation, thereby reducing the dependence on non-renewable energy sources and mitigating greenhouse gas emissions.
- The project contributed to a reduction in greenhouse gas emissions, as the organic waste that would have otherwise decomposed in landfills and released methane, a potent greenhouse gas, was effectively converted into usable energy. This reduction in emissions supported the broader efforts to combat climate change and promote environmental sustainability.
- The successful integration of the waste to energy project into the Sustainable Campus concept at HITS provided a replicable model for other educational institutions and communities to adopt sustainable practices, promoting environmental awareness and fostering a culture of sustainability among students and the broader society.

The potential wider benefits to society include:

- The adoption of the waste to energy model could contribute to improved environmental sustainability by reducing the burden on landfills, mitigating pollution, and promoting the efficient use of renewable energy sources.
- Effective waste management practices and the reduction of pollutants from waste disposal can lead to improved public health outcomes, reducing the risks associated with air and water pollution, and the spread of diseases related to improper waste disposal.
- The development of sustainable waste management and renewable energy technologies can create new economic opportunities, such as job creation in the green energy sector, fostering local entrepreneurship, and promoting innovation in sustainable technology development.

Overall, the results of the project demonstrated the viability and potential of the waste to energy approach as a sustainable solution for addressing waste management and energy production challenges, with the broader benefits extending to society at large supply disruptions.

- **Has the research led to other projects or new avenues of exploration?**

Certainly, the success of the Waste to Energy project at Hindustan Institute of Technology and Science, in collaboration with Trier University of Applied Sciences, has opened up new avenues of exploration and inspired the initiation of various related projects and research endeavours. The project has opened new avenues like upgradation of clean hydrogen production projects, industry partnerships, cross-cultural collaboration and the most important of all, public awareness and education.

CHENNAI IN TRIER: ACADEMIC EXCHANGE ON RENEWABLE ENERGY AND WASTE MANAGEMENT



The visit of Chennai delegates to Trier, Germany, kicked off at the city hall where the mayor of Trier, Mr. Wolfram Leibe, gave a warm welcome and discussed his city's goal on having exchange programmes between the Trier University of Applied Sciences, represented at the meeting by Professor Peter Konig, and the Hindustan University of Chennai with the support of the IURC programme. The study visit in Trier followed the visit of the Trier delegates to Chennai, India, on 21-23 September 2022, during which a Letter of Intent was signed to formalize the two cities' commitment to collaboration.



Later that day, the Chennai delegates had a tour at SWT (Stadtwerke Trier Versorgungs-GmbH), a mostly city-owned company providing Trier with electricity, gas, drinking water, heat and managing wastewater (sewer network and sewage treatment plants) in a sustainable manner, and exchanged ideas on sustainable waste management. SWT also shared their strategy to make Trier become energy-independent. The next stop on the site visit was the Energy and Technology Park (ETP) newly built by SWT to illustrate their strategy and circular economy.



On the second day, the Chennai delegates learned about good practices on zero-emission at Umweltcampus Birkenfeld, The Environmental Campus Birkenfeld, which presented the Sustainable Campus Concept. In the afternoon, they finished the visit at ZAK, Central Waste Management Kaiserslautern, checking out a modern waste management facility and demonstrating the separation of biowaste and plastics.



On the last day, the Chennai delegates had a tour of the Trier University of Applied Sciences. They observed various demonstrations of auto vehicle safety systems, food technology,

efficient heating systems, and energy generation. To close off the day, they visited Waste Management Region Trier, where they learned about advanced waste sorting technology and toxic water treatment.



The Chennai delegates' visit to Trier was full of learning sessions on best practices implemented in Trier. Chennai and Trier will discuss their future cooperation and implement a pilot action within the IURC programme.