Guam Strategic Energy Plan

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EXECUTIVE SUMMARY

This document presents various energy strategies that are available to Guam in the pursuit of diversifying fuel sources and reducing fossil energy consumption 20% by 2020 (20x20). The information in this document is based upon input from the Guam Energy Task Force (GETF), the National Renewable Energy Laboratory's (NREL's) *Guam Initial Technical Assessment Report*, and additional stakeholders. The information presented in this strategic energy plan is intended to be used by the GETF in developing an energy action plan. The next step in reaching the 20x20 goal involves selecting the most appropriate strategies from the options outlined in this strategic plan and creating a roadmap for implementation in the *Guam Energy Action Plan*.

The strategies are categorized based on the time required to implement them. Near-term strategies can be accomplished in 1-2 years, mid-term strategies require 3-5 years, long-term strategies require 6-8 years, and some strategies require 8 or more years before they can be fully implemented. The prioritization of the strategies will help facilitate the development of an action plan and the selection of appropriate strategies for meeting Guam's 20x20 goal. The strategies that will be used in reaching the 20x20 goal are broken down into five energy categories. The energy categories are shown in figure 1.

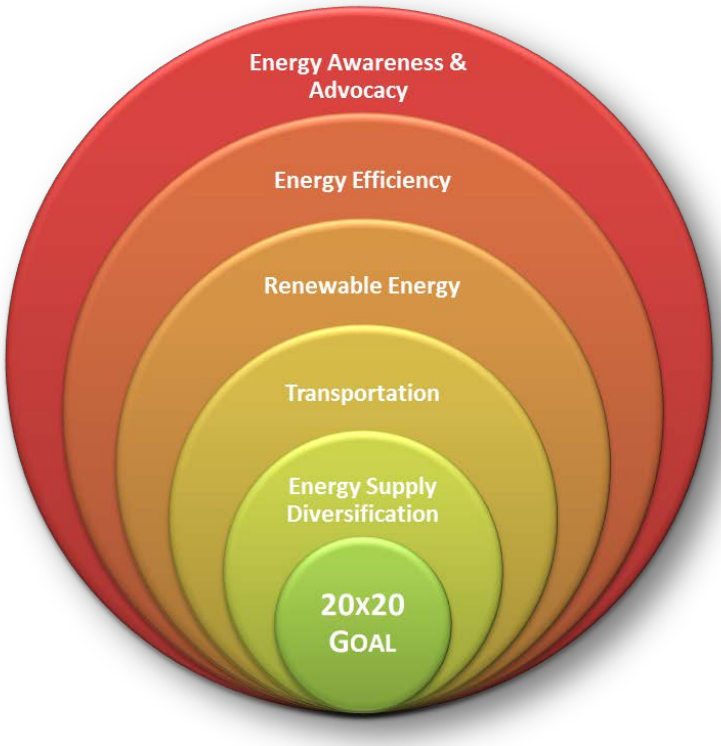

Figure 1. Areas to be addressed in order to reach Guam's 20x20 goal

Energy education and outreach is addressed in detail in the report due to its impact on fossil fuel consumption in all of the energy categories. Effective energy education and outreach strategies can significantly reduce fossil fuel consumption and do not require large capital investments. Education and outreach strategies listed include building and energy code education and enforcement, providing energy efficiency courses for industry stakeholders, ensuring that energy projects remain transparent and accessible to the public, and using websites, events, and other outlets for renewable energy and energy efficiency education to the public. Strategies for implementing energy efficiency, renewable energy, transportation, and energy supply diversification are addressed and summarized in tables. Energy efficiency, renewable energy, and transportation strategy recommendations for Guam include:

- Use of energy conservation measures for buildings
- Implementation of a cool roof and cool pavement program
- Use of efficient outdoor lighting
- Increased efficiency in the utility's generation and distribution of electricity
- Use of waste-to-energy technologies
- Use of biofuels
- Use of wind energy
- Use of solar water heaters
- Use of solar photovoltaics
- Use of seawater air-conditioning
- Use of geothermal technologies
- Reductions in vehicle miles traveled
- Vehicle fuel-economy improvements
- Reductions in vehicle idle time
- Use of electric vehicles
- Use of biodiesel
- Improvements in traffic flow

Additionally, liquefied natural gas (LNG) is presented as a strategy for increasing Guam's energy supply diversification. The technology approach, technology details, strategy barriers, and time frame for each strategy are shown in the tables in the section titled Technology Options. Guidance for creating effective energy-related policies is provided, along with clean energy policy considerations for Guam. Additional information can be found in the Appendices and is intended to supplement the information found in the body of the document.

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INTRODUCTION: THE URGENT NEED FOR ENERGY TRANSFORMATION

Due to fluctuating energy prices, including the record high price for oil in 2008, and the anticipated military build-up, Guam has focused attention on the need to develop alternatives to its near 100% reliance on fossil fuels. Guam is in a unique position to undertake a concerted effort to address current energy and environmental challenges. Due to its geographic isolation, non-renewable resources are extremely limited and subject to large volatility in pricing and availability. Energy security is fundamental to Guam's economic future and sustainability. Creating a stable investment atmosphere remains challenging, while the quality of life for residents and visitors continues to be affected. However, the unique position of Guam also offers many natural advantages. The island is endowed with sources of alternative energy.

Guam's energy goal of reducing fossil fuel consumption 20% by the year 2020 encourages Guam to rise to the challenges created by volatile energy prices, increasingly scarce resources, vigorous world competition and technological innovation. Based on the principle of sustainability; Guam must meet the needs of today without compromising the ability of future generations to meet theirs. Variability on Guam, such as fuel pricing and the cost of energy, natural disasters, uncertainty about the extent of the military build-up, and fluctuations in income from tourism, make it difficult to achieve economic security. Sustainability is more than an environmental policy; it is an economic one as well. Energy touches every sector of a community, with far-reaching consequences when prices soar, stability is threatened or environmental impacts realized. Saving energy saves money and indigenous energy creates economic self-reliance. This new green economy approach is being implemented around the world. It is utilizing mature technologies, sparking innovation of new technologies, opportunities, jobs and economies.

By investing in green technology, energy conservation, energy efficiency, renewable energy, efficient transportation, green building design and smart grid technologies, Guam is building a new energy infrastructure that reduces its reliance on fossil-fueled centralized power and increases its use of green distributed power. Creating efficient systems that are integrated leads to security, resource efficiency, and sustainability. By investing in green business and technology Guam can be sustainable in the way it grows. A green infrastructure, powered by green technology, creates jobs.

By embracing the energy transformation process, Guam participates in this new economic framework by positioning itself at the forefront of change and innovation. Oftentimes, the most detrimental option is to continue to follow the status quo. While this is an easy route to take, the future energy security of Guam is dependent upon changes to its current approach.

The Energy Planning Process

In March of 2010, the U.S. Department of the Interior (DOI) Office of Insular Affairs (OIA) sponsored a regional energy meeting in Golden, Colorado, that included Guam, the CNMI, and American Samoa. Guam delegates met with representatives from the U.S. Department of Energy (DOE) and senior principals from DOE's National Renewable Energy Laboratory (NREL) to discuss ways to improve energy efficiency and increase the deployment of renewable energy technologies in the Pacific. As a result of

this meeting, the Governor of Guam established the Guam Energy Task Force to help coordinate energy policy and promote long-term planning.

In the summer of 2010, OIA funded NREL to conduct an initial technical energy assessment for Guam[1] that detailed energy consumption and production data to establish an energy baseline. This assessment was used to conduct an energy analysis that estimated the energy efficiency and renewable energy potential for Guam.

The *Guam Initial Technical Assessment Report* was published in April 2011, and was used by the GETF as the starting point for developing this *Guam Strategic Energy Plan*.

The purpose of Guam's strategic energy plan is to provide project options to be further investigated and detailed in an implementation plan, or energy action plan. Developing an action plan is the next step in the energy transformation process. The *Guam Energy Action Plan* will select a handful of specific strategies that are achievable in the short-term (1-3 years), break down those strategies into feasible incremental steps, identify the stakeholders and desired outcomes, identify the organizations and individuals responsible for implementing the actions, and set a timeline for each step. The *Guam Strategic Energy Plan* will contribute to the development of the energy action plan by providing vital strategy options and information on those options.

Establishing the parameters of the strategic energy plan provides focus for the strategic planning team. Certain topic areas, such as water, are considered important to overall energy strategies, however were not considered within the Guam assessment due to budget constraints and the priority of targeting energy efficiency and renewable energy.

There are many energy efficiency and renewable energy technologies on the market today. Included within the *Guam Initial Technical Assessment Report*'s parameters were mature technologies that are commercially available and feasible. There are other technologies that Guam may want to investigate for future study, but for the basis of this report, technologies included have the following criteria:

- Commercially available
  - Tested and demonstrated
  - Carry warranty
- Service and parts available
- Ready for immediate deployment
- Economically viable
- Financing available from private sector organizations.

Technologies are constantly changing; therefore it is important to understand that assessments need to be updated to reflect these changes. Strategies for renewable energy and energy efficiency technology, modular nuclear, and LNG require further investigation to quantify the impact of specific technologies,

[1] Ian Baring-Gould et al., *Guam Initial Technical Assessment Report*. National Renewable Energy Laboratory, NREL/TP-7A40-50580, April 2011.

programs, and/or projects. Environmental, regulatory, legislative, technical, and financial considerations will also need to be addressed during the energy planning and project development process.

THE GUAM ENERGY GOAL

Guam's goal is to secure its energy future and increase autonomy by diversifying fuel sources and **reducing fossil fuel energy consumption 20% by 2020 (20x20 goal)**. This includes all energy consumed through power generation (utilities) and ground based transportation (vehicles), but does not include air and sea transportation. The GETF is responsible for facilitating Guam's efforts to reach the 20x20 goal.

Strategies for Achieving the Goal

The GETF has a multitude of approaches it can implement to achieve its 20x20 goal. These approaches, as shown in figure 2, are broken down into five categories: energy awareness and advocacy, energy efficiency, renewable energy, transportation, and energy supply diversification. Each approach contains strategies that can be utilized to successfully reduce fossil fuel consumption. To facilitate the success of these strategies they are broken down by the amount of time required to plan, assess, and implement them. On the path to achieving the 20x20 goal, the strategies will be implemented in three phases: near-term (1-2 years), mid-term (3-5 years), and long-term (6-8 years). Additional projects that will not be completed by 2020 can be placed in a longer time frame. The time structure will allow the GETF to focus on a select group of strategies and set project completion milestones.

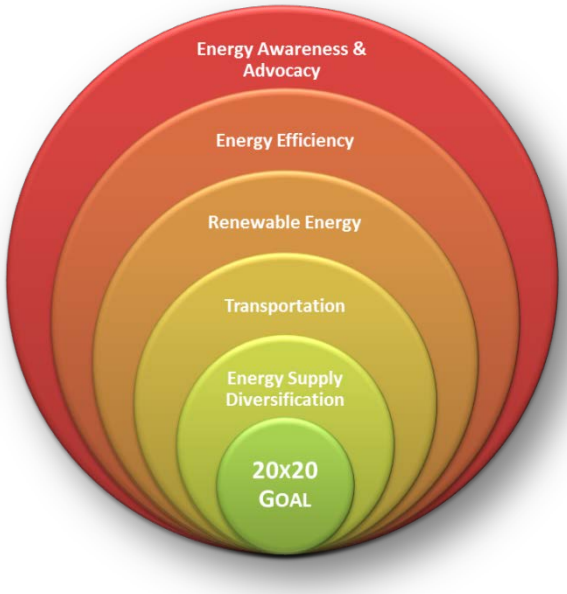

Figure 2. Areas to be addressed in order to reach Guam's 20x20 goal

Metric for Evaluation

Progress towards the Energy Task Force's goal will need to be measured to determine if it has been met. All fossil fuel consumption will be compared to 2010 levels. Jet fuel reduction strategies are not being investigated and pursued as part of the reduction goal, and so jet fuel will not be included in the measurement calculation. The total number of gallons of fossil fuel consumed on Guam for any given year will be calculated by adding the total fuel sales by petroleum companies, minus jet fuel, to the amount of fossil fuels consumed by the Guam Power Authority (GPA). The number of gallons sold by petroleum companies is tracked by the Guam Energy Office[2], and GPA can provide the data on the annual amount of fossil fuel consumed for power

[2] http://www.guamenergy.com/?s=petroleum

generation. The total number of gallons of fossil fuels consumed will then be divided by the current population to provide per capita consumption. This measurement will account for growth. Census data is available for 2010, the baseline year, and will be available for 2020, the target year for achieving a 20% fossil fuel consumption reduction. For all other years during which census data is unavailable, population growth will be estimated based on GPA customer growth. The resulting measurement will then be compared to the identical measurement in 2010 to determine the reduction in fossil fuel consumption. Total fossil fuel use for Guam, not including jet fuel, in 2010 was 185,192,596 gallons and the population was 159,358, yielding an annual per capita fossil fuel consumption of 1,162 gallons.

GUAM ENERGY TASK FORCE (GETF)

The GETF was established by Executive Order 2010-15 on May 10, 2010. The GETF is a nonregulatory advisory group sponsored by the Government of Guam. The GETF is comprised of local volunteers from multi-sector stakeholder communities and supported by federal agencies. Convened in September 2010, the GETF recruited appropriate leaders for membership to ensure diverse and equitable representation. The GETF was established to facilitate a transition towards a more sustainable energy future that will utilize the island's natural resources. The GETF is a forum for considering options and offering guidance related to the achievement of the island's energy goals. The task force's vision, mission, and goal are described below.

Vision

The GETF's vision is a secure, sustainable, and economically prosperous future for Guam.

Mission

As stated in Executive Order No. 2010-15, GETF's mission includes the following objectives:

- Reduction of reliance and expenditures on fossil fuels
- Development of indigenous and renewable energy sources
- Improvement of energy generation infrastructure
- Resource preservation, restoration and enhancement
- Training and education regarding energy efficiency and conservation
- Development of funding and financial strategies for sustainability and economic development
- Engagement in national and regional efforts to address island energy concerns
- Support energy literacy curriculum in all educational institutions
- Develop a vision, mission and goals for reducing dependence on fossil fuels, improving energy efficiency, and developing renewable energy resources
- Establish an organizational structure to appropriately develop a comprehensive, long-term strategic energy plan for Guam.

GETF Organizational Structure and Subcommittee Objectives

The GETF is led by an Executive Committee with four subcommittees: energy technologies, policy and finance, education and outreach, and federal facilities (figure 3). The four subcommittees and their focuses are described below.

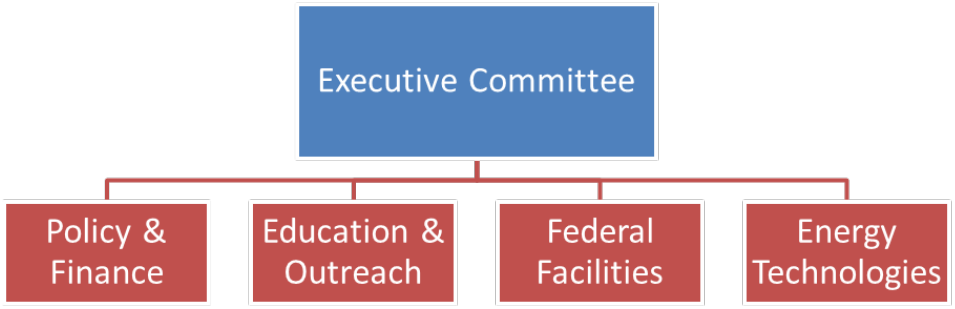

Figure 3. GETF organizational structure

Policy and Finance

Governmental policy is foundational to reshaping the regulatory landscape to clear the way for a new energy future. The Policy and Finance subcommittee assists lawmakers and other clean energy advocates in analysis and development of policy opportunities to promote implementation of energy efficiency and renewable energy.

Education and Outreach

The Education and Outreach subcommittee is focused on identifying and developing educational tools and programs needed to develop and advance a clean energy economy. This included community outreach and education, technical and vocational training, and certification and degree programs.

Federal Facilities

In an effort to share information and facilitate dialogue, representation from the DOD has been essential. This subcommittee has been responding to federal mandates. They concentrate on energy conservation, building efficiency, outreach, renewable energy, and alternative vehicles.

Energy Technologies

The Energy Technologies subcommittee is focused on assessment and deployment of cost-effective energy efficiency and renewable energy opportunities. This includes energy conservation strategies,

efficient building design, facility- and utility-scale renewable energy technologies, grid integration, and transportation.

POLICY FRAMEWORK AND PROJECT DEVELOPMENT

Policy is an effective tool in addressing clean energy adoption and subsequent development (figure 4), and the process of policy development addresses social concern through public participation. A policy is typically described as a principle or rule to guide decisions and achieve rational outcome(s). The term is not normally used to denote what is actually done; this is normally referred to as either procedure or protocol.

Whereas a policy will describe the "what" and the "why," procedures and protocols address the "what," the "how," the "where," and the "when." Policies are generally adopted by the Board of, or senior governance body within, an organization whereas procedures or protocols would be developed and adopted by senior executive officers.

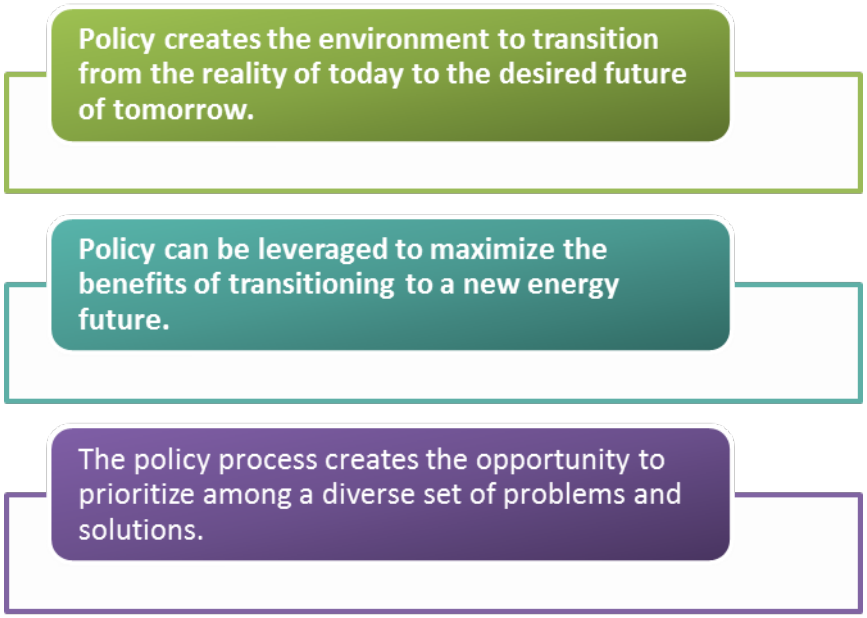

Figure 4. Advantages of a strong policy framework

A precursor in directing Guam's energy transformation is to establish energy-related policies. The key principles that will guide Guam toward a prudent and sustainable energy future are listed below. The challenge in developing principles and policies is that at some level, inconsistencies, gaps and overlaps are inevitable — for example, when balancing sound economics with ecological integrity.

- Enhance the general quality of life through energy strategies that will benefit Guam

- Promote ecologically friendly propositions that create a healthy environment
- Promote environmental stewardship through energy conservation and energy efficient practice
- Support opportunities for local economic vitality
- Emphasize alternative power sources
- Support options that will reduce market volatility, stabilize rates, and increase reliability.

It is important to have a robust set of policies that are:

- **Comprehensive** — Barriers to renewable energy and energy efficiency are diverse, growth may be halted from any number of wholly unrelated barriers
- **Broad-based** — Applies across all types of entities and sectors
- **Multifaceted** — Attacks problems and barriers from various angles
- **Multitiered** — Includes mandates or quotas but also addresses siting and permitting
- **Practical** — Focus on small victories
- **Long-term** — Create the market conditions to build a *real* and *sustainable* industry.

CLEAN ENERGY POLICY CONSIDERATIONS FOR GUAM

- RENEWABLE PORTFOLIO STANDARD
- ENERGY EFFICIENCY PORTFOLIO STANDARD
- LEAD BY EXAMPLE
- LATEST BUILDING CODES
- ENERGY CODES
- PERMITTING AND SITING STANDARDS
- ✓ NET METERING
- ✓ INTERCONNECTION
- APPLIANCE EXCHANGES AND REBATES
- SMART METERING
- TAX INCENTIVES
- INDUSTRY RECRUITMENT INCENTIVES
- REBATES AND GRANT PROGRAMS
- LOAN AND LOAN GUARANTEES
- PUBLIC BENEFIT FUND
- PUBLIC FINANCING PROGRAMS

✓ Denotes policy Guam has already implemented

No single policy exists in isolation. Policy success is often determined by the ability to address multifaceted barriers with the appropriate mix of tools. One of the key benefits of policy development is that through this process, a specific set of challenges can be identified and strategies developed to address them; it does not necessarily attempt to be everything to everyone all at the same time. This process is incremental and topic-specific. A deliberate and methodical approach can help to minimize policy gaps and failures. Consider alternatives — think creatively.

Policy Recommendations

The following are some policies that could attract greater investment in renewable energy and energy efficiency technologies and facilitate project development.

Develop Financial Mechanisms and Opportunities

1. Explore public-private partnerships with local businesses, developers, and banks with the idea of creating local markets for renewable power generation, energy efficiency, and energy conservation products and services.
2. Investigate third party financing
3. Pursue subsidies for renewable projects
4. Consider opportunities such as peak pricing, grants and subsidies to reduce the overall cost of electricity

Investigate alternative financing models such as power purchase agreements and performance savings' contracting.

Standardize the Development Process

In order to entice investment, communities are trying to reduce the level of project uncertainty as much as they can. Several strategies can be implemented, such as determining and offering quality information to potential investors through the request for proposal mechanism. This supplies potential investors with accurate information and the level of detail necessary to reduce their risk and increase their level of interest. This also casts a wider net, bringing in high quality companies. Providing information on a community's legal requirements for building a project — including site access, permitting and environmental processes, and what types of project ownership structures are recognized — can also be highly beneficial to potential investors. Communities are surveying their processes, eliminating unnecessary steps, and streamlining processes as an incentive to bring in investors. This strategy has multiple benefits — it organizes a community, encouraging people to survey what exists and develop what is needed; it provides consensus; and offers investors high quality information and reduces their uncertainty. A project development framework is provided in the Appendices.

EDUCATION AND OUTREACH RECOMMENDATIONS

Education and Training

1. **Code Enforcement**
   Once building and energy codes are updated, it will be necessary to educate the agencies and departments responsible for executing them and train enforcement officers for both inspection and enforcement capabilities.

2. **Courses and Materials**
   Develop training courses and materials for both architects and workers in the construction sector to improve energy awareness. Energy efficiency in retrofit, renovation, and new construction can be included in design, materials, and equipment.

3. **Guidebooks**
   Create guidebooks and self-assessment checklists. These guidebooks could be designed as stand-alone products for specific sectors or integrated into training courses described above.

Outreach Campaigns

1. **ETF Visibility**
   It is important for the Energy Task Force to have visibility and credibility with all stakeholders, especially the citizens of Guam, so that its recommendations will have maximum impact. This can be accomplished by establishing a strong identity or brand for the ETF. One option is to embark on a contest within the school system for materials such as a logo, song, tag line, etc. Another option is to establish a website where all materials and calendars can be viewed and a blog or feedback loop implemented for people to comment on said materials and their concerns.

2. **Energy Literacy**
   Create citizen buy-in in for new technologies, programs and policies by holding educational fairs, creating fact sheets, radio announcements/shows, electronic newsletters and a variety of activities that promote energy literacy from cradle to grave: understanding where energy comes from, how it is moved and used, how to make use more efficient, and how to conserve it and its life cycles.

FEDERAL FACILITIES

It is essential to look at the energy picture of Guam holistically. The Department of Defense (DoD) has considerable representation on-island, accounting for between 21% and 22% of Guam's energy consumption. An extensive understanding of the relationship between Guam's DoD installations and the rest of the island is necessary to establish energy efficiency and renewable energy baselines and potential. NREL's assessment team concentrated on baseline factors taking into account DoD presence. This report focuses on island-wide utility generation and consumption patterns, not specific DoD energy efficiency and renewable energy activities. DoD has its own internal goals for renewable energy and energy efficiency. As DoD seeks to meet these goals, there may be impacts on the operations and economics of Guam Power Authority (GPA); it is important for DoD and GPA to continue to work together to understand these impacts and seek to develop win-win solutions.

Energy Technology Options

The GETF has numerous technology approaches it can implement to achieve its 20x20 goal. These technology approaches are broken down into four sectors: renewable energy, energy efficiency, transportation, and energy supply diversification. Each technology approach contains strategies that can be implemented to successfully reduce fossil fuel consumption. To facilitate the success of the strategies they are broken down by the amount of time required to plan, assess, and implement them. On the path to achieving the 20x20 goal (figure 5), the strategies can be implemented in three phases: near-term (1-2 years), mid-term (3-5 years), and long-term (6-8 years). Additional projects that will not be completed by 2020 can be placed in a longer time frame. The time structure will allow the GETF to focus on a select group of strategies and set project completion milestones. Tables 1 through 4 present the technology options, technology details, barriers for implementing the technologies, strategies for overcoming the barriers, and the achievable time frames for implementation.

Table 1. Technology Strategy: Energy Efficiency

N = NEAR-TERM M = MID-TERM L = LONG-TERM B = BEYOND

Energy Efficiency				
Technology Type/Sector	**Technology Examples**	**Barriers**	**Strategies**	**Time Frame**
Buildings - Public (Existing)	• Measures identified in energy audits • Measures installed in EE retrofits • Additional energy conservation measures (ECM)	• Funding • Costs • Lack of on-site expertise and capacity to conduct energy audits	• **Energy Audit Training Programs for on-site facility managers and staff**	N
			• **Energy assessments and modeling trainings**	M
			• **Revolving loan fund**	L
Buildings - Residential (Existing)	• Low income subsidies • Accelerate weatherization programs • Efficient lighting, control settings, etc.	• Lack of "how to" knowledge • Lack of will to change behavior • Lack of knowledge of what is available to the consumer • Perception of high initial costs	• **Awareness and education campaigns**	N
			• **Pilot a real-time feedback program utilizing smart measuring devices**	L
			• **Revolving loan fund**	M
Buildings - Commercial (Existing)	• Energy audits • EE retrofits • Utilize ECMs	• Costs • Lack of on-site expertise and capacity to conduct energy audits	• **Energy Audit Training Programs for on-site facility managers and staff**	N
			• **Energy assessment and modeling trainings**	M
			• **Revolving loan fund**	M

Energy Efficiency				
Technology Type/Sector	**Technology Examples**	**Barriers**	**Strategies**	**Time Frame**
Buildings - Industrial (Existing)	• Energy audits • EE retrofits • Utilize ECMs	• Costs • Lack of on-site expertise and capacity to conduct energy audits	• **Energy Audit Training Programs for on-site facility managers and staff**	**N**
			• **Energy assessment and modeling trainings**	**M**
			• **Revolving loan fund**	**M**
Buildings - New Construction & Major Renovations	• Adopt and enforce 2012 building codes • Integrated design and systems integration – HVAC, plumbing, electrical, lighting, etc. • Integrating renewables to achieve efficiency (e.g., building orientation)	Lack of: • Expertise and knowledge in employing integrated system design approach and whole building design practices • Expertise and capacity to operate and maintain such systems • How to measure bldg. performance	• **Identify and publicize funding sources (ESPCs, etc.)**	**M**
			• **Provide informative resources describing whole building design practices and systems integration**	**N**
			• **Training programs for O&M and M&V managers and technicians**	**N**
			• **Revolving loan fund**	**M**
Cool Roofs & Pavements	• Light colored surfaces (white or reflective)	• Potential increased short wave irradiation through large scale installation of reflective surfaces could increase cooling loads (unintended consequence).	• **Develop a detailed land use database**	**M**
			• **Perform detailed analysis (Energy impacts)**	**M**
			• **Develop implementation programs (roofs, pavements, trees)**	**L**
			• **Develop a feedback system**	**M**
			• **Develop energy codes, standards, guidelines**	**N**
			• **Develop demonstration projects**	**M**
Efficient Outdoor Lighting	• Fixture selection • Lighting standards • Energy consumption	• Initial costs and tight budgets • Concerns over lighting color • Proper design capacity	• **Training on photometric analysis combined with life cycle cost and energy analysis**	**M**
Utility Efficiency	• Transmission • Distribution • Generation	• Funding • Load balancing challenges • Voltage optimization	• **Loss assessment study**	**N**
			• **Ensure that all consumption is metered**	**M**
			• **Waste heat recovery**	**L**
			• **System upgrades**	**M**

Table 2. Technology Strategy: Renewable Energy

N = NEAR-TERM M = MID-TERM L = LONG-TERM B = BEYOND

RENEWABLE ENERGY				
TECHNOLOGY TYPE	TECHNOLOGY EXAMPLES	BARRIERS	STRATEGIES	TIME FRAME
BIOMASS/ WASTE-TO-ENERGY (WTE)	• Landfill gas (LFG) • Biomass • Anaerobic digestion	• Public Law PL 25-175[3] • Characteristics of the waste feed stock • Tipping fees are usually required to make WTE projects economically viable	• **Form a working group to address WTE and PL 25-175**	N
			• **Repeal PL 25-175**	M
			• **Biomass resource assessment**	M
			• **WTE feasibility studies: Waste characterization, economic and technical analyses**	M
BIOFUEL	• Ethanol • Coconut oil	• Limited land area • Limited feedstock supply	• **Biofuel feasibility study**	N
WIND	• Typhoon rated turbines • Turbines that can be lowered	• Cost • Integration • Social acceptance • Local capacity • Extreme weather events	• **Erect MET towers for correlation to other data**	N
			• **Social acceptance and outreach program**	N
			• **Environmental and radar impact study**	M
			• **Investigate typhoon-rated turbines**	M
			• **Permitting for available sites**	M
			• **Environmental reviews, economic modeling, and interconnection studies**	M
			• **Wind farm project implementation**	L
SOLAR WATER HEATERS (SWH)	• Flat-plate collector • Integral collector-storage systems • Evacuated-tube solar collectors	• Cost • Social acceptance of the technology	• **Rebate program**	M
			• **Outreach program to encourage home energy and water conservation**	N
			• **Mandatory SWHs on government buildings**	M

[3] http://guamlegislature.com/Public_Laws_25th/P.L.%2025-175.pdf, accessed 6.27.2013

Renewable Energy				
Technology Type	**Technology Examples**	**Barriers**	**Strategies**	**Time Frame**
Solar PV	• Large-scale distributed systems • Off-grid systems • Must consider optimal panel tilt for efficiency and protection from extreme weather events • Must incorporate corrosion- and wind-resistant components	• Cost • Integration • Variability	• **Proceed with Layon Landfill Solar Facility**	N
			• **Rebate for residences**	M
			• **Microclimate studies specific to planned PV sites**	M
Sea Water Air Conditioning (SWAC)	• District cooling system	• Few commercial examples • High initial cost	• **Feasibility study**	M
			• **Develop a business plan for implementation (permitting, financing, etc.)**	L
			• **Contract procurement**	B
Geothermal	• Direct use geothermal • Electricity production • Heat pumps	• May not be cost-effective • Uncertainty over resource availability	• **Assess geothermal potential**	M
			• **Environmental, economic, and interconnection studies**	B

Table 3. Technology Strategy: Transportation

N = NEAR-TERM M = MID-TERM L = LONG-TERM B = BEYOND

TRANSPORTATION				
TECHNOLOGY TYPE/GOAL	**TECHNOLOGY EXAMPLES**	**BARRIERS**	**STRATEGIES**	**TIME FRAME**
MILES TRAVELED REDUCTIONS	• Public transportation system • Bicycle and pedestrian travel • Work from home and carpool programs	• Funding • Coordination between multiple sectors • Reliance on personal automobiles • Behavior change	• **Rideshare website**	**N**
			• **Bike route designation**	**N**
			• **Education for alternative transportation**	**N**
			• **Coordination plan for taxis and GRTA**	**N**
			• **Bus tracking and coordination**	**N**
			• **Telecommute**	**N**
			• **Bike share system**	**N**
			• **Coordinate ADA compliance with biker and pedestrian friendly facilities**	**N**
			• **New buses and routes**	**N**
FUEL ECONOMY IMPROVEMENTS	• High miles per gallon vehicles • Efficient road system (reduce stopping events) • Hybrid vehicles	• Lack of knowledge of fuel saving practices • Inefficient vehicle fleet • Cost of fuel efficient vehicles	• **Registration fee/rebate to encourage purchasing efficient vehicles**	**M**
			• **Education campaign for fuel economy**	**N**
			• **Motorcycle and bicycle safety plan**	**N**
			• **Mobile emissions testing**	**M**
IDLE TIME REDUCTIONS	• Auxiliary power (Shorepower)	• Lack of knowledge of idling impacts • Difficulty in enforcing idling policies	• **Idle reduction limitations for trucks and school buses**	**M**
			• **Auxiliary power (Shorepower) for passenger buses**	**M**
ELECTRIC VEHICLES	• Electric vehicles • Electric/solar-electric charging stations	• Cost • Fleet turnover rate	• **EV trial fleets**	**L**

TRANSPORTATION				
TECHNOLOGY TYPE/GOAL	TECHNOLOGY EXAMPLES	BARRIERS	STRATEGIES	TIME FRAME
BIODIESEL	• Waste grease and coconut oil esterification	• Collection and farming systems • Processing infrastructure	• **Improved enforcement of grease disposal laws**	N
			• **Waste grease to biodiesel**	M
			• **Coconut oil to biodiesel**	M
			• **Construct a new biodiesel refinery for coconut oil processing**	L
TRAFFIC FLOW IMPROVEMENTS	• Traffic signal coordination	• Funding	• **Central coordination center**	N

Table 4. Technology Strategy: Energy Supply Diversification

N = NEAR-TERM M = MID-TERM L = LONG-TERM B = BEYOND

ENERGY SUPPLY DIVERSIFICATION				
TECHNOLOGY TYPE	TECHNOLOGY EXAMPLES	BARRIERS	STRATEGIES	TIME FRAME
LNG (WILL NOT CONTRIBUTE TO FOSSIL FUEL REDUCTION GOAL)	• Import terminal • LNG open rack vaporizers or submerged combustion vaporizers • Dual fuel generators	• Capital cost • Investment risks • Conversion of existing system	• **RFP to acquire a bidder for land, permitting, engineering, commissioning, warranties, and O&M**	M
			• **Reduce risk: design build or design build operate approach; fixed price contract; contract with one lead contractor; convert existing units early to dual fuel ability**	L

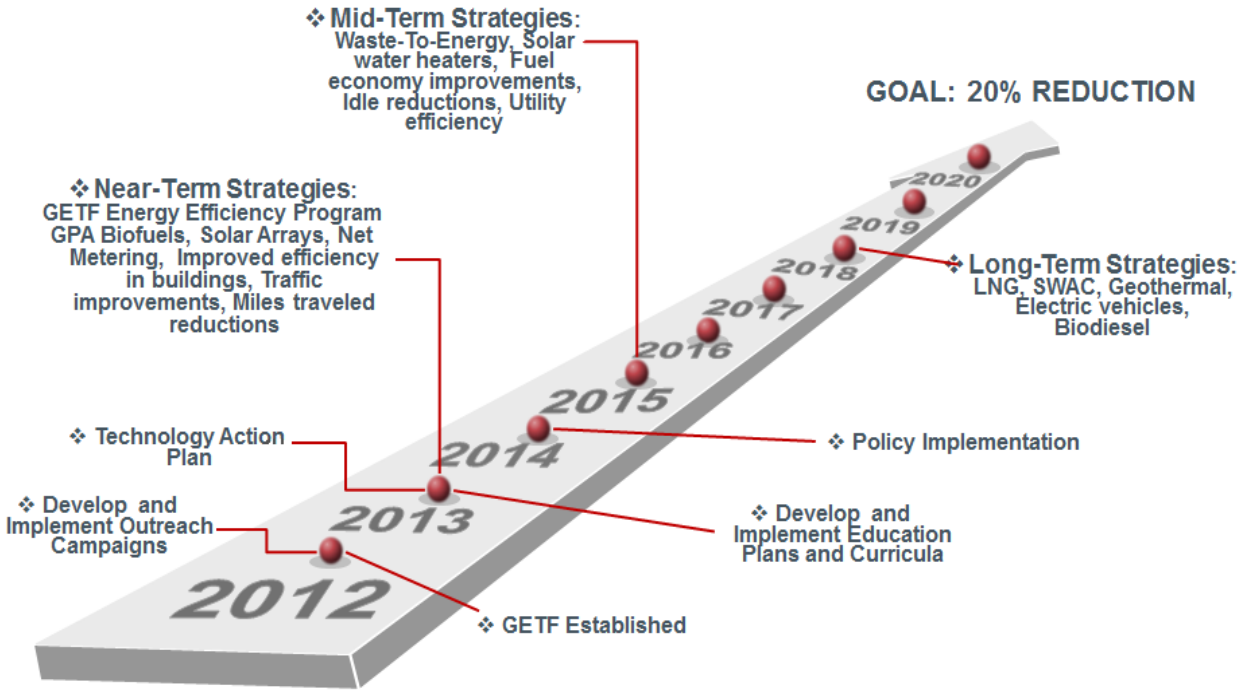

Figure 5. Timeline for achieving the energy goal

CONCLUSION: SHIFTING PARADIGMS

Guam is taking a bold step to increase energy security and strengthen its economy. In doing so, Guam seizes an opportunity to lead, charting a course for other islands to follow as they journey toward energy transformation.

Guam is envisioning ways to change how consumers make their purchasing decisions based on habit, cultural norms, and old ways of thinking. Creating new realities in which utilities make decisions based on a new green economy and "three generation thinking;" setting out on implementing policy strategies for legislators which will transcend policies originally based on political "experience" and party-line thinking and asking financiers to embrace the "Triple Bottom Line," instead of making investments based on traditional methods of risk assessment and analysis.

In order to evolve beyond the status quo:

- Consumers need to expand their knowledge of green energy technologies and make informed, sustainable choices
- Utilities will need to open the door to new ways of doing business, such as increasing efficiency, encouraging energy conservation, and interconnecting with distributed generators
- Governments will need to shift their focus from politics to the public interest by striving to reduce energy costs, developing sustainable energy policies, and embracing new, commercially proven technologies
- Investors will need to take advantage of incentives, such as RE subsidies, and take a long-term view when weighing the risks and returns of energy projects.

Most importantly, Guam is beginning to understand the criticality of energy security and embrace sustainability by actively supporting clean energy goals. Energy transformation involves a revolutionary shift in how entire communities think about and use energy.

APPENDICES

A.1. A Model for Energy Planning

The ETF subcommittees are participating in the community energy planning process described below and shown in figure 6.

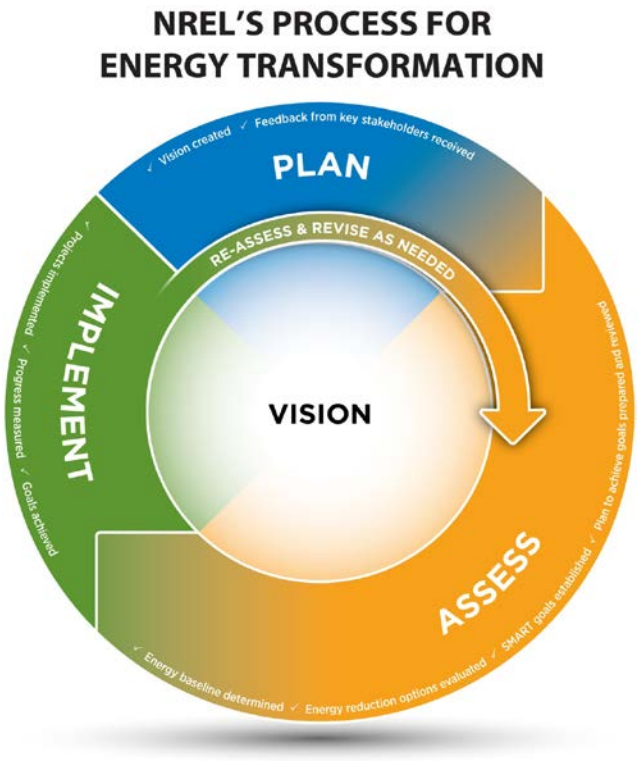

Figure 6. NREL's process for energy transformation

PLAN

The planning phase includes these steps:

- Identify and bring together stakeholders
- Develop a vision for the community's energy transformation.

ASSESS

The assessment phase includes these steps:

- Determine an energy baseline
- Evaluate options
- Develop goals
- Prepare an energy plan
- Solicit feedback on the plan from a broad set of stakeholders.

The goals of this phase are to:

1. Determine the community's energy baseline
2. Establish specific, measureable, attainable, relevant, and time-bound goals for energy transformation
3. Put the goals into a plan for action.

IMPLEMENT

The implementation phase includes these steps:

- Develop, finance, and implement projects
- Create early successes
- Evaluate effectiveness and revise as needed.

The goals of this phase are to:

1. Implement projects that can build community support for ongoing and future energy projects
2. Measure the progress and effectiveness of the plan and its projects.

A.2. Framework for Project Standardization

Reduce investor uncertainty by adopting a project development framework such as NREL's SROPTTC™[4] to examine the key issues and identify next steps towards resolving them. The following methodology outlines SROPTTC™:

- **Site —** Identify the physical location for the physical assets of a project, including property rights, length of tenure, terms and conditions, etc.
- **Resource —**Characterize and understand the renewable resource being considered.
- **Off-take —**Establish and secure by contract the buyer of both the energy and any other characteristics of output (e.g. renewable energy credits.
- **Permits —**Identify and obtain all permits necessary for project construction and operation.
- **Technology —**Invest in engineering design, equipment selection, and procurement activities of the chosen technology.
- **Team —**Assemble a fully qualified team that addresses all business, technical, financial, legal, and operational aspects.
- **Capital —**Attract financial resources necessary for final development, construction, commissioning, and initial operations.

[4] http://www.nrel.gov/tech_deployment/project_development_model.html

A.3. Reduction Scenarios – Wedge Analysis

Methodologies and Assumptions

The wedge analysis was done using information provided from the Guam Power Authority and various stakeholders to establish a business as usual (BAU) case or base case. From this, and information gathered for the *Guam Initial Technical Assessment Report*, low- and high-impact scenarios were created reflecting 20% and 53% fossil fuel reduction and then compared to the base case. The wedge assumes a linear 0.119% growth in electricity consumption in the future, a rate that was calculated from utility data from the last ten years of consumption. The wedge analysis, while including some small specific renewable energy projects, is designed for high level analysis to depict potential fuel reductions from various commercially available and ready-to-deploy technologies. It assumes no major fluctuations in fuel prices by estimating the average fuel cost for the past ten years.

Base Case

Under the base case (figure 7), it is assumed that no significant steps are taken to curb fossil fuel use. It depicts the energy use in a business as usual scenario, and is used to compare the potential impacts of deploying energy efficiency measures and alternative technologies. The base case reflects the fact that Guam's electricity is generated mainly from fossil fuels.

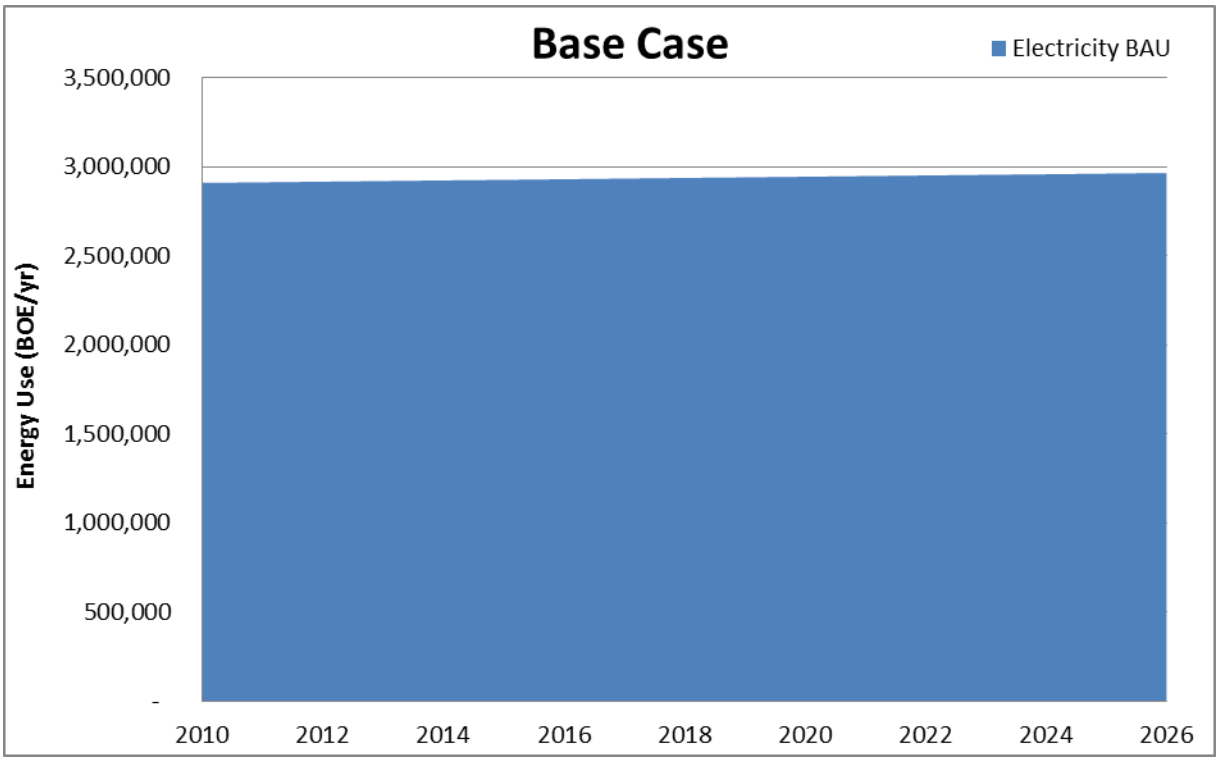

Figure 7. Base case

Figure 7 illustrates the consumption of electricity in barrels oil equivalent (BOE) through 2026. This chart assumes 5,800,000 British thermal units (Btu's) for every barrel of oil. The unit of measure, barrels of oil equivalent, indicates how many barrels of oil would need to be consumed to meet the demand for electrical energy.

20% Reduction Scenario

Figure 8 illustrates one potential path to reducing fossil fuel consumption by 20%. The top of the graph represents the same linear increase as the base case. The red wedge shows the direct reduction of energy not needing to be produced due to potential efficiency improvements in generation and/or end-use consumption. The green wedge represents the potential contribution of various renewable energy technologies to the 20% reduction in fossil fuel consumption.

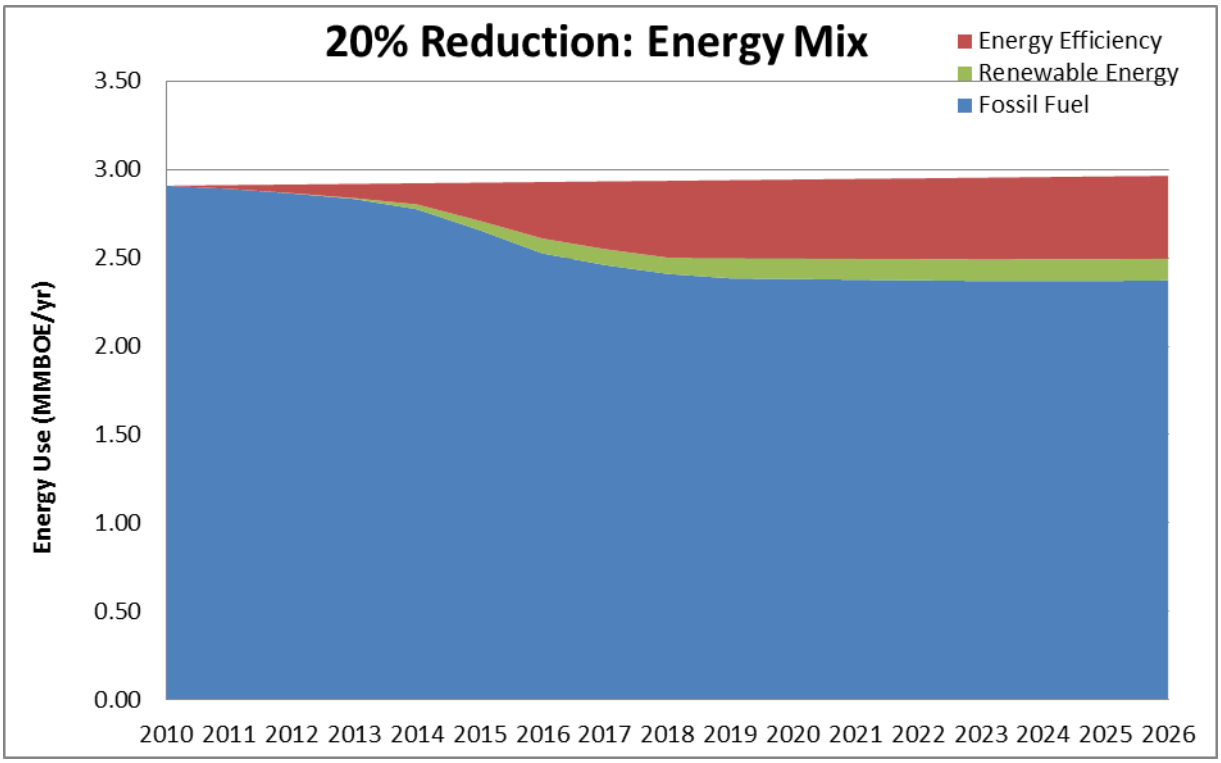

Figure 8. 20% reduction: energy mix

Figure 9 represents the same information shown in figure 8 but in more detail. It shows how several renewable energy technologies, and energy efficiency actions in specific end-use sectors, could contribute to the overall reduction of fossil fuel consumption in Guam. Note that the legend is in the same order as each wedge is stacked. Similarly, the area cut out by energy efficiency improvements matches that of the red wedge in figure 8; additionally, the renewable energy wedge matches the same area in both charts.

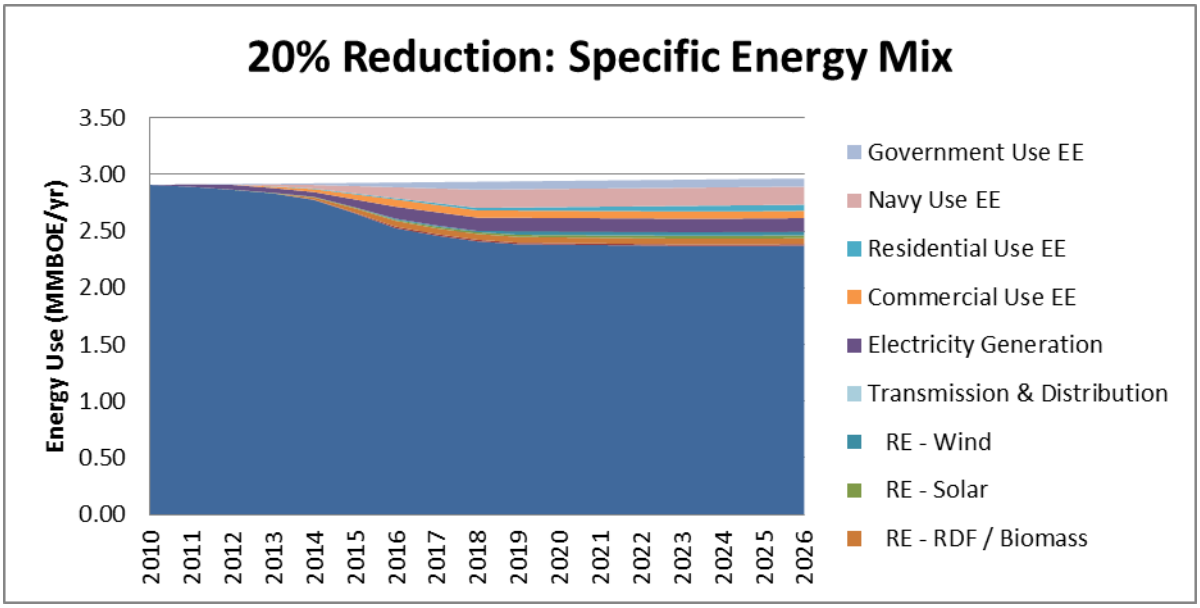

Figure 9. 20% reduction: specific energy mix

53% Reduction Scenario

The high-impact scenario (figure 10) was determined by considering strategies that could meet a 53% fossil fuel reduction goal. The top of the graph again assumes the linear increase as the base case. The red wedge shows the direct reduction of energy not needing to be produced due to efficiency improvements in generation or end-use consumption while the green wedge represents the contribution of various renewable energy technologies to the reduction in fossil fuel consumption.

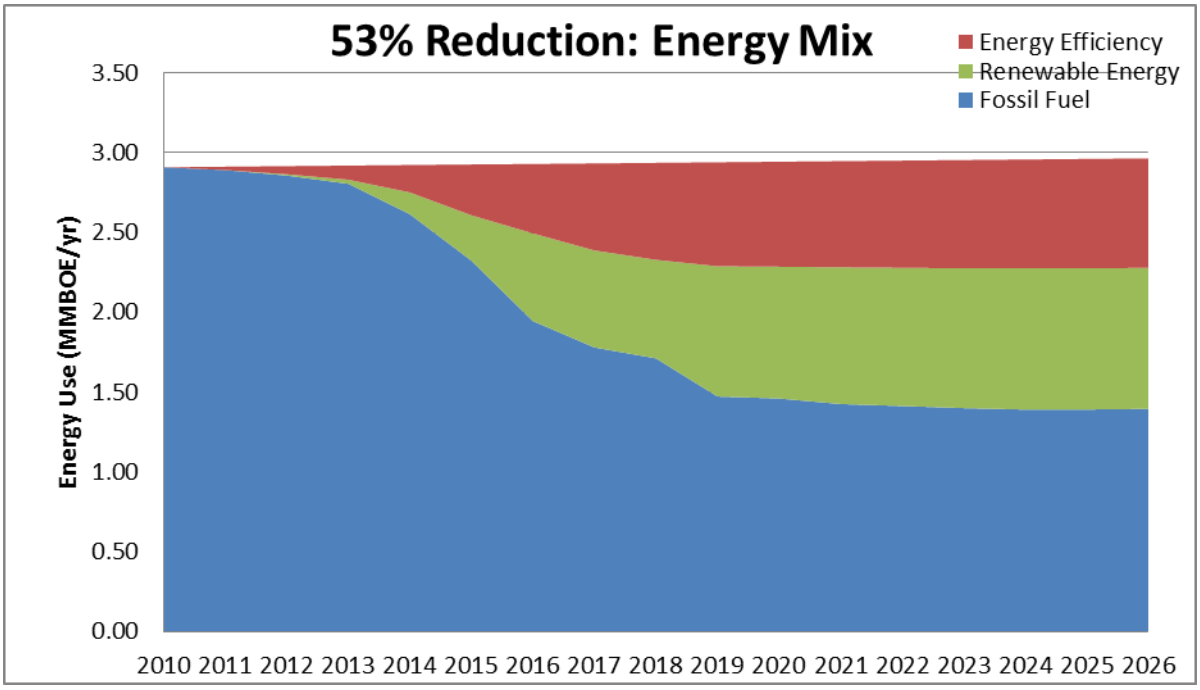

Figure 10. 53% reduction: energy mix

Figure 11 represents the same information shown in figure 10 but in more detail. It shows how several renewable energy technologies, and energy efficiency actions in specific end-use sectors, would contribute to the overall reduction of the fossil fuel consumption in the energy portfolio for Guam. Note that the legend is in the same order as each wedge is stacked. Similarly, the area cut out by energy efficiency improvements matches that of the red wedge in the low impact energy mix chart above; additionally, the renewable energy wedge matches the same area in both charts.

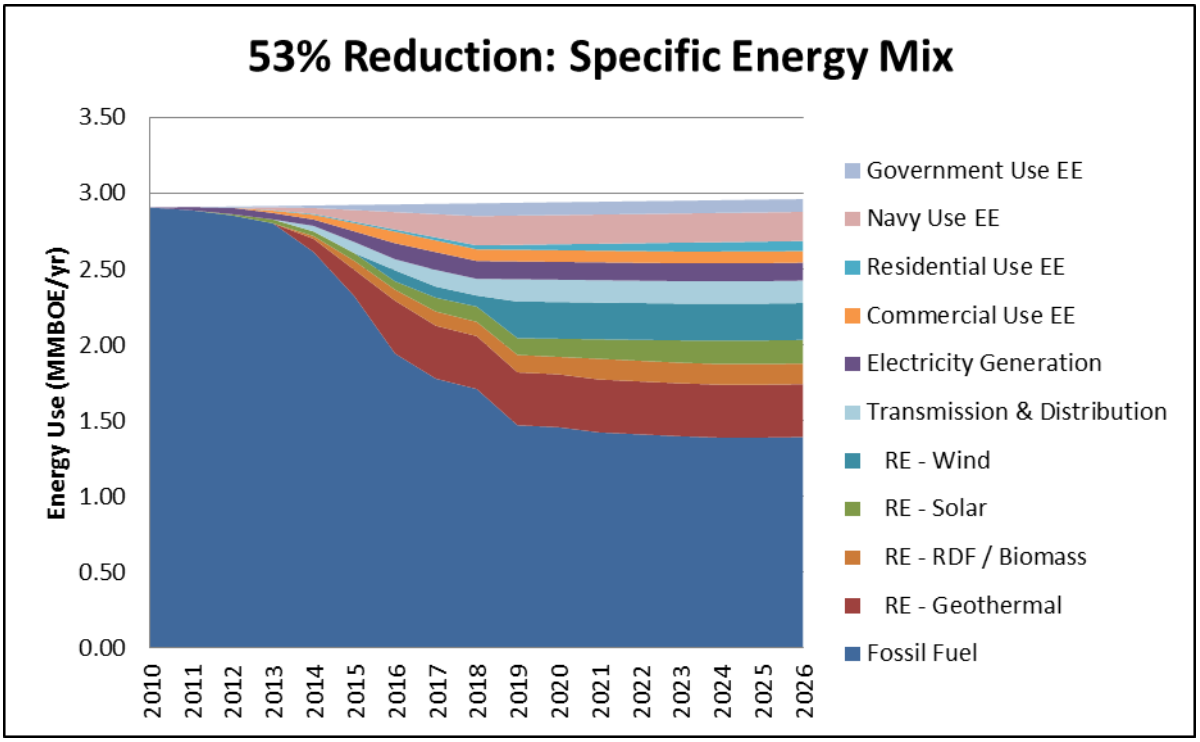

Figure 11. 53% reduction: specific energy mix

Comparing all scenarios, one can see how implementing a wide range of energy efficiency and renewable energy technologies over time can reduce fossil fuel consumption and begin to paint a picture of sustainability. Strategy implementation takes time and so does project development. Change does not happen overnight, but with decisive goals and clear action steps, change will be incremental.

A.4. Proposed Transportation Projects

Proposed transportation projects[5] are listed in table 5, ranked first by cost (low to high), then by anticipated impact on petroleum reduction (high to low), then by popularity (high to low), then by speed of implementation (fast to slow).

Table 5. Transportation Projects by Rank

Rank	Strategy	Project	Cost	Petroleum Reduction	Popularity	Time Frame
1	Vehicle Miles Traveled (VMT)	Rideshare website	Low	High	High	Fast
2	Biodiesel	Waste grease to biodiesel	Low	High	Med.	Fast
3	Idle Reductions	Idle reduction initiatives for delivery trucks and school buses	Low	High	Med.	Med.
4	Fuel Economy	"Feebate" for improved fuel economy	Low	High	Low	Slow
5	VMT	Bike Route	Low	Med.	High	Med.
6	Fuel Economy	Education campaign for fuel economy	Low	Med.	Med.	Med.
7	VMT	Education campaign for alternative transportation	Low	Med.	Med.	Med.
8	VMT	Coordination plan for taxicabs and GRTA	Low	Med.	Med.	Med.
9	Fuel Economy	Guam motorcycle and bicycle safety strategic plan	Low	Low	Med.	Slow
10	VMT	Bus tracking and coordination system	Med.	High	High	Fast
11	VMT	Telework	Med.	High	High	Med.
12	Fuel Economy	Mobile emissions testing facility	Med.	Med.	Low	Med.
13	VMT	Bike share system	Med.	Low	High	Fast
14	Idle Reductions	ShorePower for buses	Med.	Low	High	Med.
15	VMT	Coordinate ADA compliance with bike- and pedestrian-friendly facilities	Med.	Low	Med.	Fast
16	Biodiesel	Coconut oil into B5	Med.	Low	Med.	Slow
17	VMT	New buses and routes	High	High	High	Fast
18	VMT	Port pipeline project	High	High	Low	Med.
19	Flow	Traffic signal coordination	High	Med.	High	Med.
20	Electric Vehicles	EV trial fleets	High	Med.	Med.	Med.

[5] Johnson, C. (2013). *Guam Transportation Petroleum-Use Reduction Plan*. NREL Report No. TP-7A30-57191.

PHOTO CREDITS

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