REPUBLIC OF THE PHILIPPINES
Department of Science and Technology
PHILIPPINE ATMOSPHERIC, GEOPHYSICAL and ASTRONOMICAL SERVICES ADMINISTRATION (PAGASA)
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TERMS OF REFERENCE
FOR THE SUPPLY, DELIVERY, INSTALLATION, TESTING, SUPERVISION, TRAINING AND COMMISSIONING OF PAGASA CLIMATE FORECAST COMPUTING SYSTEM – RE-BID

A. OVERVIEW

There is a need to further improve PAGASA's seasonal forecast system. The Climate Monitoring and Prediction Section of the Climatology and Agrometeorology Division (CAD) only uses statistical downscaling techniques that establish empirical relationship between large-scale atmospheric variables (predictors) and station-scale rainfall (predictands), also known as model output statistics (MOS). A dedicated High Performance Computing System is extremely essential to develop and operate a PAGASA-Climate Forecast System (P-CliFS) to deliver extended short range, sub-seasonal to seasonal climate forecast, products and services.

High resolution global climate models (GCMs) and regional climate models (RCMs) are recognized as promising tool for dynamic downscaling to provide essential climate information for assessing impacts of climate variability, climate change, seasonal climate predictions, studies on regional climate variability and better understanding of regional climate processes. The dynamical climate model uses the physics of the oceans, atmosphere, land and ice and the multiple complex interactions between them to estimate the most likely average climate state for several months ahead. As it uses physics, a dynamical model is suitable for use in areas experiencing long-term trends.

Several studies showed that high resolution GCMs or RCMs have potential to forecast seasonal rainfall, including those influenced by complex topography and detect tropical cyclones (TCs) and simulate their tracks at sub seasonal to seasonal (S2S) time-scale, thus, forecasting high impact weather/climate extremes. Therefore, dynamical models could provide substantial added forecast value when rainfall is governed by intraseasonal variability and complex topography, such as the Philippines.

GCMs and RCMs are also important tools for climate studies and could further improve spatial pattern of mean rainfall, daily rainfall intensity distribution, and daily rainfall extremes. Hence, the system could be utilized for research and development (R&D).

The establishment of PAGASA-Climate Forecast Computing Systemneeds high performance computing system, two (2) imperative climate modeling systems and system development, all necessary administration, application, visualization, compilers and system softwares, visualization tools, several trainings/meetings, Uninterruptible Power Supply, extended warranties and support. Furthermore, this project should be easily or readily to be deployed into a current PAGASA setting, that will be able to be used immediately once installed or implemented.

B. APPROVED BUDGET FOR THE CONTRACT

The Approved Budget for the Contract is **ONE HUNDRED MILLION PESOS (PhP 100,000,000.00)** inclusive of Value Added Tax (VAT), custom duties, and other government taxes.

C. BID VALIDITY

The bid proposals shall remain valid for a period of one hundred twenty (120) calendar days from the date of submission of bids.

D. QUALIFICATIONS OF PROSPECTIVE BIDDERS

Please refer to Section II, Instructions to Bidders, the Bid Data Sheet and Checklist of Eligibility and Technical Requirements of the Bidding Documents).

In addition, thereto, the prospective Bidder(s) must have the following:

1. High performance Computing Environment Experience – The manufacturer of the high performance computing system to be supplied must have at least four years of experience of providing computing resources intended for scientific and technical problems on the premise of computer simulation.
2. Prospective Bidder's experience and capability
    - 2.1 The prospective Bidders must have completed contract(s) that are similar in nature and scope of the Project to be bid within the period of four years from the date of the scheduled opening of bids. Similar project involves installation of High Performance Computing Facilities.
    - 2.2 For purposes of achieving shortened down time of the computing system, especially during the warranty period, prospective Biddersare expected to provide a team of qualified local and/or foreign numerical modelers and technicians that can provide and sustain 24/7 support services. Prospective Biddersare required to submit curriculum vitae of a

least two (2) numerical modelers and/or technicians including their corresponding training certificates.

2.3 After Sales Support for a detailed Level of Support that the Winning Bidder shall provide during the warranty period.

3. Additional Requirements for Winning Bidders

3.1 It shall be required that the Winning Bidder or the manufacturer must collaborate with National Center for Atmospheric Research (NCAR) in Boulder, Colorado, through its scientists for the installation and implementation of Weather Research and Forecasting (WRF) for Seasonal Climate Forecast System of PAGASA, including technical training.

3.2 The manufacturer of the proposed HPC system should have at least 25 systems in the latest top500 supercomputer list. Manufacturers that have more systems in top500 have higher technology,resources, experience, and leadership in HPC systems;

E. DELIVERY PERIOD AND PLACE OF DELIVERY

The Winning Bidder shall supply, deliver, install, test and commission the PAGASA Climate Forecast Computing facilities with installed WRF for Seasonal Climate Forecast System of PAGASA, at PAGASA Data Center, WFFC Compound, Agham Road, Diliman, Quezon Cityand the requisite training and technical meeting thereto, within one hundred calendar days (100 c.d.), commencing from the date of issuance of the Notice to Proceed. Moreover, technical training and meeting related to the implementation of APEC Climate Center-PAGASA Regional Prediction System (APCC-PRePS) shall also be provided by the Winning Bidder, within one hundred calendar days (100 c.d.), commencing from the date of issuance of the Notice to Proceed.

F. BID PROPOSAL CONTENTS

1. The Prospective Bidder shall submit an **Engineering Plan and Block Diagram** (i.e., electrical, networking, mechanical, cooling system) of the whole computing system, its power supply requirement, Uninterruptible Power Supply (UPS), the grounding system and other accessories with complete sets of brochures. The Engineering Plan and Block Diagram should be duly signed by Professional Electrical Engineer and shall be subject for approval by PAGASA Engineering and Technical Services Division.

2. The prospective Bidder shall likewise clearly indicate in its bid offer the model number and specifications of the computer system and all other equipment and accessories referred to in **Item G. Technical Specifications and Requirement (1-13)** to be supplied, if awarded the contract for the Project.

3. To aid the Procuring Entity in its procurement planning and to ensure a sustainable and continuous operation and maintenance of the computing system, the prospective Bidder shall be required to include in its bid proposal a list of recommended spare parts, both serviceable and disposable, with their corresponding prices and guarantee their availability in the market within the next five years.

4. Product documentation on the HPC systems management and software solution detailing use for HPC scenarios should be submitted together with this bid.
5. The prospective bidder or manufacturer should provide at least three (3) customer references on the proposed HPC system. The site references must currently be used for production by operational National Hydrological and Meteorological Services who are members of the World Meteorological Organization (WMO).

G. TECHNICAL SPECIFICATIONS AND REQUIREMENT

The Winning Bidder shall **Supply, Deliver, Install, Test, Supervise, Train and Commission the PAGASA CLIMATE FORECAST COMPUTING SYSTEM at PAGASA, Quezon City** and conduct the required meetings/trainings based on the following minimum specifications:

TECHNICAL SPECIFICATIONS:

Item No.	**QUANTITY AND UNIT**	DESCRIPTION	**SPECIFICATIONS**
1	1 lot	High Performance Computing System	• 180 TFlops or higher System Peak Performance • 16TB or higher Total System Memory • Minimum of 2, maximum of 3 Cabinets
2	60 units	High Performance Computing (HPC) compute nodes	• Number of compute nodes: 60 • At least 2 x 20-core processors of Intel Scalable processors clocking at 2.4GHz; • At least 192 GB DDR4 2666MHz RAM. Each memory DIMM module must be an ECC 16GB DDR4-2133 RDIMM; • At least 1 x 10Gb 4-port Base-T LOM; • At least 1 x Intel OPA 100 series single-port PCIe network card; • Diskless configuration
3	2 units	High Performance Computing (HPC) visualization nodes	• At least 2U form factor; • At least 2 x 20-core processors of Intel Scalable processors clocking at 2.4GHz; • At least 768 GB DDR4 2666MHz RAM. Each memory DIMM module must be an ECC 16GB DDR4-2133 RDIMM; • At least 2x NVIDIA Quadro P6000 24GB GPU; • At least 1 x 1Gb 4-port Base-T LOM;

			• At least 2 x Intel OPA 100 series single-port PCIe network card; • At least 2 x 240 GB SSD's
4	2 units	High Performance Computing (HPC) login/master nodes	• At least 2 x 20-core processors of Intel Scalable processors clocking at 2.4GHz; • At least 384 GB DDR4 2666MHz RAM. Each memory DIMM module must be an ECC 16GB DDR4-2133 RDIMM; • At least 1 x 1Gb 4-port Base-T LOM; • At least 1 x Intel OPA 100 series single-port PCIe network card; • At least 1 x 12Gb SAS HBA card; • At least 2 x 240 GB SSD's
5	1 units	Shared Storage for Log in nodes	• At least 2U form factor; • At least two storage controllers; • At least 4 x 12Gb SAS ports per controller; • At least 12 x 1.2TB 10k HDD
6	1 unit	High Performance Computing (HPC) Storage Subsystem	The proposed HPC storage subsystem: • must include a scalable parallel filesystem solution; • should support and implemented with high performance interconnect of Omni Path Architecture (OPA) or Infiniband; • should support low latency RDMA communication for data transfer between compute node and fileserver; • should have no single point of failure in the overall architecture and the solution should be highly available so that there is no loss of access to data even in the event of a complete node or controller failure; • must support detecting access pattern as sequential, random, fuzzy sequential, or strided, and prefetches striped data in parallel; • must support using multiple physical disks spread across multiple nodes to store a file in separate blocks; • must support distributed lock management with fine-grained block-level locking and byte-range locking; • must support defining file system block sizes of between 16KB and 16MB; • must support data replication (mirroring) at a file, directory tree, or file system level; • must support filesystem journaling where all filesystem operations are logged; • must support partitioning a file system's storage into collections of disks or arrays with similar properties that are managed together as a group;

			• must support upgrading versions of the filesystem without downtime to the system; • must support user, group, and fileset quota levels; • have at least 500TB usable capacity;
7	5 units	100Gbps 48-Port Low Latency interconnect	The proposed HPC system: • must include a scalable system interconnect that provides quick data access with low system overhead and efficient scheduling; • interconnect should support parallel filesystem, must be capable of unidirectional throughput of at least 100Gb/sec, must be capable of bidirectional throughput of at least 198Gb/sec, must be capable of MPI bidirectional throughput of at least 195Gb/sec, must be capable of providing latency of at least 0.60 seconds; • interconnect must be capable of messages rates of at least 150 million/second; • interconnect must include two (2) spine switches and three (3) leaf switches; • interconnect must be configured in fully non-blocking FAT tree mode;
8	2 pcs	42U server racks	with included power distribution units as required by the proposed system and KVM console;
9	2 pcs	network switches	with 48x 10/100/1000BASE-T RJ-45 ports and four 10 Gigabit Ethernet SFP+ ports to act as management switches;
10	1 unit	Uninterruptible Power Supply (UPS)	• The proposed HPC solution must include a Uninterruptible Power Supply (UPS) subsystem that provides minimum system backup time of 15mins, at least 40KW full load capacity or KVA rating will depend on the total power requirement of a given proposed design. • The UPS system should include auxiliary transformers and connection requirements, if needed.
11	1 pc	Management Software	The proposed HPC system must include software solution that: • Must be customized specifically for HPC - that simplifies the management and use of distributed clusters for HPC workload; • must include an open source cluster management software stack, consolidating the management, monitoring and scheduling functions into a single platform • should include a web-based portal to execute, monitor and manage HPC jobs on a distributed cluster; • should include workflow templates to provide an intuitive starting point for less experienced

			users; • should include management of private space on shared storage through the GUI; • should be capable of monitoring of job progress and log access; • should include console access for advanced cluster users with command-line skills; • should include a single cluster management portal consolidating monitoring, alarms, and reporting; • should include user management and multi-user support with user and billing groups; • should be compatible with popular shared file systems (Spectrum Scale, NFS, Lustre, Ceph); • should include report generation for job activity, alarms, and actions in the cluster; • should include generation of notifications and alarms based on cluster status
12	1 pc	Operating System	• Must be Linux environment, preferably Linux CentOS
13	10 unit	Compilers and required libraries	• GNU Compilers with 10 licenses or unlimited • Intel Fortan Compiler Commercial version that will be suitable for compiling the imperative models – 10 user licenses; • All required libraries to run and implement the WRF for Seasonal Climate Forecast System of PAGASA

9. NETWORKING AND DATA CABLING

The winning bidder shall supply necessary supporting peripherals required by the system design including connection with existing PAGASAData Center local area network.

10. ELECTRICAL SYSTEM

The Winning Bidder shall coordinate with PAGASA Engineering and Technical Services Division (ETSD) regarding the electrical system before and during the implementation of the project.

H. IMPERATIVE NUMERICAL MODELS

The Winning Bidder shall install the latest stable version of the following numerical models for operational and research use of PAGASA:

- Weather Research and Forecasting Model (WRF - NCAR/UCAR USA) designed for

- In addition to the above-mentioned model, the Winning Bidder shall assist the Scientist and Technical staff of APEC Climate Center on the installation of APCC-PAGASA Regional Prediction System (APCC-PRePS) to the HPC.

It is important that the Winning Bidder shall recommend the most optimized configuration of the above models mentioned in terms of the combination of physics and parameterizations, as well as the data assimilation and ensemble, and whether there is a need to optimize such models per season. The optimized configuration shall be a product of sensitivity analysis on the different configurations tested by the Winning Bidder. Sensitivity analysesdone for WRF for Seasonal Climate Forecast System of PAGASAshall be documented by the Winning Bidder with the assistance from PAGASA and the results of which shall be presented to the PAGASA Executive Staff and other concerned entity.

The configuration of WRF for Seasonal Climate Forecast System of PAGASA including the resolution, domains/nests and the number of grid points, shall be finalized upon approval of PAGASA. All output parameters (temperature, pressure, rainfall, etc.) and formats (for images, station data, etc.) shall be discussed by the Winning Bidder with PAGASA operations and research staff during the technical training and/or technical meeting.

For WRF for Seasonal Climate Forecast System of PAGASA, which shall be used primarily for operational seasonal prediction shall be following model requirements addressed by the Winning Bidder:

- automatic downloading/access of boundary /model data through a dedicated bandwidth;
- Boundary data (6-hourly) with standard data format of input layers from different GCMs and hindcast dataset;
- Standard data format for post-processing, therefore, requires standardized algorithm and tools;
- licensing, if applicable;
- Provide soil moisture data and needed algorithm for constant update;
- all output parameters and formats, as well as the model configuration, shall be discussed with the concerned PAGASA staff;
- other issues and concerns critical to the operationalization

Optimization of APCC-PRePS shall be achieved primarily by APEC Climate Center (APCC) climate scientists to be discussed with the Winning Bidder and PAGASA.

I. VISUALIZATIONTOOLS

A web-based user's portal for displaying the model output (images, station data, etc.) from WRF for Seasonal Climate Forecast System of PAGASA shall be developedby the Winning Bidder. The interface of the portal shall be user-friendly and not require specialized knowledge. All products to be displayed in the portal shall be discussed with PAGASA.

J. TESTING PROCEDURE

The Winning Bidder shall include in its submissions **a detailed testing procedure or methodology**. The detailed testing procedure and methodology shall include the full validation and testing on-site.

K. FACTORY ACCEPTANCE TEST (FAT) AND FACTORY TRAINING ON HPC

The Factory Acceptance Test (FAT) shall be conducted to the nearest factory site of the HPC, to be witnessed and accepted by at least three (3) members of the PAGASA Executive Staff (Administrator and/or Deputy Administrators or Chief of CAD and shall be conducted within a total of seven (7) calendar days.

The Winning Bidder shall also conduct a 7-day Factory Training on HPC(exclusive of travel time)to be attended by at least three (3) qualified technical personnel of PAGASA (2 from ETSD and 1 from CAD).

All related expenses during FAT and Factory training, such as, but not limited to round trip airfare, local transportation, lodging/accommodation, training materials and allowable travel expense based on the prevailing UNDP-DSA rates for each participant shall be borne by the Winning Bidder.

L. SITE ACCEPTANCE TEST (SAT) and On-Site Training

Site Acceptance Test (SAT) shall be conducted on-site. The purpose of the test is to verify the performance of the system in accordance with the specifications and functional requirements. Any defect or deviation discovered during the site acceptance test shall be rectified by the Winning Bidder immediately or within a maximum period of one (1) month from the completion of the test. After such rectification, another testing shall be made to verify the rectification.

The SAT shall be witnessed and accepted by at least three (3) members of the PAGASA Executive Staff (Administrator and/or Deputy Administrators or Chief of CAD)and/or end-user and shall be conducted within a total of seven (7) calendar days.

A 5 –day on-site training on HPC shall also be conducted.All expenses related to the on-site training on HPC shall be provided to a minimum of five (5) participants by the Winning

Bidder.

All related expenses shall be borne by the Winning Bidder.

The Site Acceptance Test (SAT) may be conducted simultaneously with the On-Site Training.

M. WRF User's TRAINING, IN-DEPTH WRF ON-SITE TRAINING AND APCC-PRePSTECHNICAL TRAINING/MEETING

A 5-day Training on the **WRF for Seasonal Climate Forecast System of PAGASA** shall be attended by at least five(5) qualified PAGASA modelers(4 from CAD and 1 from RDTD) and shall be done in the models' country of origin and the schedule to be arranged with PAGASA. All related expenses, such as, but not limited to the training materials, round trip airfare, local transportation, lodging/accommodation and allowable travel expense based on the prevailing UNDP-DSA rates for each participant shall be borne by the Winning Bidder.

An in-depth training on WRF for climate model shall be done on-site. This will serve as a follow-up relative to the training attended by the PAGASA modelers. The said training shall be activity- based, to promote effective and active learning. Its core premise shall include hands-on activities not only geared toward familiarizing more with the model cited above but likewise with the HPC system including but not limited to cluster computing. Training materials and meals shall be provided to the participants and Lecturers by the Winning Bidder.

The following activities shall be conducted by the Winning Bidder with at least ten (10) participants each:

- A 5-day On-Site Training for WRF for Climate; and
- A 5-day On-Site Training for sub-seasonal to seasonal forecasting

Training course topics shall cover operation, maintenance, data interpretation and other related topics. Lecturers (including fees, if applicable), training materials and meals shall be provided to the participants by the Winning Bidder.

For the **APCC-PRePS**, the following activities/expenses shall be borne by the Winning Bidder:

- A 5-day Technical Meeting between PAGASA and four (4) APCC Research Fellows to discuss and gain key information to ensure the effectiveness of the APCC-PRePS System;
- A 4-day Installation Trip where the APCC-PRePS system will be installed into the HPC by two (2) APCC technical staff; and

- A 5-day Technical Training-Workshop for four (4) PAGASA technical personnel from CAD by two (2) APCC Research Fellows on how to operate and maintain the technical aspects of the system.

The schedule of the Technical Meeting andInstallation Trip to be held in Quezon City, Philippines shall be arranged with PAGASA; while the 5-day Technical Training Workshop shall be arranged with PAGASA and APCC, to be held in South Korea, the models' country of origin (if the APCC-PRePS system is not yet installedby APCC) or on-site (if the system was already installed by APCC). All related expenses, such as, but not limited to the training materials, round trip airfare, local transportation, lodging/accommodation and allowable travel expense based on the prevailing UNDP-DSA rates for each APCCor PAGASA personnel shall be borne by the Winning Bidder. Meals during the Technical Meeting, Installation activity and Technical Training Workshop (if on-site) shall also be provided to the participants and APCC personnel by the Winning Bidder.

N. SYSTEM COMMISSIONING

After the satisfactory conclusion of the Site Acceptance Test, the Winning Bidder shall demonstrate the capability of the high performance computing system which will be operated continuously for a 5-day period. The successful demonstration thereof shall mean that the high performance computing system has been commissioned.

O. WARRANTIES

All workmanship, system parts, accessories, other materials and equipment and services shall be warranted by the Winning Bidder for **three (3) years**. The Winning Bidder shall be required to post a **warranty bond** in any acceptable form under the procurement law in order to assure that manufacturing defects will be corrected within the warranty period.

During the warranty period, any workmanship, system parts, accessories, other materials and equipment that fails to provide satisfactory operation shall be timely replaced at the Winning Bidder’s expense.

The repair of any defective material or equipment may be permitted; *provided*, however, that, the item/s being repaired is/are restored to its/their original specifications.

Procedure: Upon receipt and acknowledgment of PAGASA’s report of such defect or problem, the Winning Bidder warrants that it shall take the necessary remedial action/s within **seven (7) calendar days or any specified period acceptable to PAGASA**. Failure on the part of the Winning Bidder to take appropriate action within the specified period shall

render the Winning Bidder liable for penalty using the following formula: **one percent (1%) of cost of material(s) to be replaced/repaired multiplied by number of days of delay**. Said penalty shall be charged against any collectible amount by the Winning Bidder to PAGASA or shall be deducted from the warranty bond posted by the Winning Bidder in favor of PAGASA.

While the equipment is undergoing repair, a spare unit shall be substituted thereto to maintain the continuous operation of the system.

P. AFTER SALES SUPPORT

The Winning Bidder shall include in its bid a commitment for at least five (5) years support to PAGASA for the repair and maintenance of the equipment to be supplied.

It shall include in its commitment a provision of a reliable, swift and efficient on-site support, available 24/7 trouble and ticketing and response system (especially during critical events), and ensure a quick and readily available supply of spare and replacement parts.

Service Level/ Support Structure:

Priority	Incident	Description/Basic Support	Response Time	Commitment
1	**Production or development system down** Technical Services Engineer on-site	An error that renders product inoperative or causes the product to fail catastrophically. Major system impact, system down. Inability to use the licensed product or a critical impact on operations requiring immediate solutions.	The winning bidder shall agree to use commercially reasonable efforts to respond to the Client's trouble calls within four (4) hours in Metro Manila area.	The Winning Bidder will commit the necessary resources around the clock to resolve the situation or obtain work-around.
2	**Moderate system impact, system hanging** Technical Services Engineer on-site	An error that substantially degrades the performance of the product or materially restricts business. Ability to use licensed product, but an important function is not available and operations are severely impacted.	Within eight (8) hours in Metro Manila area.	The Winning Bidder will commit full-time resources during normal business hours to resolve the situation (or obtain workaround) and alternative resources.
3	**Minor feature or function failure** Telephone Support	The defect can be easily circumvented. The error can cause some functional restrictions but it does not	Within 24 hours.	The Winning Bidder will commit full-time resources during normal business hours

		have a critical or severe impact on operations.		to restore service to satisfactory level.
4	**Minor Question** Telephone Support	Questions regarding product features, hardware sizing, performance issue, TCP/IP related questions, platform questions.	Within 24 hours.	The Winning Bidder will provide resources during normal business hours to provide information assistance as requested.

Q. SYSTEM DOCUMENTATIONS

The Winning Bidder shall likewise provide PAGASA with the HPC's installation, operations and maintenance manuals. Said manuals shall contain among others the complete and detailed schematic diagrams, theory of operations, calibration and maintenance procedures. **This should also provide modifications on the original setup of the HPC.**

All other hardware and software requirements shall also be turned-over to PAGASA prior to the issuance of the Final Inspection and Acceptance report.
In addition, the Winning Bidder shall provide a complete list of deliverables and installation materials.