Integrated Program on Energy Efficiency & Conservation

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NAST Foresight

Thematic Area

Geographical

Overall Strategies

Human Resource
- Capacity building of MSMEs in energy management and conservation
- Capacity building on local development of energy monitoring software & hardware systems
- Strengthening DOST regional offices energy auditor's capability

R&D Technologies
- Establishment of Philippine MSMEs energy profile using innovative methods and technologies
- Selection and adoption of low-carbon technologies for MSMEs application
- Technology demonstration of online energy monitoring and reporting system for government offices
- Local development of energy-efficient devices and equipment (reluctance electric motors, lightings, waste-heat recovery systems, energy data analytics, full energy management control systems)

Facilities / Services
- Establishment of Energy Research and Innovation Center (NICER)
- Establishment of Energy-Efficient Technology Aggregator Hub

S&T Policies
- Development of policy recommendations for MSMEs incentive for the use of energy-efficient technologies

POSSIBLE SOLUTIONS

MILESTONES

2021

2022
- Energy-efficient government offices compliant to GEMP/ RA11285
- Locally developed reluctance motor
- Energy-efficient Tech Research (NICER) preliminary concept proposal developed
- Energy-efficient lighting control systems

2023

30M
- (Smart Energy/ IoT) Monitoring & Network/ IoT) Technology demonstration of energy monitoring systems for government offices
- (Smart devices) Design and development of local energy-efficient electric motors
- Design conceptualization of energy-efficient technology research center (NICER)
- Design and development of energy-efficient lighting control systems

60M
- Energy profiling of Philippine MSMEs using innovative methods and technologies
- (Energy Recovery) Local development of low-carbon technology i.e. heat recovery system/ HVAC energy management systems/ control system software and hardware design
- Energy auditing of **24 large industries in NCR**

2024
- Philippine MSMEs energy profile established
- Low-carbon and energy-efficient technologies adopted for MSMEs application
- Locally developed energy-efficient equipment, management systems and controls
- 24 industries audited (NCR) / food manufacture, plastic and rubber products, electrical/electronics

2025

147M

Energy auditing **of 26 large industries in Region-3**

ESCOs techno-demo of low-carbon technologies for MSMEs

Energy profile establishment (ice plant facilities, food manufacture, logistic facilities)

Installation of smart EMS for selected LGUs (10) and government buildings (10)

2026
- Next-generation energy-efficient technology developed
- Energy-efficient government offices compliant to GEMP/ RA11285

2027

20M
- (Smart Energy) Technology scoping for next-generation energy-efficient systems research and development (lightings, devices, equipment)
- Energy management adoption and exploitation for government offices

2028

VISION
- Cost-competitive locally developed energy-efficient technologies
- Energy-efficient MSMEs and Government Offices

Overall Outcomes

Human Resource
- Technology equipped and energy-efficient MSMEs
- New skills developed on energy management systems software/hardware design
- DOST regional offices energy auditors capacitated on new technology trends
- Increased numbers of energy researchers and developers

R&D Technologies
- New industry business opportunities on the development of local technologies (reluctance motors, EMS control systems, software and hardware systems)
- Increased numbers of energy researrch and development projects

Facilities / Services
- Network and linkages established for local R&D collaboration thru NICER
- Central hub established for energy-efficient technology acquisition (supply and services)

S&T Policies
- Recommended S&T-based policy on the use of energy-efficient technologies

Energy : Micro-hydro Power (MHP) Program

POSSIBLE SOLUTIONS

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Overall Strategies

Human Resource
- Capacity building on Micro-hydro turbine design/fabrication
- Capacity building on Micro-hydro site assessment/evaluation
- Capacity building on Micro-hydro operation and maintenance

R&D Technologies
- New and emerging turbine technologies
- Localization of electromechanical components
- Development of hydrokinetic turbines
- Low-head, low flow hydraulic turbine technology
- Supply-chain analysis of available MHP technologies

Facilities / Services
- Establishment of Micro-hydro Turbine testing facility

S&T Policies
- Development of S&T-based policies for MHP technology

Thematic Areas
- Technology Development
- Application and Demo

Geographical

2021
- Improved capability on MHP fabrication
- Locally developed BOS components
- Bankable MHP system components improved
- Microgrid system utilizing RE resources evaluated

2022
- Simulation and modeling facility
- Improved energy generation through cacading MHP
- Localized micro-hydro electromechanical components

2023
- Hybrid microgrid RE+MHP facility demonstrated
- Low-head and low-flow micro-hydro turbine designed and developed
- Hydrokinetic turbines design and developed

2024
- Novel MHP turbine design and application
- Improvement of MHP penetration to energy mix due to increase resource utilization

2025
- Improved Distributed RE generation utilizing multiple MHP resources

2026
- Automation and control systems for MHP system – Off-grid/Grid integrated facility
- Local development of pump as turbines for energy generation application

2027

2028

40M
- Microgrid RE system
- Local turbine inventory assessment and fabrication capability
- MHP performance and efficiency improvement

60M
- Improvement of MHP research facility
- Development of local MHP equipment
- Design and development of cascading MHP systems

60M
- Design and development of hydrokinetic turbines
- Design and development of low-head/low-flow micro-hydro turbines
- Demonstration of hybrid microgrid RE facility (wind, solar, hydro)

50M
- Design and development of novel micro-hydro turbines, housing, and load controllers
- Utilization of irrigation channels for MHP technology applications

20M
- Technology development for aggregation and synchronization of multiple micro-pico hydro systems
- Strengthen performance and efficiency characterization standards

30M
- Flow regulation automation and controls
- Improvement on pump-turbine including multiple units and AC-excitation control for start-stop

50M
- Integration of Deriaz type turbine for micro hydro application
- Improvement of hydrodynamic screw type turbine for possible irrigation channel application

30M
- Introduction of variable speed turbine (part-full loading) coupling with converter fed synchrounous or double fed induction

VISION
- Cost-effective and efficient MHP technology
- Increase energy reserve thru MHP utilization
- Competitive MHP industry

MILESTONES

NAST Foresight
- Microhydro Systems using rainwater in high rise building
- Carbon neutral resorts

Overall Outcomes

Human Resource
- New skill acquired and increased workforce capacity on MHP design, fabrication, assessment, and operation/maintenance

R&D Technologies
- Local and competitive MHP parts and components developed
- New and cost-effective MHP technology developed

Facilities / Services
- Micro-hydro turbine research facility established
- Increased number of MHP industry catered thru the facility

S&T Policies
- Policy recommendations for MHP technologies

Energy : Hydrogen Production for Energy Applications

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Overall Strategies

Human Resource
- Consultation meeting with hydrogen industries and experts
- Improve local expertise on hydrogen development, from feedstock to utilization
- Capacity building on hydrogen storage design and development
- Capability building on hydrogen logistics and transportation

R&D Technologies
- Hydrogen production from biomass and other renewable sources
- Design and development of hydrogen production system
- Development of alternative storage of electricity from renewables to run electrolysers to produce hydrogen on-site
- Development of cost effective and durable catalyst and membranes
- R&D on hydrogen storage and transport

Facilities / Services
- Establishment of shared service laboratory/facility for biomass feedstock development and R&D
- Hydrogen evaluation facility

S&T Policies
- Minimial Life Cycle Cost and environmental impact on hydrogen production strategy and projects

POSSIBLE SOLUTIONS

2021

20M
- Design and development of new methodology for hydrogen extraction using renewable energy

2022

30M
- Hydrogen production from biomass conversion
- Design and development of hydrogen production system

2023

30M
- Development of membrane technologies for separating and purfying hydrogen
- Development of water gas shift reactors and hydrogen compression technology

2024

20M
- Liquid biofuel conversion via liquid reforming
- Development of Dark Fermantative hydrogen produ ction and microbial electolysis cell

2025

15M
- Hydrogen Storage R&D, involving compressed and liquid hydrogen.

2026

15M
- Establishment of shared service laboratory/facility for biomass feedstock development and R&D

2027

10M
- Small scale distributed hydrogen production using

2028

VISION
- Locally developed cost effective and durable hydrogen production system
- New industry on hydrogen sector

MILESTONES

2021
- Demonstration facility for hydrogen production utilizing RE system (electrolysis)
- Innovative methodologies for hydrogen extraction using renewable energy
- Cost-effective and efficient locally-designed and developed electrolysis cells
- Hydrogen production through gasification

2024
- Biomass derived hydrogen
- Alternative hydrogen production via Renewable Liquid reforming
- Solar assisted hydrogen production
- Cost-effective and efficient membrane technologies for hydrogen separation and purification

2028
- Solar Driven water gas shift reactors
- Hydrogen storage facility including, high pressure tanks, metal/chemical hydrides

Overall Outcomes

Human Resource
- Increase in expertise and skills in hydrogen production technology

R&D Technologies
- New industry and business opportunities in the hydrogen production sector
- Uptake on Hydrogen application, including power generation and vehicle

Facilities / Services
- Shared services facility and linkages for hydrogen development and utilization

S&T Policies
- Recommended S&T based policy I=on hydrogen development and utilization

Initial Draft – For Sectoral Consultation

Energy : Ocean Energy Program

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Overall Strategies

Human Resource
- Capacity building on ocean energy resource assessment/ ocean thermal energy conversion
- Capacity building on ocean turbine system services, repair and maintenance for project sustainability

R&D Technologies
- Detailed resource assessment for remote island communities (wave, tidal, marine current)
- Design and development of mechanical harvesting device modeling tools
- Design and development of wave energy harvesting systems

Facilities / Services
- Establishment of ocean energy research facility (wave and marine current)

S&T Policies
- Development of S&T-based policies for ocean energy technology adoption

POSSIBLE SOLUTIONS

15M
- Hydrokinetic turbine demonstration for grid integration.
- Wave array energy conversion modellling
- Power absorption geometry and controls

10M
- Capacity building on ocean thermal energy conversion resource assessment

5M
- Supply-chain analysis for ocean technology from generation to utilization

30M
- Design and development of wave energy harvesting system

7M
- Design and development of mechanical harvesting device modeling tools

10M
- Ocean energy detailed resource assessment in remote island/ isolated communities and other strategic areas (wave, tidal, marine current)

VISION
- Competitive ocean energy industry
- Increase energy reserve thru ocean energy utilization
- Increase number of rural electrification on island community

2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028

- Supply-chain analysis results for ocean technology available in the market
- Capacitated on ocean thermal energy conversion resource assessment

- Design and development of tidal harvesting equipment
- Wave tank and assessment equipment
- Floating platform for wave/tidal demonstration system
- ORE harvesting devices Modeling tools

- Resource assessment data for specific Mindanao areas (wave, tidal)

- Mechanical harvesting device design and development modeling tools
- Performance assessment of mechanical harvesting devices
- Modeling simulation facility for Ocean/Hydrokinetic Technology

MILESTONES

Overall Outcomes

Human Resource
- New energy research opportunities and skills developed
- Increased number of ocean energy researchers

R&D Technologies
- Updated and detailed ocean energy resource maps
- Locally developed ocean turbine technologies and systems

Facilities / Services
- Ocean energy research facility established (wave, marine current)

S&T Policies
- Ocean energy technologies exploited
- Increase energy reserve thru ocean energy use

Energy : Wind Energy Program

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Overall Strategies

Human Resource
- Capacity building on small-wind micro-siting assessment tools development for hybrid applications
- Capacity building on BOS local development
- Improvement in turbine design, fabrication and manufacturing ability

R&D Technologies
- Design and development of micro-sting tools for small wind remote area applications
- Design and development of novel harvesting device for small-wind turbine system – modeling using laboratory level
- Design and development of wind turbine for hybrid offshore systems
- Improvement of turbine blade design

Facilities / Services
- Establishment of small-wind research facility
- Distributed wind energy system

S&T Policies
- Development of policy based on S&T project results conducted

POSSIBLE SOLUTIONS

20M
- Establishment of small-wind turbine research facility

8M
- Development of micro-siting tools for specific remote island communities' small wind applications

10M
- Design and development of small wind turbine hybrid system for microgrid system

10M
- Novel harvesting device design and assessment: modeling laboratory

8M
- Hybrid offshore system (ocean and wind) assessment and design

15M
- Turbine blade design improvement
- Development of improved BOS for small wind turbine systems
- High fidelity modeling using high performance computing

2021 2022 2023 2024 2025 2026 2027 2028

MILESTONES

- Development of small-wind turbine system for water-pumping application
- Development of permanent-magnet generator, wind turbine blades, power electronics

- Wind resource data, modeled wind resource/maps for power systems
- Small-wind hybrid turbine developed
- Small-wind turbine research facility established

- Small-scale wind resource assessment database
- Next generation wind technology prototype and demonstratio
- Demonstration facility for hybrid wind/solar/diesel supported microgrid

- Improved blade design to harness available wind speed, including slower speeds
- Balance of system components for wind energy system components
- Resource maps, technology evaluation results

VISION
- Competitive wind energy industry
- Sustainable wind energy systems
- Increased energy reserve thru renewable energy sources
- Improvement of energy system for the people

Overall Outcomes

Human Resource
- Capacitated on the development of small-wind micro-siting tools and balance-of-system (BOS)

R&D Technologies
- Increased number of small-wind energy applications for rural and urban areas
- New technology developed for off-shore wind applications

Facilities / Services
- Increased number of wind-turbine suppliers catered under the wind research facility

S&T Policies
- Policy recommendations on the use of hybrid microgrid system including small-wind turbine system

Energy : Solar Energy Program

Legend (Text Font): Done | Ongoing | Not yet Available

Overall Strategies

Human Resource
- Capacity building on solar PV and concentrator testing and validation
- Capacity building on solar PV/ concentrator repair services and maintenance for sustainability

R&D Technologies
- Development of forecasting model for solar installation and resources assessment
- Development of modular stand-alone mobile desalination unit for brackish and seawater
- Solar PV marine floating platform design optimization

Facilities / Services
- Establishment of Solar PV laboratory (certification-type)

S&T Policies
- Recommendation of S&T-based policies to support microgrid RE utilization for off-grid/on-grid applications

POSSIBLE SOLUTIONS

60M
- Localization of efficient solar thermal system, i.e. concentrators, for drying, portable water production
- Demonstration of Micro Grid RE system

15M
- Development of forecasting model for solar installation and resources assessment
- Solar Home System Energy Use Optimization

15M
- Modular Stand Alone and Mobile desalination unit for brackish and seawater
- Establishment of Solar PV Laboratory (For Certification)

20M
- Solar PV Marine Floating Platform Design Optimization
- Development of hybrid RE system to support microgrid facility

20M
- Demonstration for New thin film solar pv farms and concentrator applications
- Integration of Solar PV to building needs

10M
- Solar Energy evolution and diffusion – small innovative applications
- CSP – mechanism for new thermochemical storage

2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028

- CSP system for energy generation and heating purposes
- Demonstration site for Microgrid PV system

- Web-GIS information on solar data with emphasis on cloud variation and meteorological data
- Solar home energy management system

- Cost-efficient solar desalination system for potable water
- Solar PV Testing facility and Balance of System for component test
- Support to PV standards development
- Improvement and bankable PV system components
- Cost effective balance of system components of PV, inverters, combiners and co nverters

- Hybrid RE system (RE combination) to support microgrid facility and operation
- Robust marine floating platform design for solar PV

MILESTONES

VISION
- Competitive solar PV industry
- Energy reserve increased thru renewable energy for human utilization

Overall Outcomes

Human Resource
- Increased capacity on solar PV and concentrator testing services
- New skills acquired for solar PV/concentrator services, repair and maintenance

R&D Technologies
- Optimized solar home system for off-grid areas
- Web-GIS based information solar data established
- Cost-effective solar desalination system for additional potable water source developed
- Cost competitive balance-of-system (BOS)

Facilities / Services
- Solar PV and BOS testing facility established

S&T Policies
- Microgrid RE system using solar PV exploited for off-grid areas

Initial Draft – For Sectoral Consultation

Energy : Waste To Energy Program

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Overall Strategies

Human Resource
- Capacity building on hydrogen production using biomass technology

R&D Technologies
- Design and development of cost-effective process to produce biofuels from agri-based resources
- Hydrogen gas production using environmentally sound technologies
- Assessment and evaluation of Non-food and other possible energy crops
- Methods and Tools development for enhancing Waste Analysis and Characterization Study (WACS)

Facilities / Services
- Establishment of WTE demonstration facility
- Shared service facility for feedstock analysis and evaluation
- NICER facility for WTE

S&T Policies
- Development of S&T-based policies supporting biomass technology utilization
- Science Based approach on promotion of WTE facility, including emission compliance

POSSIBLE SOLUTIONS

15M
- Develop technologies to improve the use of hemi cellulosic materials
- Development and assessment for biogas storage and transport

10M
- Develop new catalysts and catalytic and separation process

20M
- Improve pyrolysis systems to produce bio-oils from cellulosic feedstock at high efficiency rates
- Locally developed biogas gas engines

10M
- Development of superior feedstock crop plants with improved yield and quality

10M
- Development of Innovative and novel conversion technology from feedstock to finished fuel (algae, energy crops, forest resources
- Advanced algal system to lower the cost of producing algal biofuels and bioproducts

8M
- Development of cost-effective process to produce biofuels from agri-based resources

40M
- Design and development of waste-to-energy from Municipal Solid Waste (MSW)

2021 2022 2023 2024 2025 2026 2027 2028

- Novel conversion technologies
- Biogas transportation methods, processes and equipment developed

- Endemic energy crops with high yield rate.
- Efficient and effective pyrolysis facility
- Cost competitive gas engines

- Biofuel production from alternative feedstock
- Cost effective and efficient algal biofuel development

- Waste-to-Energy (WTE) demonstration facility
- Co-hydrothermal process for MSW and biomass, gasification and production of syngas for energy generation

MILESTONES

VISION
- Cost-competitive biomass energy production
- Increase energy reserve thru biomass energy use
- Competitive biomass industry
- Utilization of waste resources for the benefit of the people

Overall Outcomes

Human Resource
- Capacitated experts on biomass development, from feedstock to fuel

R&D Technologies
- New conversion technologies developed in biomass energy production
- Increased energy use and alternative energy production

Facilities / Services
- WTE biomass research facility established

S&T Policies
- Policy developed for biomass technology exploitation

Microgrid Renewable Energy R&D Roadmap

Legend (Text Font):	Done	Ongoing	Not yet Available
NAST Foresight			
Thematic Area			
Geographical			

Overall Strategies

Human Resource
- Capacity building on microgrid renewable energy operation, maintenance, and sustainability (end-users and technology adoptors)
- Capacity building on microgrid services i.e. parts and components outsourcing, repair services, etc.

R&D Technologies
- Design and development of cost-effective balance-of-systems (BOS)
- Demand side management development
- Design and development of energy optimization tools
- Design and development of microgrid RE with energy storage system
- Integration of data analytics for optimum energy use
- Demand-side management development
- Supply-chain analysis (generation, transmission, distribution, utilization)

Facilities / Services
- Establishment of solar and ocean research facility
- Establishment of small-wind turbine research facility
- Development of data-sharing platform and microgrid test-bed research facility

S&T Policies
- Development of policy recommendations for microgrid technology use i.e. incentives, support facilities, tariffs, etc.

POSSIBLE SOLUTIONS

50M
- Establishment of concentrating solar and tidal/wave research facility
- Establishment of small-wind turbine research facility
- Conduct of on-grid microgrid feasibility study
- Establishment of Solar PV research facility

100M
- Design and development of cost-effective BOS, control systems, and demand-side management system
- Supply-chain analysis (generation – utilization)
- Data analytics integration for energy flow and safety
- Development of data-sharing platform and test-bed facility

20M
- Development of microgrid systems for urban applications
- Microgrid modelling using suppressed load methods
- Scoping of next-generation microgrid technologies

MILESTONES

2021

2022
- Concentrating solar and ocean research facility established
- Small-wind facility for turbine testing and micro-siting applications established
- Energy-efficient Tech Research (NICER) preliminary concept proposal developed

2023

2024

2025
- Cost-effective and locally developed microgrid components (BOS, contollers, management systems)
- Supply-chain analysis established
- Improved data-analytics for energy optimization and safety
- Data-sharing platform established

2026

2027

2028

VISION
- Sustainable and cost-competitive microgrid systems for the people
- Microgrid systems for off-grid/on-grid applications demonstrated

Overall Outcomes

Human Resource
- Microgrid renewable sustainability and maintenance capacitated

R&D Technologies
- Cost-competitive and accessible microgrid technology
- Increased number of microgrid researchers and developers

Facilities / Services
- Network and linkages established for local R&D collaboration between universities and academe
- Service accessibility for performance testing and validation of avaialble concentrating solar/ ocean technologies

S&T Policies
- Recommended S&T-based policy on the use of microgrid systems both for off-grid and on-grid settings

Energy Storage R&D Roadmap

Legend (Text Font):	Done	Ongoing	Not yet Available
NAST Foresight			
Thematic Area			
Geographical			

Overall Strategies

Human Resource
- Hiring of experts and consultants for energy storage development
- New battery architecture training and development
- Indigenous material assessment
- Design, development, and simulation program/experts
- Training on energy storage assessment/evaluation
- Establishment/organizing energy storage system association

R&D Technologies
- New and emerging energy storage system technologies
- Analysis of industry and energy storage stakeholders
- Development of chemical, electrochemical, and mechanical energy storage systems
- Development of standards and testing procedure/protocol for energy storage system
- Local material utilization for battery systems
- Household integration of energy storage systems

Facilities / Services
- Energy storage R&D facility and innovation center
- Indigenous materials for energy storage assessment and evaluation facility
- Energy storage system test facility

S&T Policies
- Development of S&T-based policies for energy storage technologies

POSSIBLE SOLUTIONS

2021 — 25M
- Creation of indigenous battery program for high power applications
- Design and development of aluminum-air reactor device
- Nickel-iron battery development
- Advanced lead-acid development
- Lead-acid battery life span improvement

2022 — 5M
- Development of energy management system for flywheel energy storage system (FESS)

2023 — 100M
- Establishment of energy storage R&D facility and innovation center
- Energy storage system testing facility

2024
- Energy storage management system developed for flywheel applications
- 20 Ah, 70 Ah, 120 Ah, Al-air reactor developed
- New architecture for lead-acid batteries
- Energy storage R&D facility established
- Energy storage system testing facility established
- Battery innovation and testing facility
- Assessment of local indigenous materials
- Support to energy storage standard testing/ protocols
- Improvement on bankable PV energy storage system

2025 — 50M
- Hydrogen production from RE sources
- Continuation of lead-acid battery life span improvement

2026
- Hydrogen energy production models
- Hydrogen based energy storage facilities, from production, storage, transport and utilization
- Hydrogen-based design for energy storage and production with capacities beyond 10 kW
- Hydrogen gas and fuel cell system training and evaluation
- Locally developed Ni-Fe battery
- Energy storage facility demonstrated

2027 — 70M
- Hydrogen-based storage system
- Battery systems from indigenous materials and process
- Nickel-iron battery development
- Integration of energy storage to grid/off-grid applications

2028

VISION
Cost-effective and efficient energy storage system for the people utilizing indigenous materials

MILESTONES

Overall Outcomes

Human Resource
- Increased number of energy storage system experts and researchers
- New and alternative battery source identified and developed
- Competitive energy storage industry

R&D Technologies
- Electrochemical and non-electrochemical energy storage technology developed
- Testing standards and protocol established
- Local battery energy storage sources identified

Facilities / Services
- Energy storage R&D facility and innovation center established
- Increased number of energy storage industry catered for testing

S&T Policies
- Policy recommendations on energy storage utilization