TERMS OF REFERENCE

Developing mobile source emissions inventory & emissions inventory integration

I. Background

As part of the "Sustainable Development Strategy (SDS): Egypt Vision 2030",[1] the country committed to halving its fine particulate matter (PM_{10}) air pollution by 2030. Significant improvements have been made towards that goal in recent years. In fact, Cairo's PM_{10} concentration fell by about 25 percent over the past decade. Despite these improvements, the city's pollution levels are still several times the WHO recommended concentrations and higher than national guidelines taking as these high levels are taking their toll on the health and quality of life of the population, in particular poor people. Subsequently, the Greater Cairo (GC) Cost of Environmental Degradation (COED) attributed to air pollution is by far the highest in the country, with a mean estimate equivalent to 1.35 percent of national GDP in 2017. Conversely, the GC COED attributed to waste (net of air pollution damages, via the burning of waste) is half the air pollution's COED and results in a mean estimate equivalent to 0.68 percent of national GDP in 2017 which includes the opportunity losses from composting, recycling, methane capture, etc. Moreover, recent studies on the COVID-19 show that there is an increased likelihood of contracting the disease with high levels of ambient pollutants.[2]

Climate change models project Egypt's mean annual temperature to increase between 2 ºC and 3 ºC by 2050 and an increase in the duration of long-lasting heatwaves. Hot sandstorms known as khamsin blow millions of tons of grit from the Sahara to the North African coast and increases in local temperatures of up to 20 ºC are projected to increase in frequency and intensity. By 2050 the intensity and seasonality of heavy rains, as well as the probability of droughts will increase. Long-lasting heatwaves likely will increase in duration of between 9 to 77 days by 2085. The GC area is vulnerable to all of these, as well as to river and urban flooding, water scarcity and wildfires. The impacts are severe, particularly for public health and agriculture. Climate change will put additional pressures on citizens' health, in the form of increases in the prevalence and severity of cardiopulmonary conditions through heat and sandstorms, potential increases in vector-borne diseases, through decreased nutrition and food security and reduced water quality. Further, it has been demonstrated that extreme heat events are linked to worsening air pollution.[3]

In response to this situation, the Government of Egypt (GOI) is implementing the Greater Cairo Air Pollution Management and Climate Change Project (hereafter "The Project") financed by The

[1] http://www.cabinet.gov.eg/English/GovernmentStrategy/Pages/Egypt%E2%80%99sVision2030.aspx and https://www.greengrowthknowledge.org/sites/default/files/downloads/policy-database/Egypt%20Vision%202030%20%28English%29.pdf.

[2] Larsen, Bjorn. 2019. Egypt: Cost of Environmental Degradation: Air and Water Pollution. The World Bank. Washington, D.C.; and Back of the envelop calculations for cost of solid waste environmental degradation performed by the Team.

[3] Markandya and Chiabai, Valuing Climate Change Impacts on Human Health: Empirical Evidence from the Literature, Int. J. Environ. Res. Public Health, 6, 759–86, 2009.

World Bank. The Project seeks to reduce air and climate emissions from critical sectors and increase resilience to air pollution in Greater Cairo i.e., Cairo, Giza and Qalubiah Governorates[4], and is implemented by the Ministry of Environment through its Egyptian Environmental Affairs Agency (EEAA) and its Waste Management Regulatory Authority (WMRA) and in collaboration with other partners. A Project Coordination Unit oversees overall project implementation and ensures that fiduciary requirements are met.

The Project aims specifically to reduce emissions that contribute to air pollution concentrations, thus leading to air quality improvements, and to simultaneously mitigate climate change. Air pollutants include PM_{10} and $PM_{2.5}$, while climate pollutants include both longer lived greenhouse gases (GHGs) such as CO_2, as well as Short-lived Climate Pollutants (SLCPs) that include black carbon, methane and several short-lived HFCs.

Successful Air Quality Management (AQM) planning requires a detailed assessment of these emissions in ways that enable decision makers to (i) understand the many sectors that contribute to a city's air pollution problems, (ii) track the effectiveness of policies and strategies over time to establish an accountability framework for both climate mitigation and AQM planning and (iii) utilize these data to conduct periodic international reporting and to process emissions estimates for dispersion modeling, critical to AQ forecasting.

The requested services covered by these terms of reference are **to support implementation of Component # 1 of the Project, on Enhancing the Air Quality Management (AQM) and Response System, implemented by EEAA.** This component aims to support the enhancement of the AQM decision support system in GC through a strengthened AQM infrastructure (monitoring and analytical), capacity building activities, developing emergency response plans and raising public awareness through information dissemination.

II. Objective of the Assignment

The objective of this assignment is to hire a qualified consulting firm, referred to hereafter as "the Consultant" to provide support to the Egyptian Environmental Affairs Agency (EEAA) and World Bank through the Greater Cairo Air Pollution and Climate Change Project (hereafter "The Project") to advance existing integrated climate and AQM planning (IC-AQMP) for the tri-city GC area as well as the country of Egypt as a whole, with a specific focus on reviewing existing emission inventory data products for greenhouse gases (GHGs), short-lived climate pollutants (SLCPs), and criteria air pollutants, fill any gaps in these existing inventories, and synthesizing these with other information, including the development of a mobile source emission inventory resulting in a single unified database useful for policy tracking, international reporting, and dispersion modeling/forecasting to address air pollution and climate mitigation in GC and Egypt.

[4] More details on the Project Components are provided in Annex 1.

III. Scope of Work and Detailed Tasks:

The Consultant is requested to conduct the following tasks:

1. **Review, refine, enhance and consolidate existing emission inventories:**
   The consultant will work with EEAA teams that are currently updating emission inventory databases for Egypt to obtain the best available data. EEAA has recently completed an inventory for point sources, area, biogenic and geogenic sources and has developed a preliminary "Roadmap" report for developing a mobile source inventory. The consultant will refine/ review and assess the existing system.

   Reports from previous studies conducted by EEAA include source pollutants collected through PEMS for public transit vehicles (Full Size Bus, Mini-Bus, Micro-bus) and medium and heavy trucks. These reports were used to drive emission factors locally for the Greater Cairo fleet of vehicles.

   The consultant will need to work with EEAA to understand existing gaps and align the available information with best practices to develop a comprehensive inventory[5] for the GCA and surrounding area[6]. The consultant will be asked to fill gaps, improve and enhance available data resulting in a single, internally consistent comprehensive inventory (i.e. covering point, area, biogenic, geogenic, and mobile, sources) that will be available for photochemical and dispersion modeling.

   Deliverable: 1.1 Current State Assessment Report & Gap Analysis
   Deliverable 1.2: Detailed Road Map Report for Comprehensive Inventory Development, Processing and Expected Deliverables

2. **Develop mobile sources Inventory:**
   The consultant will refine/ review and assess the existing system and develop the mobile source emission inventory (MEI). The MEI shall include local emission factors for mobile sources for (Diesel, Gasoline and NG) vehicles. A new emission testing program based on Chassis Dynamometer testing shall be utilized, including the development of driving cycle representative of GC drawing on the collected traffic data.
   EEAA has a Chassis Dynamometer[7] (refer to Annex 2 for further details) at its premises in Cairo, through which the consultant is required to conduct actual measurements to

[5] For example, the mobile source inventory roadmap describes steps to be taken and data to be used, but has not yet used this information to develop the emissions estimates. Similarly, the biogenic and geogenic inventory that has been developed by another vendor does not include the relatively small contribution to NOx from lightning or GHG emissions due to vegetation and land-use changes but may need to be completed (guidance has already been developed for both of these tasks) and integrated into this emissions framework.

[6] The entire country of Egypt will have to be covered to some degree both to satisfy the need to provide international reporting of GHGs at the national level under IPCC methodologies, and to include air pollution emissions from areas surrounding the tri-city area in so far as emissions from surrounding regions need to be included within larger nested modeling domains for GC AQ forecasting.

[7] Chassis Dynamometer is a testing device used to measure the performance and emissions of vehicles under controlled conditions. It consists of rollers onto which the vehicle's tires are placed, allowing the engine's power output to be measured while the vehicle remains stationary. The Chassis Dynamometer is set to be used for emissions testing of passenger cars and light vehicles and performance evaluations, providing valuable data on

derive and update local emission factors for various light-duty mobile sources. Sampling procedures and emission measurement testing plan is part of the consultant scope and shall be clearly stated in the technical proposal.

EEAA shall subcontract a specialized vendor to conduct the required maintenance and provide the required consumables and spare parts during the operation of the Chassis Dynamometer for conducting the assignment. EEAA shall be responsible for the repair in case of malfunctioning of the Chassis Dynamometer.

Deliverable: 2.1 Traffic Data and Mobile Source Data Collection & Analysis Report
Deliverable 2.2: Emission Inventory Report for Air Pollutants from Mobile Sources and Development of Local Emission Factors

3. **Developing new comprehensive integrated modeling for the emission inventory from all sources of air pollution and climate change**
   The consultant will work with EEAA to develop and incorporate available emission inventory data, including the review, updating and utilization of new data provided by relevant ministries (e.g. see the roadmap report, but this will include vehicle registration data from Ministry of Interior, industrial activity data from Ministry of Industry, etc.) and integrate these data with the existing inventories. The creation of gridded emission files may include defining the airshed that affects air quality in GCA, applying land-use regression techniques to define sharp spatial gradients (e.g., via satellite-based methods) or identifying socio-economic indicators or technology distributions that that can be used to improve spatial surrogates for emissions distributions, and potentially break out inventory data by socio-economic status.

   The consultant could also propose the development of locally appropriate source characterizations/emission profiles for specific source categories known to affect GCA air quality or to identify and address weaknesses in the national GHG inventory. In this task, the consultant will develop an interface for data extraction and reporting.

   Deliverable:3.1 Emission Inventory Data Collection Report from other Sources & Analysis Report
   Deliverable:3.2 Emission Modelling from all Source and Recommended Action Plan for Combating Climate Change

4. **Synthesize and integrate data in a single unified emission inventory for Egypt:**
   The resulting inventory will be presented in (a) a spreadsheet or database format as well as (b) gridded emission files (NetCDF format) appropriate for chemical transport

exhaust emissions, fuel efficiency, and other parameters to assess the environmental impact and compliance of vehicles with emission standards.

modeling and finally (c) as a IPCC-compliant national GHG emission inventory useful for submission under the UNFCCC. The final products should include all pollutants as relevant (e.g., IPCC-compliant inventory should include the six Kyoto gases, black carbon, methane, short-lived HFCs and N_2O; the gridded emission files should include Pb, CO, primary $PM_{2.5}$, primary PM_{10}, NOx, SO_2, VOC, ammonia and hazardous air pollutants; the database should include all of the above).

Deliverable:4.1 Integrated Database and Detailed Metadata of all collected data
Deliverable 4.2 Comprehensive Data Analysis and Visualization Report

5. **Training EEAA and their partners in the use, updating and processing of the emissions data for future policy tracking, air dispersion modeling and international reporting:**
   The consultant will work with EEAA and the relevant partners to ensure that the final products are useful for Ministry staff, their vendors and their partners to achieve air quality and climate mitigation goals with the emissions database. This means identifying and training on aspects of inventory collection and refinement that may have come out during the course of the refinement process undertaken, ensuring that chemical transport modelers are able to process gridded emissions files in the future based on updated or refined inputs, and ensuring that members of the Egypt Climate Change Committee are able to generate new IPCC-compliant reports of GHG and/or SLCP emissions.
   Deliverable 5: Capacity Building & Training Program (including Training Program, Venue Logistics, Print Outs, Guidelines and User Manual)

IV. Administrative Arrangements

The Consultant will work under the supervision of and report to the Head of the Environmental Quality Department, in his capacity as the Head of the Technical Implementation Unit of Component 1 of the Project, and/or his designee and with the Lead Advisor of the Component. Contract management and other administrative responsibilities are overseen by the Project Coordinator of the Greater Cairo Air Pollution Management and Climate Change Project, or his designee.

The consultant will closely work with EEAA staff members of the TIU, and will collaborate as needed with other partners that are also supporting EEAA staff with AQM planning. The Consultant will also liaise, in consultation with EEAA, with other consulting firms. The consultant will also need to liaise with other ministries that may be providing data inputs to the emissions estimation process, but this is to be coordinated through EEAA.

V. Duration of the Assignment and Time Schedule for Deliverables

The consultant will work to complete deliverables between **December 2023 and December 2025** (within 24 months of the start of contract). This work will require reporting to the EEAA as outlined above.

Serial No.	Deliverable	Time from Contract Signature
1	Deliverable 0: Inception Report laying out the work program.	1 month
2	Deliverable 1.1: Current State Assessment Report & Gap Analysis	2 months
3	Deliverable 1.2: Detailed Road Map Report for Comprehensive Inventory Development, Processing and Expected Deliverables	3 months
4	Deliverable 2.1: Traffic data, and mobile sources data collection & Analysis Report	13 months
5	Deliverable 2.2: Emission Inventory Report for air pollutants from mobile Sources, and development of local emission factors	14 months
6	Deliverable 3.1: Emission Inventory data collection Report from other Sources & Analysis Report. Driving Cycle for GC, and development of local emission Factors Report	16 months
7	Deliverable 3.2: Emission Modelling from all Sources, and recommended Action Plan for combating climate change	18 months
8	Deliverable 4.1: Integrated Database, and detailed Metadata of all collected data	20 months
9	Deliverable 4.2: Comprehensive data analysis and visualization Report	20 months
10	Deliverable 5: Capacity Building & Training (including Training Program, Venue Logistics, Print Outs, Guidelines and User Manual)	Ongoing during contract period
11	Deliverable 6: Final Report and Integrated Database	24 months

Reporting Requirements

The Consultant shall report to and work under the supervision of the Head of the Environment Quality Sector of EEAA.

Report	Contents	Submission Date/Frequency		Number of Copies	
		Draft	Final	Draft	Final
Quarterly Reports	Work progress, team mobilization, tasks undertaken, partial results, meetings held and persons met, planning of activities	Every quarter		3	

	for next quarter, updated works schedule and mobilization plan, difficulties encountered, assistance required. The quarterly report will also include the draft of the EEAA's quarterly report for Component 1 of the Project. Copies of all ad-hoc reports produced during the quarter will be included as annexures.				
Mission Reports	Participants, people met, objectives of mission, content of mission, extent to which objectives have been met.	1 week after return from mission	1 week after comments from Client	3	3
Ad-hoc Reports	Review reports, recommendations, model documents, audit reports, etc, as detailed above	As and when required	2 weeks after comments from Client	3	3

* All results, data (raw and final), reports should be delivered to EEAA in hard and electronic (editable) Copies.
*All available and updated data is completely owned by EEAA, and it will not be allowed to be used by the contractor by any means, otherwise he will be subject to legal accountability.

The Consultant shall prepare the reports with 3 paper copies and complete digital files in a format and manner acceptable to EEAA. All reports will include a summary in English and in Arabic. Some full reports will be in English and in Arabic, but this will be decided on a case-by-case basis as needed and as agreed with Head of the Environment Quality Sector of EEAA. Reports would be prepared initially in draft and finalized within an agreed upon period following receipt of comments from EEAA.

V.II Team Composition & Qualification Requirements for the Key Experts:

The consultant team composition must include as a minimum the key staff below:

No.	Position (person-month)	Qualification	Experience
1	Team Leader (8 person-month)	Master's degree or above in transportation, economics, environmental science or a related field	Practical experience at least 15 years in developing emissions inventory and mainly mobile sources emissions inventory. Experience in transportation planning, and familiarity with transportation modeling tools and methodologies. Experience in analyzing transportation related emissions data and air quality modelling from mobile sources is required.
2	Transport Engineer (s) / Traffic Engineers (14 person-month)	Master's degree or above in engineering, planning, or a related field	At least 10 years of traffic data collection, and relevant experience. Experiences with similar projects funded by World Bank or other development partners is preferred. Good spoken and written English language skills is required.
3	Air Quality and Emission Modeling Expert (8 person-month)	Master's degree or above in atmospheric science, environmental science, or related discipline.	At least 5 years of experience of atmospheric chemistry, air pollution modeling, and the behavior of pollutants emitted from mobile sources. Experience in conducting air quality assessments, interpreting monitoring data, and analyzing emission sources and their impacts is preferred. Track record of at least 5 years of experience in emission modeling software and tools (e.g., MOVES, COPERT). Experience in developing emission factors, performing

			data analysis, and utilizing emission estimation methodologies for various types of vehicles and fuels. Experience with similar projects funded by World Bank or other development partners are preferred. Familiarity with the Bank safeguards policies and the ESF is necessary. Good spoken and written English language skills is required. Relevant experience in MNA is preferred.
4	Geographic Information System (GIS) & Data Analysts / Statisticians Specialist (12 person-month)	Bachelor's or master's degree in engineering, geography, geospatial science, statistics, mathematics, or a related field.	At least 5 years of experience. Expertise in GIS tools and spatial analysis techniques. Experience in integrating transportation data with spatial information, mapping emissions from mobile sources, and conducting spatial analysis to identify emission hotspots and pattern, including advanced regression modelling. Experiences with similar projects funded by World Bank or other development partners are required. Good spoken and written English language skills is required.
5	Senior Stakeholder and Project Coordinator (4 person-month)	A bachelor's or master's degree in a relevant field such as environmental science, environmental management, project management, business administration, or a related discipline.	Proven experience in engaging and managing diverse stakeholders, such as government agencies, industry representatives, non-governmental organizations, and community groups. Experience in conducting stakeholder consultations, facilitating meetings, addressing concerns, and building

			consensus among stakeholders. Experiences with similar projects funded by World Bank or other development partners are required. Good spoken and written Arabic and English language skills is required. Local experience in Egypt is a must.
6	Technical Operator / Operations Manager (6 person-month) *	A bachelor's or master's degree in a relevant field, such as project management, business administration, or a related discipline.	At least 5 years of experience in operating vehicle-testing equipment, including of similar nature to Chassis Dynamometers or similar testing setup Local experience in Egypt is preferred. This position could be furnished in coordination with EEAA team.
7	Emission Measurement Operator ** (6 person-month)	Degree in environmental science, engineering, or a related field. Knowledge of emission testing regulations and standards.	At least 5 years of experience in operating the gas analyzer part of the Chassis Dynamometer. Responsible for conducting emissions testing, collecting and analyzing exhaust gas samples, and ensuring compliance with relevant emission standards. Local experience in Egypt is preferred.

* can be individual expert of specialized / small size firms to provide technical operations support.

** It is up to the consultant to propose the required team in terms of emissions measurement or the data collection campaign. The consultant is encouraged to propose options of selected individuals or associate with specialized firms in operating the Chassis Dynamometer testing facilities.

A total of **58 person-months** inputs are expected.

The presence of the Consultant's team members in Egypt is expected not to be more than a total of **20 person-months**.

The consultant staff will be available for meetings and appointments per agreement with EEAA. The consultant will be expected to present results to multi-stakeholders in GCA every ٣ months during the contract period.

The Consultant team should include expert in position **5** who is fluent in both speaking and writing the Arabic language. For Experts in positions **6** & **7** translation to Arabic language is necessary.

Consulting Firm Qualifications and Experience

- Experience in air quality management planning.
- Experience in emissions inventory development, inventory verification system, and establishing ongoing reporting mechanisms.
- Experience in dispersion modeling.
- Experience in international GHG reporting.
- Experience in developing vehicle emissions factors (gasoline, diesel & NG), and establishing ongoing reporting mechanisms.
- Broad access to both academic and private sector expertise that can contribute knowledge to Egyptian agencies, institutions and personnel.
- Experience in capacity building in the use, updating and processing of the emissions data for future policy tracking, air dispersion modeling and international reporting, and in undertaking complex data analysis and environmental assessments in low- and middle-income countries.

In addition, specific key experts may be deployed on 'as-needed basis' to supplement the core team, as stipulated in advance in the work plan that will be agreed between EEAA and the Consultant every three (3) months. They may be supported by junior level engineers, technicians, and support staff. The core team will require access to administrative support and proposals should account for this role.

The estimated total person-months of the core team members are estimated at approximately **58** man-months; however, proposals are free to estimate more or less time than what is anticipated with justification for why more or less effort is appropriate for the tasks listed.

The Consultant shall be totally responsible for collecting the required essential information, and conducting the required campaigns without any responsibility related to that on EEAA.

The assignment will be performed in Egypt, mostly in Cairo. The Consultant team members may be required to travel to nearby cities by EEAA. Each such visit shall be followed by a mission report, stating the objectives of the mission, mission contents, and conclusion.

Scheduling

The Consultant will prepare the proposed schedule of activities and staff mobilization plan at the inception stage; and these may be reviewed and revised every six months in response to EEAA's needs and in agreement with EEAA.

Client's Input and Counterpart Personnel

Services and facilities that shall be made available to the Consultant by the Client if possible, and under supervision of EEAA without any consequences on implementation or its quality:

- EEAA as possible shall assist with arranging meetings with local Government and other authorities as necessary during the course of the consultant's work.
- EEAA shall make available to the Consultant the available air quality data, emissions inventory, meteorological data and air quality index data as relevant to the conduct of the Project. Air quality data in many areas may not be available at the start of the project.
- EEAA shall make best efforts for collaborative working arrangements with EEAA, PCU, and counterpart staff.

The consultant will report directly to:

- Head of Environment Quality Sector
  Egyptian Environmental Affairs Agency (EEAA)
  Ministry of Environment

The Consultant will also work closely with the World Bank members of the Project team.

Annex1
Greater Cairo Air Pollution Management and Climate Change Project

The Government of Egypt (GoE) is currently implementing **Greater Cairo Air Pollution Management and Climate Change Project** (the Project) financed by The World Bank. The Project seeks to reduce air and climate emissions from critical sectors and increase resilience to air pollution in GC,i.e., Cairo, Giza and Qalyubia Governorates and is being implemented with Ministry of Environment (MoE) in close collaboration with Ministry of Local Development (MoLD), Qalyubia Governorate, Cairo Transport Authority (CTA) and other stakeholder agencies. The Project focuses on two main sources of air pollution: solid waste management and vehicle emissions in GC region and includes the following five main components:

Component 1: Enhancing the Air Quality Management (AQM) and Response System: This component aims to support the enhancement of the AQM decision support system in GC through a strengthened AQM infrastructure (monitoring and analytical), capacity building activities, developing emergency response plans and raising public awareness through information dissemination.

Component 2: Support the Operationalization of Solid Waste Management (SWM) Master Plans in GC: This component aims to support operationalization of Governorate SWM master plans, which lay down the full range of necessary actions and investments needed for each governorate to improve SWM services in accordance with the specificity of each Governorate. In view of the complexity and magnitude of SWM system in GC, the Project follows a phased and gradual approach to achieve tangible results on the ground. This approach involves providing technical support at the central level to the Waste Management Regulatory Authority (WMRA) and the MoLD and specific investments, technical, financial and project development support to SWM actions at the local level to the Qalyubia Governorate.

Component 3: Vehicle Emission Reduction: This component aims to support activities aimed at reducing vehicle emissions from public transport sector. This shall be achieved through procurement of about 100 electric buses and the infrastructure required to operate and maintain these buses. The component will also support the CTA in acquiring the needed knowledge and experience in operating and scaling up electric bus fleet in Cairo. The Project will also upgrade facilities at CTA, including retrofitting existing bus depots with electric charging stations, power supply and related safety equipment; training CTA staff such as bus drivers and mechanics on operating and maintaining the new e-equipment.

Component 4: Communication and Stakeholders Engagement: This component aims at ensuring that all stakeholders, in an inclusive manner, are actively involved in the design, implementation and monitoring of all Project activities and the Project is implemented following a full consultative participatory approach that is meant to build a constructive relationship between the stakeholders and the GoE. This component is complementary to the comprehensive Stakeholders Engagement Plan (SEP) developed as part of the environmental and social risk management.

Component 5: Project Management and Monitoring and Evaluation (M&E): This component* will support the establishment of Project Coordination Unit (PCU) at MoE and four Technical Implementation Units (TIU) for each of the first four components.

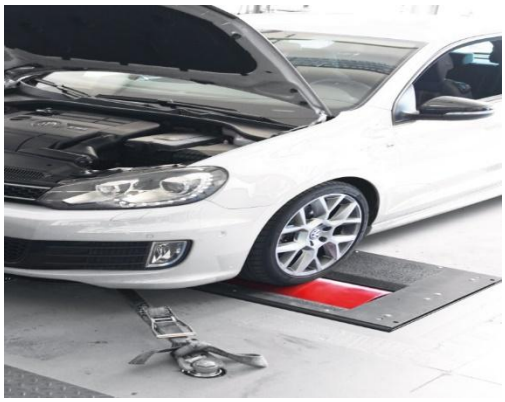
Component 6: Enhanced E-Waste and HCW management for Reduction of uPOPs: It is an additional finance (AF) to the parent project, this new activity focuses on reduction of unintended persistent organic pollutants (uPOPs) aligns with the "GEF Project Design and Review Considerations in Response to the COVID-19 Crisis and the Mitigation of Future Pandemics".

Annex2
Supplementary Information on EEAA's Chassis Dynamometer

The Chassis Dynamometer is brand new and has been installed and tested in 2021, in the "Technical center for Vehicles Emissions" in Shubra El Khaima District, Qalubia Governorate, Greater Cairo.

1- Mechanical Function Testing

- Model : MAHA MSR 550
- Description:
  - Single-axle single roller dynamometer for cars with axle load of up to 2.4 ton, eddy-current brake included, ideally suited for performance measurements, tuning and diagnostic work in powerful vehicles.



  - Test speeds of up to 300 km/h
  - Tyre rolling action as it would be on the road.
  - Tyres are preserved as a result of limited flexing action
  - Simple restraining mechanism for quick vehicle fixation
  - High level of flexibility in use due to extensive variety of operating modes, covering all fields of application:

    - Static power measurement at constant RPM
    - Static power measurement at constant speed
    - Static power measurement at constant tractive force
    - Dynamic power measurement with adjustable acceleration
    - MAHA towing power measurement guarantees the highest degree of accuracy when measuring power: Precision calculation of the parasitic losses of the dynamometer, of the vehicle's drive train and the tyre to roller friction and flex losses
    - Tachometer testing with up to ten freely selectable test points
    - Distance measurement included
    - Stopwatch function for measurement of acceleration between optional speed markers as standard
    - Optional load simulation with freely programmable load profile
    - Optional driving simulation with freely programmable speed profile
    - Option of storing programmed profiles in database

  - Professional, intuitive-use software for the highest expert standards with:

- Continuous graphic display and recording of up to 16 freely selectable parameters per performance measurement cycle on one measurement screen.
- In addition to the current performance measurement cycle, fade-in of up to three stored cycles on the measurement screen for optimum comparability during calibration work.
- Two circular dial displays for RPM and speed as well as current oil temperature display, ensuring constant control of key parameters during performance measurement
- Determination of wheel power, power dissipation, engine power and torque
- Standardized extrapolation of motor power in line with DIN 70020, EEC 80/1269, ISO 1585, JIS D 1001 and SAE J 1349 (configuration-dependent)
- Circular dial display of motor power, RPM, speed and tractive force during simulation cycles
- Color-highlighted user prompts integrated within the circular dial facilitate the accurate reproduction of simulation cycles
- With radio remote control as standard for complete control of the dynamometer from within the vehicle.
- Radio remote control with long-life battery and charging station.
- Cooling fan switched on and off either at the control console or with the radio remote control.
- With interface box including stand and long connection cable as standard for optimum placement at the dynamometer with MAHA plug-in CAN-DRZ module card for connecting RPM sensor.
- Interface box optionally upgradeable with MAHA plug-in card for comprehensive recording of external Ambient data such as air temperature, air pressure, rel. humidity and intake temperature
- Interface box optionally upgradeable with MAHA plug-in analogue input module card with 4 sensor inputs for temperature and pressure sensors or lambda sensors.
- Optional connection of MAHA MGT 5, MDO 2 LON and MET SERIES emission testers
- Optional connection of Krupp/AIC fuel consumption measuring instruments for petrol- and diesel engines

- Roller Set Standard Delivery:
  - Robust self-supporting, closed roller set with an eddy-current brake
  - Varnished with high-quality powder coating: Anthracite Grey, RAL 7016

2- Gas Analyzer for emissions Testing

- Model: HORIBA MEXA -1700D-EGR
- The measuring gases: CO-CO_2-HC-NOx and Solid Particle (Counting System PM up to 23 nanometer)
- Description:
  - The MEXA-1700 is a gas analyzer system targeting raw exhaust measurement from diesel and gasoline engines. The system can measure CO, CO2, THC, NOx and O2 in real-time and can be used for various applications such as engine development and catalyst evaluation. Based on the core technology of the MEXA-ONE series, the MEXA-1700 offers a high-accuracy measurement, fast response time and it is both user-friendly and easy to maintain.

  - The target group of the MEXA-1700 are Research and Development, Universities and Engineering Companies, that want to measure with high accuracy and worldwide-approved quality measurement equipment, but seek for systems that meet their budget and therefore have limited options and functionality.
  - The DCU is a control and communication module that interfaces the DMC to each system module.
  - Device Management Controller (DMC):
  - The DMC controls all system components and functions, featuring a user-friendly GUI. User defined hardware options include desktop or rack-mounted solutions. The menu-guided navigation takes place through the MEXA-1700 touch panel or by a desktop PC with monitor and mouse (usually in the control room). Optionally, a remote control, using for instance a tablet PC, is available for a flexible overview and control of the system.
  - Power Supply Unit (PSU): The PSU provides power for each of the system components.
  - Solenoid Valve Selector (SVS): The solenoid valve matrix provides test and calibrations gases and includes checks for humidity and interference. Additionally the gas divider can be connected to the SVS.

- Sample Handling System (SHS): The SHS contains the pumps for cold and hot analyzers (EGR as option). A hot FID for CH4, THC and NMHC can be built in.
- Cabinet: The cabinet is designed to maintain a steady temperature, providing enhanced analyzer stability and durability.
- Device Control Unit (DCU): The DCU is an interface unit connecting various MEXA system modules into the MEXA-ONE Software
- Several counters give a summarized overview:
  - Elapsed time
  - Stand-by time
  - Sample measure time
  - Cal measure time
  - Purge time
  - Measure and purge time
- The Device Management Controller software provides:
  - Maintenance control and quality control management
  - Precaution for calibration
  - Precaution for maintenance
  - Trouble shooting
  - Calendar functions
  - Reporting
  - User management
  - Average and real time analyzer component concentration
  - Real time trend chart & post trend chart
  - A/F ratio & Lambda (HORIBA standard)
  - EGR calculation (HORIBA standard)

- Graphical User Interface (GUI): The MEXA-1700 offers an intuitive interface with a highly efficient software design. This leads to increased efficiency and economic operation with improved reliability and accuracy. These advances are possible, because the MEXA-1700 software uses the new operating "HORIBA ONE PLATFORM". This platform integrates the test systems and devices of the test cell under a single user interface.
- Enhanced Function: The MEXA-ONE-1700 incorporates highly efficient functions to ensure measurement accuracy and precision. Periodic quality checks and preventative

maintenance work are essential for consistently accurate performance of emission analyzers. The reliable and stable operation of the MEXA-ONE-1700 minimizes unexpected downtime and maximizes test cell efficiency.

- Quality and Safety Management: Automatic notifications of periodic inspections and adjustments are generated as required by emission regulations in accordance with a user-defined schedule. Inspections and adjustments can also be started from the control window. User defined part can also be set up with counters and notifications.
- Preventive Maintenance Feature: This automatic function provides advanced notification for the replacement of consumable parts. This process enables proactive maintenance to be performed.
- Effective Troubleshooting: When an alarm occurs, the MEXA-ONE not only displays details of the alarm, but also generates a display with troubleshooting instructions. A quick alarm resolution enables effective testing.
  - Precaution: hour meter - QC
  - Precaution: status analyzer
  - Precaution: status vacuum pump pressure
  - Precaution: status sampling pump
- HORIBA Solenoid Valve Selector (SVS): The SVS supplies the operation and calibration gases to the analyzer modules and controls them, incorporating humidifiers for interference checks. In addition, the SVS connects the GDC modules for analyzer linearization and the checking of the NOx converter efficiency. This device is also available as a stand-alone module integrated into the cabinet.
- Analyzers: All MEXA-ONE analyzers use a 24-bit ADC (analog/digital converter) converter with effective 21 bits of usable resolution, resulting in a wider dynamic range, greater precision and lower noise than previous generations of HORIBA analyzers.
  All analyzers use the same ADC, requiring fewer spare parts.

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