

PCIEERD R&D PROGRAM THRUST

The R&D program of PCIEERD are focused on four (4) major strategic thrusts, namely, competitive industries; sustainable energy; sustainable mass transport; and environment, and climate change adaptation and disaster risk reduction. These R&D thrusts are aligned to the government’s policy direction for: (1) Rapid, inclusive and sustained economic growth; (2) Poverty reduction and empowerment of the poor and vulnerable; and (3) Integrity of the environment and climate change adaptation and mitigation. It is also geared towards the achievement of the committed 8 outcomes of the DOST.

The R&D programs and projects are directed towards harnessing the potential of emerging technologies, expand technology development and innovation for the industry, energy and transport sectors, and develop S&T interventions and solutions for climate change adaptation and mitigation and disaster risk reduction. Listed below are specific research directions and technologies that are expected to be produced from the R&D programs of PCIEERD.

COMPETITIVE INDUSTRIES

Research Area	Program Objectives	Specific technologies/topics	Sectoral Assessment
Electronics/ Semiconductor/ Information and Communications Technology (ICT) Industry	<p>Development of technologies that will boost global competitiveness of our local industries, Filipino students, and researchers. In addition, this research area will also play an important role in innovating/improving ways to effectively and efficiently gather/disseminate information with regard to environment and climate related issues.</p> <p>Priority Beneficiaries:</p> <ol style="list-style-type: none"> 1. Electronics/Semiconductor/ Information and Communications Technology (ICT) Industries 2. Filipino students enrolled in public and private schools 3. Teachers in public and private schools 4. Local Government Units (LGUs) 5. Disaster Risk Reduction and 	<ul style="list-style-type: none"> • Information and Communication Technology (ICT) <ul style="list-style-type: none"> - Interactive learning software for K-12 students in the Philippines - Pervasive / Ubiquitous Computing (Hardware Network) - Computational Services and Systems - Big Data/Analytics - Digital Media - Creative Content Management Services - Next Generation Network (NGN) - Human Machine Interaction 	<ul style="list-style-type: none"> • ICT for Education Technologies have been developed to support the Department of Education in the pursuance of the K-12 Program. Some programs and projects used ICT applications such as Pervasive / Ubiquitous Computing; Creative Content Management Services; Computational Services and System in achieving this goal. - Inter-disciplinary Signal Processing (ISIP): ICT For Education Program - addressed augmentation of teaching methods, independent study tools for students, and generation of database for researchers in language and speech for educational applications using the Filipino language

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	Management Officers		<ul style="list-style-type: none"> - Inter-disciplinary Signal Processing (ISIP): Software Applications or ISIP SAFE - will also develop technologies to augment teaching, boost student performance and enhance education curricula - Towards a Context-Aware Classification and Retrieval System of e-Learning Material - provided a more efficient retrieval system for e-learning materials by focusing on learner-centered contextual attributes - Test Coverage-based Automatic Program Evaluation - developed an on-line system that collects and automatically evaluates submitted programs intended to solve a finite set of computing problems <p>• ICT for Development (Government Thrusts – usage and applications) Computational Services and Systems were also applied in technologies for Government usage and applications. One of these is the NOAH-WISE or Weather Information Integration for System Enhancement which generate weather forecast 7 days ahead through high-performance computing and analytics. Assimilation of data from ground stations, radar and satellite will help improve the accuracy of forecasts. To add, an ongoing project CoARE or the Computing and Archiving Research Environment essentially targets to enable multiple data</p>

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			<p>integration from ASTI-initiated projects and collaborative projects with other agencies that have high requirements for data storage and high-performance computing.</p> <p>In addition to this, another major intervention titled PHL-MICROSAT Program aims to develop and launch the first Philippine Microsatellite (PHL-MICROSAT) that is robust and efficient in providing on-demand and real-time status of the country's environment particularly for applications such as land-use (i.e. forest, agriculture/crop), aquatic resource assessment and monitoring and disaster risk management.</p> <ul style="list-style-type: none"> • Optics and photonics have increased the capacity of the Internet by nearly 10,000-fold over the past two decades, and bandwidth demand is expected to grow another 100-fold, possibly more, over the next 10 years. A technology wall is currently blocking the next factor-of-100 growth. Without optics, the Internet as we know it would not exist, and it may not be able to keep up with growing demands without a breakthrough. - Grand Challenges: invent technologies for the next factor-of-100 cost-effective capacity increases in optical networks. Develop a seamless integration of photonics and electronics components, as a mainstream platform for low-cost

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		<ul style="list-style-type: none"> - Intelligent Transport System (ITS) 	<p>fabrication and packaging of systems on a chip.</p> <ul style="list-style-type: none"> • The ITS program started off with the Development of a Philippine Metropolitan Advanced Travelers Information System (PhilMATIS) in 2013. While the Advanced Traffic and Pollution Monitoring System (ATPMS) project started in 2014. The Development of a Customized Local Traffic Simulator and the Integrated and Optimal Bus Scheduling system started in 2015. However, they are working towards one common goal, which is to increase Mobility by 20% and provide real time vehicle performance fuel economy data.
		<ul style="list-style-type: none"> • Electronics/ Semiconductor <ul style="list-style-type: none"> - Instrumentation Control Electronics - Embedded System and Controllers 	<p>The technology on Sensors and Controls covers an essential aspect of the majority of projects under the Smarter Philippines agenda. Most of the completed and ongoing projects under the Electronics and Semiconductor Sectors are focused in these areas.</p> <ul style="list-style-type: none"> • Sensors for Environment The Rain Monitoring and Alarm System Using Hybrid Wireless Networks as Sensors installed and deployed a highly scalable proof-of-concept hybrid broadband wireless network with 26 GHz WIPAS (Wireless IP Access System) as its core technology in combination with 5 GHz transceivers from SMART to proof test novel approach to rain telemetry and disaster management, that uses broadband

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			<p>wireless links as real-time integrated long-path sensors, in conjunction with real-time acoustic rain rate point sensors.</p> <p>The HYDROMET project deployed hydrometeorological devices to forecast the onslaught of rising waters, and a reliable network in which the data can be transferred and its resulting information shared. The project has installed 600 units of automated rain gauges (ARG) and 400 units of water level monitoring sensors (WLMS) throughout the country. While the Hybrid AWS developed and deployed 80 AWS and 100 ARGs, in strategic areas across the country. A web-based weather monitoring is likewise created, whereby all data acquired from remote stations are collected and further analyzed. All processed data are easily accessible over the Internet, real-time.</p> <p>The on-going project Urban Flood is developing and installing flood-monitoring stations in identified flood-prone streets by the MMDA. The sensed data will be sent to a server via GPRS or SMS. APIs will also be made to share the data to other agencies (MMDA, UP, etc.) automatically. Flood information can be viewed using a visualization tool and through a mobile application. LED displays will also be deployed to disseminate information for commuters who are on the road already. The Disaster Risk Management using</p>

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		<p>- Communications Technologies, Robotics and Automation</p>	<p>Sensor Network And Computing: Early Warning System for Landslide, Slopes and Debris Flow (DRMS) is a multi-disciplinary research program that targets the application of new, increasingly cost-effective electronic and computing technologies to the problem of landslide monitoring. These studies are undertaken with the intention to mitigate impending landslides and prevent further loss of livelihood, property and lives.</p> <p>Electronics projects which use the Communications Technologies, Robotics and Automation have also been pursued. The recently completed project Robust and Rapidly Deployable GSM Base Stations and Backhaul for Emergency Response (ROGER) conducted research towards the development and deployment of robust, rapidly deployable infrastructure for providing faster restoration of communications capability in the event that a typhoon or other calamity disables the regular facilities. The Local Capability Development for Radar Systems (LADDERS) project on the other hand intends to enhance the Philippines' current capability in the sustainable operation of radars by investigating opportunities for local design on both radio frequency (RF) front-end and radar signal processing blocks or sub-systems.</p>

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		<p>- Micro-thermography of Integrated Circuits and Other Semiconductor Devices</p>	<ul style="list-style-type: none"> • Electronics in Health Application Health application was also explored through the RxBox2: Integrating Medical Devices in the National Telehealth Service Program which developed locally manufactured, medical-grade telemedicine devices, and demonstrated its usefulness in target Rural Health Units (RHUs) / Local Health Centers in GIDA (Geographically Isolated and Disadvantaged Areas) municipalities. RxBox measures blood pressure, heart rate, and dissolved oxygen and electro cardiogram and will also measure and transmit physiologic signals on maternal uterine contraction, and fetal heart rate; maternal and child health services form the bulk of services of RHUs. • SmartWire Program aims to create, refine and develop the necessary technologies needed to make the SmartWire vision a reality. One specific objective of the Smart Wire project is to develop the necessary technologies to implement a fully integrated sensor node with (1) power-line and RF energy harvesting, (2) data acquisition and signal conditioning for AC current and line temperature measurements, (3) power line and RF communications capability, and (4) computation and control for node management, communication protocol implementation as well as data processing. Another is the ongoing program example under this area is the “Building Robust and

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			<p>Sustainable Cooperative Community Networks” or BAYANIHANETS Program which aims to develop technologies and techniques that would enable the creation of cooperative community networks, and likewise aims to demonstrate the use and utility of such networks through the development of novel applications running on top of such networks.</p> <p>The sector also prioritized test and prototyping facilities for the electronics and semiconductor industry such as the Advanced Device and Materials Testing Laboratory (ADMATEL) an ISO/IEC 17025 -certified national testing facility equipped with advanced analytical instruments for failure analysis and materials characterization. Apart from testing and failure analysis, ADMATEL hopes to provide product and process development assistance. Another is the newly inaugurated Electronics Product Development Center (EPDC) which houses hardware and software tools that can be used to design, develop, and test hardware and software for electronic products for their intended applications. Through the operation of this facility, companies and researchers alike will gain access to services for electromagnetic compatibility (EMC) testing, electrical safety testing, and product prototyping.</p> <ul style="list-style-type: none"> • Optics and photonics are central to modern

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			<p>life; these technologies are needed to make and inspect the integrated circuits in nearly every electronic device we use. Moreover, optics and photonics technologies are used in the displays on smart phones and computing devices, optical fiber that carries the information on the Internet, advanced precision manufacturing and metrology, enhanced defense capabilities, and a plethora of medical diagnostics tools. New opportunities arising from optics and photonics offer the potential for even greater societal impact in the next few decades, including solar power, high-efficiency lighting, genome mapping, medical devices, and new optical capabilities that will be vital for supporting the continued exponential growth of the Internet.</p>
		<ul style="list-style-type: none"> • Food Security <ul style="list-style-type: none"> - Sensors and Transducers - Materials Development for Food - Quality Monitoring, Detection of Chemical, and Industrial Process Controls 	<ul style="list-style-type: none"> • DNA-based single and multiplex biosensors for food pathogen detection using electrically active/magnetic nanoparticles • Nanosensors for soil Nitrogen (N), Phosphorus (P) and Potassium (K) nutrients
		<ul style="list-style-type: none"> • Environment Integrated Circuit (IC) Sensors for the following: <ul style="list-style-type: none"> - Water Level - Chemical Detection - Proximity Detection 	<ul style="list-style-type: none"> • DNA-based single and multiplex biosensors for water pathogen detection using electrically active/magnetic nanoparticles • Nanosensors for ammonia • Nanobiosensors for arsenic detection • Fabrication of smart sensors for various

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			<p>applications (e.g. heavy metal detection and water quality parameters for mine sites)</p> <ul style="list-style-type: none"> • Laser guidance (farm machine automation) • Imaging (water conservation, crop management and pest and livestock management) • Sensing (surveying) • The Development of Field Monitoring System (FMON) project established a field monitoring system that is capable of real-time and accurate measurement of agricultural information, which will help researchers, and scientists develop and improve crop production. The objective of the project is to modernize the acquisition of significant agricultural information necessary in the productive growing of crops to increase food production and achieve food security for the Philippines.
		<ul style="list-style-type: none"> • Mining & Minerals Cost-effective and environmentally-friendly process for refining of copper from electronics and semiconductor wastes to 99.9999% purity 	<ul style="list-style-type: none"> • The sector is still looking for implementing agency that could develop the technology/process
Manufacturing	Development of value-added agro-based products, automotive parts & components & equipment	<ul style="list-style-type: none"> • Improved processing technologies for resource-based industries through innovative equipment design, enhanced processing systems and diversified product modifications (rubber, cacao, abaca, essential oils, alternative sweeteners, etc.) 	<ul style="list-style-type: none"> • The Phase I of the Cacao Program has been completed and developed value-added processing technologies for the fermentation, drying and processing of beans into tablea. A complete manual for the recommended practices will be distributed and launched within the year. The Phase II of the Program will be

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		<ul style="list-style-type: none"> <li data-bbox="992 676 1451 874">• Strengthening the value-chain and provision of support systems through use of enhanced technologies for resource-based industries (rubber, cacao, abaca, essential oils, etc.) <li data-bbox="992 1257 1451 1385">• Improvement of conventional textile processing systems and natural dyeing productions and industrial applications 	<p data-bbox="1496 236 2018 400">prepared and evaluated to complete the R&D needs of the industry, which are focused on the production of high value products from cacao, namely cocoa powder, butter and chocolate on industry scale.</p> <ul style="list-style-type: none"> <li data-bbox="1496 408 2018 975">• The 1st set of the Rubber Program will end by 2016 but three (3) more projects will be finished by 2018. The next three (3) projects are focused on developing models for rubber products formulation and processing of rubberwood products using improved treatment technologies. Meanwhile, the testing laboratory for Technically Specified Rubber (TSR) and enhanced services of the Industrial Technology Development Institute (ITDI) rubber products laboratory target to serve the needs of the industries starting December 2015. Improved processing techniques for cup lumps up to rubber products formulation with the development of substitute additives are on-going. <li data-bbox="1496 983 2018 1385">• The Revitalization and Smart Textiles program are on their final implementation years, with most of its deliverables already achieved. The Innovative Center for Yarns have been inaugurated and are ready to produce yarns composed of blended indigenous fibers and cotton. The weaving hubs and colorants production hubs are also actively operating and will be using the yarns produced by the center. Commercial dyeing facilities are also working in collaboration with the Philippine Textile

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		<ul style="list-style-type: none"> • Capability for reference and reference materials for value determination of priority food contaminants 	<p>Research Institute (PTRI) in using natural dyes for large scale dyeing needs. The geotextile lab is also completing its project activities for testing services, with commitment from the Department of Public Works and Highways (DPWH) to use its services. The finishing technology being developed to produce textiles with smart functionalities are already on its 2nd year, validating observed desirable functions such as UV-blocking and biocidal for blended textiles.</p> <ul style="list-style-type: none"> • The MiC Program team, now on its final year of implementation, have been exposed to various trainings and were successful in conducting two (2) rounds of proficiency tests (PTs) for Benzoic Acid in Fruit Juice, two (2) rounds for Histamine in Fish and four (4) rounds for metals in water. Satisfactory results of participating laboratories were reported for the PTs conducted. The team has conducted pre and post-workshops in order to give proper instructions to the laboratories before the PT and to report the results of the PT. In terms of establishing the international recognition of STD for MiC, STD was recognized this year as the Designated Institute for MiC by BIPM. The laboratory is on the process of applying for accreditation on ISO 17025 and ISO 17043 for the target analytes. They have also been very active in participating on the Asia Pacific Metrology Programme (APMP) and

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		<ul style="list-style-type: none"> • Product reliability testing automotive parts & components & equipment 	<p>Consultative Committee on Quantitative Measurements (CCQM) meetings and workshops to learn more on the technical and operational aspects of advanced NMIs in the regions and to promote the activities of MiC in the Philippines. With this, the MiC team should accomplish the ISO 17025 and ISO 17043 accreditations for the analytes studied in the program. After which, CMC application should be prepared and submitted to BIPM. The next analytes to be studied are for evaluation and immediate implementation by 2016, in ensuring that the MiC development is progressive to augment economic efforts for the industries and safeguarding of the country's welfare on its food safety laws. Candidate analytes include pesticides, veterinary residues and other contaminants in various food matrices.</p> <ul style="list-style-type: none"> • Precise measurements (metrology) impact our daily lives. The ability to make precise and reliable photonics measurements is what underlies areas as diverse as global positioning systems (GPS), communications, and satellite and aircraft positioning and manufacturing. Today's integrated circuits found everywhere from cellphones and tablets to automobiles could not be manufactured without optical sensing and metrology. The entire consumer electronics industry relies on optical sensing and metrology. Advanced metrology and precision laser printing have

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		<ul style="list-style-type: none"> • Machining , fabrication, and tool & die making • Competitive manufacturing technologies 	<p>enabled continuing improvements in the level of detail (number of transistors) that can be built into new integrated circuits. Processor power and memory capacity have increased dramatically while cost has remained flat. Continued leadership in the field of nano/microelectronics among others will depend on further advances in metrology and sensing.</p> <ul style="list-style-type: none"> • The Automotive Parts and Components Testing facility was only officially launched in June 2015. Further, some of the equipment is yet to be delivered at the 3rd quarter of 2015. • Cutting, Welding and Micromachining • Surface reconstruction • Imaging • Safety (e.g. light curtains) • Lithography • Competitive manufacturing technologies using biotechnology is the aim of the various industrial biotechnology projects supported by Process. Preliminary lab production studies were done for laccase and colors from microbes. Upscale processing and downstream production of colors are the next steps for the sector. Starter cultures, enzymes and different feeds and fertilizers were also developed. Recombinant technologies are being targeted for applications to improve techniques and to reduce cost of the

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		<ul style="list-style-type: none"> • Advanced drive technologies 	<p>products.</p> <ul style="list-style-type: none"> • Nanoclays for commodity / engineering plastics, ceramics, coatings and packaging products • Nanosilica /siliceous materials for high strength concrete /construction composite materials • Nanosilica as fluid in heat exchanger • Fullerene-based nanomaterials for optoelectronic applications • Optimized and robust coating processes for various applications: Surface treatment for decorative and functional MAX Phase materials • Modification of polymer surface by plasma treatment • Deposition of superior metallization layers via pulse plating technique • Diamond-like carbon films using low-energy carbon ions • Supercapacitors fabricated using indigenous textiles • Flexible electronics • Testing Laboratory for advanced device and materials • Grand Challenge: develop optical sources and imaging tools to support an order-of-magnitude increased resolution in manufacturing

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Metals and Engineering Machining and Fabrication Sector	The sector is aiming for providing globally competitive products, machineries and services and support the manpower development, upgrading equipment and develop new market for the local machining and fabrication sector with a viable and competitive industry providing the tool and requirements of the local markets	<ul style="list-style-type: none"> Metals related project 	<ul style="list-style-type: none"> The projects on Machining and Fabrication such as Development of DC Inverter Welding Machine, Electroplating on Various Non-Conductive Materials and Upgrading of Heat Treatment Facility are still ongoing and anticipated to be completed on December 2015
		<ul style="list-style-type: none"> Facilities and technology <ol style="list-style-type: none"> Surface Engineering Heat Treatment CNC Router Gear Making Facility Finite Element Analysis 	<ul style="list-style-type: none"> The Surface Engineering an Heat Treatment facilities was launched and offered to Industry Still under implementation (on-going project)
		<ul style="list-style-type: none"> Innovation Center (Region 2,CSU) 	<ul style="list-style-type: none"> Regional Innovation Center is expected to be established by CSU
		<ul style="list-style-type: none"> Road map: (HRD program expanded CSF establish (Phase 1) ISO9001 certified companies Partnership with foreign companies Expanded Incentives for machining and fabrication) 	<ul style="list-style-type: none">
Tool and Die Sector	Support the manpower development needs of the Tool and Die sector, equipment upgrading requirements and establish common service facilities, (e.g. vacuum heat treatment, etc.) Export capable and competitive metal casting industry providing quality products and services	<ul style="list-style-type: none"> Die and Mold Projects Testing design facility for T&D Roadmap: 	<ul style="list-style-type: none"> Die and Mold Solution Center was launched and offered to industry, other equipment are still being installed/ commission. The center have already graduated more than 30 trainees that were already employed

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		(CNC maintenance program maintenance program Design facility Product certification program Commercially produced components)	by the industry • CAD/CAM technologies are upgraded
Metal Casting Sector	Support the manpower development needs of the metal casting, support the capability building initiatives of the metal casting sector and make the metal casting industry export- capable on selected products	<ul style="list-style-type: none"> • Micro cupola technology • R&D programs on material Technology: Cupola Pig Iron • Roadmap: <ul style="list-style-type: none"> - Expanded MIRDC testing facility - ISO certified productivity foundries - Locally fabricated MPEPs - R&D programs on manufacturing 	<ul style="list-style-type: none"> • Technology is ready for commercialization • Technology is used by schools (i.e. UP-Diliman for OJT and trainings as an elective course) • For future R&D development
Services in Support to M&E and Other Sectors	To upgrade the technical facilities and expand the scope of services	<ul style="list-style-type: none"> • Strengthening of DOST Regional Metrology Laboratories • DOST metrology Services <ol style="list-style-type: none"> 1. Mass Calibration (Balance and Test weights) 2. Volume Calibration (Small and Big volume) 3. Pressure Calibration 4. Temperature Calibration 5. Length Calibration 	<ul style="list-style-type: none"> • Expand and upgrade DOST RMLs facilities and services. Most of the laboratories in some region have attained 100% of their expansion and upgrading of services and around 30% are still in the process of procurement of equipment • For ISO/IEC 17025 accreditation; seven (7) regions has been accredited, five (5) regions with PAB application and remaining three (3) regions are in the process of documentation for submission and application to PAB

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		<ul style="list-style-type: none"> • HRD training services <ol style="list-style-type: none"> 1. CNC 2. Tool and Die 3. Welding 	<ul style="list-style-type: none"> • Availed by trainees from various regions and private sector
Mining and Minerals	<p>Researches will involve determination of available technologies and processes for small and large scale mining as well as policy makers in support of responsible mining</p>	<ul style="list-style-type: none"> • Geological assessment of untapped/undiscovered minerals • Development of value-adding technologies for industrial applications <ul style="list-style-type: none"> - Copper (Cu) - Iron (Fe) - Chromite (FeCr₂O₄) - Nickel (Ni) - Chromium (Cr) - Gold (Au) • Environment friendly, cost effective and highly efficient extraction technologies applicable to small-scale miners • S&T based environmental protection and enhancement plan for rehabilitation • Small-scale mining best practices and pollution mitigation 	<p>From the Mining and Minerals R&D Roadmap (2012-2016), two (2) programs and three (3) independent projects emerged which resulted to sixteen (16) projects.</p> <p>The S&T Program for Responsible Mining in Mindanao which aims to make mining in Mindanao socio- economic and sustainable through responsible mining has eight (8) projects. These includes (1) assessment of terrestrial biodiversity, (2) assessment of the aquatic biodiversity, (3) monitoring, assessment and profiling of artisanal small scale gold mining, (4) contamination pathways and pollution management, (5) rehabilitation of nickel mined-out areas, (6) environment friendly and cost effective gold extraction technology, (7) alternative technology for processing of chromite and laterite ores and (9) ICT for responsible mining.</p> <p>The other program, Mineral Extraction with Responsibility for Sustainability (MINERS), aims for sustainable growth in the development of small scale mining industry through better mine practices and technologies. It is composed of five (5) projects which are as follows: (1) Non-hazardous methods of gold extraction; (2) &</p>

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			<p>(3) Treatment of wastewater from mine tailings (cocopeat and nanofiber); (4) Modelling of fate and transport of heavy metals and (5) Life cycle analysis of gold. However, the three (3) independent projects are (1) Technical study for the value-adding of iron resources, (2) Trace and rare earth elements geochemistry in Cu-Au epithermal deposits and (3) Black sand mineral characterization. All the projects are funded by the Department of Science and Technology (DOST) and the Philippine Council for Industry, Energy and Emerging Technology Research and Development (PCIEERD) and are expected to be completed in 2015 and 2016 respectively. Although the projects are not yet completed, the PCIEERD has organized a mining forum in Manila and co-organized a mining stakeholder's forum in Mindanao. The aim is to disseminate the initial outputs of the projects to the various mining stakeholders in Manila and Mindanao. From the fora, some large companies showed interest in the technology on rehabilitation of mined area, biodiversity assessment and the technology on chromite and laterite ores. Representative of the small-scale mining in Caraga has also signified interest in the gold extraction technology.</p>
Food Security	Researches will aim to upgrade laboratories, including its new services and accreditation; train companies on values, quality, and food safety; and	<ul style="list-style-type: none"> • Intermediate food ingredients from local materials sources <ul style="list-style-type: none"> • Dehydrated Food Products • Fruit Concentrates 	<ul style="list-style-type: none"> • Okara, a processing waste from taho, tofu, and soymilk processing was stabilized and utilized as ingredient for snack foods (cheese curls)

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	develop prototype equipment for processing & post harvesting. At the end, MSMEs will meet the quality & food safety standards and let our local products to compete internationally.	<ul style="list-style-type: none"> • Bench –scale verification of the production and testing of the following: <ul style="list-style-type: none"> • Nano sensors <ul style="list-style-type: none"> ➢ Food ➢ Virus Detection for Banana ➢ Detection for Bisphenol A • Nano-biodegradable packaging materials for food application • Food grade nano-precipitated calcium carbonate from limestone • Nano-encapsulated plant growth promoter for high value crops 	<ul style="list-style-type: none"> • Utilization of the Developed Cassava Grates/Flour Processing of VSU for Jojie’s Bakeshop bakery products (11 bakeshops in Bohol) • Standardized Sago flour processing; sago flour utilization (as source of gluten-free flour) for breads, ice cream cones, cookies, and noodles. • Ready-to-drink fruits and vegetable juice blends • Roll-Out of Complementary Food Products in 4 LGUs (Zamboanga, CARAGA, Surigao del Norte, Palawan)) and 2 SUCs (Apayao and Sultan Kudarat) • Adoption and commercialization of the brown rice bar by Nutridense Food Manufacturing Corporation • Adoption of the ready-to-eat arroz caldo by Kai-Any Foods, Inc. <ul style="list-style-type: none"> • Bench-scale production of the following: nanosilica for the remediation of arsenic in contaminated water; nanosensors for ammonia; cellulosic nanocrystals from bamboo; biodegradable covering for mangoes in trees; nanocomposite film coating for the shelf-life extension of papaya and mango; and nanoencapsulated plant growth regulator for sweet pepper, bell pepper, tomato and coffee • Food grade nanoprecipitated calcium carbonate from local limestone • Portable nanosensors for rapid detection and measurement of microbial

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			<p>contaminants in food and water, chemical contaminants and endocrine disrupting compounds using molecularly imprinted polymers</p> <ul style="list-style-type: none"> • Nanobiosensors for detection of diseases in banana and abaca • Low-cost and portable <i>in situ</i> sensing devices and kits for contaminant screening to ensure food safety from farms to tables <ol style="list-style-type: none"> a) Surface Plasmon Resonance Molecular-Imprinted Polymer-Based sensor for histamine b) Diffraction-based sensor for Profenofos and malathion residue in mango, banana, okra, soil and water c) Potentiometric sensor for Celnbuterol d) Chemiresistive gas sensor to determine fish freshness e) Molecular-Imprinted Polymer-Based sensor for Nitroimidazoles and Chloramphenicol f) Molecular-Imprinted Polymer-Based sensor for Chlorpyrifos (organophosphate), Atrazine (Triazine)
		<p>Sugarcane Genomics for Increased Productivity, Profitability, Sustainability and Global Competitiveness of the Philippine Sugar Industry :</p> <ul style="list-style-type: none"> - Genomics-Assisted Discovery of Genes and Molecular Markers for Important Targeted Traits in Sugarcane : High Sucrose 	<p>Establishment of Core facilities – DNA Sequencing Facility and Core facility for Bioinformatics.</p> <p>Sugarcane program is now on its third year, candidate molecular markers for high sucrose, and fungal resistance (downy mildew and smut resistance) have been identified. Testing and validation of these</p>

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		Content, Resistance to Smut & Downy-Mildew - Application of Molecular Breeding Techniques in Sugarcane Improvement - Development of New Sugarcane Varieties Using Marker-Assisted Selection	markers in sugarcane breeding populations is on-going. By 2016, Five new improved varieties of sugarcane with high sucrose content and resistance to fungal diseases through molecular assisted selection will be field tested.

SUSTAINABLE MASS TRANSPORT

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Land Transport	Development of an integrated, responsive, effective, efficient and safe land transport systems	<ul style="list-style-type: none"> • Smart inter-modal transport and infrastructure systems • Intelligent Transport Systems (ITS) • Cost-effective alternative mass transport systems and components 	<ul style="list-style-type: none"> • Automotive <ul style="list-style-type: none"> - Lighting - Navigation Systems - On-board communication systems - LIDAR for parking and highway cruising - On-board entertainment systems - Drive-by-wire • Logistics <ul style="list-style-type: none"> - Goods tracking - Traffic monitoring • Under the EV research domain, most of the activities focused on the Fast Charging Systems, Batter Cell Degradation and Optimization of Battery packs were completed on time. • Efficient and low cost power electronics and locally developed; and first fast charging station locally established. However, these are all

Research Area	Program Objectives	Specific technologies/topics	Sectoral Assessment
			<p>prototypes and will still require further R&D prior deployment.</p>
Sea/Water Transport	Development of a safer, cleaner and efficient maritime transport systems and services	<ul style="list-style-type: none"> • Cost-effective sea-worthy hull design using alternative lightweight materials for passenger and fishing vessels • Cost-competitive amphibious rescue vessel for 10-12 passenger 	<ul style="list-style-type: none"> • Aside from being a newly developed roadmap in 2013, the Sea/Water transport roadmap is faced with the challenge of finding specific implementing agencies for the specific technologies/topics identified. Most of the strategies identified under the roadmap have already concept proposals, but no implementing agencies. • Recommendations: Exert more effort in expanding the networks and linkages for the Sea/Water Transportation

Research Area	Program Objectives	Specific technologies/topics	Sectoral Assessment
			Sector.

SUSTAINABLE ENERGY

Research Area	Program Objectives	Specific technologies/topics	Sectoral Assessment
Energy Efficiency and Conservation	Researches aim to continue the development and deployment of cost-efficient smart technologies	<ul style="list-style-type: none"> • Energy cost-efficient technologies for buildings • Cost-effective smart energy control and sensor systems 	<ul style="list-style-type: none"> • Design and development of a Smart Home Platform • Design and development of an Advance Metering Infrastructure (AMI) Emulator • Prepaid metering and Smart Home System: Technology acceptance and technology features studies • Rapid electric vehicle charging station • Design and implementation of a Power Distribution System for data centers • Nanocoating for windows for anti-heat and anti-microbial applications • Solid-state rechargeable Li-ion Battery • Sensing for process automation • Photovoltaics • Fuel Analysis • Solid state lighting • Energy infrastructure security
Renewable Energy	Researches aim to increase the adaptation of renewable energy systems	<ul style="list-style-type: none"> • Cost-effective RE technologies and business models integration for sustainable off-grid power supply • Efficient micro-hydro and hydrokinetic turbines development and utilization • Cost-competitive bioenergy technologies 	<ul style="list-style-type: none"> • Development of grid tied inverter for Philippine electronics companies • Improvement of locally -designed micro hydro turbines and establishment of MHP test rig • Tidal current integrated resource assessment and spatial planning tool • Wind resource assessment for wind

Research Area	Program Objectives	Specific technologies/topics	Sectoral Assessment
		<ul style="list-style-type: none"> • Bench scale fabrication of polymer electrolytes from carrageenan, carbon nanotubes heterojunctions, conjugated di-block heterojunctions and graphene for solar cells and solar panel (at least 24% Efficiency) 	<p>power system</p> <ul style="list-style-type: none"> • Pilot testing of wind turbine generator • Biojet fuel production from coconut oil • Graphene – based electrochemical supercapacitor for solar cells • GaAs solar cells, photovoltaics and bulk heterojunctions solar cells • Modification of grapheme for nanostructured solar cells • Carrageenan-based dye-sensitized solar cells • Flexible nanohybrid supercapacitor based on conducting polymers and metal oxides • Carbon nanotubes (CNT)-silicon heterojunctions for the fabrication and assembly of a solar panel • Platinum- and Palladium-based anode catalysts for direct ethanol fuel cell • Nanomaterials for printed electronics using carbon ink • Biofuel from nano-carbon based catalysis of biomass • Novel cathode material for direct ethanol fuel cell • Direct ethanol fuel cell-powered LED emergency light • Energy storage device based on laser-scribed graphene-electrochemical capacitors (LSG-EC) for solar cells • Carbon-based (CNT) catalyst for biomass conversion

ENVIRONMENT, CLIMATE CHANGE ADAPTATION & DISASTER RISK REDUCTION

Research Area	Program Objectives	Specific technologies/topics	Sectoral Assessment
Environment			
Water	<ul style="list-style-type: none"> • Development of cleaner and safer technologies that will respond to critical concerns on industrial wastewater, waste management, safe and potable drinking water, use of biotechnological approaches for biodiversity conservation and other pressing environmental problems • Field-testing/application of cleaner technologies for the benefit of the industry, domestic households and general public 	<ul style="list-style-type: none"> • R&D on the following areas: <ul style="list-style-type: none"> • Water use management (pollution prevention) • Effluent treatment (point and non-point sources) • Water resources and water environment • Water supply (potable/clean drinking water) 	<ul style="list-style-type: none"> • Nano-photocatalytic treatment of organic waste water and gasous formaldehyde • Techno-demo on Prevention and Control of Water Pollution/Tech verification of water technologies for SMEs • Pilot demonstration of treatment / rehabilitation /remediation technologies
Air	<ul style="list-style-type: none"> • Reduction of risks being posted by H₂S emission in the environmental and industrial sectors 	<ul style="list-style-type: none"> • Development of H₂S gas sensor based on EPI/AuNPs membranes and mats 	<ul style="list-style-type: none"> • Metal nanoparticle-doped • Electroactive polymer as H₂S gas sensor
Climate Change Adaptation & Disaster Risk Reduction	Development of S&T-based integrated DRR/CCA decision support system and infrastructure proofing	<ul style="list-style-type: none"> • LiDAR data processing technologies • Remote Sensing technologies • Advance Climate Change and Weather Modelling • Big Data/ Analytics • Inter-connectivity, operability, visualization and harmonized DRR/CCA database systems • Location-based hydrometeorological hazard public information systems • DRR/CCA proofing systems for critical infrastructures • Multi-natural hazard observation/monitoring, modeling, 	<ul style="list-style-type: none"> • NOAA-WISE or Weather Information Integration for System Enhancement generates weather forecast 7 days ahead through high-performance computing and analytics. Assimilation of data from ground stations, radar and satellite will help improve the accuracy of forecasts. • CoARE or the Computing and Archiving Research Environment essentially targets to enable multiple data integration from ASTI-initiated projects and collaborative projects with other agencies that have high requirements for data storage and high-

Research Area	Program Objectives	Specific technologies/topics	Sectoral Assessment
		forecasting and early warning systems	<p>performance computing.</p> <ul style="list-style-type: none"> • PHL-MICROSAT Program aims to develop and launch the first Philippine Microsatellite (PHL-MICROSAT) that is robust and efficient in providing on-demand and real-time status of the country's environment particularly for applications such as land-use (i.e. forest, agriculture/crop), aquatic resource assessment and monitoring and disaster risk management. • The Disaster Risk Management Using Sensor Network and Computing: Early Warning System for Landslide, Slopes and Debris Flow (DRMS) is a multi-disciplinary research program that targets the application of new, increasingly cost-effective electronic and computing technologies to the problem of landslide monitoring. • Space Technology Applications <ul style="list-style-type: none"> - A space-based information system and data sharing protocols will be established in 2016, and fully operational by 2018 - Research on space technology applications on climate studies will be augmented by 2017 - Utilization of commercially-available satellite data through the PEDRO Center and LIDAR data from the regional centers to develop hazard maps for the Philippines

Research Area	Program Objectives	Specific technologies/topics	Sectoral Assessment
			<ul style="list-style-type: none"> - Creation of space-information system and data-sharing protocols for rapid dissemination of hazard information - Creation of a comprehensive and sustainable decision support system for resources management using space-based information - Enhancement of monitoring system for GHG, sea-surface temperature and other climate conditions - Persistent monitoring of climate conditions using available remote sensing technologies • Photonics <ul style="list-style-type: none"> - Use of leading-edge imaging systems in remote sensing, astronomical observations and imaging from nearby planets to outer space.