GHG REDUCTION AND ECONOMIC DEVELOPMENT THROUGH COMMUNITY ORGANIC WASTE RECYCLING, COMPOSTING, AND ECONOMIC INCUBATION

1. OVERALL PROJECT SUMMARY AND APPROACH

Food waste and its disposal in landfills and animal waste stored or collected in lagoons or holding tanks play a major and significant role in greenhouse gas (GHG) emissions. Specifically, the decomposition of organic matter in landfills and manure management produces primarily methane and nitrous oxide gases. According to the EPA report, this accounts for about 55% of the total emission of Methane[1]. Methane is a potent greenhouse gas with a much shorter average lifespan in the atmosphere than carbon dioxide (CO_2). Its global warming potential is 84–86 times that of CO_2 measured over 20 years [2]. Reducing methane emissions at the early stage can be more cost-effective than addressing CO_2 emissions on a per-ton basis.

Composting is a clean alternative to landfilling for managing organic wastes and a cost-effective alternative to Methanation or Anaerobic Digestion. GHG Reduction using composting encapsulates a strategic approach to significantly reducing methane emissions. It also promotes converting organic waste into a valuable resource, contributing to environmental sustainability and climate change mitigation efforts. However, conventional composting of large volumes of waste is labor-intensive, requires large space and takes a long time to complete the composting process.

The proposed solution utilizes a proven and innovative composting technology that has demonstrated effectiveness in Scandinavia. This technology, which relies on a potent yet safe bacterium, can convert organic waste into nutrient-rich, pathogen-free compost in 24 hours. Our team at the University of Texas Rio Grande Valley's (UTRGV) Center for Advanced Manufacturing Innovation and Cyber Systems (CAMICS) has collaborated with Swedish researchers from Lund University, led by Professor Torleif Bramryd and SOLSERV AB, over the past five years to enhance the processes and performance of this composting technology. This technology was successfully introduced in Sweden 15 years ago and has been adopted by various companies, including Volvo, Ikea, and Grand Hyatt Hotels, among others. The proposed GHG reduction measure, its logic model, and the overall approach outlined in this project are illustrated in Fig. 1.

As shown in Fig. 1, the proposed project follows a logic model that starts from reshoring of manufacturing of advanced composting machines/facilities, which will be installed at schools to process 1.4 million tons of food and organic waste and to prevent more than 54 thousand metric tons (mt) of methane (1.733 million metric tons of CO_2e) from being released into the atmosphere at more than 1,600 schools in an area that covers 38 counties and 177 school districts. Plans are in place to expand the program to include other regions and dairy farms in the Texas panhandle. This initiative will alleviate many of the social and economic challenges that communities in our area face. Most of the communities in our area are classified as low-income, underserved communities including more than 900 colonias. This initiative will contribute to lifting many low-income families out of poverty through applied research and development (R&D), workforce training, entrepreneurship mentoring and business incubation, and high-paying high-quality jobs. It will also contribute significantly to the improvement of health and wellness conditions, empowerment of communities, revitalization of neighborhoods and community resilience.

In addition to reducing GHG emissions, this project will produce high quality compost that can help amend and restore soil health, replace the use of chemicals and pesticides in agricultural applications, and improve climate resilience in our region.

1 https://www.epa.gov/sites/default/files/2019-06/documents/methane_emissions_overview_may2019.pdf
2 Food Waste and its Links to Greenhouse Gases and Climate Change | USDA

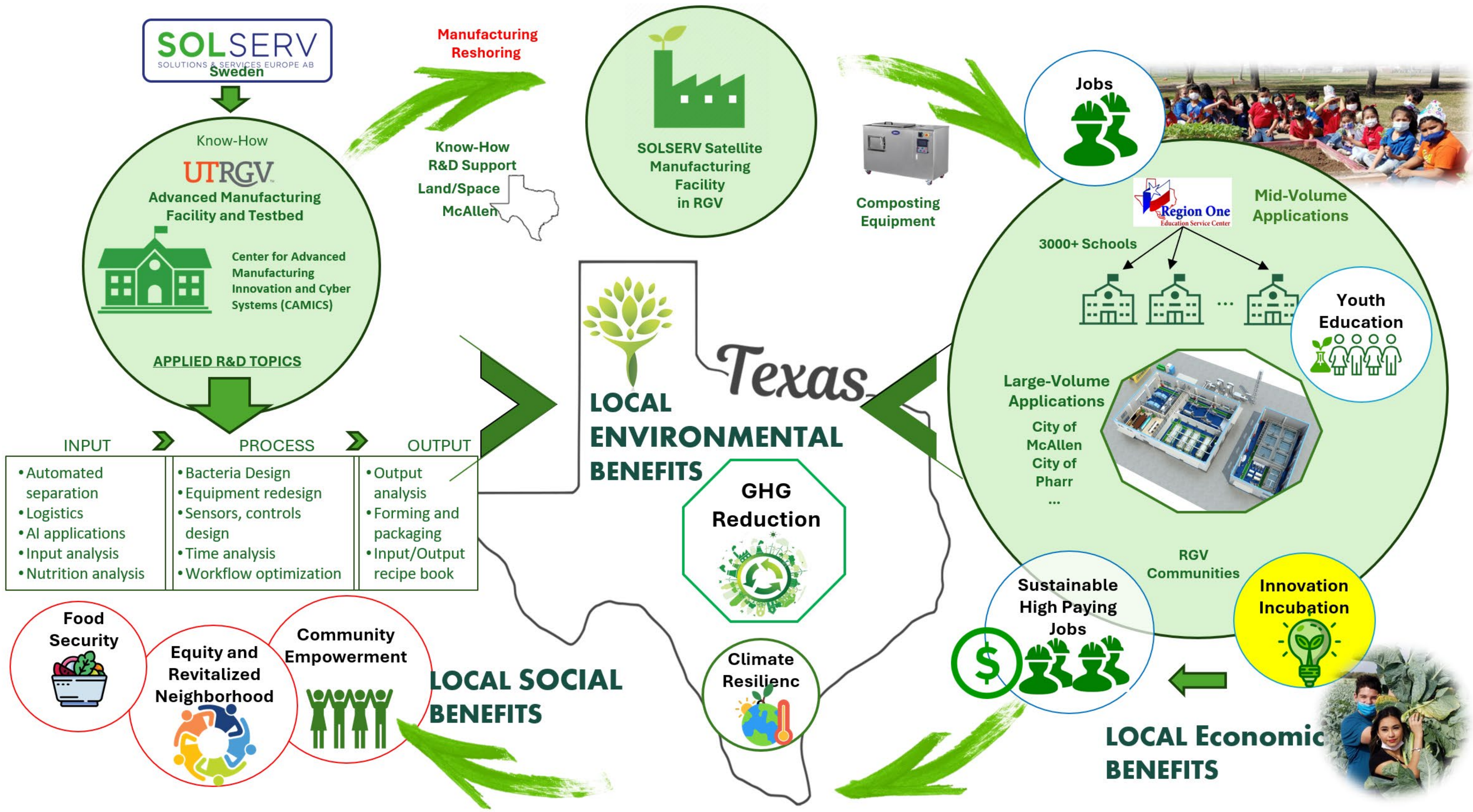

Figure 1: The proposed composting-based GHG reduction and its impacts on regional communities from both economic and social perspectives

We are confident that, when funded, this project can transform Texas' poorest region's economic landscape by promoting a sustainable green circular economy with immediate financial benefits from job creation, enhanced productivity, and ultimately increased household income, as well as long-lasting secondary benefits such as improved public health, reduced poverty and inequality, and mitigated impacts of climate change.

1.A. DESCRIPTION OF THE PROPOSED GHG REDUCTION MEASURE

The proposed measure is to reduce the amount of organic waste, especially food and animal waste, going to landfills and lagoons by composting it at the source where it originates whenever possible, including school cafeterias, farms, residential houses, and in composting centers for all organic waste collected by municipalities.

Currently, in the Rio Grande Valley (RGV), the city of McAllen has the only organic waste composting program and facility, which consists of a conventional, open row composting that takes between 9 months to 1 year to compost organic waste and requires 50 acres to store the waste while composting. The McAllen process described above requires several machines (front loaders, compost trommel screeners, tractors, dump trucks, etc.) and is labor intensive as the piles of organic waste must be turned at least once a week. While the benefits of conventional composting are evident, it can be a lengthy labor and space-intensive process. We have developed and successfully tested advanced composting technology in McKinney, Texas on horse manure at an animal rescue center, Farmhouse Fresh. The proposed advanced composting technology has also been successfully tested on pig and chicken waste conducted by research partners in Sweden. The proposed advanced composting system as demonstrated in Fig. 2 is an automated, in-vessel smart, and energy-efficient composting system specially designed to create the ideal environment for the bacterium to be active and to optimize the composting process.

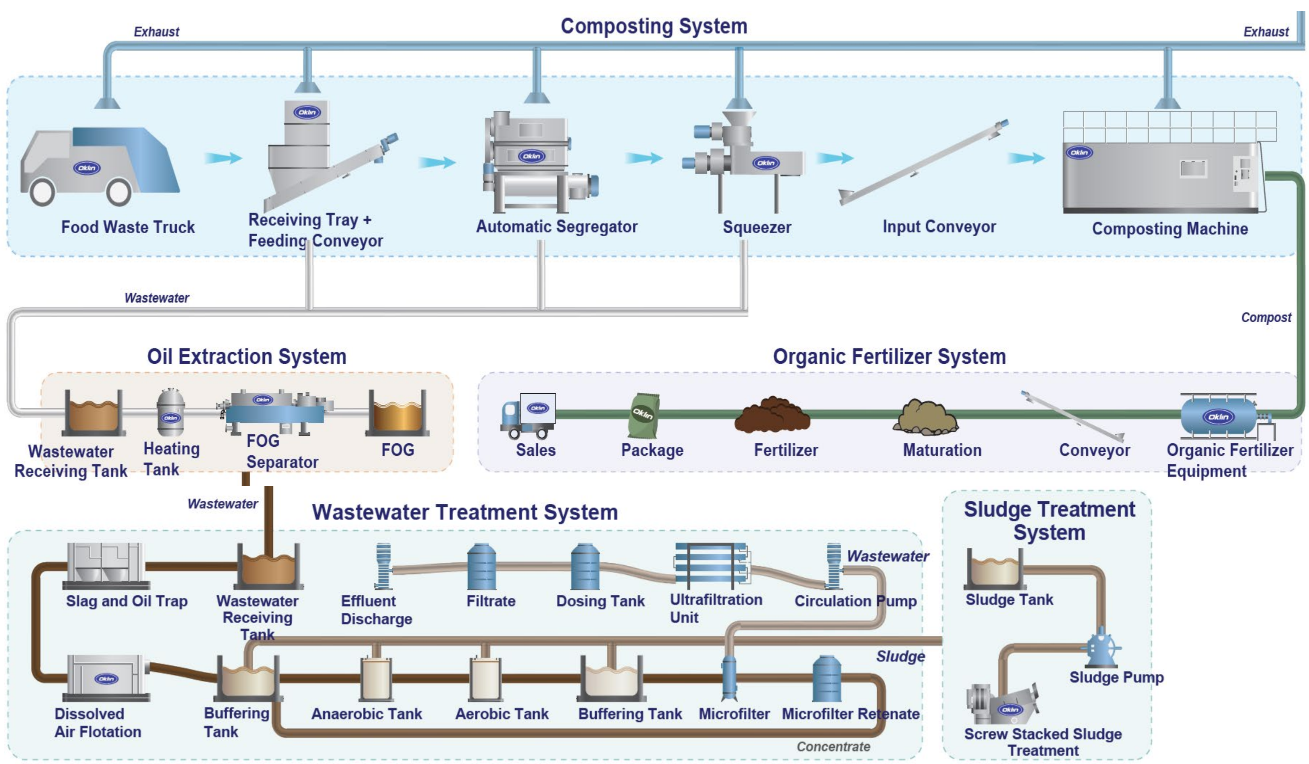

Figure 2: Food waste facility treatment process flow chart.

The 24-hour in-vessel system requires five ingredients that work symbiotically together to convert organic waste into compost: 1- air: air is pushed into the composting chamber; 2- moisture: most organic materials composted already contain sufficient moisture. With dry organic waste, a small amount of water is added to the chamber; 3- heat: a sheet-shaped heating device is placed below the composting vessel with a thermostat set at 85°C; 4- Acidulo bacterium: the bacterium is activated when it enters in contact with moist organic waste, heat, and air. 5- agitator: the organic waste is rotated continuously during composting to allow the waste to be aerated. The agitation rate is set at 2 rpm, and the agitation bar's rotation direction is reversed every 2 min. An 8-minute agitation is alternated with a 24-minute interval.

The composters are fitted with sensors that detect moisture, temperature, airflow, and when fresh organic waste has been loaded onto the machine. The composter enters dormant mode once the compost is ready, reducing energy usage. Municipal facilities are equipped with water purification and reverse osmosis systems and biodiesel reactors that process any liquid in the organic waste into clean, drinkable water or biodiesel.

Bridging the gap between innovative waste management, municipal settings, and the education sector is pivotal. This project's proposal of partnerships showcases the practical application of cutting-edge composting technology in municipal settings. It extends its benefits into the educational sector, where the future stewards of our environment are nurtured. For such purpose, CAMICS proposes to work with three Texas Educational Service Centers (ESCs) and install composting systems in schools within the three southern Texas regions: Region 1- Edinburg, Region 2- Corpus Christi, and Region 20- San Antonio. Schools in our three regions have a combined student enrollment of 1.02 million pupils, 19% of Texas's total student enrollment, and produce more than 20 thousand tons of food waste annually. In addition, UTRGV CAMICS center intends to establish municipal composting facilities in the principal urban center within our region. Municipal composting facilities can process large volumes of organic waste very efficiently because of economies of scale.

Composting at schools prevents much of the food waste from being landfilled and eliminates the need to transport the waste. Thus, emissions from landfilled waste and diesel-powered trucks and other heavy equipment used to bury the waste are eliminated. At the same time, diesel fuel needs are reduced, and municipalities' waste management expenses are reduced.

SIGNIFICANT FEATURES OF THE PROPOSED GHG REDUCTION MEASURE

The proposed GHG reduction measure is not just effective, it is also highly adaptable and scalable. It can be implemented in any environment, region, climate, and type of organic waste. Whether it's a small school or a large urban center, the proposed composting facilities can handle any volume of organic waste. The facilities are modular and can be easily scaled up or down to accommodate any change in the volume of organic waste treated. They are also energy efficient, with a dormant feature that significantly reduces energy consumption when the process is completed. These features, along with others, make the 24-hour composting system effective and cost-efficient.

MILESTONES, RISKS; AND RELATIONSHIP OF EACH MEASURE TO THE PRIORITY CLIMATE ACTIONS PLAN

MILESTONES

The project's key tasks and associated milestones include:

- Reduction of methane gas emissions by 93,404 metric tons by 2030 (2,932,991 mt CO_2e). (2025-2050) [3,4,5].
- Performing applied R&D for manufacturing, automation, recipe optimization of the composting process.
- Installing advanced composting systems in municipalities and in school cafeterias in the three selected TEA regions (Region 1, 2 and 20, where a high percentage of low-income families are located) and in 6 municipalities in south Texas within a 4-year period (2025-2028). Expand the implementation of the program to the rest of the state progressively.

3 https://ag.umass.edu/crops-dairy-livestock-equine/fact-sheets/manure-inventory
4 https://www.rd.usda.gov/sites/default/files/rr217.pdf
5https://www.epa.gov.

- Establish an annual review process that will assess progress towards these ambitious targets, with adjustments made as needed to accommodate technological advancements, community feedback, municipal feedback, and educational partnerships. (Starting in 2025 and ongoing)
- Provide training (train the trainer) and educational programs at the 1,601 participating schools in the three regions on sustainability, ecology, healthy eating, healthy living, and green circular economy. (Starting in 2025 and ongoing)
- Develop a food waste recycling program and improve collection services for homes with school children and expand it to the rest of the community including businesses. (Starting in 2025 and ongoing)
- Develop a program to expand composting technology to dairy farms in Texas[6]. (starting in 2027)
- Establish a manufacturing facility near low-income underserved communities, providing high paying employment opportunities. (Operational by the beginning of 2026)
- Create 1,000 FTE permanent jobs in manufacturing and organic compost related industries. (2025 to 2030)
- Provide advanced manufacturing training in additive manufacturing, robotics, PLC programming, AI and machine learning with a focus on smart composting technologies and eco-friendly manufacturing technologies and processes. (Starting in 2025 and ongoing)
- Provide workforce development programs in low-income and underserved communities. (Starting in 2025 and ongoing)
- Provide entrepreneurship training and mentoring in low-income, underserved communities to capitalize on green-and circular economy opportunities. (Starting in 2025 and ongoing)
- Incubate at least 60 new green economy businesses between 2025 and 2030.
- Promote STEM education and careers among underserved communities, leveraging partnerships with the EPA, Department of Defense, Department of Energy, and local educational institutions. (Starting in 2025 and ongoing)

RISKS AND MITIGATION

This project harnesses the potential of cutting-edge composting technology to mitigate methane emissions from decomposing organic waste, a significant step toward environmental sustainability. Central to its implementation are projections of strong willingness among community and governmental bodies to adopt innovative waste management solutions and that adequate financial resources and institutional support will be in place to sustain the initiative over time. We also expect that the educational endeavors will successfully shift public perceptions, cultivating a deep-rooted sense of environmental responsibility and enthusiasm for recycling.

The success of this initiative hinges on several critical external factors. The regulatory environment must favor, or at least not obstruct, the adoption of eco-friendly technologies and methods for waste reduction. Policies that incentivize sustainable practices could significantly enhance the project's impact. Likewise, securing ongoing funding poses a challenge; to ensure its viability and scalability, the project must attract support from government grants, private investment, and possibly public crowdfunding. An eco-friendly and favorable regulatory environment would positively affect the predisposition of decision makers, waste management professionals, and other stakeholders to seriously consider new and more effective and efficient GHG emissions reduction technologies. In addition, a favorable regulatory environment is an explicit signal that the government considers GHG emissions reduction a priority and may also be a tacit signal to private investment and the public in general that GHG emissions reduction technologies, processes and methods may provide less volatile investment opportunities.

6 https://www.milk4texas.org/interactive-milk-data-map/

Public and community engagement is another pivotal element. The community's readiness to participate in recycling and composting efforts will influence the program's effectiveness. This requires altering longstanding habits and overcoming skepticism toward new waste management technologies. Moreover, the initiative's progress and adaptability will depend on continuous advancements in composting technology and waste management strategies. Maintaining a close connection with scientific research and technological innovation is essential for adapting to new challenges and opportunities.

This project represents a comprehensive approach to tackling methane emissions through waste management innovation, education, and community engagement. Its potential for meaningful environmental change is significant, yet it will rely upon a supportive policy landscape, reliable funding, community buy-in, and the evolution of waste management technologies.

The goal of this initiative is to aggressively reduce GHG emissions. However, the risks identified above can significantly reduce the rate at which GHG emissions are effectively reduced. To mitigate these risks, UTRGV has secured the support and collaboration of TEA's Regional ESCs to implement the school programs. In addition, UTRGV demonstrated the effectiveness of the proposed technology to some municipalities and conducted cost benefit analyses that demonstrated the economic benefits to the municipalities and to the community. Many of the risks identified above can be overcome if the technology is economically attractive.[7]

1. B. DEMONSTRATION OF FUNDING NEED

Although existing funds, discussed in the next paragraph, have different primary foci that include the development of new technologies through applied R&D, workforce training, or promotion of STEM education, they all incorporate a component to educate and disseminate information about the importance of environmental responsibility and the critical role eco-friendly features of new technologies and processes have on sustainability and improved competitiveness. The requested funds would focus primarily on GHG emissions reduction and will bring a novel technology to an underserved area[8] of great need of high paying and quality jobs, and sustainable clean industries. The existing funds will be leveraged to help magnify the impact the requested funds will have in accelerating the efforts and the effectiveness of GHG emissions reduction and ensuring the sustainability of the program.

Through the Department of Defense Manufacturing Communities program, funds of $7.5 million (OLDCC award #: MSC2106-23-01) have been secured to support manufacturing reshoring. With this fund, UTRGV, together with U. of Texas San Antonio and U. of Houston, seeks to re-shore manufacturing operations by 1) developing and providing technical support for novel materials and processes leveraging AI, Robotics, and Convergent Manufacturing; 2) offering certificate/training programs to members of the academic and industrial sector that upskill and reskill the incumbent workforce; 3) serving as a regional tech demonstration hub to expose modern technologies to small and medium local manufacturers and incubate new companies in the three regions we serve, South Texas, Central Texas and Gulf Coast regions. Part of the funds will support workforce training, R&D, and technical support for reshoring the composting equipment manufacturing effort.

UTRGV is leading a Department of Energy-funded project ($5 million, award #: DE-NA0004003) with a focus on Research and Education on Additive Manufacturing for Renewable Energy Systems. Education and research on effective community recycling is an important area. In addition, a contract of $100,000 was signed with Oak Ridge National Lab (ORNL) to support sustainable practices and renewable energy education in South Texas. Plans are made to support the establishment ORNL South which will support education and research on renewable energy, sustainability, and greenhouse gas reduction.

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7 See Cost Effectiveness Section 2.c. Table 7.
8 the Climate and Economic Justice Screening Tool (CEJST)8;

CPRG funds are needed for the acquisition and installation of GHG emissions reduction equipment in schools and municipalities. The acquisition of this equipment will not only provide the tools to reduce GHG emissions, but it will also provide a large enough initial demand for SOLSERV to be interested in reshoring and establishing manufacturing facilities in South Texas. These efforts will include developing the necessary education, research capabilities, and technical support.

The majority of our communities are low-income underserved communities with limited resources, especially for grant writing and management. UTRGV has campuses in three counties, Cameron County, Hidalgo County, and Starr County, and strong ties to all the communities in the Rio Grande Valley. As shown in Fig. 3, with sites throughout RGV, UTRGV is poised to provide resources and support with the expertise and the experience to secure and manage funds for these types of projects.

***Figure 3:* UTRGV sites throughout the Rio Grande Valley**

This project will leverage three Technology Demonstration Centers to be established at Rio Grande Valley and San Antonio under the DoD DMC grant for training, technical support, and community outreach efforts. These Tech Centers will be utilized to support the proposed project activities.

To the best of our knowledge, municipalities in our region have not received funds or tax incentives related to GHG emissions reduction. They have expressed support and excitement about the implementation of a project that addresses organic waste recycling effectively and efficiently and frees up resources like large tracts of land and heavy equipment that have been dedicated to organic waste disposal. Letters of support were secured to support the installation, operation, and sustainment of large community waste food composting facilities after the funding period. The team has conducted discussions with City of Pharr regarding incentives, land and other resources that are needed to reshore the manufacturing facilities to Texas.

1. C. TRANSFORMATIVE IMPACT

The proposed GHG reduction measure is a multifaceted program designed to reduce GHG emissions, provide workforce training, organic waste recycling awareness programs, and educational programs for students and parents on the benefits of recycling and healthy eating and living. But it also provides entrepreneurship and business opportunities and training in the green economy to help lift low-income, underserved communities out of poverty. Reducing short-lived climate pollutants like methane can swiftly decrease the pace of global warming between now and 2050 and significantly reduce its impact on health, food security, and air quality.[9] In addition, it can transform Texas' poorest region's economic landscape by promoting a sustainable green circular economy with immediate financial benefits from job creation, enhanced productivity, and ultimately increased household income, as well as long-lasting secondary benefits such as improved public health, reduced poverty and inequality, and mitigated impacts of climate change.

The purpose of this holistic approach, in addition to GHG reduction, is to permanently change the culture from one of indifference towards recycling to one that embraces the benefits of GHG reduction and opportunities that a green economy provides, to engage the community in sustainable practices proactively, and to educate

9 www.ilsr.org/initiatives/composting

school children and parents about climate change and responsible waste management and recycling. Children can be the strongest environmental advocates and inform their parents about waste recycling. A study by researchers at North Carolina State University showed that educating children about climate change increases their parents' concerns about climate change.[10] The goal of the proposed measure is to ensure the continuity and sustainability of the effort beyond the funding period and to promote a permanent change in attitudes toward the environment and greater awareness of the impact of each person's behavior on the environment.

By 2030, a statewide initiative in Texas will be implemented to reduce GHG emissions by adopting 24-hour composting technology, aiming for transformative environmental, social, educational, and economic impacts. This initiative will:

- Achieve a 30% reduction in GHG emissions from organic waste in participating regions by 2030 compared to 2024. Increase participation in organic waste recycling programs by 50% among the targeted population.
- Develop local manufacturing facilities to produce advanced composting systems using locally trained workers issued from low-income underserved communities.
- Deploy locally engineered and manufactured 24-hour composting systems across Texas schools, farms, and municipalities. We will integrate these systems with educational and research programs on recycling, healthy eating and living, and community engagement. The program will also include workforce training and business opportunities within the green economy sector.
- Leverage resources from our network to expand and scale up the adoption of this technology nationwide.
- Engage over 1,600 Texas schools in phase 1 (2025-2028) then expand statewide afterwards, in educational programs focusing on climate change, recycling, and responsible waste management, leading to a measurable increase in parental concern about climate change based on survey data.
- Leverage resources from our network and partners especially from advanced manufacturing institutes such as Tooling-U SME, America Makes, and ARM, and in partnership with local school districts, community colleges, workforce development agencies, and EDCs to provide workforce training in advanced manufacturing, AI, machine learning, and additive manufacturing to support the production and adoption of this technology at the national level.
- Leverage partnerships with educational institutions (University of Houston, UT Austin, and UT San Antonio, institutions of America's Additive Foundry Consortium members), local governments, and private sector stakeholders to support the adoption of this technology.
- Transform Texas' economic landscape through job creation in the green economy, improve public health, and foster a circular economy. The educational component seeks to change the culture around recycling and environmental stewardship, starting with the younger generation with the involvement of parents.
- Establish and incubate at least 60 green economy startups or initiatives through entrepreneurship training programs by 2030. According to the EDA, RGV has a collective prime-age employment gap of 8.63% and an average median annual household income of $40,115 compared to $74,500 in the U.S.
- Use funding and technological support from state and federal environmental initiatives to tap into the growing interest and investment in green technologies and sustainable practices.

2. IMPACT OF GHG REDUCTION MEASURES

2.A. MAGNITUDE OF GHG REDUCTIONS FROM 2025 THROUGH 2030

In the U.S., we discard nearly 62.5 million tons of food every year, more than any other country in the world. This is estimated to be 325 pounds of waste per person and almost 40 percent of the entire U.S. food supply**.** Texans send about 5.7 million tons of wasted food to landfills every year[11]. The World Wildlife

10 Lawson, D.F., Stevenson, K.T., Peterson, M.N. et al. Children can foster climate change concern among their parents. Nat. Clim. Chang. 9, 458–462 (2019).
11 https://www.rts.com/resources/guides/food-waste-america/

Organization estimated that each school student generates 39.2 pounds of waste yearly[12]. Most of this discarded food waste ends up in landfills. Food is the single largest and most significant component, taking up space inside landfills, making up 24 percent of municipal solid waste (MSW) and 58% of methane gas emissions.[13,14] Wasted food represents a double loss: not only are large tracts of land, water, fossil fuel, and other resources wasted, but harmful emissions are also created to produce that food. It is estimated that just food scraps decomposing in U.S. landfills produce 23% of U.S. methane pollution[15]. In Texas' 98 landfills, an estimated 389,437 mt of methane is emitted[16], and dairy farms emit another 911,601 mt.[17,18] From 2025 through 2030 the goal is to install advanced composting systems in schools and municipalities first and eventually in 20 dairy farms in Texas panhandle.

The advanced composting systems eliminate methane gas emissions immediately after they are activated. There are no performance lags or progressive performance curves to reach optimal emission reduction. Figure 4 shows the composting process in 4-hour increments from start to finish after 24 hours later.

Table 1 summarizes the methane reduction impact of composting food waste from school cafeterias and municipalities using 24-hour composting technology. There are 1.02 million students in schools in Regions 1, 2, and 20, producing over 20 thousand tons of food waste annually. The projected student population and subsequent food waste are expected to grow at 0.68% annually.[19]

Table 1: Estimated GHG Reductions at Schools from 2025 through 2030.

	Number of Students	Food Waste Generated in Tons	Metric Tons of Methane from Food Waste	Metric Tons of CO2e
			65-ton CH4/1000-ton waste	65-ton CH4/1000-ton waste
Base Year	1,021,411	20,020	1,301	32,532
2025	1,028,312	20,155	1,310	32,752
2026	1,035,259	20,291	1,319	32,973
2027	1,042,253	20,428	1,328	33,196
2028	1,049,294	20,566	1,337	33,420
2029	1,056,383	20,705	1,346	33,646
2030	1,063,520	20,845	1,355	33,873
2025-2030	**1,063,520**	**122,990**	**7,994**	**199,859**

*Projections are based on the U.S. Census 2012-2022 population growth rate in South Texas (0.676%)

12 https://www.worldwildlife.org/press-releases/plate-waste-in-us-cafeterias-could-total-530-000-tons-per-year
13 https://www.epa.gov/land-research/quantifying-methane-emissions-landfilled-food-waste
14 https://www.epa.gov/sustainable-management-food/wasted-food-scale
15 https://www.texasenvironment.org/wp-content/uploads/2020/08/Food-Organics-Diversion-Report-2020-FINAL.pdf
16 https://environmentalintegrity.org/news/methane-from-landfills-is-a-major-source-of-climate-pollution-that-epa-is-failing-to-adequately-control/
17 https://extension.usu.edu/agwastemanagement/manure-management/how-much-manure
18 https://extension.psu.edu/growth-charts-for-dairy-heifers
19 The U.S. Census

Figure 4: ***Illustration of Conversion of food waste into compost in 4 hours Intervals.***

The estimated volume of methane reduction, assuming that 1000 tons of waste produces 65 tons of methane[20], for the period 2025 through 2030 is 7,994 mt (199,859 mt CO_2e), equal to a yearly average of 1,332 metric tons of methane (42,635 mt CO_2e) over those 6 years. Table 2 presents the impact of 6 municipal composting facilities, each processing 100 tons of organic waste daily. The estimated methane emission reduction from 2025 through 2030 is 85,410 mt (2,733,132 mt CO_2e). The combined estimated total amount of methane emission from diverted schools' food waste and municipal organic waste from 2025 to 2030 is 93,404 mt of methane (2,932,991 mt CO_2e). The conversion of organic and animal waste into compost using the 24-hour composting systems is consistent and does not vary. The durability of reducing methane emissions is consistent with the volume of waste treated.

Table 2: Estimated GHG reductions of Municipalities from 2025 through 2030.

	Organic Waste Generated in Tons	Metric Tons of Methane from Food Waste	Metric Tons of CO2e
		65-ton CH4/1000-ton waste	65-ton CH4/1000-ton waste
McAllen	219,000	14,235	455,520
Pharr	219,000	14,235	455,520
Brownsville	219,000	14,235	455,520
Laredo	219,000	14,235	455,520
Corpus Christi	219,006	14,235	455,532
San Antonio	219,006	14,235	455,532
2025-2030	**1,314,006**	**85,410**	**2,733,132**

20 https://www.biocycle.net/connection-climate-calculations/

Table 3: Estimated GHG reductions of Schools and Municipalities from 2025 through 2030.

2025-2030	Number of Students	Organic Waste Generated in Tons	Metric Tons of Methane from Food Waste	Metric Tons of CO2e
			65-ton CH4/1000-ton waste	65-ton CH4/1000-ton waste
Schools	1,063,520	122,990	7,994	199,859
Municipalities	-	1,314,006	85,410	2,733,132
Total	**1,063,520**	**1,436,996**	**93,404**	**2,932,991**

2.B. MAGNITUDE OF GHG REDUCTIONS FROM 2025 THROUGH 2050

Table 3 summarizes the volume of food and organic waste generated and recycled over 6 years, and the volume of methane emissions averted; similarly, Table 4 summarizes the volume of compostable organic waste and the methane reduction and the carbon dioxide equivalent for 2025 through 2050, and the volume of manure composted and the GHG emissions averted from 2030 to 2050. The projected student population and the subsequent food waste are expected to grow from 1.02 million students in 2025 to 1.22 million in 2050, while food waste is likely to increase from 20,020 tons in 2025 to 23,850 tons in 2050. The total amount of food waste expected to be produced in our region's schools between 2025 and 2050 is 570,769 tons, while the volume of organic compostable waste our 6 municipalities are expected to compost is 5.7 million tons. The estimated volume of methane reduction for the period 2025 through 2050 for schools and municipalities is 407,213 mt (12,771,127 mt CO_2e). From 2030 to 2050, dairy farms will produce 17.66 million tons of waste. The combined estimated total amount of methane emission from diverted schools' food waste, municipal organic waste from 2025 to 2030, and dairy farm manure from 2030 to 2050 is 1.815 million mt (57,814,940 mt CO_2e).

Table 4: Estimated GHG reductions of Schools and Municipalities from 2025 through 2050.

2025-2050	Number of Students	Organic Waste Generated in Tons	Metric Tons of Methane from Food Waste	Metric Tons of CO2e
			65-ton CH4/1000-ton waste	65-ton CH4/1000-ton waste
Schools	1,216,829	570,769	37,100	927,499
Municipal Facilities	-	5,694,052	370,113	11,843,628
Dairy Farms (2030-2050)*	-	17,660,145	1,407,619	45,043,813
Total (waste and manure)	**1,216,829**	**23,924,966**	**1,814,832**	**57,814,940**

* Calculations include waste generated at 20 Texas Panhandle dairy farms.

2.C. COST EFFECTIVENESS OF GHG REDUCTIONS

Organic waste diversion, especially composting, is a practical, economical, and sustainable solution to mitigate methane gas emissions produced by methane-generating organic waste. The Climate and Clean Air Coalition (CCAC) lists the average cost per ton of methane reduced by source.[21] Table 5 shows the different costs of reducing methane emissions per ton. While oil and gas, agricultural sector, coal mines, and wastewater

21 https://www.ccacoalition.org/content/benefits-and-costs-mitigating-methane-emissions

treatment have positive costs ranging from $190 to $3,240, waste management has a negative cost, implying that organic waste diversion with smart waste management is "economically profitable".

Table 5: Average cost per ton of methane reduced by source.

Methane-Generating source	Average Cost per ton of methane reduced
Oil and gas	$520
Solid waste management	-$2,900
Agricultural sector	$830
Coal mines	$190
Wastewater treatment	$3,240

Composting converts an economic *bad* (waste) into a valuable economic *good* (nutrient rich compost). The revenue generated from high-quality, nutrient-rich compost can more than compensate for the costs associated with composting organic waste. High-quality nutrient-rich compost can fetch upward of $100 per kilogram.[22] The yield of compost as percentage of organic and food waste varies between 10% and 30% depending on the moisture content in the waste. The lower the moisture content in the waste the higher the compost yield. The labor requirement for a 100 ton per day composting facility is 6 workers and 2 technicians. The distance travelled by refuse trucks annually is 25,000. The number of trips to haul food waste from school cafeterias is 8,199. The estimated fuel mileage of a refuse truck is 3 miles per gallon.[23]

Composting equipment will be installed at school cafeterias to eliminate the need to haul food waste to a composting center. In Table 6, we estimate that 8,199 trips require 273,311 gallons of diesel to haul the food waste generated by students to landfills.

Table 6: Transportation cost of waste.

Transportation cost of food waste	
Distance travelled annually[24]	25,000
Distance travelled daily during a school year (180 days)	100
Fuel consumption (3 miles per gallon)[25]	33
Cost of fuel/ truck (1) $3.748 Brownsville/Harlingen MSA[26]	$125
number of trucks trips needed (30,000 pounds hauled per truck)[27]	8,199
Total fuel consumption in gallons	273,311
Total fuel consumption in $	$1,024,370
CO_2 emissions[28,29]	2,782 Metric Tons

22 https://supersoilglobal.com/en-us/products/ss-max-strength-1-kg
23 https://www.nrel.gov/docs/fy01osti/29073.pdf
24 https://afdc.energy.gov/data/10309
25 https://www.nrel.gov/docs/fy01osti/29073.pdf
26 https://gasprices.aaa.com/?state=TX#state-metro
27 https://www.wastequip.com/blog/finding-right-garbage-truck-your-fleet-needs
28 https://www.eia.gov/environment/emissions/co2_vol_mass.php
29 https://www.nrel.gov/docs/fy01osti/29073.pdf

Table 7 summarizes the cost-effectiveness of reducing GHG through composting organic waste and the revenue generated from the sale of compost. The calculations are based on 1.4 million tons of compostable organic waste treated at the source in the case of schools and at municipal composting facilities. The overall expense for the treatment of organic waste is $161.48 million (CPRG grant dollars), resulting in the production of 287,399 tons of high-quality, nutrient-rich compost. Additionally, this process prevents the release of 93,500 mt of methane (2.94 million mt of CO_2e) into the atmosphere.

The treatment cost, ignoring any potential revenue generated by the compost produced, is estimated at $57.60 per ton of waste, $1,002.41 per mt of methane, and $31.92 per mt of CO_2e. However, the process of preventing the release of GHG into the atmosphere converts an economic *bad* into a highly desirable and marketable economic *good,* as stated above. The potential revenue from the sale of compost could ensure the economic sustainability of the project. However, all the compost produced during the project period will be used to support business incubation and distributed to interested stakeholders free of charge. Compost produced at participating schools will be used to support school gardens and provided free of charge to members of the community, and community gardens. Compost produced at municipal compost facilities will be distributed free of charge during the project period to small farmers, community gardens, and the public. Members of the community will be encouraged to bring their own food waste and exchange it for high-quality compost. This will help encourage members of the community to be proactively engaged in this project. Gardening and urban farming workshops will be conducted in collaboration with the master gardeners' program from Texas A&M extension to foster interest in sustainable practices.

A potential value of $287.40 million is estimated to benefit the targeted low-income community from 2025 to 2030. When including the potential value of generated compost in our calculations, the cost of reducing methane emissions is only 25.08% of the total value if the equipment is amortized and 56.18% if the equipment is not amortized, the cost would be offset by the value by a factor of 4 (amortized) and 1.8 (if not amortized). The last two columns in Table 7, columns 5 and 6, provide a summary of the total cost and generated compost value (column 5) from 2025 to 2030 and the 2025 to 2030 cost of the equipment if it is amortized over 26 years (2025-2050) at a 5.48% discount rate (column 6). The cost also includes the cost of labor, energy, and maintenance. The table also shows a total cost of $93,72 million and a generated compost value of $287.4 million from 2025 to 2030. The potential annual generated compost value return on investment (ROI) is between 19.99% if using the full CPRG grant award and 10.76% if the CPRG grant award is amortized over 26 years. These results are consistent with the results reported by CCAC in Table 7.

There are additional advantages associated with using high-quality organic compost that have not been quantified in our calculations. These advantages include substituting away from chemical fertilizers, which degrade the soil, leach nitrogen, compact the soil, reduce organic matter in the soil, and deplete soil carbon. Using organic compost helps restore soil health, improves water retention, prevents soil erosion, adds nutrients to the soil, suppresses soil-borne pathogens, and mitigates GHG emitted during the production of chemical fertilizers.

Table 7: Cost-effectiveness of GHG reduction using 24-hour composting technology from 2025 to 2030.

	Organic Waste Generated in Tons	Metric Tons of Methane from Food Waste	Metric Tons of CO2e	Cost of Systems	Cost of Systems over the 2025-2050 period
		65-ton CH_4/1000-ton waste	65-ton CH_4/1000-ton waste		Discount rate 5.48%
Composting systems	1,436,996	93,404	2,932,991	$161,479,500	$72,088,239
Diesel Consumption	273,311	87	2,782	-	
Cost of diesel per ton hauled	($8.33)	($10.96)	($0.35)	($1,024,370)	($1,024,370)
Labor cost	$9.38	$144.17	$4.59	$13,478,400	$13,478,400
Energy consumption	$6.38	$98.12	$3.12	$9,173,782	$9,173,782
Composting system cost 2025-2030/ton.	$50.17	$771.07	$24.56	-	
Sub-Total	$57.60	$1,002.41	$31.92	$183,107,312	$93,716,051
Compost @ 20% of waste (in tons)	287,399	-			
Revenue per ton (@ $0.50/lbs.)	$200.00	$3,076.95	$97.99	$287,399,200	$287,399,200
Net revenue (Revenue - cost)	$142.40	$2,074.54	$66.07	$104,291,888	$193,683,149
Annual ROI				10.76%	19.99%

Methodologies, assumptions, and detailed calculations are included in Appendix 1.

2.D. DOCUMENTATION OF GHG REDUCTION ASSUMPTIONS

To estimate the reduction of methane emissions, we first estimate the volume of waste produced using the World Wildlife Organization estimate and the number of students enrolled in schools in the 3 TEA region. We estimated the average annual growth rate for school-aged people in the 3 TEA regions using U.S Census population data for 2012 and 2022 and assumed the growth rate will remain the same between 2025 and 2050. Most estimates of methane emissions from landfills are calculated based on the biodegradation of municipal solid waste (MSW). Methane is estimated to have a Global Warming Potential (GWP) of 27-30 over 100 years[30]. The EPA estimates that every ton of food waste produces 65 kg of methane[31,32]. We used the EPA's food waste methane estimate, the GWP of methane, and the annual population growth rate of 0.676% to calculate the amount of methane and CO2e produced by school cafeterias' food waste from 2025 through 2030 and from 2025 through 2050.

30 https://www.epa.gov/ghgemissions/overview-greenhouse-gases#methane
31 https://www.biocycle.net/connection-climate-calculations/
32 https://www.epa.gov/land-research/quantifying-methane-emissions-landfilled-food-waste

In calculating the abatement cost of methane gas emissions per ton, we assume in Table 7 column 5 full CPRG grant dollars, and column 6, we assume the equipment is amortized over 25 years at a discount rate of 5.48%.[33] We assume a 20% conversion rate from organic waste to compost and a potential price of $0.50 per pound of compost. The distance traveled by refuse trucks annually is adjusted to reflect the distance traveled during a typical 180-day school year. The estimated number of trips during the school year is obtained by dividing the volume of food waste produced during the school year by the hauling capacity of refuse trucks.

3. ENVIRONMENTAL RESULTS – OUTPUTS, OUTCOMES, AND MEASURES

3.A. EXPECTED OUTPUT AND OUTCOMES

While the EPA does not prescribe specific reduction targets, plans developed under the CPRG and implementation programs, including our proposed project, must align with the United States' formal commitments. These commitments include reducing emissions by 50-52% relative to 2005 levels by 2030 and achieving net-zero emissions by 2050**.** Mitigating GHG emissions requires us to reshape everything we do, from how we power our economy and grow our food to how we travel, live, and dispose of the waste we generate. It is a problem created locally but affects all of us globally.

The Texas Commission on Environmental Quality (TCEQ), the lead agency representing the State of Texas, and McAllen-Mission-Edinburg MSA PCAPs include a comprehensive plan with numerous programs that lay the groundwork for targeted interventions that yield tangible results in emission reduction. One of the programs is composting organic waste using the latest and most effective and efficient technology.

The composting program's implementation produces two types of outputs and outcomes: direct and indirect. The direct outputs and outcomes address the primary objectives of the CPRG, GHG emissions reduction, while the indirect outputs and outcomes are the ancillary benefits and positive externalities the program produces, which include: 1) education and training opportunities to teacher, parent and about 1.02 million pupils in over 1,600 schools. 2) creating high paying jobs through reshoring of manufacturing of the composting facilities and incubation of new green businesses. 3) mitigating climate change and extreme hot weather in the south Texas region. And 4) cultural and behavioral changes in recycling and sustainability, societal shift toward environmental stewardship, and healthy living. A detailed table outlining outputs and outcomes is included in the appendix.

3.B. PERFORMANCE MEASURES AND PLAN

MODEL ASSUMPTIONS, EXTERNAL FACTORS, METRICS, IMPACT, AND SUSTAINABILITY

A suite of metrics has been established to track and assess the progress and impact of the proposed measures. These metrics provide a concrete framework to evaluate the effectiveness and impact of the project on waste management, education, community engagement, and environmental sustainability:

1) Quantitative measures include tons of food waste diverted, methane and CO2e prevention, number of educational and training sessions, program participation rates, recycling rates improvement, workforce individuals trained, job creation and business formation, technicians trained and employed, research outputs.

2) Qualitative measures are focused on changes in attitudes, behaviors, and practices related to sustainability, environmental stewardship, and health within communities. These changes will be assessed through community study regarding awareness and knowledge increase, cultural and behavioral changes in recycling and sustainability, inter-generational transmission of sustainable practices, engagement and connection to nature, changes in school meal quality, perception of environmental health improvements, and societal shift toward environmental stewardship.

33 https://www.stacksource.com/commercial-mortgage-rates

Sustainability is a core focus, with ongoing partnerships and funding strategies being developed to ensure the initiative's growth and continuity. Efforts are made to integrate composting and recycling practices into the standard educational curricula and municipal policies, thereby embedding these practices within the fabric of daily life. Furthermore, there is a concerted effort to support and scale successful green businesses to ensure their economic viability and ability to create jobs.

Finally, the project is subject to continuous monitoring, evaluation, and adaptation to remain effective and responsive to technological advancements and societal changes, ensuring that the program remains at the forefront of sustainable waste management practices.

EVALUATION TIME FRAMEWORK

An initiative to reduce greenhouse gas emissions and promote economic development in the green sector will be evaluated over four years. The evaluation will use formative and summative methods to assess the initiative's impact, adaptability, and sustainability. Various methodologies will be employed to determine the initiative's influence on environmental sustainability, community engagement, and economic growth.

In the first year, the focus will be on the initial implementation and baseline assessment. Quantitative methods will be used to gather baseline data on participant enrollment and initial waste diversion rates. Program staff and initial participants will be interviewed qualitatively to understand their experiences, expectations, and perceived barriers. The outcomes of these activities will be compiled into an Initial Implementation Report and a Baseline Data Report, which will establish critical metrics for subsequent comparison and adjustments.

During the second and third years, attention will shift to monitoring the ongoing activities of the initiative and evaluating its progress toward achieving short-term outcomes. Participation rates and waste diversion metrics will be analyzed quantitatively. Feedback on the initiative's impact and participant satisfaction will be collected through focus groups and surveys. A comprehensive report summarizing the findings will be developed at the end of the mid-term review. An Outcome Evaluation Brief will also be produced, contrasting the achieved outcomes with the projected targets.

The fourth and final year will be dedicated to the final evaluation and impact assessment. The aim is to assess the long-term effects of the initiative on environmental sustainability, economic development, and community well-being. Key performance indicators will be evaluated quantitatively, such as the total reduction in greenhouse gas emissions, cumulative participation and engagement metrics, and financial impact assessments. In-depth interviews and focus groups with a wide range of stakeholders will be conducted to evaluate the initiative's sustainability, its impact on community practices, and its influence on policy.

The impact assessment phase will seek to understand the initiative's broader implications, including its contributions to climate change mitigation, economic revitalization, and shifts in community attitudes toward sustainability. All collected data, both quantitative and qualitative, will be synthesized to assess the initiative's contribution to national and local sustainability goals, economic benchmarks, and educational achievements.
A Final Evaluation and Impact Report will comprehensively analyze the program's effectiveness and impact. The Evaluation Findings will also inform policy and practice recommendations to educate stakeholders, funders, and policymakers about scalable models and best practices for replication.

This structured approach to evaluation will ensure meticulous monitoring, analysis, and refinement of the initiative's efforts to mitigate climate change and foster economic growth within the green sector, contributing to a sustainable and prosperous future.

3.C. AUTHORITIES, IMPLEMENTATION TIMELINE, AND MILESTONES

The project will be managed by a team of experts from higher education institution (UTRGV) and TEA Region One Education Service Center. Its operation will be guided by a steering committee that is composed of representatives from local governments, schools, private sector entities, and NGOs.

Dr. Can (John) Saygin, will serve as the **Principal Investigator**. He is the Senior Vice President for Research at the University of Texas Rio Grande Valley (UTRGV). With full support of UTRGV President Bailey and Senior VP Veronica Gonzales (Governmental and Community Relations), the proposed EPA project will be managed by Dr. Saygin as a presidential initiative at the highest level. UTRGV is well-positioned as a regional university to successfully execute the proposed scope of work in coordination with a strong network of partners.

As the PI, Dr. Saygin oversees the operations of the project. He will be the point of contact who maintains the strategic plan and manages all planned activities. Dr. Saygin will also be responsible for coordinating participating team members, control of the stated research, education, acquisition, installation activities, organizing meetings with other team members, region one, local governments, and industrial partners. The PI will also be responsible for leading efforts in continuous improvement and developing plans for sustaining the GHG reduction project after the funding period.

Co-Principal Investigator, Dr. Jianzhi (James) Li, is the President Endowed Professor of Manufacturing at UTRGV. He has 20+ years of leadership and research/education experiences in the areas of advanced manufacturing, material recycling and circular economy, renewable energy, laser material processing, additive manufacturing, machine learning and AI with application in process modelling and optimization. He also has 8 years of industrial and business incubation experience, including serving as chief technology officer of an IT startup company in early 2000. Since 2014, as PI and Co-PI, Dr. Li secured about $60 million funding in research and education in grants supported by local governments and federal agencies including Army, DoD, DOE, NNSA, NSF, NIST and EDA. He is the founding director of the DOE Consortium for Advanced Additive Manufacturing for Research and Education in Energy Related Systems funded by a $5 million grant from NNSA. He served as the founding director of DoD I-DREAM4D a Consortium for Innovation Driven Research/Education Ecosystem for Advanced Manufacturing, funded by a $4 million grant from DoD. Dr. Li provided leadership in workforce development programs to support the talent needs for U.S. military and U.S. renewable energy. More recently, working with local governments and three institutions in Texas, he received a total of $7.5 million in grant from DoD Manufacturing Community Program to promote advanced manufacturing research, training, and incubation in Central, South and Gulf Coast Regions in Texas. Throughout his career, Dr. Li has maintained a distinguished scholarly record, while devoting strong efforts to developing new programs that significantly benefit the institution and the local communities.

As Co-PI and the Director of the UTRGV CAMICS center, Dr. Li will be the point of contact who leads the effort in monitoring the manufacturing, design and other planned activities of the proposed composting process, system, and facilities.

Co-Principal Investigator: Dr. Mostafa Malki holds a Ph.D. in Applied Economics and an M.S. in Economics from Auburn University; an M.A. in Finance from the University of Alabama, and a B.A. from the University of Massachusetts-Boston. Dr. Mostafa Malki has more than 15 years of experience teaching and conducting economic and financial research, as well as providing economic development and financial consulting services to local governments and businesses. His analyses have been employed in incentives negotiations, site selection analysis, market sizing analysis and forecasting, and to inform policy with impacts in the billions of dollars. Site selection analysis using Geographic Information Systems (GIS) is as fundamental to business as any market analysis or financial forecasting. Dr. Malki has used both GIS and market sizing analysis in his consulting work. He has provided economic consulting on several projects for both public and private sectors, including a $65 Billion LPG project impact in South-west Louisiana, a $3 billion LNG project at the Port of Brownsville, Space X in Brownsville, offshore windmill projects, Ministry of Agriculture, Kingdom of Morocco, economic development workshops for the Ministry of Urban Planning, Kingdom of Morocco.

As a Co-PI, Dr. Malki will serve as the prime faculty mentor for business incubation. He will assist in project management, reporting, and support in technology transfer and business incubation.

Co-Principal Investigator, Dr. Daniel King, is the Executive Director of Region One Education Service Center that oversees 38 school districts and 750 schools with 430,000 students enrolled. Dr. King served 42 years in public education with experience at all levels, including 20 years as a superintendent in both small and large Region One area school districts, retiring in 2019 from PSJA ISD. Most recently, Dr. King has been involved in transforming leadership teams in areas of organizational performance, leadership development, and executive coaching. As a Co-PI of the project, Dr. King will lead the Region One team and provide guidance to the team in installation and operation of the proposal composting facilities at schools. He will also guide the team in sustainability and scale up of the project in long-term expansion to cover other regions of Texas.

Co-Principal Investigator, Dr. Jaime B Curts will lead the entire team in evaluation, assessment and continuous quality assurance and improvement. Dr. Cuts has expertise in quantitative/qualitative evaluation and research methods, with an accumulated experience of 35+ years. He recently joined the ESC, and as of today, nineteen grant-funding projects have been completed and submitted to diverse grant-funding agencies. He is a retired professor from UTRGV (since 2015) -with a solid record of funding projects (Department of Education and National Science Foundation) and an experienced administrator. After his stay at UTRGV, he joined in 2016 the Pharr-San Juan-Alamo Independent School District (up to 2021) as the Senior Grant Administrator and successfully securing +45 projects totaling $70 M. Later (2021-2023), he was invited by the Doctors Hospital at Renaissance (Edinburg, Texas) as the Executive Vice President for Education and Employment, was he implemented several data project management cloud-based systems as well as obtaining grant funds (Skills Development Fund, SKF) from the Texas Workforce Commission (TWC) to train new hospital staff or upgrade the skills of existing workers. In this project, Dr. Curts will lead the team in data collection, assessment, evaluation, and community engagement programs.

4-YEAR TIME FRAMEWORK

Years 1: Foundation and Pilot Phase

Q1-Q2, Year 1: Establish a Steering Committee and Initiate Stakeholder Engagement. Partner With Local Governments, Schools, Private Sector Entities, and NGOs. Develop Local Manufacturing Facility Design Concept.
Q3-Q4, Year 1: Expand Partnerships and Additional Fundraising. Manufacturing Facility Layout Finalized and Investment Secured. Complete Pilot Composting Projects at Schools and design Educational Programs.

Year 1 Milestone:

- Install and implement modular composting equipment at 40 schools in Region One. Perform research on optimization of the composting process, develop new recipe tailored for RGV region.
- Obtain authority for installation of composting process municipal waste management centers at McAllen, Brownsville, Laredo, and Pharr.

Year 2: Launch Pilot Composting Projects in Select Schools and Municipalities

Q1-Q2, Year 2: Roll Out Initial Educational Curricula Focused on Sustainability Practices. Manufacturing Facility Design Concept finalized. Construction of Manufacturing Facility.
Q3-Q4: Year 2: Evaluate Pilot Projects and Refine Them Based on Feedback. Begin Advocacy for Supportive Policies and Regulatory Framework. Local Manufacturing of the Composting Equipment Started

Year 2 Milestone:

- Install and implement modular composting equipment at 619 schools in Region One.
- Install and implement modular composting equipment at 38 schools in Region Two.
- Start construction of community composting facilities at City of McAllen and Pharr

Years 3-4: Expansion and Optimization

Q1, Year 3: Based on Pilot Success, Scale Up Composting Systems to Additional Locations. Expand Educational Programs Across More Schools.
Q2-Q3, Year 3: Launch Green Job Training Programs. Strengthen and Expand Private-Public Partnerships.
Q4, Year 3 – Q1, Year 4: Implement a Comprehensive Monitoring and Evaluation System and Continue Policy Advocacy Efforts.

Q2-Q4, Year 4: Optimize Composting Operations and Educational Outreach Based on Evaluation Insights. Secure Further Funding and Legislative Support.

Year 3 milestone:

- Install and implement modular composting equipment at 154 schools in Region Two.
- Start construction of community composting facilities in the City of Brownsville and Laredo.

Year 4 milestone:

- Install and implement modular composting equipment at 756 schools in Region 20.
- Start construction of community composting facilities at City of Corpus Christi and San Antonio.

SUSTAINABILITY PLAN

Years 5: Integration and Policy Advocacy

Q1-Q2, Year 5: Achieve widespread integration of composting systems within municipal waste management. Standardize sustainability-focused curricula in schools.
Q3-Q4, Year 5: Achieve key legislative wins, including incentives and mandatory waste diversion policies. Enhance public-private partnerships.

Year 6: Solidify the composting initiative in texas.

Years 7-8: Consolidation and Community Empowerment

Year 7: Ensure full operational status for composting systems across all targeted areas. Scale up community centers for broader educational reach.
Year 8: Focus on economic development within the green sector, supporting startups and businesses in composting and recycling. Document and share the initiative's impacts on community health and the environment.

Years 9-10: Sustainability and Scaling

Year 9: Diversify funding mechanisms to ensure financial sustainability. Document successes and lessons learned to prepare for national expansion.
Year 10: Launch state and initiate a nationwide expansion effort, leveraging policy influence and community empowerment outcomes. Establish the initiative as a model for replication, aiming to influence broader sustainability policies and practices nationally.

4. LOW-INCOME AND DISADVANTAGED COMMUNITIES

4.A. COMMUNITY BENEFITS[34]

The proposed GHG reduction measure is multidimensional. Its objectives include mitigating GHG emissions and addressing various related issues. These include workforce training, awareness programs for organic waste recycling, improving living conditions for underserved and vulnerable communities, and educational initiatives targeting students and parents. These educational efforts emphasize the benefits of recycling, healthy eating, and sustainable living practices. Furthermore, the program aims to foster entrepreneurship and create business opportunities within the green economy. By doing so, it seeks to uplift low-income and underserved communities, ultimately alleviating poverty.

Composting is one of the most cost-efficient, effective, and environmentally friendly approaches to managing organic waste. Not only does it contribute to waste and GHG emissions reduction, but it also offers a plethora of economic, social, and health benefits. Despite these advantages, composting remains a marginal activity in the solid municipal waste sector, while “bury-or-burn” approaches remain the industry norms. Both landfilling

34 Farhidi F, Madani K, Crichton R. How the US Economy and Environment can Both Benefit from Composting Management. Environ Health Insights. 2022 Oct 15;16:11786302221128454. doi: 10.1177/11786302221128454. PMID: 36262199; PMCID: PMC9575438.

and incinerating have significant negative impacts on the environment and the well-being of nearby communities. Landfills, the third largest source of methane pollution, emit toxic and cancer-causing substances like benzene. Meanwhile, waste incineration releases persistent organic pollutants that harm human health and accumulate globally.[35,36] Unfortunately, the most affected groups are often lower-income families residing in disadvantaged areas, who lack the resources to address the resulting health risks adequately.[37] On the Texas-Mexico border there are over 2,300 colonias, with approximately 900 concentrated in the Rio Grande Valley. These colonias, predominantly inhabited by Hispanic communities, are characterized by their unincorporated status and impoverished conditions. Residents of these areas reside in makeshift shacks or trailers, facing significant challenges that in many cases reach extreme levels comparable to third world levels.[38,39] including lack economic stability, lack of healthcare services, wellness, and education.[40] One relation is the frequent exposure to pesticides and chemicals used by farms located nearby and the contamination of colonias residents' drinking water. Substituting the use of chemical fertilizers would significantly reduce the exposure to harmful chemicals used in farming. In addition, it will provide employment and entrepreneurship opportunities to vulnerable communities. The EPA is currently offering several programs specific to the colonias and underserved communities. These programs address needed infrastructure, environmental and public health problems, and communities' resilience, and are aligned with the objectives of this project.[41,42]

With challenges posed by global warming becoming increasingly urgent, composting is progressively emerging as a promising GHG mitigation strategy**.** Its impact extends beyond environmental benefits. By increasing the compost-to-waste ratio by 18% from the existing 10%, the U.S. could annually reduce carbon emissions by a staggering 30 million tons. Moreover, this shift would lead to substantial cost savings, approximately $16 billion, in municipal waste management.[43] It's crucial to address these environmental challenges and prioritize sustainable waste management practices.

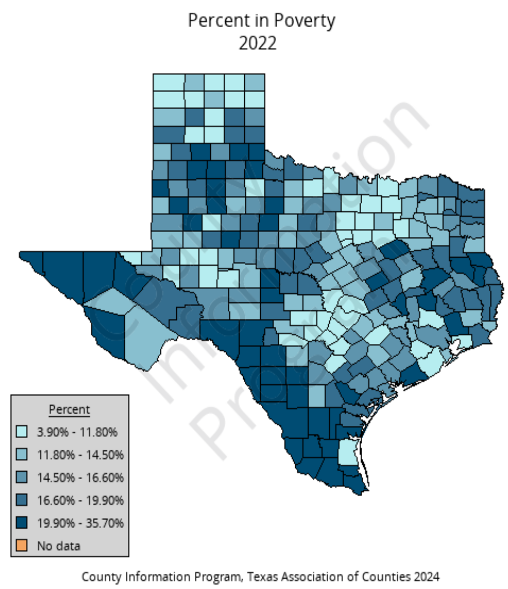

***Figure 5:* Texas Counties: Percent in Poverty**

The following tables summarize the economic impact of the proposed program. The economic impact analysis was estimated using IMPLAN, a highly respected economic impact modeling and analysis program in the United States. The proposed project will create 564 direct FTE jobs in the construction sector paying an average salary of $31,000 and another 72 indirect FTE jobs in sectors supporting the construction industry. These jobs are temporary, and the benefits associated with them will last the duration of the construction phase. The proposed project will also create 530 FTE jobs in the manufacturing sector (direct), 271 FTE jobs in industries supporting the

35https://education.nationalgeographic.org/resource/landfills/
36 https://www.nrdc.org/bio/daniel-rosenberg/burned-why-waste-incineration-harmful
37 https://www.edf.org/media/epa-unveils-plan-reduce-dangerous-pollution-landfills
38 Christopher S. Davies, Robert K. Holz, Settlement evolution of 'colonias' along the US-Mexico border: The case of the Lower Rio Grande Valley of Texas, Habitat International, Volume 16, Issue 4, 1992, Pages 119-142,
39 Barton, J., Perlmeter, E.R., Blum, E.S., Márquez, R.R. (2015). Las Colonias along the Texas-Mexico Border. In: Orrenius, P.M., Cañas, J., Weiss, M. (eds) Ten-Gallon Economy. Palgrave Macmillan, New York.
40 Texas Matters: The Struggles of Life in a Border Colonia | Pulitzer Center
41 https://www.epa.gov/small-and-rural-wastewater-systems/us-mexico-border-water-infrastructure-grant-program
42 https://www.epa.gov/usmexicoborder
43 Farhidi F, Madani K, Crichton R. How the US Economy and Environment can Both Benefit from Composting Management. Environ Health Insights. 2022 Oct

manufacturing sector (indirect), and 234 various sectors of the economy that are not related to the manufacturing sector. The expected average salary in the manufacturing sector is $58,000. These jobs and the benefits associated with them are permanent and long lasting.

Table 8: Summary Impact of Construction of Composting Facilities. (Temporary Impact)

Impact	Employment	Labor Income	Value Added	Output
Direct	470	$14,722,385	$15,227,775	$40,445,121
Indirect	60	$2,845,717	$5,158,212	$12,065,700
Induced	82	$3,243,748	$6,253,560	$11,536,146
Total	**612**	**$20,811,850**	**$26,639,547**	**$64,046,966**

Table 9: Summary Impact of Manufacturing of Compost Machines. (Permanent)

Impact	Employment	Labor Income	Value Added	Output
Direct	180	$12,434,236	$17,867,505	$53,108,325
Indirect	86	$3,918,538	$6,150,588	$14,353,822
Induced	75	$2,979,440	$5,737,646	$10,587,831
Total	**341**	**$19,332,214**	**$29,755,739**	**$78,049,978**

Table 10: Summary Impact of Construction of Manufacturing Facility. (Temporary Impact)

Impact	Employment	Labor Income	Value Added	Output
Direct	94	$2,944,477	$3,045,555	$8,089,024
Indirect	12	$569,143	$1,031,642	$2,413,140
Induced	16	$648,750	$1,250,712	$2,307,229
Total	**122**	**$4,162,370**	**$5,327,909**	**$12,809,393**

Table 11: Summary Impact of Composting Operations. (Permanent)

Impact	Employment	Labor Income	Value Added	Output
Direct	350	$26,609,721	$42,905,506	$92,340,848
Indirect	185	$8,305,541	$12,911,444	$27,938,198
Induced	159	$6,291,183	$12,119,403	$22,362,013
Total	**694**	**$41,206,444**	**$67,936,353**	**$142,641,059**

TRANSFORMATIONAL IMPACT TO LOW-INCOME FAMILIES

This ambitious goal not only targets significant reductions in GHG emissions but also seeks to improve public health and wellness of low-income underserved communities, and to educate and engage these community in sustainable practices, promote economic development within the green sector, and foster a statewide shift towards a circular, green economy.

By 2030, a statewide initiative in Texas will be implemented to reduce GHG emissions by adopting 24-hour composting technology, aiming for creating transformational impact to low-income families through engaging low-income family in incubation and/or creating high paying jobs for members from low-income families in environmental, educational, and economic spinoff from this project. The broad impact will include:

1. Establish a two-way communication and feedback mechanisms to ensure proactive engagement of our communities, and to monitor effectiveness of common strategies and initiatives.
2. Establish at least 60 green economy startups or initiatives through entrepreneurship training programs targeted to members from low-income families.
3. Engage over 1,600 schools from low-income regions in educational programs focusing on climate change, recycling, and responsible waste management, leading to a measurable increase in parental concern about climate change based on survey data.

4. Through this well-planned project, we anticipate transforming Texas' economic landscape through job creation in the green economy, improving public health, and fostering a circular economy. The educational component seeks to change the culture around recycling and environmental stewardship, starting with the younger generation.

This project is also aiming at creating sustainable impact beyond the funding period. Sustainability is ensured through ongoing partnerships especially with the communities, the private sector, funding strategies, and integrating composting and recycling practices into educational curricula and municipal policies. Continuous monitoring, evaluation, and adaptation will keep the program effective and responsive to technological advancements, societal changes, and above all the needs of the communities.

SUSTAINABILITY OF KEY COMPONENTS

This project proposes seven (7) key components to collectively ensure that composting initiatives and sustainable waste management practices are effectively implemented, supported, and sustained, contributing to broader environmental and community well-being goals.

1. **Stakeholder Engagement and Partnership Development**: Building robust public-private partnerships (PPPs) to pool resources and expertise and drive innovation in environmental protection.
2. **Infrastructure and Technology Implementation**: Investing in scalable, adaptable, and efficient composting system infrastructure to accommodate different community needs and minimize environmental impact.
3. **Educational Programs and Curriculum Integration**: Developing tailored educational programs to encourage sustainable behaviors and widespread adoption of composting practices, utilizing community-based social marketing techniques.
4. **Workforce Development and Green Economy Opportunities**: This initiative fosters economic growth and job creation in the green economy sector through skill development and training programs focused on composting, waste management, and environmental stewardship.
5. **Monitoring, Evaluation, and Feedback Mechanisms**: Implement robust systems to monitor effectiveness, engage stakeholders for feedback, and foster iterative learning to continuously improve the composting initiatives.
6. **Funding and Financial Sustainability**: Securing a diversified funding model through government grants, private sector partnerships, community fundraising efforts, and innovative financing mechanisms like green bonds and pay-for-success models.
7. **Policy Support and Advocacy**: Engaging in strategic policy advocacy to align composting programs with broader environmental goals, secure legislative and regulatory support, and promote environmental justice.

4.B. COMMUNITY ENGAGEMENT

In a concerted effort to foster sustainability and environmental stewardship, the installation of advanced composting equipment in school cafeterias and municipal facilities marks a significant stride towards reducing food waste and mitigating greenhouse gas emissions. This initiative is complemented by comprehensive community education programs, where workshops and school curriculums aim to enlighten residents and students on the mechanics and advantages of composting, underscoring its role in preserving environmental health.

To further bolster community engagement, a two-way communication and feedback system will be implemented to encourage the active participation of all stakeholders. In addition, households are encouraged to compost by providing compost bins and educational resources, facilitating home composting practices. Parallelly, implementing educational programs on recycling in schools catalyzes student and parent engagement, transforming them into proponents of sustainability. These programs are meticulously designed to instigate a shift in generational waste management attitudes, significantly contributing to cultivating a recycling-oriented community ethos.

Moreover, collaborating with local community organizations, local businesses, and public organizations to orchestrate community-wide recycling events amplifies public awareness and participation, establishing a robust recycling culture. Augmenting these efforts, training workshops for families on effective recycling practices deepen community involvement in waste reduction and address pertinent topics like minimizing single-use plastics and proper waste sorting.

The initiative extends into the educational realm by establishing school gardens and providing students with hands-on experiences that illustrate sustainable agriculture principles and the significance of local food sources. These gardens serve dual purposes: educational laboratories and sources of fresh produce for healthier school meals. They are supported by farm-to-school programs that liaise with local farmers to supply schools with locally grown produce.

Training in advanced manufacturing and entrepreneurship is offered to prepare the workforce for the evolving demands of the green economy. This skill development, which encompasses workshops, certification programs, and mentorship opportunities, aims to upskill the local workforce, stimulating economic growth and job creation in sustainable sectors. Business incubation services complement this, fostering the emergence of new green businesses and providing them with the necessary support to thrive in a competitive market.

Community gardens and citizen science projects further engage the community, enhancing access to fresh produce, bolstering community well-being, and contributing to environmental research. Collectively, these initiatives manifest a holistic approach to environmental education, waste reduction, and sustainability, embedding these principles deeply within the community's fabric.

5. JOB QUALITY

The U.S. Census 2022 data for Cameron County, Texas and Hidalgo County, Texas show that income per capita is $21,440 and $20,844 respectively, that is equivalent to an hourly wage rate of $10.31 in Cameron County and $10.02 in Hidalgo County. The proposed project is expected to generate more than 1,000 high paying FTE jobs in manufacturing and compost production and processing with an average annual salary of approximately $57,000, equivalent to an hourly wage of $27. An additional 730 FTE jobs, paying $34,000 annually, will be created during the construction of the manufacturing facility and the composting facilities. However, these construction jobs and the benefits associated with them will be temporary and will be phased out when the construction phase is completed. In addition, the proposed project’s jobs will also be of high quality, with excellent working conditions, stable and predictable pay and working hours, job security, safety, opportunity for growth and advancement, Health and retirement benefits, and diversity of tasks. UTRGV CAMICS Center will help establish clear career paths and develop training and continued education programs and incentives to encourage employees to expand their knowledge and skills for career advancement and personal growth.

The manufacturing facilities will be located near low-income underserved communities. UTRGV along with its partners including TEA’s ESCs centers will provide workforce training to prepare the members of these communities to fulfill these employment opportunities. In addition, entrepreneurship programs, business mentorships, and business incubation workshop will be offered by the UTRGV CAMICS Center and the UTRGV Center for Innovation and Commercialization (CIC)

6. PROGRAMMATIC CAPABILITY AND PAST PERFORMANCE (DR. LI)

6.A PAST PERFORMANCE

The project is managed by a team of professionals with a solid track record in managing large federal grants. Examples of grants managed by the team are provided as follows:

1. “Innovation Driven Education Pathway for Defense Oriented Advanced Manufacturing Engineering”, DoD ONR, N00014-19-1-2728, $3,958,812, (2019 - 2023) Prepare future talent with multidisciplinary knowledge

required to drive innovation leveraging advanced manufacturing technologies including additive manufacturing, advanced materials, and robotics. cynthia.k.waters.civ@us.navy.mil

2. "America's Additive Foundry: Secure U.S. Supply of Tactical Alloys Through Additive and Intelligent Casting and Forging," DoD, Office of Local Defense Community Cooperation, MCS2106-23-01 $7,526,385. (2023 - 2028). The America's Additive Foundry Consortium is a coalition of entities located in the Southern Gulf Coastal Plains of Texas, with a goal to Secure U.S. Supply of Tactical Alloys through Additive, Hybrid, and Intelligent Manufacturing to address casting and forging supply chain issues facing the U.S. military. anita.c.bullock.civ@mail.mil
3. "Consortium of Advanced Additive Manufacturing Research and Education for Energy Related Systems (CA2REERs)," DOE/NNSA, $4,970,639.00. (2021 - 2025). The goal of this project is to develop and sustain the DOE Consortium of Advanced Additive Manufacturing Research and Education for Energy Related Systems (DOE CA2REERs) to expose, recruit, engage and train students from underrepresented groups for a career in Advanced Manufacturing for Energy, following a collaborative approach by a team of investigators from 3 MSI institutions and 2 DOE Labs. betsy.snell@nnsa.doe.gov
4. "CREST Center for Multidisciplinary Research Excellence in **Cyber-Physical Infrastructure Systems** (MECIS)," National Science Foundation (NSF), Assistant Listing Number: 47.076, $5,000,000 (2021 - 2026), The Center promotes innovative theoretical, computational, experimental, and empirical solutions spanning from micro (molecule)- to macro (system)-scale, which also yield practical solutions valuable for industry. tdurakie@nsf.gov
5. "HSI Institutional Transformation Project: Improving Undergraduate STEM Education Through Family-Centered Pedagogy" NSF, Award Number: 2122875, $2,997,279, Evaluate and implement a novel Family-Centered Theory of Change Model for enhancing Latinx Students success in undergraduate STEM disciplines. By utilizing curricula, pedagogies, and learning frameworks that are typically used in the Mexican American Studies courses, this program will address diversity, equity, and inclusion (DEI) through the multidimensional intersectional framework for multiple social identities, domains of power, and historicity. smontash@nsf.gov

6.B. REPORTING REQUIREMENTS

The team has an excellent history of timely submission of reports and meeting the reporting requirements under all grants received. We attest as best as we know: 1) In all grants members of the team served as PI, we submitted acceptable interim and/or final reports under those agreements; 2) we adequately and timely reported on its progress toward achieving the expected outputs and outcomes under those agreements.

6.C. STAFF EXPERTISE

UTRGV research enterprise comprise of research operations (including pre-award, post-award, grants accounting, compliance, and contracts functions) under Dr. Thomas B. Spencer, clinical and translational research under Dr. Angela Cook, research enhancement (focusing on faculty research development) under Abby Guillory, research data and analytics (dashboards, metrics and reporting) under Arya Singh, seed grants and institutional research funding under Rosalinda Salazar, internal and external communications under Maria Gonzalez, and project management and assistance under Aide Garza. With over 85 staff members and a base budget of $8.4 million, the Division of Research is committed to growing the research enterprise and proactively supporting the needs of our research faculty, university, and our community.

Over the 2018-23 period, the Division of Research has supported the submission of 2,457 applications ($2 billion) and management of 1,224 awards ($672 million). Several Division units support research faculty and oversee the post-award processes including working collaboratively with stakeholders (PI/Project Manager, sponsors, etc.) to ensure financial compliance with federal/state/local regulations as well as university policies/procedures; reviewing grant regulations with the PIs; managing expenditures (e.g., expenditure analysis, budget revisions, pre-approval of cost transactions, monitoring costs for allowability, managing time and effort system); assisting the PIs with timely completion and submission of required technical reports; submitting invoices and financial reports to funding agencies; and performing grant/fund closeout activities. The Division staff work closely to ensure compliance and proper accounting for externally sponsored projects, tracking burn rates, providing audit support, and providing human resource activity support. Additionally, compliance support includes areas of IRB, IACUC, export controls and other research security functions. Through data dashboards and financial tracking, the Division staff proactively oversee each project ensuring it meets the identified deliverables and contractual obligations.