Florida Tech Sustainability
2022 Northrop-Grumman Showcase
Student Research Posters

Post-Combustion Carbon Capture for Marine Shipping Applications

Alice Pennings

Winning Research Poster, Sustainability Category

Winning Research Poster, President's Cup Best in Show - Sciences

NORTHROP GRUMMAN ENGINEERING & SCIENCE STUDENT DESIGN SHOWCASE FLORIDA TECH

Post-Combustion Carbon Capture for Marine Shipping Applications

Alice Pennings

Faculty Advisor: Dr. Ken Lindeman, Dept. of Ocean Engineering & Marine Sciences, Florida Tech

Introduction

The shipping industry accounts for 3% of global GHG emissions [1]. With the rising threat of climate change, the International Maritime Organization (IMO) has committed to reduce the global carbon footprint by 70% in 2050. To accomplish this, relevant technologies were evaluated for their successes at capture, transportation, and storage of CO_2 from ships.

Objectives

1. Identify optimal technologies for processing exhaust gas onboard ships.
2. Determine the best practices for transporting and temporarily storing captured CO_2.
3. Compare all options in terms of storage, utilization, and cost mitigation performance.

Methods

1. Examine exhaust gas processing systems, from most developed to most novel concepts, for both land and sea operations.
2. Research existing infrastructure and recommended transport methods. Evaluate based on cost and availability.
3. Investigate storage requirements for pressurized, liquefied, and solidified CO_2. This includes pressure and temperature requirements of liquefaction, chemicals required for solidification, and sequestration methods such as Enhanced Oil Recovery.

Result 1 – Processing Exhaust Gas

The amount of carbon in exhaust gas depends on the fuel type. An analysis of >50 reports revealed multiple methods for capturing CO_2 from exhaust gas streams. The capture rate depends on the carbon content in the fuel, described by Table 1.

Result 1 – Processing Exhaust Gas Cont.

Type of Fuel	Reference	Carbon Content
Diesel/Gas Oil	ISO 8217 Grades DMX-DMB	0.8744
Light Fuel Oil	ISO 8217 Grades RMA-RMD	0.8594
Heavy Fuel Oil	ISO 8217 Grades RME-RMK	0.8493
Liquefied Petrol. Gas	Propane	0.8182

Table 1: Carbon Content in Fuel

Scrubber systems were found suitable for the marine environment. Monoethanolamine (MEA) and ammonia-based (NH_3) solvents, and Cryogenic Carbon Capture (CCC) captured over 70% of released CO_2 [2]. CCC achieved this with half the energy consumption of MEA [3].

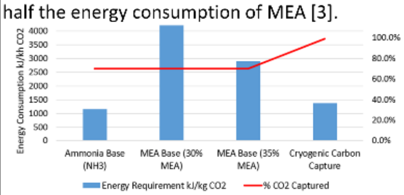


Figure 1: Carbon Capture Comparison

Capture rates at or above 70% are sufficient to meet regulations. CCC and NH_3 both decreased energy consumption, but CCC shows carbon capture rates of 99% and above.

Result 2- Intermediate Transport

Best options for transport of CO_2 from offshore to processing locations are pipelines or carriers. Differences depend on the flow rate & distance.

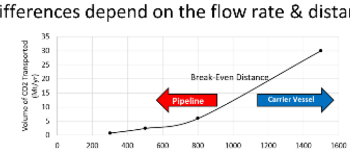


Figure 2: Ideal Transportation Method

Pipelines are preferred for all distances <300 km. For distances >900 km, carriers are cheaper [4].

Result 3- Storage and Utilization

CO_2 storage is dictated by the target phase. Fig. 3 shows a summary of the interactions of pressure and temperature on phase from the literature.

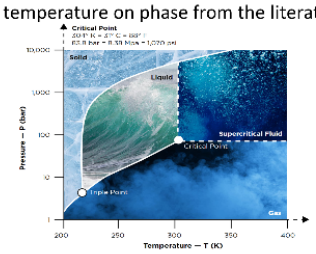


Figure 3: CO2 Phase Diagram (ABS, 2020).

Salt Basin injection is a process in which CO_2 is injected into caverns which inflict pressures >1,000 bar to permanently solidify the CO_2. Injection into oil field caverns aids in oil extraction, and companies are will pay $18/t for delivered CO_2 to mitigate costs [4].

Conclusions

Promising new technologies exist for the future of carbon capture at sea. Wet scrubbers and CCC proved to be the most industrialized/marinized. CO_2 transport method selected based on operational conditions. Storage options may mitigate capture costs, increasing its feasibility.

References

[1] Bouman et. Al. (2017). Transp. & Environment
[2] Luis, P. (2016). Desalination, 380, 93–99.
[3] Font-Palma, Carolina, et al. IEAGHG Report: 2010/03.
[4] Svensson, Rickard, et al. Energy Convers Manag.

Acknowledgements

Meg Dowling and Joseph Rousseau with the American Bureau of Shipping were vital partners.

[Showcase Book Page Submission]

Oystercrete: A Plastic- and Metal- Free Restoration Alternative

Katlynd Faust and Michelle Franklin

NORTHROP GRUMMAN
ENGINEERING & SCIENCE STUDENT DESIGN SHOWCASE
FLORIDA TECH

Oystercrete: A Plastic- and Metal- Free Restoration Alternative

Katlynd Faust and Michelle Franklin
Faculty Advisor: Dr. Ken Lindeman, Dept. of Ocean Engineering & Marine Sciences, Florida Tech

Introduction

The health of the Indian River lagoon (IRL) has declined rapidly over the last fifty years. Filter-feeding organisms such as oysters help reduce excess nutrients that cause harmful algal outbreaks and fish kills[1]. By developing and testing Oystercrete, a concrete-covered oyster shell restoration module, our goal is to reduce the amount of plastic & metal used in restoration activities. Testing was done to identify the best Oystercrete recipe, measure wave energy lost, and visually assess organismal recruitment.

Objectives

1. Develop 3 formulations of Oystercrete and compare their compressive strengths.
2. Perform wave tank testing on 3 module types to establish wave transmission and durability.
3. Assess how concrete affects the organismal recruitment on oyster shells.

Methods

Developing Oystercrete

- Narrow down to 3 Oystercrete formulas by visually assessing their properties.
- The formulas were created using cylindrical molds and tested to find their ultimate load.

Formula	Mix Type	Cement All	Water	Shell	Sand
1	Grout	2100	400	850	-
2	Grout	2100	400	850	500
3	Concrete	2100	600	850	-

Table 1: Oystercrete Formulas 1 through 3

Wave Tank Testing

- Apply a 12 Hz wave for 2.5 hours to test durability of bag, gabion and Oystercrete modules in a lagoon-like wave state.
- Analyze the wave sensor data to find the wave energy lost after the waves pass the modules.

Organismal Recruitment

- Deploy 4 bag and 4 Oystercrete modules and visually assess them biweekly for recruitment.
- Perform a literature review on the filtration rates of the organisms found on the modulus.

Results

Developing Oystercrete

The formulations shown in Table 1 were used in the compression testing of Oystercrete. They were chosen from an initial visual assessment due to their ability to coat the shells, without losing the modules porosity. Formula 1 proved to have the highest compressive strength, indicating the formula's ability to endure higher wave energy. This formula was used to make the remaining Oystercrete modules for testing.

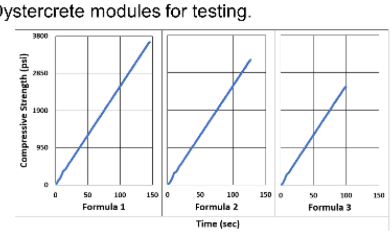


Figure 1: Compression Testing of Oystercrete Formulas

Wave Tank Testing

A wave tank was used to determine wave damping effect and durability of the 3 modules. Fig. 2 shows the energy lost as the wave passes the Oystercrete.

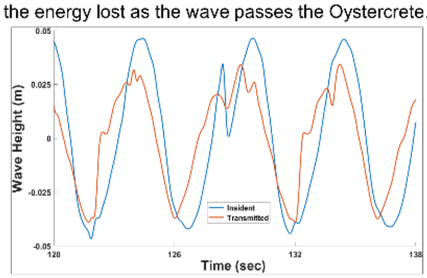


Figure 2: Oystercrete Wave Dampening Effects

Module	Bag	Oystercrete	Gabian
K_t	0.95	0.8	0.66

Table 2: Transmission Coefficient for the Module Types

Results continued

Table 2 shows the transmission coeff. (K_t) for the three models. Gabions have the lowest K_t, therefore, provide the best shoreline protection.

Organismal Recruitment

The two most common organisms on the modules were tubeworms and bryozoans (Fig. 4). Although oysters are the primary filter-feeders targeted for restoration, there are many other filter-feeding species that contribute to IRL health. For example, barnacles and tunicates have filtering rates of 0.1 L/h[2] and 3.63 L/h[3], respectively.

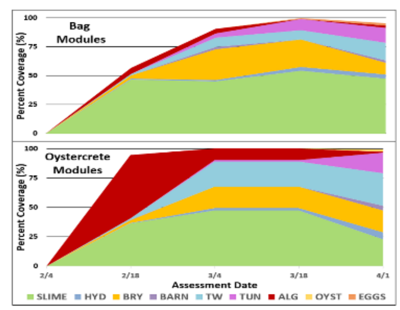


Figure 4: Visual Assessment of Deployed Modules

Conclusions

The results show the Oystercrete module using Formula 1 is recommended for future reef builds. Continuous monitoring during the oyster spat season would better evaluate oyster recruitment preferences. Additionally, further analysis of the deployed modules will show if the concrete disintegrates over continuous water exposure.

Citations

[1] Uddin, M.J. 2021. *Construction & Building Materials.*
[2] Layman, C.A. 2014. *Environmental Research Letters.*
[3] Weaver, R.J.2018. *Marine Technology Society Journal.*

Acknowledgements

Staff of the Brevard Zoo Conservation Department.

[Showcase Book Page Submission]

Implementing Sustainability Actions, City of Palm Bay, Florida

Alexa Langley

NORTHROP GRUMMAN ENGINEERING & SCIENCE STUDENT DESIGN SHOWCASE FLORIDA TECH

Implementing Sustainability Actions, City of Palm Bay, Florida

Alexa Langley
Faculty Advisor: Dr. Ken Lindeman, Dept. of Ocean Engineering & Marine Sciences, Florida Tech

Introduction

Palm Bay is the second largest city in central Florida by area and is the most populated city in Brevard County. Therefore, this coastal city is implementing many actions from a new city Sustainability Action Plan (SAP)[1]. This project summarizes a variety of actions implemented as an intern with the city.

Objectives

- Design an implementation schedule for the city Sustainability Board's action plan to identify when projects will begin.
- Identify government actions in the sustainability plan that seek to reduce greenhouse gas (GHG) emissions.
- Comparatively research attributes of a new city Low Impact Development (LID) ordinance.

Methods

Implementation schedule

The city's SAP was reviewed during board meetings to identify priority actions. Using this and funding information, an Excel file was built to calendarize SAP actions at scales of: 1 yr (current), 1-5 yr, 5-10 yr, and >10 yr.

GHG reduction actions

Worked with the East-central Florida Regional Planning Council (ECFRPC) to create an Excel document that categorized SAP actions that align with ECFRPC goals to reduce municipal GHG emissions to identify future focal points.

Low Impact Development

Compared the Titusville LID ordinances 20-2021 and 30-2021 to select Palm Bay land ordinances to identify applicable intiatives.

Results

Implementation Schedule

163 total actions were examined in the SAP (Fig. 1). The majority involved the Built Environ. (57).

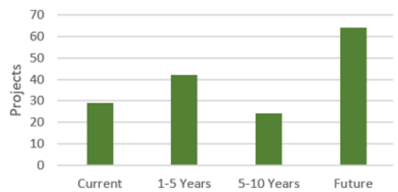


Fig. 1. Relative Amounts of Actions per Timeframe in SAP

30 projects from the SAP are actively underway. The implementation schedule includes projects that are underway and those that are highest priority. 30 are current, 66 are 1-5 yrs, 24 begin in 5-10 yrs, and 68 in >10 yrs. 3-4 priority actions for each of the categories were identified.

GHG reductions

Using the ECFRPC GHG document, the SAP was split into projects that seek to encourage grid decarbonization, vehicle miles traveled (VMT) reduction, electric vehicle (EV) adoption, building efficiency, and residential solar panel adoption.

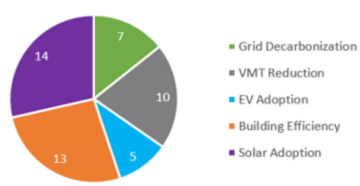


Fig. 2. Relative Distribution of ECFRPC Actions

49 total actions in the SAP, all city projects, were aligned as identifying with regional ECFRPC's goals.

Results, cont.

Low Impact Development

In Titusville's LID ordinances, most guidelines are mandatory to protect the environment. Palm Bay wants to ensure development is not hindered, but LID is encouraged, so guidelines in Palm Bay's ordinances will be optional and incentivized instead of mandatory. Fig. 3 shows a variety of incentives for developers from the Titusville ordinance (Table 11.2)[2].

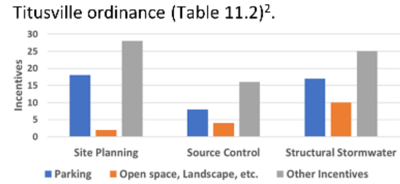


Fig. 3. Available Incentives by LID Categories

Conclusions

- The implementation schedule was presented at the Feb. 22 sustainability board meeting. This document will be updated as projects move to completion, allowing the citizens to be informed about the city's sustainability advances.
- The Excel file was shared with ECFRPC for use in their goal of reducing GHG emissions in east-central Fl. This file allows for people outside of Palm Bay to see what the city has committed to, increasing city accountability.
- The project comparing LID ordinances will continue through summer.

Literature Cited

1. Sustainability Action Plan (2021). City of Palm Bay.
2. Ordinance No 30-2021 (2021). City of Titusville

Acknowledgements

B. Kellner, S. Sherman, J. Junkula & the Sustainability Board of Palm Bay. Also, Tamara Pino of the ECFRPC.

[Showcase Book Page Submission]

Development of Sustainability Practices at Stone Magnet Middle School, Melbourne, FL

Elisabeth Harris

NORTHROP GRUMMAN
ENGINEERING & SCIENCE
STUDENT DESIGN SHOWCASE
FLORIDA TECH

Development of Sustainability Practices at Stone Magnet Middle School, Melbourne, FL

Elisabeth Harris
Faculty Advisor: Dr. Ken Lindeman, Dept. of Ocean Engineering & Marine Sciences, Florida Tech

Introduction

The Indian River Lagoon (IRL), stretching >250 km, is vital economically[1] and supports many regional ecosystems. IRL water quality and biodiversity have been in decline due to human activities. Building sustainable campus practices aids youth, adults, & the IRL. At Stone Magnet Middle School (SMMS), sited 0.65 km from the IRL, this project worked to build sustainability practices and STEM outdoor learning to inspire action in local schools and communities, starting a chain reaction.

Objectives

1. To design, install, and maintain several native plant gardens and trees with SMMS students
2. To identify credits in the Florida Green School Designation (FGSD) program to be completed.

Methods

Lagoon Friendly Landscaping

1. Design a landscape plan for areas of the campus in terms of biological planting & security issues.
2. Plan a budget & obtain support for purchases.
3. Installation of various native trees, shrubs, and ground cover between Oct 2021 - Apr 2022.
4. Maintenance of plants focused primarily on consistent watering after planting to start roots.

Florida Green School Designation

1. Determine what credits could be accomplished from the FGSD Green Apple application.
2. Focus on the most feasible and high priority FGSD credits to complete.

Results

Lagoon Friendly Landscaping

After the landscape plans were was approved by the principal & security officer, $500 from FIT and $200 from SMMS were obtained. The total number

Lagoon Friendly Landscaping cont.

of native trees, shrubs and groundcover planted on campus are shown in Fig. 1. Nineteen species of native, low maintenance plants were used, primarily

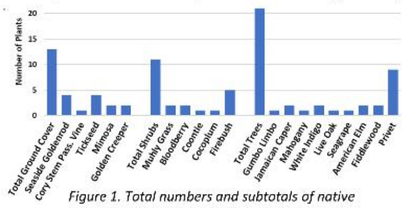


Figure 1. Total numbers and subtotals of native trees, shrubs groundcover for planting at SMMS.

Sites of 21 native trees, 9 species along the campus bus route, a STEM outdoor classroom (Fig. 2).

Figure 2. Planting sites for native trees on E side of SMMS. Green: installed, yellow: pending. See table display for letters.

Florida Green School Designation

The FGDS application is divided into five sections: Communication & Ed, Waste & Recycling, Water Conservation, Energy Efficiency, Air Quality and Transportation[2]. After analyzing the FGSD Green Apple application with SMMS staff, credits were prioritized by the 5 FGSD categories (Fig 3).

Florida Green School Designation cont.

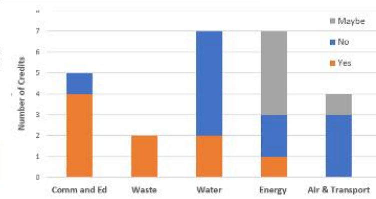


Figure 3. Number of FGSD credits and their priority.

A total of 8 credits of 17 have been accomplished, with a pending focus on Energy & Comm. (Fig. 4).

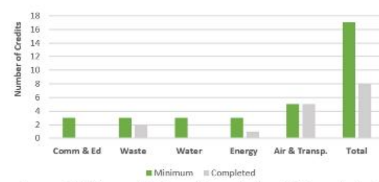


Figure 4. Minimum FGSD credits needed, with # completed.

Discussion

Sustainable practices were introduced at SMMS through the installation of >45 native plants in gardens around campus for STEM teaching. Approx. ½ of the credits to apply for the FGSD award are completed. FIT and SMMS will work to further best practices, submit a full FGSD application this winter and implement campus STEM curricula with Arts, as SMMS is a STEAM Magnet. It is hoped that these lessons will pass through generations of students and staff at Stone, and the wider community.

Literature Cited:

1. Bradshaw, D. J. et al. 2020. *PLOS ONE*, *15*(10).
2. FL DEP. Feb 2022 access: *F Green School Designat.*

Acknowledgements

Thanks to SMMS students and J. Romaine, J. Schmidt, C. Lundy, S. Straus. FIT: P. Zappala for funding, S. Pringle.

[Showcase Book Page Submission]

An Analysis of Energy Use at Florida Tech's Clemente Center

Abdullah Alsharari, Faisal Almalki, Hassan Aldarisi, Nasser Alrefaei

NORTHROP GRUMMAN
ENGINEERING & SCIENCE STUDENT DESIGN SHOWCASE
FLORIDA TECH

An Analysis of Energy Use at Florida Tech's Clemente Center

Abdullah Alsharari, Faisal Almalki, Hassan Aldarisi, Nasser Alrefaei

Faculty Advisor: Dr. Ken Lindeman, Dept. of Ocean Engineering & Marine Sciences, Florida Tech

Introduction

Buildings are responsible for about 38% of overall global carbon emissions[1]. By conducting energy analyses of greenhouse gases (GHGs) and other pollutants, emissions can be reduced. The Clemente Center is one of the most energy-consuming buildings at Florida Tech. It was therefore chosen to identify opportunities for investing in Energy Efficiency Measures (EEMs).

Objectives

- Inventory energy usage in building systems.
- Evaluate the inventory data to recommend EEMs to reduce overall energy consumption.

Methods

Inventory Energy Usage

- Site visits with facilities and building manager regarding operations & building components.
- Measure the temperature, relative humidity, CO_2, light intensity of typical rooms & spaces.
- Analyze building & utility data, including a study of the installed equipment & energy consumption.

Energy Efficiency Measures

- Use ASHRAE software *Building EQ*[2] to inform the identification of EEMs.
- Identify low-performance equipment and other attributes of low energy efficiency.
- Research possible low-cost alternatives to improve building efficiencies.
- Rank the priority of the suggested EEMs from 1 to 10, 1 being the most prioritized.
- Payback periods were estimated based on the engineering & cost features of EEMs.
- The HVAC principles & cost analysis were determining factors for some payback periods.

Results

Inventory Energy Usage

Space Type	Air Temp (°F)	Rel. Hum. (%)	Floor T. (°F)	Vert ΔT (°F)	CO_2 (ppm)
Lobby	66	54	66.6	0	684
Comfort Room	68.4	51.3	68.6	0.2	0
Basketball court	69.6	51	69.5	0	628
Bathroom	68.2	51.8	68.2	0.1	0
Weight Area	68	53	67.9	0.1	698

Table 1: Air quality of different spaces.

The ASHRAE guidelines recommend a temperature between 68° to 74° F & the lobby is 66°, which generates thermal discomfort for the occupants.

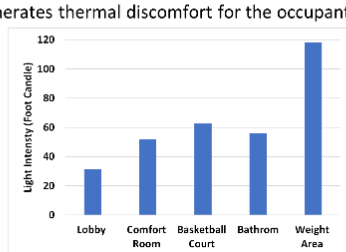


Figure 1: Light intensity comparison of different spaces.

Fig. 1 shows that the weight area has highest light intensity due to windows & sunlight exposure.

Energy Efficiency Measures

The data in Table 1 and Fig. 1 were analyzed to develop the following building EEMs.

- ***Building Envelope & Metering Suggestions***

EEMs	Cost Ranges	Payback	Priority
Perform a building envelope inspection at least once every 3 yrs.	0	< 1 yr	1
Use tinted or reflective glazing or energy control/solar window films.	5000-12000	1-4 yr	7
Replacing seal strip for main entrance doors.	200-300	1-4 yr	7
Install individual Electrical Meter.	7000-10000	<1 yr	1

- ***Lighting Suggestions***

EEMs	Cost Ranges	Payback	Priority
Reduce or turn off lighting levels in unoccupied spaces & during night.	0	<1 yr	3
Install personal lighting controls.	1000-1500	1-4 yrs	5
Upgrade fluorescent lighting to LED.	10000-12000	1-4 yrs	3

Results (cont.)

- ***HVAC System Suggestions***

EEMs	Cost Ranges	Payback	Priority
Replace or clean filters in accordance with the recommended schedule or after pressure drop.	1000-1500	1-4 yrs	1
Install occupancy sensors with Variable Air Volume systems, multiple thermostats, & shut-off boxes.	1500-2000	1-4 yrs	5
Install system controls (occupancy sensors, set-back thermostats, shut-off systems).	3000	1-4 yrs	2
Ensure proper location of thermostat to provide balanced space conditioning.	0	<1 yr	1

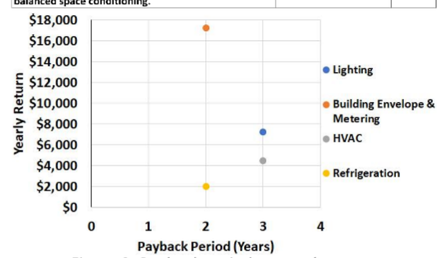


Figure 2: Payback period vs. yearly return.

Fig. 2 shows the av. yearly return on investment for differing EEMs & payback periods. The Envelope & Metering EEMs cost ≈ $17,250 & payback is in 2 yrs.

Conclusions

By applying the suggested EEMs, the building will consume less energy & reduce the amount of GHGs released. The total cost of the EEMs is ≈ $27,000, which will pay back in 4 yrs. Also, installing an electric meter for the Clemente Center is essential to track & improve the energy consumption.

References

1 - Nairobi. (2020). Global Status Rept., Buildings & Const.
2 - www.ashrae.org/buildingeq

Acknowledgments

We appreciate the time and efforts of J. Constantinide, K. Hemphil, and T. Richard throughout the project.

[Showcase Book Page Submission]

Sustainability Actions Involving Energy, Native Landscapes, and Community Outreach in the Town of Melbourne Beach, FL

Amanda McClure

NORTHROP GRUMMAN
ENGINEERING & SCIENCE STUDENT DESIGN SHOWCASE
FLORIDA TECH

Sustainability Actions Involving Energy, Native Landscapes, and Community Outreach in the Town of Melbourne Beach, FL

Amanda McClure
Faculty Advisor: Dr. Ken Lindeman, Dept. of Ocean Engineering & Marine Sciences, Florida Tech

Introduction

The Town of Melbourne Beach, FL, is located on the barrier island between the Atlantic Ocean and Indian River Lagoon (IRL). However, the lagoon and ocean are subject to stressors impacting local ecosystems, and the town is beginning climate adaptation practices. Energy conservation[1] and native landscaping[2] are two ways to address these issues. This project reflects diverse products from a town sustainability internship.

Objectives

1. To apply for a native garden grant and suggest revisions to the town tree ordinance.
2. To examine the energy use of town buildings and recommend solar alternatives.
3. To educate the community on best practices & create a map of sustainable town attributes.

Methods

Grant Application & Tree Ordinance

- Apply for the Viva Florida Grant to fund native planting at the Old Town Hall History Center.
- Suggest revisions to the tree ordinance to protect trees while preserving property rights.

Energy Conservation & Solar Energy

- Determine energy use for select town buildings.
- Propose energy-saving methods & solar energy options based on roof size & energy demand.
- Calculate the payback period for different building alternatives and the expected savings over 20 years based on offset energy use.
- Present energy conservation and solar install recommendations to the town commission.

Sustainable Actions Community Outreach

- Create educational Facebook posts regarding various methods of resource conservation.
- Teach clothing repurposing at Founder's Day.
- Create map of sustainable town features.

Results

Grant Application & Tree Ordinance

23 species are proposed (Table 1) to increase biodiversity and attract pollinators and birds. The garden is fertilizer and pesticide free, limiting harmful runoff to the IRL.

Proposed Species	Number of Plants	Planting Area (Sq. Ft.)	Funding Requested
Trees: 1	6	-	$ 120
Shrubs: 10	40	-	$ 383
Gr. Cover: 12	70	-	$ 505
Total: 23	116	1220	$ 1,008

Table 1: Grant Application Summary

Suggested revisions to the tree ordinance may include: a) mitigation to offset removal and b) reducing the use of palms for canopy trees to aid carbon sequestration and stormwater interception.

Energy Conservation & Solar Energy

Fig. 1 illustrates the energy use in kWh for 3 town buildings from July 2020 through September 2021.

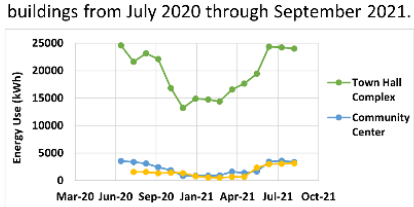


Fig. 1: Energy Use for Three Town Buildings

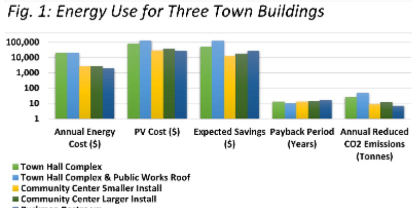


Fig. 2: Solar Install Estimate Comparison

Energy Conservation & Solar Energy

Fig. 2 compares options of photovoltaic (PV) solar installs for town buildings. The town hall complex (THC) and public works (PW) building install offers the expected greatest savings of $122,786 and the shortest payback period of 10 years.

Sustainable Actions Community Outreach

Facebook posts on energy conservation, composting, sustainable holidays, plant-based eating, green clothing, and recycling, totaled 17 posts. At Founder's Day, old t-shirts will be upcycled into bags. Fig. 3 shows a proposed map of some town SUS features including images and locations.

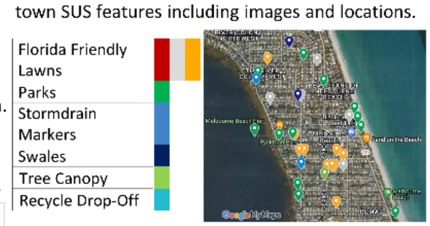


Fig. 3: Green Melbourne Beach Map

Discussion

Based on the low payback period, the solar install on the THC and PW building is the recommended alternative (Fig 2). Implementing energy conservation measures and a PV solar system would create economic savings and reduce GHG emissions. Applying for grants to expand the Green Earth Composting program is also recommended.

References

[1] EPA. (2019). Sources of Greenhouse Gas Emissions.
[2]Why Native Plants Matter. Audubon. (2017, May 18).

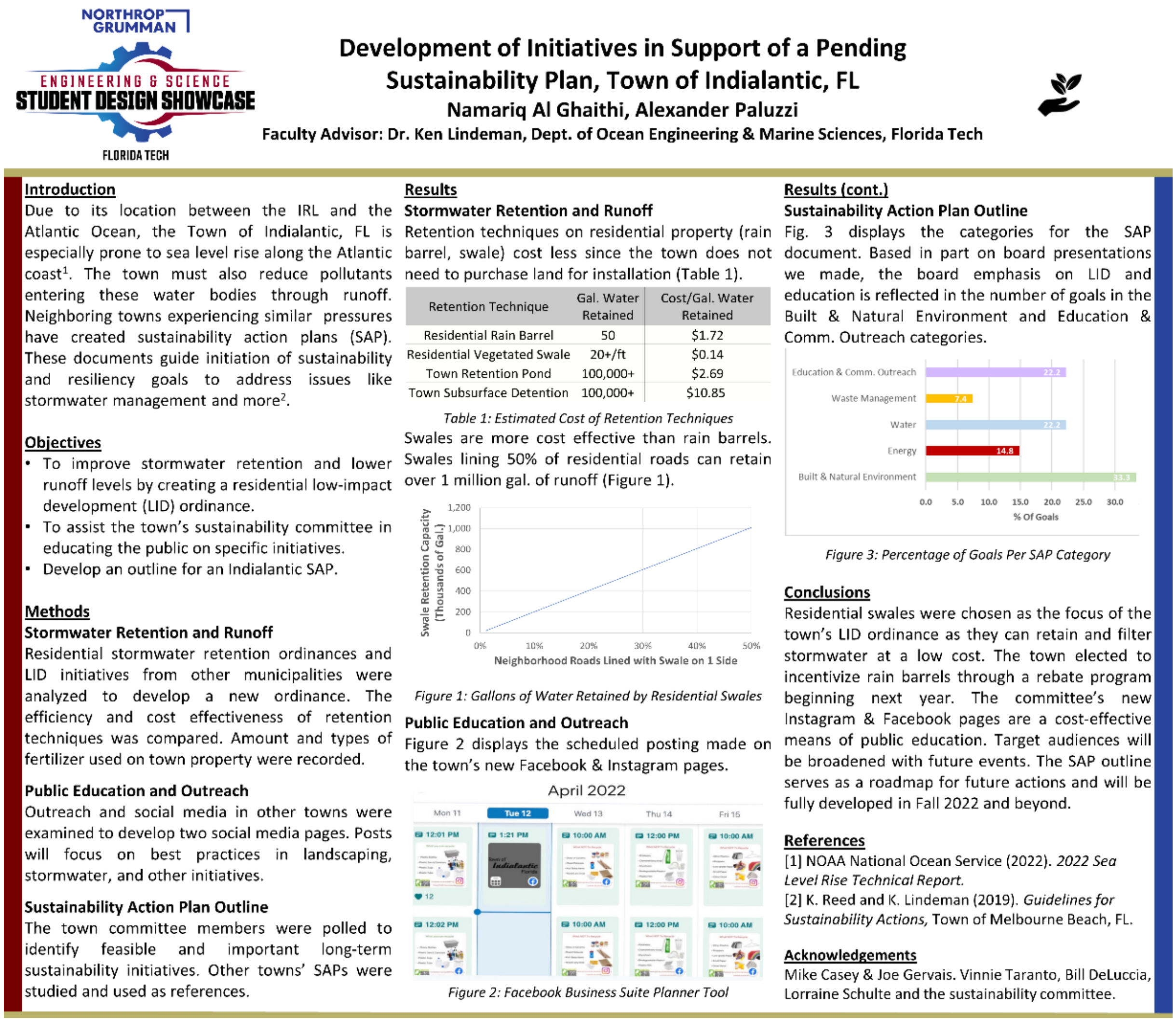
Acknowledgements

Melbourne Beach Environmental Advisory Board Members, E. Mascaro Town Manager, C. Cain Volunteer

[Showcase Book Page Submission]

Development of Initiatives in Support of a Pending Sustainability Plan, Town of Indialantic, FL

Namariq Al Ghaithi, Alexander Paluzzi



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Development of Initiatives in Support of a Pending Sustainability Plan, Town of Indialantic, FL

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Introduction

Due to its location between the IRL and the Atlantic Ocean, the Town of Indialantic, FL is especially prone to sea level rise along the Atlantic coast[1]. The town must also reduce pollutants entering these water bodies through runoff. Neighboring towns experiencing similar pressures have created sustainability action plans (SAP). These documents guide initiation of sustainability and resiliency goals to address issues like stormwater management and more[2].

Objectives

- To improve stormwater retention and lower runoff levels by creating a residential low-impact development (LID) ordinance.
- To assist the town's sustainability committee in educating the public on specific initiatives.
- Develop an outline for an Indialantic SAP.

Methods

Stormwater Retention and Runoff

Residential stormwater retention ordinances and LID initiatives from other municipalities were analyzed to develop a new ordinance. The efficiency and cost effectiveness of retention techniques was compared. Amount and types of fertilizer used on town property were recorded.

Public Education and Outreach

Outreach and social media in other towns were examined to develop two social media pages. Posts will focus on best practices in landscaping, stormwater, and other initiatives.

Sustainability Action Plan Outline

The town committee members were polled to identify feasible and important long-term sustainability initiatives. Other towns' SAPs were studied and used as references.

Results

Stormwater Retention and Runoff

Retention techniques on residential property (rain barrel, swale) cost less since the town does not need to purchase land for installation (Table 1).

Retention Technique	Gal. Water Retained	Cost/Gal. Water Retained
Residential Rain Barrel	50	$1.72
Residential Vegetated Swale	20+/ft	$0.14
Town Retention Pond	100,000+	$2.69
Town Subsurface Detention	100,000+	$10.85

Table 1: Estimated Cost of Retention Techniques

Swales are more cost effective than rain barrels. Swales lining 50% of residential roads can retain over 1 million gal. of runoff (Figure 1).

Figure 1: Gallons of Water Retained by Residential Swales

Public Education and Outreach

Figure 2 displays the scheduled posting made on the town's new Facebook & Instagram pages.

Figure 2: Facebook Business Suite Planner Tool

Results (cont.)

Sustainability Action Plan Outline

Fig. 3 displays the categories for the SAP document. Based in part on board presentations we made, the board emphasis on LID and education is reflected in the number of goals in the Built & Natural Environment and Education & Comm. Outreach categories.

Figure 3: Percentage of Goals Per SAP Category

Conclusions

Residential swales were chosen as the focus of the town's LID ordinance as they can retain and filter stormwater at a low cost. The town elected to incentivize rain barrels through a rebate program beginning next year. The committee's new Instagram & Facebook pages are a cost-effective means of public education. Target audiences will be broadened with future events. The SAP outline serves as a roadmap for future actions and will be fully developed in Fall 2022 and beyond.

References

[1] NOAA National Ocean Service (2022). *2022 Sea Level Rise Technical Report.*
[2] K. Reed and K. Lindeman (2019). *Guidelines for Sustainability Actions*, Town of Melbourne Beach, FL.

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