# Commonwealth of the Northern Mariana Islands

# Strategic Energy Plan

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**NOTICE**

# CONTENTS

# BACKGROUND

The Commonwealth of the Northern Mariana Islands (CNMI) is a Commonwealth of the United States that is geographically isolated from the mainland United States. It is an archipelago that consists of 14 islands located north of Guam in the North Pacific Ocean (roughly 15º N, 145º E). This isolated location makes fossil fuel importation and new project development a challenge, underscoring the need for a reduction in fossil fuel use by tapping indigenous energy resources.

With the exception of a few small renewable energy systems, the CNMI is completely dependent on fossil fuels for meeting its energy generation needs. There are no natural oil reserves in the islands, forcing the CNMI to import all of its fuel oil at high shipping rates and fuel prices.

As a result of the economic impacts of fluctuating energy prices — including the record high price for oil in 2008 — and current global economic instability, the CNMI recognizes the need to address energy consumption and the associated costs of energy. Energy security is also a priority and by reducing the need for imported fossil fuels and investing in indigenous resources, the CNMI can develop a future that is economically sustainable.

All of the electric power plants in the CNMI are powered by diesel fuel. The Commonwealth's population has declined dramatically over the past decade and is likely to decrease further as new immigrant worker laws take effect. This, combined with a reduction in tourism visits, has resulted in a smaller electric utility customer base, which may require additional electricity rate increases to cover electricity production and other fixed utility operating costs.

The CNMI has few non-renewable resources. Relying almost 100% on fossil fuel imports, the CNMI is subject to substantial volatility in fuel pricing and availability that impacts security, the environment and economic viability. However, the unique situation of the CNMI also offers many ecological advantages as the Commonwealth has diverse sources of alternative energy which can be cost-effective compared to current electricity generation. These resources also provide long-term fuel-price stability and offer other environmental and health benefits resulting in reduced air emissions, waste reduction, and conservation of water resources.

# 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 the CNMI, American Samoa, and Guam. CNMI delegates from the Governor's Office, the Commonwealth Utilities Corporation (CUC) and the Northern Marianas College (NMC) 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 CNMI Governor established an 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[1] for CNMI that detailed energy consumption and production data and established an energy baseline. This

[1] Ian Baring-Gould et al., *Commonwealth of the Northern Mariana Islands Initial Technical Assessment Report*. National Renewable Energy Laboratory, NREL/TP-7A40-50906, July 2011. http://www.nrel.gov/docs/fy11osti/50906.pdf

assessment was used to conduct an energy analysis that estimated the energy efficiency and renewable energy potential for the CNMI.

The *Commonwealth of the Northern Mariana Islands Initial Technical Assessment Report* was published in July 2011, and was used by the CNMI Energy Task Force (ETF) as the starting point for developing this strategic energy plan.

# THE CNMI ENERGY TASK FORCE

## VISION

To create a sustainable energy future for the CNMI.

## MISSION

The CNMI ETF is charged with development and oversight of a strategic energy plan for the CNMI with the overarching goals of reducing dependence on imported fossil fuel and establishing a sustainable energy solution for the Commonwealth in the interest of improving quality of life and promoting economic prosperity. It is anticipated that this strategy will be a living document, evolving as potential energy strategies are tested, and therefore beyond creation of the initial strategic plan. The role of the ETF will be to assess the efficacy of energy strategies implemented and to evaluate and recommend new approaches as appropriate.

# THE STRATEGIC ENERGY PLAN: OVERVIEW

This document serves as a starting point for energy planning and builds upon various prior resource assessments.[2] This strategic energy plan addresses a range of energy options focusing on energy efficiency and renewable energy technologies, policies, and programs. Various steps are presented, including ready-for-action opportunities as well as those that that require further investigation. This plan will serve as the foundation for formulating actions and implementation strategies.

This plan presents three future scenarios regarding the energy efficiency and renewable energy technical potential in the CNMI — a base case, a low-impact scenario (20% reduction in fossil fuel consumption), and a high-impact scenario (53% reduction in fossil fuel consumption). The purpose of this scenario exercise is to show what CNMI's energy portfolio could look like by the year 2026. Using industry-standard profiles and potentially achievable targets in CNMI's energy technology portfolio, various scenarios of end-user energy efficiency, supply-side efficiency improvements. and use of renewable energy were modeled to produce outputs that provide a visual picture of the opportunities. The scenarios are not prescriptive, they are tools designed to serve as a guide. As the CNMI ETF develops opportunities, with it will come an understanding of the costs and benefits that will play an influential role in implementation. The results displayed here should be viewed with this in mind and followed by more detailed economic and power system studies.

Sound energy planning involves evaluating three different aspects of project development simultaneously: (1) the available technology options, (2) policies, programs and incentives that are needed to ensure the success of the project, and (3) financing mechanisms. This is sometimes referred to as the three-legged stool of energy planning. Without considering all three aspects, a project is unlikely to succeed.

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[2] http://www.nrel.gov/docs/fy11osti/50906.pdf; http://www.doi.gov/oia/reports/upload/U-S-Insular-Area-Energy-Assessment-Report-2006.pdf

# APPROACH

This section reiterates the parameters of the energy study and planning process as originally outlined in the *Commonwealth of the Northern Mariana Islands Initial Technical Assessment Report*. Certain topic areas, such as transportation and water systems, are important to overall energy strategies but were not considered in detail within the CNMI assessment due to lack of data on energy use by these sectors and the priority of targeting energy efficiency and renewable energy opportunities.

There are many energy efficiency and renewable energy technologies on the market today. Included within the technical assessment's parameters were mature technologies that are commercially available. There are other technologies that the CNMI may decide to investigate for future study, some of which are included in the Other Energy Strategies section, but for the basis of this strategic plan, technologies included have the following criteria:

- Commercially available
    - Tested and demonstrated
    - Carry warranty
    - Service and parts available
- Ready for immediate deployment
- Demonstrated to be a sound investment
- Financing available from private sector organizations.

There are a number of power generation options potentially available to the CNMI including diesel, heavy fuel oil, liquefied natural gas, and nuclear technologies, as well as renewable energy technologies such as solar, wind, biomass, waste-to-energy, and geothermal energy. Each of these technologies has its own operational characteristics, initial and operational costs, implementation time horizon, and near- and long-term environmental impacts. Most power generation choices require a large investment that can impact a community for many years. For these reasons, any technology choice should be identified through a process of strategic energy analysis to help ensure that the most appropriate choices are made for current and future generations of the Commonwealth. Increased power generation is not the only option to address the Commonwealth's energy challenges. Energy conservation and efficiency is a cost-effective method to potentially reduce the need for increased investment in electricity generation.

For the purposes of this document, commercial clean energy technologies considered include energy conservation and efficiency, wind, solar (photovoltaic [PV] and water heating), biomass, and geothermal technologies. NREL did not assess opportunities associated with other renewable energy technologies such as ocean thermal energy conversion, off-shore wind, marine hydrokinetic energy, or nonrenewable technologies such as nuclear, coal, and natural gas. The nonrenewable technologies of particular interest to the Energy Task Force (ETF) have been included in this plan and should be investigated by the task force.

This plan discusses renewable energy and energy efficiency technology potential as well as current barriers and opportunities. Further investigation is needed to quantify the impact of specific technologies, programs, and/or projects. Environmental, regulatory, legislative, and financial considerations will also need to be addressed during the project development process. Technologies and markets are constantly changing and evolving. Continual reevaluation of options and strategies is necessary.

# REDUCTION SCENARIOS – WEDGE ANALYSIS

The purpose of this "wedge" analysis is to show, in graphical form, the likely impact of measures taken to reduce the use of fossil fuels over the period 2010 to 2026. After an alternative technology or policy is implemented, it creates an irregular-looking wedge on the graph, hence the name given to this type of analysis.

## METHODOLOGY & ASSUMPTIONS

The wedge analysis for the CNMI was performed by NREL using information provided by the Commonwealth Utilities Commission and various stakeholders to establish a "business as usual" or base case. From this, and information gathered for the *Commonwealth of the Northern Mariana Islands Initial Technical Assessment Report*, low- and high-impact scenarios were created reflecting 20% and 53% fossil fuel reduction compared to the base case.

The wedge assumes no annual growth in energy consumption over the 16-year period as there has been declining demand over the past several years. Energy usage is assumed to remain level due to the uncertainties regarding if there will be further decreases in consumption or potential future economic growth over that time period.

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 calculating the average fuel cost for the past ten years.

As this strategic plan is focused on fossil-fuel reduction, the analysis illustrates the consumption of electricity in barrels of oil equivalent (BOE) through 2026, a unit of measure that indicates how many barrels of oil would need to be consumed to meet the demand for energy. The analysis assumes 5,800,000 Btu's for every barrel of oil.

## BASE CASE

The base case does not attempt to curb fossil fuel use. It is a business-as-usual scenario, and is used to compare the potential impacts of deploying energy efficiency measures and alternative generation technologies. The CNMI's electricity usage is almost exclusively from fossil fuel generation, which is why figure 1 shows only fossil fuels.

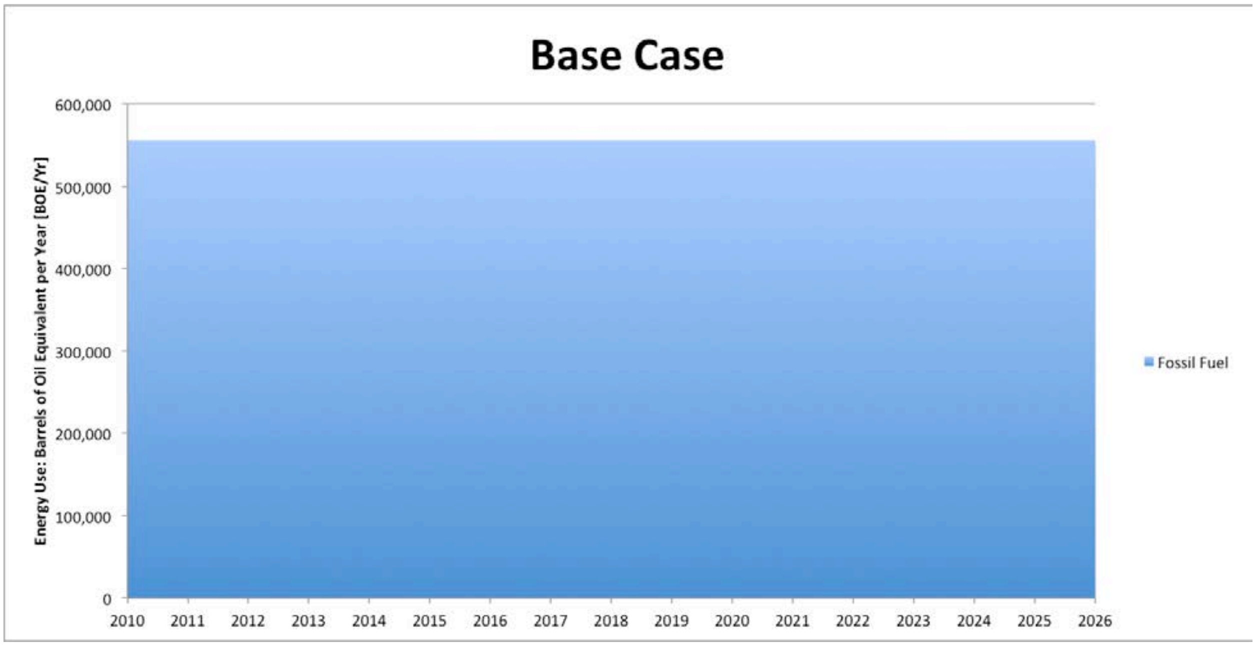


***Figure 1. Base case***

## LOW IMPACT SCENARIO

The low impact reduction scenario (figure 2) was determined by attempting to meet the goal of reducing fossil fuel consumption 20% by 2026, which was deemed achievable based on the initial technical assessment. The top of the graph represents the same linear consumption level depicted in the base case. The red wedge shows the direct reduction of energy not needing to be produced due to efficiency improvements in generation and/or end-use consumption. The green wedge represents the contribution of various renewable energy technologies to the reduction in fossil fuel use.

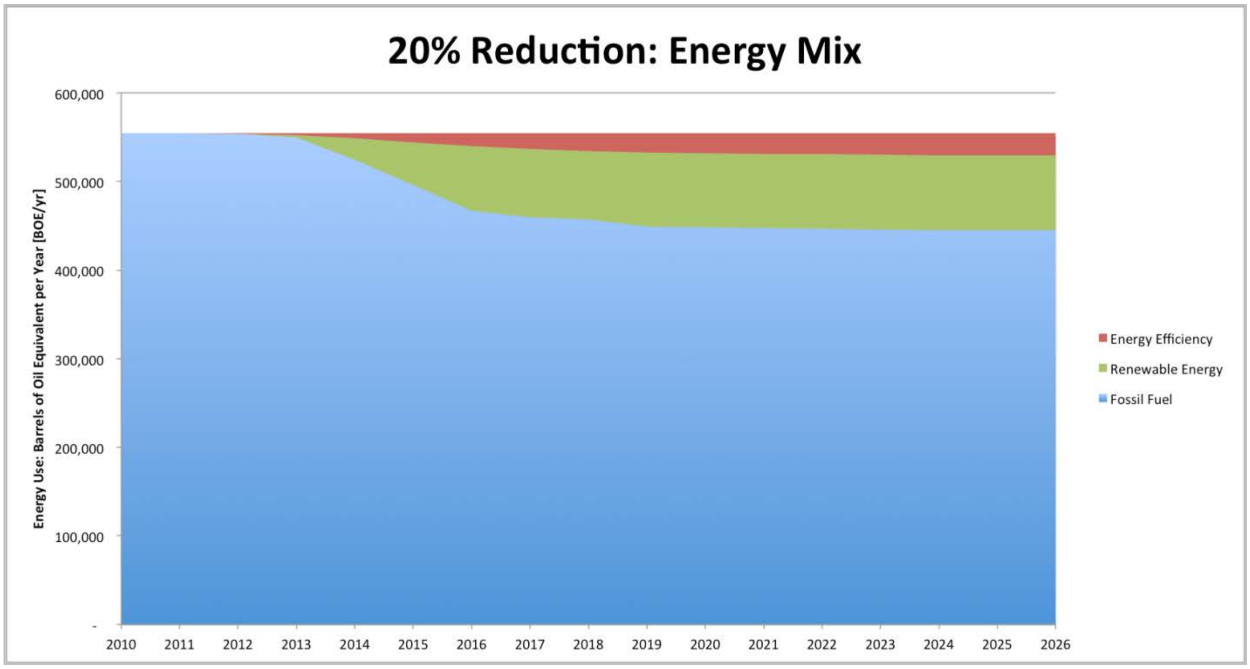


***Figure 2. 20% reduction: energy mix***

Figure 3 depicts the same information shown in figure 2 but in more detail. It shows how individual energy efficiency and renewable energy technologies could contribute to the overall reduction of fossil fuel consumption in the CNMI's energy portfolio. Note that the legend is in the same order as each wedge is stacked. The area cut out by energy efficiency improvements matches that of the red wedge in figure 2; similarly, the renewable energy wedge matches the same area in both charts.

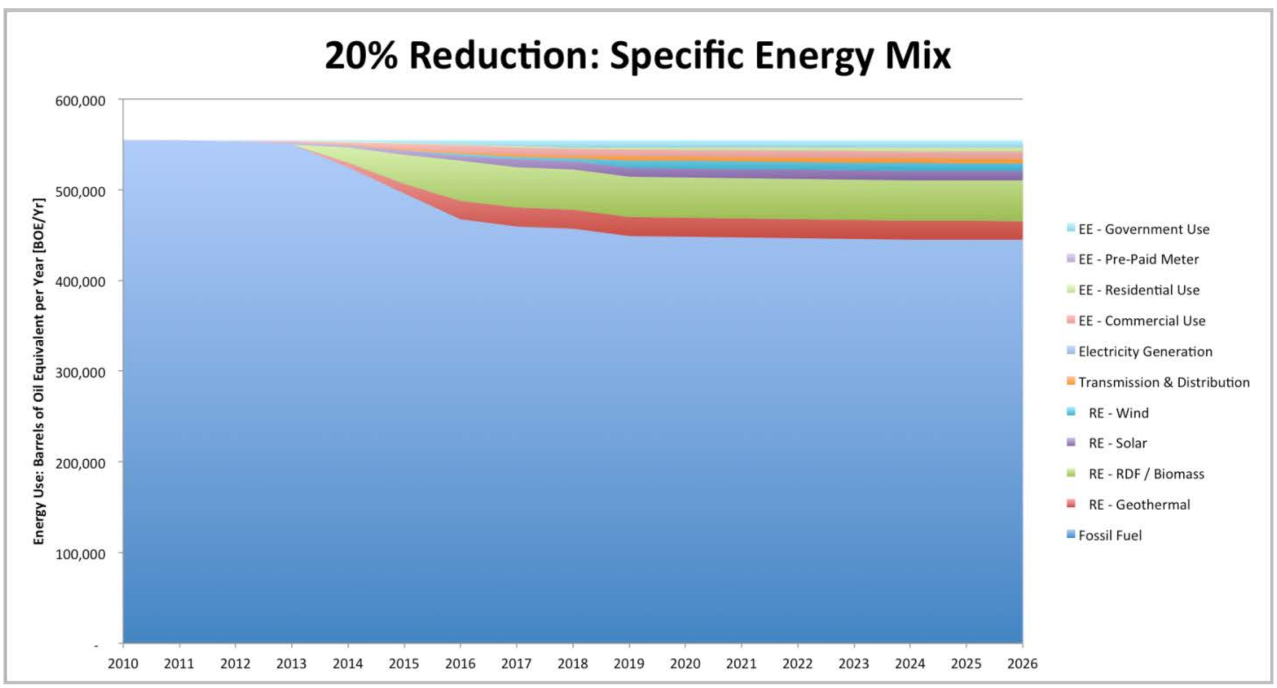


***Figure 3. 20% reduction: specific energy mix***

## High Impact Scenario

The high impact reduction scenario (figure 4) was determined by attempting to meet a 53% fossil fuel reduction goal. Based on initial observations about land availability, likely renewable energy resources, and energy efficiency, NREL established that a 53% reduction in fossil fuel use is potentially achievable, albeit a stretch goal. The top of the graph again assumes the linear consumption level depicted in 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 use.

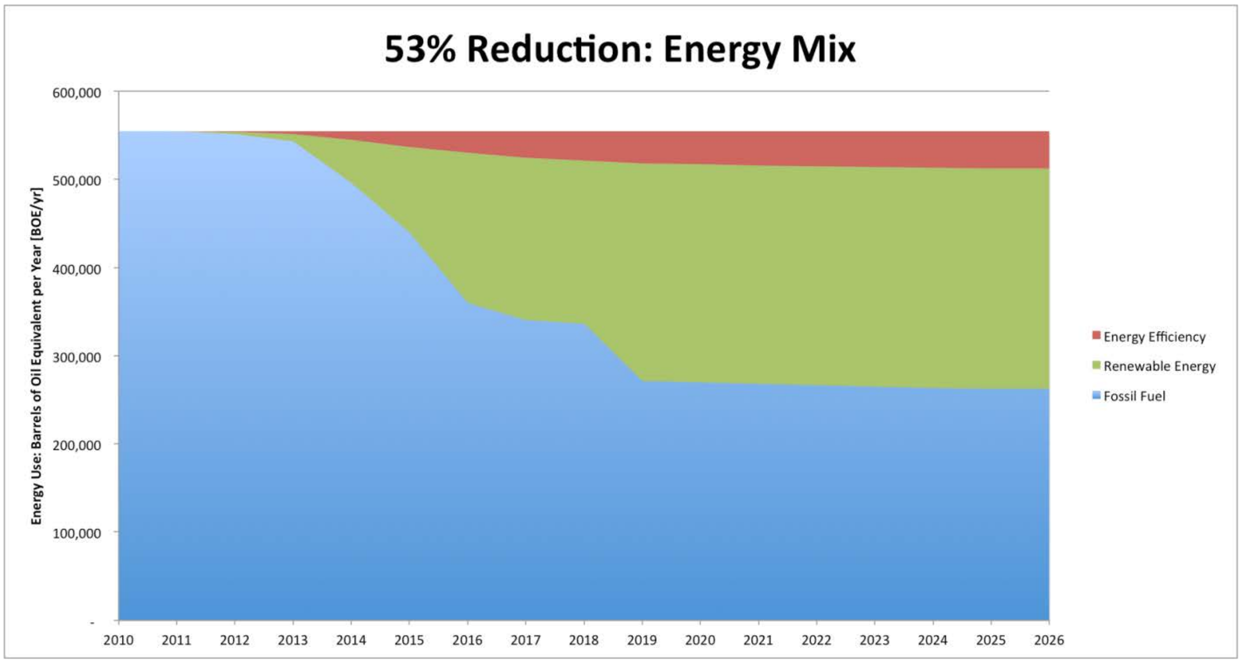


***Figure 4. 53% reduction: energy mix***

Figure 5 depicts the same information shown in figure 4 but in more detail by showing how individual energy efficiency and renewable energy technologies would contribute to the overall reduction of fossil fuel consumption in the energy portfolio for the CNMI. Note that the legend is in the same order as each wedge is stacked. The area cut out by energy efficiency improvements matches that of the red wedge in the low impact energy mix chart above; similarly, the renewable energy wedge matches the same area in both charts.

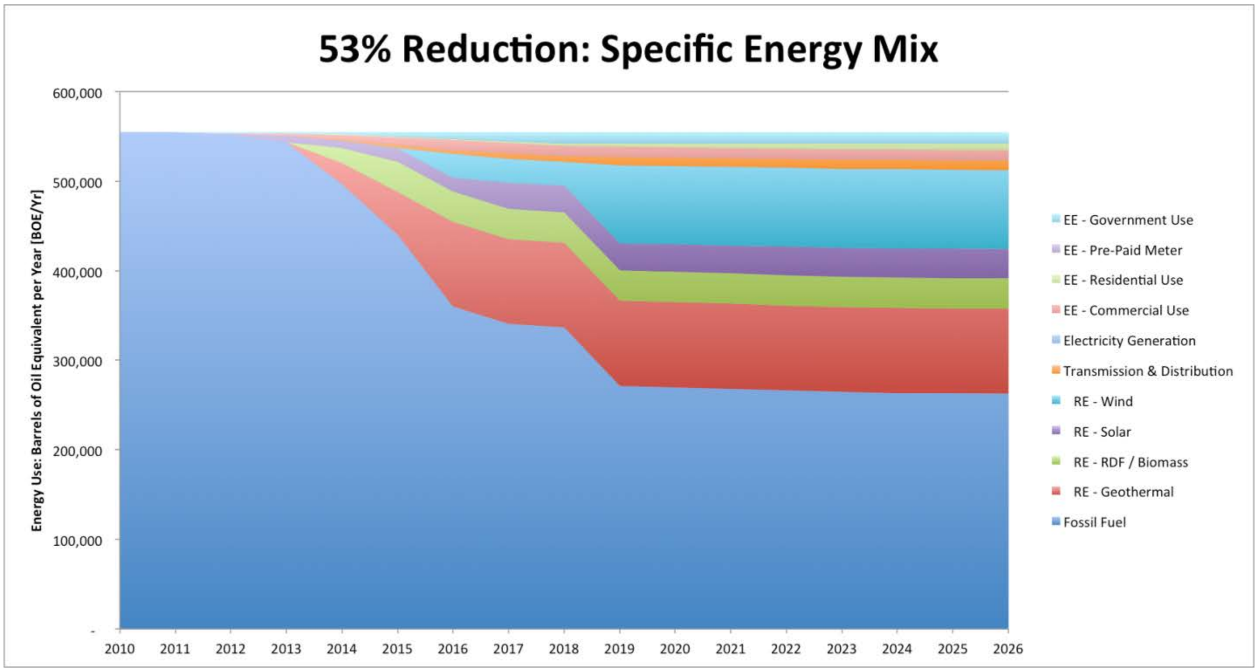


***Figure 5. 53% reduction: specific energy mix***

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.

# COST OF ENERGY

There are several possibilities for reducing the cost of energy in the CNMI:

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. Pursue subsidies for renewable projects
3. Consider opportunities such as peak pricing, grants and subsidies to reduce overall cost of electricity
4. Investigate alternative financing models such as power purchase agreements and energy savings performance contracting.

# 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 the CNMI, 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. Social Awareness and Energy Literacy

Build on current awareness campaigns to increase citizen willingness to accept new technologies, programs and policies by holding educational fairs, creating fact sheets, radio announcements/shows, electronic newsletters, posters, newspaper inserts, stickers and a variety of activities that promote energy literacy from cradle to grave: understanding where energy comes from, how it is moved, used, how to make use more efficient, how to conserve it and its life cycles.

# Education & Training

## 1. Code enforcement & Sector Training

Further educate appropriate sectors responsible for executing codes and enforcement officers for both inspection and enforcement strategies.

Training materials could take the form of curriculum for workshops, handbooks, presentations, websites, and other tools. A training module would need to begin with an assessment of the current level of knowledge and determine areas of the greatest need for improvement. The audience would need to be assessed in advance so that materials could be tailored to be the most effective.

## 2. Courses and Materials

The Commonwealth Utilities Corporation and the Northern Marianas College (NMC) are currently engaged in an apprenticeship program. Use this program to develop training courses and materials for other sectors to improve energy awareness. Energy efficiency in retrofit, renovation, and new construction can be included in design, materials, and equipment.

Buildings would ideally have engaged facilities management staff who monitor the energy consumption prior to and after energy projects, such as a cool roof installation, to measure the change in energy consumption. Furthermore, project experiences can be compared, such as comparing buildings that vary by sector and type of cool roof application, to determine what is most effective at reducing energy consumption.

# POLICY FRAMEWORK AND DEVELOPMENT

Policy is an effective tool in addressing clean energy adoption and subsequent development, and the process of policy development addresses the interconnectedness of social concern. 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 contain the 'what' and the 'why', procedures or protocols contain the 'what', the 'how', the 'where', and the 'when'. Policies are generally adopted by a senior governance body or the board of an organization. Procedures or protocols are developed and adopted by senior executive officers.

A precursor in directing the CNMI's energy transformation is to review and revise energy-related policies. Energy policy mechanisms are used to provide support for the development of programs that advance local energy efficiency and renewable energy objectives. The CNMI's government has adopted new, and modified existing, energy efficiency and renewable energy policies over the past few years. Public Law (PL) 15-23, adopted in 2006, set forth a range of energy policies to encourage the use of renewable energy and incorporate energy efficiency in both the private and public sectors. Since that time, PL 15-23 has been amended and new energy policies have been enacted. Reviewing the existing policies for effectiveness, making revisions where needed to increase impact, and developing programs to implement the policy objectives will greatly assist in achieving the CNMI's energy goals.

Below is an outline of current energy policies and policies that could be considered to help the CNMI meet their goal of increasing use of energy efficiency and renewable energy, increasing energy supply diversity, and reducing dependence on imported fossil fuels.

**Clean Energy Policy Considerations for the CNMI**

- Renewable Portfolio Standard
- Energy Efficiency Portfolio Standard
- Lead By Example
- ✓ Latest Building Codes
- ✓ Energy Codes
- Permitting and Siting Standards
- ✓ Net Metering
- ✓ Interconnection
- ✓ Residential Solar Water Heating loan program (new construction)**
- ✓ 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 the CNMI has implemented*
** Denotes ARRA funded items that will end when funding ends*
*** PL 15-26 allows loan program, but not currently implemented*

In order for policies to be effective, it is important that they be robust:

- **Comprehensive -** Barriers to renewable energy are diverse. Growth may be halted from any number of wholly unrelated barriers.
- **Broad-based -** Applies across all types of entities and sectors.
- **Multi-faceted -** Attacks problems and barriers from various angles.
- **Multi-tiered -** Includes mandates or quotas but also addresses siting and permitting.
- **Practical -** Focuses on small victories.
- **Long-term** – Creates the market conditions to build a *real* and *sustainable industry.*

No single policy exists in isolation. Policy success is often determined by the ability to address multi-faceted barriers with the appropriate mix of tools. What is so beneficial about 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 STRATEGIES

## 1. OVERALL ENERGY POLICY

While individual policies have been implemented by the CNMI, the adoption of an overall energy policy is needed. This policy would entail an energy action plan that details, among other things, the goals, strategies, and desired outcomes for the CNMI power system. The policy should also appoint different programs to the proper departments, prioritize strategies, evaluate budgeting and funding for projects, and establish timelines. Until an energy policy is adopted, there is no binding commitment to ensure that the appropriate changes will occur in the CNMI.

## 2. POLICY ANALYSIS

Policy analysis should be conducted on the CNMI's Renewable Portfolio Standard (RPS). Analysis of the RPS will determine if the appropriate goals have been established, the requirements for meeting those goals, and the impact on the CNMI's government, economy, and power system. Additional analyses can also be conducted on any implemented policies to ensure that they are in line with the CNMI's and the ETF's energy goals.

# ENERGY EFFICIENCY STRATEGIES

## BUILDINGS

### 1. Energy Audit Program

There have been plans to set up an energy audit program for the government sector. Implement these plans and begin deeper auditor training. Include training local private companies or trades people with the applicable technical background (for example, electricians, mechanical equipment technicians, etc.) to perform energy audits on different types of buildings. These audits should continue and, where possible, the measures that are applicable to similar buildings should be gleaned from audit reports and implemented across the building stock. A strategy for identifying and implementing the most commonly recommended measures could be a next step, but would require input from the entities conducting the energy and water audits. The audit effort and implementation of results should be prioritized based on a balance of total impact and individual cost savings. This will allow building owners and occupants to make informed decisions about potential energy savings investments.

### 2. Alternative cooling

Cooling is one of the biggest sources of energy use in the CNMI within all sectors. Implementing promising alternative cooling technologies will assist with reducing fossil fuel consumption related to conditioning indoor spaces. There are a number of options available under the umbrella of alternative cooling technologies such as solar air conditioners, desiccant cooling, or opting for a higher SEER rating.

A medium-cost option is to install solar air conditioning units. While relatively new on the market, solar air conditioning units are available from a number of manufacturers and suppliers, and have a variety of different installation applications from split wall window units to larger outdoor units. This technology is an efficient type of air conditioner (upwards from a SEER 20) that operates off of a solar photovoltaic (PV) panel, which reduces the energy demand from the grid during times when cooling and conditioning are needed.

### 3. Cool Roof Program

A cool-roof program could be implemented island-wide by using low-cost technologies, such as elastomeric paint and coatings, which would need to be applied to roofs and maintained through a cleaning program (to prevent debris and mold build-up). Newer materials continue to be available that help resist mold and can be applied both to rooftops and siding. More information about selecting buildings and implementing a cool-roof program can be found on the DOE website[3]. This would provide an implementation mechanism to achieve the CNMI Tropical Building Code requirements.

Another cool-roof approach is to use green roofs where, if structurally sound, a variety of appropriate vegetation is seeded on the roof, acting as an insulator[4].

Facilities in need of roof replacement, particularly if there is a budget for replacement in the near-term, may be most applicable as initial projects. Once this pilot program has been completed, the results should be analyzed and shared with community leaders and the design and construction industry. A strategy should be developed to replicate the most effective cool roof type throughout the building stock, with continued monitoring and savings reports.

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[3] http://www1.eere.energy.gov/femp/features/cool_roof_resources.html
[4] http://www.epa.gov/hiri/mitigation/greenroofs.htm

### 4. Building design

In 2010, the CNMI took a proactive approach to energy efficient new construction by adopting the International Building Code (IBC) energy codes for residential and commercial buildings and a local Tropical Energy Code, which provides requirements based on both the local climate and expertise.

Additional strategies for efficient building design and sustainability include planning and design for use of natural day lighting to minimize electric lighting and cooling loads, dehumidification (or desiccant cooling) to reduce demand on air-conditioning, incorporating cool roof or energy saving roofing materials, using landscaping to shade and designs that maximize tree canopies to reduce heat build-up, and efficient use of water and reduce runoff through the use of natural drainage, landscaping techniques and efficient irrigation systems.

One lower-cost option in buildings with no requirements for conditioning for moisture control is to install ceiling fans. Where moisture buildup is not a concern it may be possible to utilize natural ventilation (from breezes and open structures of windows, doors, etc.), and ceiling fans, which are in operation only when needed. There may be open structures where this could be a suitable option.

Plant 'green roofs' when possible; this may be a lower cost option to consider in building design integration. Where roofs are flat and structurally sound they can be used to plant vegetation, which not only provides a thermal barrier, but also creates a wicking-type action. The wicking of moisture and heat upwards and out of the building is beneficial in reducing cooling loads in buildings.

# RENEWABLE ENERGY STRATEGIES

The initial screening of renewable energy technology potential indicates the likelihood of considerable resource and technical probability. Further resource assessment and grid interconnection analysis will need to be undertaken to determine the specific potential for large scale renewable power generation.

## WIND

### 1. Anemometry studies

This consists of resource assessment combined with data correlation. It would include the installation of 50 m or 60 m meteorological masts (towers instrumented to record wind speed and direction) for a minimum of one year on at least one potential site on each of the three main islands. It will also be critical to correlate the wind resource data with any other available local data, including the U.S. Navy Mt. Alifan tower in Guam.

Based on the sites identified in this report, an additional screening of other potential wind sites should be undertaken, either formally or informally. Once all potential sites have been identified, a review process should be undertaken to rank all of the sites based on the following criteria:

- Extent of the wind resource
- Available land and title assessments
- Zoning requirements
- Initial environmental impact assessments, including consultation with USEPA and USFWS
- Initial FAA review of prospective sites
- Geotechnical assessments
- Initial grid interconnection, road access and infrastructure assessment

Utilize the existing data from recent wind installations.

**2. Initiate an active social acceptance outreach and education activity around wind**

For successful project development it will be critical to educate the local community around the deployment of wind technologies in the CNMI, potentially building on the current planned developments at Southern High and other public schools on Saipan. This would include performing a cost-benefit analysis and gathering information regarding potential negative impacts, such as conducting a noise impact assessment, an avian study, and visual simulations for the most likely sites. All of this information should be publically available with open forum discussions conducted by CUC or another organization to identify and address these potential issues. If possible, this should be implemented during the initial assessment phase (within the next year) to avoid the development of potentially inaccurate preconceived notions. These efforts should not directly advocate for a wind project, but should provide fair and unbiased information on the impacts of wind development.

**3. Expand investigation of additional potential sites for community and large wind development**

Given the potential savings that could result from wind deployment on the islands and clear access to a viable wind resource, efforts should be made to identify additional potential sites on each of the islands for wind development. This would include an island-wide screening study using land ownership, resource through an island-wide wind map, environmental sensitivities and restrictions, and known development limitations. This would allow the identification of additional potential locations that could be developed at varying levels of cost. This information would then be used to support longer term strategic planning.

**4. Conduct an initial screening of potential turbine options for typhoon environments**

If wind development is to be seriously considered, an assessment of available equipment as well as a risk assessment considering the frequency of typhoons of different classes will be needed. Through turbine manufacturers or independently, insurance companies could be contacted to determine if insurance policies for wind turbine projects in the CNMI could be obtained and, if so, at what cost.

## SOLAR

**1. Solar Hot Water**

Assign a subcommittee within the ETF to explore possibilities of policies and programs for solar hot water systems for all sectors. Consider creating incentives or other policies for supporting the installation of solar hot water heaters, particularly in high hot water use applications such as hotels, laundromats, and restaurants. Residential water heating programs should also be considered, potentially in conjunction with the local housing authority, such as outlined in PL 15-26.

**2. Solar Data**

Initiate the collection of solar resource data to support public and private development of PV and solar hot water systems. Conduct a feasibility study to analyze the potential for both large- and small-scale PV installations in the CNMI. This can aid in utility planning for new infrastructure including controls, storage, and dispatchable power sources.

**3. Locate areas available and conducive to development**

Conduct a screening assessment of potential large PV application sites as described previously on each of the islands. Consider including a PV interconnection study for high probability sites to support the development of potential sites.

## GEOTHERMAL

Due to the enormous need for clean base-load power and the increasing need for energy diversity, the potential for geothermal power production should be assessed to determine whether it may be a likely technology to implement for the CNMI. Although Saipan itself is not volcanically active, preliminary investigations have shown evidence of elevated water temperatures in existing shallow water wells. This potential evidence of geothermal fluids at shallow depths suggests that geothermal reservoirs may exist at greater depths on Saipan. Further investigation is needed to determine if a geothermal exploration program is warranted. A crucial step will be to drill one or more temperature gradient holes to verify the presence of heat at economically drillable depths.

1. The CUC is moving forward with initial efforts to secure expertise for a temperature gradient test hole drilling program. Near term next steps include evaluation of the capability or modifications required to use a local drill rig, owned by the Water Task Force, to drill test holes up to 3000 feet in depth.
2. Through an RFP process, select a qualified firm to drill one, or preferably more, temperature gradient test holes and analyze the results. This should include a detailed drilling plan that includes protection of aquifers and fluid emissions.
3. Select test hole locations based on screening for accessibility, cost, permitting requirements, and environmental impact.
4. Once the well is drilled and results analyzed, determine a path forward based on the results.

If a sufficiently high thermal gradient is confirmed, it may be possible to attract private sector investment in further geothermal exploration, which could then lead to development of the geothermal resource for electricity generation.

## WASTE-TO-ENERGY

1. Perform a waste composition analysis and use the data to refine estimates of waste-to-energy (WTE) potential.
2. Evaluate other potential sources of feedstock for a WTE plant, including tires, corrugated cardboard and organic matter.
3. Evaluate local recycling efforts, markets, and options and determine potential impacts on the waste stream and the economics of WTE.
4. Conduct a technology search for commercial units operating in the size range needed.
5. Perform an economic analysis of project feasibility. Include evaluation of financing and ownership options – government (CUC, SWMD) vs. private sector and potential sales of renewable energy credits (RECs) and carbon credits, as well as incentives and tax benefits.
6. Evaluate the potential for energy production from landfill gas at the former Puerto Rico dump and the current Marpi landfill.
7. Investigate the potential production of digester gas from agricultural sites and from waste-water/sewage treatment plants.

## BIODIESEL

1. Conduct a survey of waste grease supplies in the CNMI, particularly on Saipan. Determine who produces the material, how it is collected and disposed, what the costs are, and if there are opportunities for a local business to manufacture biodiesel locally.
2. Determine the expected costs of procuring biodiesel from off-island sources.
3. Gather case study data associated with the use of biofuels or vegetable oil in diesel systems in Hawaii, other islands, and other communities.
4. Determine equipment modifications needed to use biodiesel or vegetable oils in the CUC system. Based on other case studies or work done in Hawaii, it would be useful for CUC to conduct a test of biofuel use within its system. This would be a comprehensive assessment that evaluates costs, impacts on heat rates and performance, fuel storage and handling, air emissions, and overall feasibility.
5. Estimate the levelized cost of energy produced from biodiesel in various blends of biodiesel/petroleum diesel percentages.
6. Prepare a report and briefing to communicate results of the detailed assessment.

## BIOMASS

1. Use geographical information systems to filter out all steep lands and developed areas to identify areas not suitable for biomass feedstock production.
2. Overlay land use and vegetation maps to determine current usage of the land base.
3. Evaluate land ownership of large contiguous parcels. The objective would be to identify potential lands suitable for growth of biomass feedstocks. For example, DOD may have the land — whether it is available for purposes of biofuel production would need to be determined.
4. Based on estimated acreage available as well as potential yields of various species, evaluate technical and economic feasibility of producing biofuels or solid feedstocks.

## MICRO HYDROPOWER

Micro hydropower systems use moving water to rotate a turbine to create electricity, and by definition typically produce less than 100 kW of power. With pipelines in place to deliver water to two villages on Rota, micro-hydro systems may be cost effective, and warrant further investigation.

- Conduct a more detailed evaluation of micro hydropower potential on Rota and perform a screening for micro hydropower potential on Saipan and Tinian.

# OTHER ENERGY STRATEGIES

## GRID STUDIES

The parameters of the CNMI grid should be investigated to establish whether grid upgrades might be necessary within the foreseeable future. Hotels and other self-generators may be required to connect to the grid in Saipan, which would add at least 7 MW of demand. Renewable energy is intermittent in nature which could require a flexible generating source for maximum penetration. Energy conservation, efficiency improvements, baseload power generation, renewable energy, and grid upgrades are all interconnected and should be evaluated in tandem in order to ensure the best return on investment. As of 2011, on all three islands, the grid carrying capacity is at least 50% more than the peak electricity load.

## UNDERWATER POWER CABLE BETWEEN TINIAN AND SAIPAN

There could be value in connecting Tinian to Saipan via an undersea cable that would carry electricity between the two islands, which are approximately 5 miles apart. Tinian currently has a peak electricity demand of roughly 5 MW, with a single fuel-oil-based power plant capable of generating 20 MW. Ships from Guam currently supply the plant, as the vessels serving Saipan are too large to dock in Tinian's harbor. One consequence of delivering fuel in this manner is that the plant's fuel cost is 60 cents/gallon more than the fuel purchased by Saipan. It appears that there are good wind resources on Tinian but, according to ETF members, the potential for wind energy development has not been investigated because there is a power purchase agreement that prevents renewables from being installed as long as there is any need for fuel-oil-based generation on the island. It could be a good idea for the ETF to reexamine the agreement to see if there are any options that would permit the use of renewable energy on Tinian.

## MODULAR NUCLEAR POWER

Small modular nuclear reactors (SMRs) have been proposed as another low-emissions option for power generation from nuclear fission, which is the process of splitting the atom to release energy. The generating capacity of current SMR design concepts range from 10 MW to approximately 300 MW, and include sealed "nuclear batteries" that could potentially operate for extended time periods without refueling or maintenance. However, SMRs are not commercially available today and the cost, performance, and safety claims made by proponents are unverifiable. No SMR designs have been licensed by the Nuclear Regulatory Commission (NRC), which has oversight over all civilian nuclear power generation in the United States.

The first prototype SMR in the US, developed by Hyperion Power Generation Inc., is not expected to be completed until 2020. As nuclear power may one day provide a useful contribution to CNMI's energy mix, this option should be reevaluated once (1) the NRC has given design approval to an SMR, and (2) real-world cost data is available.

## ELECTRICITY FROM NUCLEAR FUSION

The ETF has expressed interest in exploring the possibility of hosting a fusion reactor on Saipan. Nuclear fusion is the process of generating self-sustaining reactions from the collision of two or more atomic nucleii, which combine to form new elements, potentially releasing more energy than is used to initiate the reaction. Uncontrolled fusion reactions are used to make nuclear bombs, referred to as hydrogen bombs or H-bombs. Controlled fusion reactions have been investigated since the 1950s in the hope of developing a controllable process that can be harnessed to generate electricity. Theoretically, a fusion reactor could produce anywhere from ten to fifty times more energy than is needed to initiate the nuclear reaction while producing far less radioactive waste than existing nuclear power plants.

There are several research facilities working on fusion technology for civilian power applications. In an effort to accelerate development of nuclear fusion, the European Union, India, Japan, China, Russia, South Korea and the United States are cooperating in the construction of the International Thermonuclear Experimental Reactor (ITER) in France. To date, according to ITER scientists, there have been no controlled fusion reactions that generate more energy than is required to initiate the reaction anywhere in the world. The current record for energy release is a controlled reaction at a facility in the UK that generated only 70% of the input power. The ITER aims to develop a functioning nuclear power plant that could be generating grid electricity from nuclear fusion as early as 2040. Once such power plants are available, CNMI could revisit the possibility of using this technology.

### Liquefied Natural Gas

CNMI has also expressed interest in exploring liquefied natural gas (LNG) as a source of electricity generation. Where natural gas is readily available, gas-fired generating plants are an excellent complement to renewable energy systems. If natural gas is not available locally, it must be imported in liquid form. Traditional LNG infrastructure, which requires import terminals capable of receiving tankers carrying at least 135,000 cubic meters of fuel, can be prohibitively expensive. However, the cost of building an LNG receiving and regasification terminal varies widely depending on the location and facility specifications.

In 2011, Guam Power Authority concluded that an LNG import terminal and storage facility on Guam would cost $207 million. Costs of this magnitude, which do not include distribution pipelines or power plants, could be difficult to recoup unless (1) LNG is virtually the only source of baseload power in the country, and (2) there is substantial demand for electricity. The Dominican Republic, which has one of the world's smallest LNG terminals, runs 555 MW of baseload generation on LNG. Power generation from LNG could make economic sense for grids with lower levels of electricity demand, especially with the introduction of smaller LNG delivery tankers. However, the risks of becoming overly dependent on a single fuel whose prices are highly volatile should be assessed.

### Energy Development in Northern Islands

There is an argument for exploring the possibility of incorporating renewable energy generation in CNMI's precinct 4. Although there are currently only approximately 150 residents on the northern islands of the CNMI archipelago, it is possible that the population could expand in the foreseeable future as a consequence of (1) interest from investors in developing ecotourism on the islands, and (2) a homesteading program intended to expand agricultural production in this precinct. The fact that there has been little prior energy development provides a unique opportunity to ensure that the electricity systems are established sustainably. Care should be taken to regulate the number of ecotourists visiting the islands as excessive ecotourism can damage the environment that the tourists are coming to see. This has already happened in some areas of Hawaii, for example.

## Transportation

Vehicle fuels are expensive in CNMI due to high import costs. Exploring ways to reduce the need for transportation fuels is an important part of a long-term energy strategy for CNMI. A comprehensive approach to reduce the use of vehicle fuels could include (1) reducing miles traveled (e.g., by expanding the public transportation system), (2) improving fuel economy (e.g., by using more fuel-efficient vehicles, coordinating traffic signals to improve traffic flow, and redesigning traffic intersections to reduce stopping events), (3) switching to using electric vehicles (which can be charged using solar power to avoid adding additional burden to the grid), and (4) producing biodiesel from existing on-island resources (as mentioned in the section on Renewable Energy Strategies, above).

## WATER STRATEGIES

Energy costs and savings opportunities for providing potable water, and removing and treating wastewater, should be evaluated. The current water distribution system has been estimated to be losing up to 50% of the water volume due to leaks. This results in a large amount of wasted energy for water pumping. A survey of the water distribution system should be conducted to determine where repairs or replacement is needed.

Additionally, end use water conservation strategies should be encouraged for both residential and commercial water use. The hotel sector and government facilities provide ample opportunity for cost savings.

## WORKFORCE DEVELOPMENT AND EDUCATION

There are several possible approaches to workforce development and education in the CNMI:

1. Develop an educational program about energy (where it comes from, how it moves, etc.), energy conservation, efficiency and renewable energy, sustainability and around any current energy-related programs.
2. Sponsor workshops and invite local builders, architects, homeowners and business owners.
3. Distribute educational materials to schools, libraries, media and other appropriate organizations.
4. Create educational displays whenever possible.

## CONCLUSION

The CNMI has shown commitment to increasing energy security, strengthening its economy, and ensuring the protection of its natural resources by reducing reliance on fossil fuels. The strategies presented in this plan are designed to assist the CNMI with this process in an effort to achieve energy goals in the most efficient and effective manner possible. The wedge model analyses illustrate the reductions that are possible and visualize the path towards a sustainable future.

Education and training will be the building blocks upon which a sustainable future will be built. Energy efficiency, renewable energy, and fossil fuel reductions can be successful with outreach campaigns that will produce an educated and supportive public building local expertise and comprehensive energy policies. The CNMI's first steps are towards establishing these crucial elements.

Energy efficiency strategies will reduce fossil fuel use, thus saving money and strengthening the economy and power system. The CNMI has already taken the initiative by adopting the International Building Code and a local Tropical Energy Code. Additional future actions may include an energy audit program for the government sector, upgrading to high energy efficiency cooling methods, and enacting a low-cost cool roof program to reduce cooling demands.

Energy efficiency can contribute to significant reductions in fossil fuel consumption, but when coupled with renewable energy, these reductions increase dramatically. Energy literacy programs on the benefits of renewable energy can help alleviate public concerns and create support for projects. A next step is that the CNMI’s alternative resources be further studied and assessed for both technical and cost-benefit effectiveness.

The process of creating a sustainable future is ongoing and constantly evolving; it is fluid. It takes dedication, commitment and time, and is accomplished through a robust set of policies and actions. By staying the course towards a common goal of creating a sustainable future, this can be realized. The strategies for achieving the CNMI’s goal not only benefit future generations, but will have an immediate impact on the current well-being and economic viability of CNMI's citizens by creating jobs, strengthening the economy, establishing energy security, and protecting the picturesque environment that is the CNMI.

**PHOTO CREDITS**

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