"Electronic ECOWAS for Decision-Making with Distributed Simulation"

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PROJECT SUMMARY

1. Overview:

The Paris climate pact in December of 2015 was a historical success with many nations' pledges to reduce carbon emissions and global warming. However, most nations need to significantly improve their pledges require rigorous simulation studies (*), to meet their Sustainable Development Goals (SDGs). This will require regular and transparent global cooperation with collective and shared responsibilities in democratic fashion. We plan to achieve this cooperation as firstly interlinking the sector models for each of the "Sustainable Development Goals (SDGs)" (17 of them in total) with "Center for Understanding Change (C4UC)" system dynamics solver to produce a single country model for each of the ECOWAS countries. Then we plan to interlink those individual countries' comprehensive SDGs simulation models together with the use of our patent-pending procedures through broadband Internet, to form the "**Electronic ECOWAS**," "**Electronic African Union**" and eventually the "**Electronic United Nations (e-UN)**." The ultimate education goal is "**HOW TO PREPARE FOR THE EMERGENCE OF SOCIETY WITH NO GREENHOUSE GAS (GHG) EMISSION BY THE END OF THIS CENTURY.**"

(*) With the use of "integrated SDG" (iSDG) model of the Millennium Institute <http://www.isdgs.org/#!documentation/kri3x>

2. Objectives:

2.1 Intellectual Merit:

The most significant contribution of this project is its transformational use of stakeholder-crafted models for developing sustainable strategies, leveraging an unprecedented critical mass of global expertise for national level problem solving. The multi-disciplinary, multi-institutional project team consists of academics and researchers with substantial experience in using modelling and simulation for development objectives. We will develop a global network of federated and standardized systems models of national sustainable development that can collect and share data on complex energy, healthcare, food security and natural resource management problems. This will be an unprecedented effort that could transform the effectiveness of sustainable development and foster global collaboration in solving "wickedly complex" problems. Pioneered in the aerospace and military industries, globally distributed simulation using a global virtual super-computer through broadband Internet has never been done before in the socio-economic-energy-environment system context.

2.2 Broader Impact:

This initiative is unique in that it integrates advances in understanding complex development problems through modelling and simulation, with training and educating young decision-makers from developing nations in systems thinking for sustainable development. Given its developing country focus and gender empowerment objective, the initiative will both engage and serve underrepresented population groups and potentially enhance broader societal welfare within the target countries. It also creates an infrastructure for building an unprecedented global network of academics, decision-makers and practitioners who can share knowledge, expertise and data, as well as the cyber-infrastructure necessary to allow large-scale education and training of students and citizens across the globe in sustainable development strategies through gaming and simulation. At later stages, we will leverage resources to develop additional national sustainable development models, creating a larger and more effective global network in the form of a **Global Early Warning System (GEWS),** forming the core of an "**Electronic African Union**" and eventually, the "**Electronic United Nations**."

3. Implementation:

Upon request from the Nigerian Ministry of Science and Technology, we will embark on the "Transition from Fossil Fuels to Renewable Energy" Project (*) (hereinafter "Energy Transition Project"), which is a part of our "Creating Electronic United Nations (e-UN)" Project. We would later replicate this Nigerian Energy Transition Project and adapt it to Ghana (**) and then to other ECOWAS countries. This Nigerian and ECOWAS Energy Transition Project will significantly provide clean energy and reduce emissions of carbon dioxide and GHG, but will also aid in creating new jobs, e-learning and e-healthcare with renewable energy (solar and wind, etc.) in remote areas of the African continent.

(*) This Nigerian Energy Transition Project is to create by 2030 13 GW of electric power from renewable energy (e.g., solar, wind, biomass, other) generation units, as postulated in the Nigerian pledge that appeared in the Intended Nationally Determined Contribution (INDC) <http://www4.unfccc.int/submissions/indc/Submission%20Pages/submissions.aspx>.

(**) The Ghanaian INDC pledge indicates a similar renewable energy generation requirement.

NARRATIVE

1. Problem:
In spite of greenhouse gas (GHG) emissions causing climate change, global cooperation has not yet produced tangible results. We need a significant transition from fossil fuels to renewable resources. At the 2015 IPCC in Paris, all the UN countries submitted their Intended Nationally Determined Contribution (INDC) pledges for GHG emission reductions by 2030.

The major reasons for the slow progress on reducing GHG emissions and increasing the use of renewable resources for power generation and transport are the lack of the leadership and the framework based on the universally shared rational decision-making skills among national and global policy-makers. Without these skills, the policies to cope with climate change are likely to be inconsistent, conflicting, and uncooperative. Creating the leadership and the framework that promote rational decision-making is urgent and indispensable. This project will develop the appropriate leadership among future policy-makers and the required framework for their collaboration.

2. Nigerian Energy Transition Project:
Recently, the Nigerian government requested and we submitted a Proposal to the Nigeria Ministry of Science & Technology for "Transition to Clean & Renewable Energy; SDGs Interlinked to Power Generation, Transport, and Other Energy Sectors in Nigeria" to assist Nigeria meet the INDC submitted goals for significantly reduced carbon emissions by 2030. (Similar proposals are in development for Ghana and other ECOWAS countries in Africa.) The SDGs interlinked with clean energy (SDG #7) production and use include water & waste management, food supplies, infrastructure, sustainable cities, transportation, innovative technology, jobs and economic growth, education, healthcare, etc. It is essential to assist companies and governments on how they can use the SDG framework to implement a transition from fossil fuels to clean renewable energy in urban and rural areas of each country in the world.

One of the key requirements of successful policy-making and implementation of clean energy and environment program is to accept the inter-linkage of many of the 17 SDGs. We must simulate, measure, monitor, and evaluate the impacts the various proposed policies and target SDGs may have on each other. For example, energy affects the environment and climate change, but also water, food supply, health, jobs & economic growth, infrastructure and urbanization, education, etc. The other targets are clean energy, water & sanitation, food & agriculture, health, education, infrastructure, transportation, sustainable cities, technology innovations, partnerships of companies & governments, and several other interlinked SDGs, and investments/projects in Sustainable Development.

Our working group is a collaboration of several companies and universities with expertise in energy, environment, climate change, telecommunications broadband & computer engineering, education & training, economic analysis & project planning, role-playing negotiation qualitative energy models, and dynamic simulation quantitative models on energy systems and interlinked SDGs. The primary collaborating organizations include: Stevens Institute of Technology in New Jersey, Global Systems Analysis and Simulation Association (GLOSAS/USA) in New York, Columbia University School of International and Public Affairs in New York, Millennium Institute (MI) in Washington, DC, Energy Mentors International LLC (EMI) in New Jersey, Center for Understanding Change (C4CU) in Maryland. They are collectively known as the "e-UN Group."

3. System Analysis and Simulation Model for Policy Analysis:
Specifically regarding SDGs, government and business planning, the Millennium Institute (MI) has developed a significant piece of work, called the "Integrated Sustainable Development Goals (iSDG)" planning model <http://www.isdgs.org/#!documentation/kri3x>, which we adapt to each country we evaluate. The link below offers a short descriptive video and insight on the value and methodology of the iSDG <https://www.youtube.com/watch?v=Kc9rBwtrV00>.

As similar to weather forecasting, simulation is an indispensable tool for "what if" scenario assessments, policy analysis and decision-making of complex global social behaviors. The e-UN Group (*) in each of ECOWAS countries will conduct system analysis to construct simulation model with the use of the iSDG Model. This is a comprehensive simulation tool that can generate country-specific development

scenarios to show the implications of policy on a country's progress towards the United Nations Sustainable Development Goals (SDGs) <http://www.un.org/sustainabledevelopment/inequality/>.

It enables decision-makers to use system dynamics thinking and tools to analyze and understand the interconnectedness between economic, social, environmental factors. It also handles macro analysis of economic, social, and environmental development challenges, and understanding of the complexity of and interrelationships among policies in each sector. It has helped to create greater and more open dialogue among stakeholders in the formulation of policies. The iSDG Model supports looking into alternative future scenarios from the business as usual scenario, and make informed choices on a way forward that optimize the synergies and minimize or mitigate the unintended consequences of policy decisions.

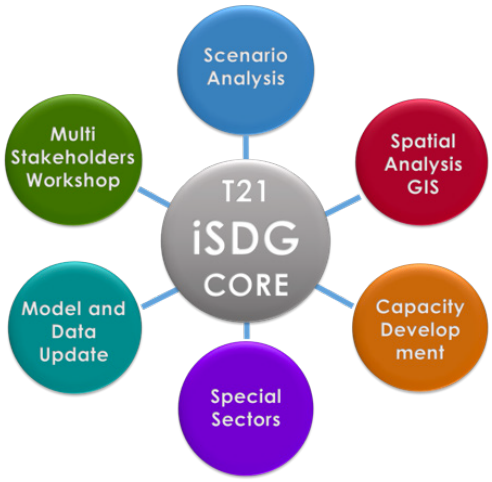

Figure 1: Integrated Sustainable Development Goal (iSDG) Model

The iSDG Model gives policy-makers and planning officials the capacity for the following:

- ✓ Visualize progress towards each of the SDGs, highlighting specific areas requiring more attention or resources,
- ✓ Evaluate the likely benefits of proposed policies and strategies, and reduce undesired long-term impacts (up to 2050),
- ✓ Ensure policy coherence across areas of interventions and facilitate the alignment of SDG strategies with other national development plans,
- ✓ Define an efficient policy implementation schedule that facilitates high-impact results and monitors progress towards achieving policy objectives.

3.1 How does iSDG Model work?:
The iSDG Model utilizes VENSIM modeling software, which gives users the ability to conduct on-the-spot simulations, perform complex policy analyses and visually project results through graphs and data charts. The interface allows users to chart potential progress toward each goal of the SDGs, evaluate anticipated benefits of proposed policies and strategies, and foresee long-term impacts. The iSDG Model can generate scenarios up to the year 2050.

3.2 User-Friendly Interface:
The iSDG Model offers a user-friendly interface, which enhances the ease and speed with which interactive simulation experiments can be run, even incorporating a large number of policies simultaneously. It offers flexibility to address a wide range of development problems. The interface also provides diagrams and descriptions that give insights into the structural causes of behavior to show the interconnectedness of the SDGs.

Recognising this need, the iSDG Model is an interactive simulation model designed for policy-makers and planners or others concerned with achieving the SDGs. The iSDG Model is intended to help policy-makers and planners make sense of the complex and interlinked SDG system, and to help them design efficient pathways to their goals.

3.3 Synergies:
Actions to achieve progress in one SDG sector may cause underachievement or failure in another. Similarly, a successful SDG initiative in one sector might create synergies for improvements in another. The SDGs can be thought of as a complex system of interwoven feedback loops, lengthy time lags between causes and effects, and nonlinearities that are often unrecognised. Such systems are known to present serious impediments to learning and policy design. Within this difficult environment there is a need for tools to aid learning and policy design focused on SDG attainment.

3.4 Who should use the iSDG Model?:
The iSDG Model is highly beneficial to policy-making and planning by officials, but can also be used by multiple stakeholders at various levels of society. Ideal users include:

- Policy planning institutions (both government and non-government) that conduct research and analysis for policy decision-makers;
- Government officials and decision-makers who want to explore a range of alternative strategies and trade-offs to achieve desired outcomes;
- Stakeholders in multilateral and bilateral international development organizations, sustainable development experts, educators and researchers committed to the Sustainable Development Goals.

The iSDG Model's integrated, multi-sectoral and systems approach helps achieve policy coherence and integration at both policy design and evaluation stages. The iSDG Model is customized for countries through a collaborative process involving consultation with a broad range of local/national stakeholders. This approach ensures that the model reflects the unique development dynamics of each country and fits expressed needs and priorities.

3.5 Implementation of iSDG to Nigerian Energy Transition Project:
The e-UN Group will evaluate the proposed solution for use of Renewables in Power Generation, Transport Systems, and Other Economic Sectors of the Energy Transition Project in Nigeria (i.e., the Nigerian Energy Transition Project mentioned above) during 2010-2030 by using the iSDG Model. For the necessary local content and inclusion of opinions of all stakeholders, several Nigerian higher educational institutions (e.g., the Federal University of Technology (FUTO) in Owerri of Imo State and/or River State University of Science and Technology in Port Harcourt, etc.) will actively participate in the development of this Model. Later the University of Ghana and the Advanced Information Technology Institute (AITI)/Ghana-India Kofi Annan Centre of Excellence in ICT in Accra, Ghana, will assist in the development of a similar Model for Ghana. Both the Nigeria and Ghana Models will be developed in cooperation by the e-UN Group.

The Model is an analytical tool for strategy development and policy analysis at the national level, focused on Climate Change Impacts and Adaptations, and yet meeting the Sustainable Development Goals (SDGs) <http://www.un.org/sustainabledevelopment/education/> with the use of iSDG Model of the Millennium Institute. It integrates climate change with economic, social, energy, and environmental considerations into a single, transparent computer model. We will use the Model to assess various scenarios for the impact of solar, wind, other renewable clean energies co-located with diesel or natural gas power generation, transport, and other energy use at existing and new sites from 2010 (baseline) to 2030. Nigerian's parameters for the Model to evaluate include: changing oil/gas production, new technology & energy efficiency, reducing carbon emissions, mitigating climate change and improving the environment, population, e-healthcare and public health, rural & urban infrastructure, e-learning education & vocational training, jobs & economic growth, personal income, capital investment, gender equality, and other social, economic, and environmental Sustainable Development Goals (SDGs) which are interlinked to Clean Energy (SDG #7).

We will demonstrate the benefits from the proposed energy plans and related policies that will promote economic growth and avoid negative side effects. We will include the benefits of shifting to renewable resources for local distributed power generation to avoid extending the electricity grid too far and for clean transportation in urban and rural areas. In addition to significant reduction in carbon emissions from clean renewable energy, we will include in the feasibility study the impact on other interlinked SDGs (e.g. jobs, economic growth, infrastructure, e-healthcare and public health, water, food, e-learning and education, etc.) that have important targets in the Nigeria government plans for the short term and long term.

4. Collaboration:

4.1 Domestic Collaboration with Inter-linkage of Each Goal Sector Model:

Because of its integrated and transparent structure, the iSDG Model can reveal chains of impacts from policy interventions, helping policy-makers identify trade-offs, synergies, and leverage points. The interactive nature of the iSDG Model provides means to design and test evidence-based policies to improve efficiencies, reduce risks, and increase the likelihood of achieving the Sustainable Development Goals.

None can be the almighty as knowing in detail every goal sector of the SDGs. We will then assign experts to each goal sector to construct their own simulation model with the use of iSDG Model, which will reside in their own computing unit (desktop, laptop, tablet etc.) located at their preferred locations. We will inter-link the multiple, distributed goal sector models via Internet with the use of C4UC system dynamics solver <http://tinyurl.com/hd9sb8h>, e.g., an example of **Beowulf Mini Super-Computer** approach in broad sense.

The C4UC solver was created to solve the stakeholder challenge. Specifically, it was designed to solve sets of system dynamics models where it is not possible or practical to create a single, "supermodel" out the set. This situation can arise in the following situations:

a) Where the models are large and numerous and therefore combining the models ad hoc in a timely fashion is not practical;
b) Where the models are not located on the same device and moving them is, for whatever reason, problematic;
c) Where the models contain information that is considered sensitive and must remain behind firewalls; and
d) Where the models contain information that is restricted and neither the data nor the functions within the model may be shared – in other words, where the model must act as a black box to the outside world.

System dynamics models, including those created with VENSIM, contain sets of equations that must be solved "simultaneously." The first step in solving "simultaneous" equations is to determine the order of operations of the equations – in other words, how to go about the actual process of operations. In a single model, this is a straight-forward process that can proceed in a deterministic fashion. When the models are remote from one another and the actual equations are hidden (not exposed in any way), it is probably impossible to solve the order of operations in a deterministic fashion. The C4UC solver gets around this by employing non-deterministic methods that act in modes very analogous to biological systems.

This also leads to the exploration of uncertainty in some cases. Often (particularly in the case of the T21/iSDG models) there is much overlap in the causal loop diagrams of the various models in the set to be solved. In these overlapped areas, it is a normal occurrence for variables from the constituent models to have different functions associated with them. For example, one model may have "A" as a function of "B" and another model may have "A" as a different function of "B" or as a function of "BC". The C4UC solver can take multiple paths through the function space, generating a number of solutions at each time step, and/or it can take a different path at each time step. The resulting set of somewhat stochastic data can be explored visually to understand the uncertainty among the models.

In the case of what we are proposing here, the C4UC solver will be used to solve the model set stochastically at each time step. As students of each goal sector "turn the dials they have control over," the set of models is solved again, displaying the results, and so on. From the participants point of view, the system is robust and fast enough that they will view it as real-time.

4.2 International Collaboration with Inter-linkage of Each Country Model:

This e-UN Project will bring together young decision-makers from participating countries to jointly construct and use socio-economic-energy-environmental simulation models for their respective countries. This will be the result of inter-linkage made on 17 SDG sector models by the C4UC solver mentioned above. Each country model will then be interlinked for their collaborative international policy analysis, decision-making, and rational scientific thinking to assist government officers and aspiring future leaders in order to further their co-prosperity as per "**NO SINGLE COUNTRY CAN EXIST ALONE**." This inter-linkage of distributed country-models via the Internet will also contribute to the international conflict resolution for the fair distribution of benefits and burdens of global climate change by transforming

adversaries to collaborators, as achieved when enacting the Law of Sea. Another example is the policy analysis on the economic consequences at the outbreak of the Ebola epidemic.

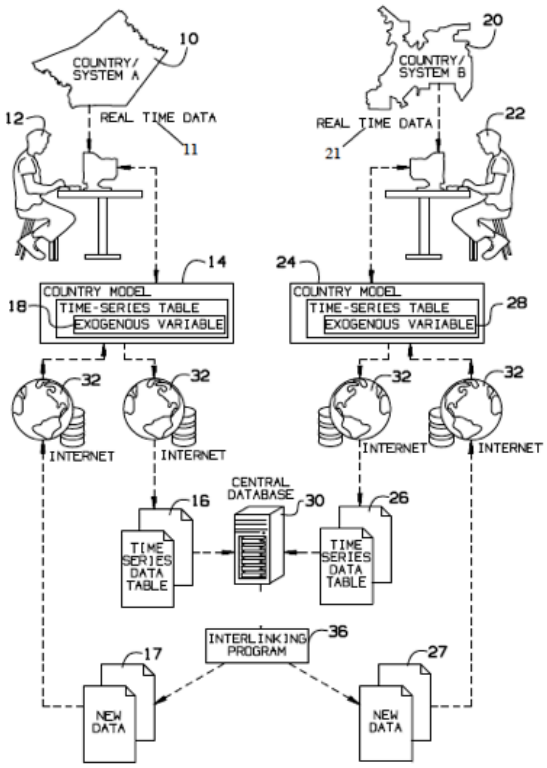

Figure 2: Inter-Linkage Mechanism for Distributed Simulation Models with Human Intervention (US Patent Pending #61/764,843 <http://tinyurl.com/d4oj9py>)

5. Education & Training Program:

Columbia University (Reference (1)) uses qualitative role-playing normative gaming in international political science courses. We will combine that role-playing with quantitative model-based simulation of Nigeria, which the Nigeria Ministry of Environment constructed with the Millennium Institute (Reference (2)) to produce the one package deal. This combined use will be a significant paradigm shift in the international political science field with the fusion of humanity and science.

The successive stages will invite major universities in Nigeria and Ghana, etc. We will then produce video-oriented educational material out of this exercise at Columbia University. This will later be used for the solicitation of participants from ECOWAS and Nile river basin countries. We will transplant this procedure to the higher educational institutions in ECOWAS countries, and then will conduct the inter-linkages of models among ECOWAS countries and later among Nile River basin countries, thus forming a prototype of the "**Electronic African Union (e-AU)**." We also plan to make this e-AU affiliate with "**Smart Africa**" <http://tinyurl.com/jntgrz7>.

This education program for selected Nigeria Universities will educate and train young Nigerian entrepreneurs on Transition to Clean Renewable Power Generation, Transport, and Other Energy Systems in Nigeria. We will offer the program to students, workers, young government officers and aspiring future leaders in various fields. The Education & Training Program will be by global e-learning with these institutions.

5.1 Normative (Role-Playing) Qualitative Gaming:

The School of International and Public Affairs (SIPA) of Columbia University has been conducting a role-playing negotiation exercise. This qualitative gaming negotiation allows participants to investigate how these factors interact in a realistic situation, how trade-offs can be made for mutual long-term benefit, how

alliances can be built, how long-term sustainability can be assured or threatened, and how sustainability failure can damage a country, a region, and the planet.

The starting point is a business or political challenge – the decision to commit to investment in a major industrial development, or for a government to nationalize an industry, or for a municipality to extend an urban transport system. The decision must be taken within one year of simulated time from the start. The decision will have long-term financial, economic, environmental, and political consequences and may well trigger social change. A wide range of stakeholders will be affected by the decision and though some may benefit from it, others will see it as a threat to their wellbeing and way of life. Participants – role-players – are provided with a detailed description of the natural, political, economic and social conditions within the country or city being simulated. This corresponds to the key public-domain information that one would access by an internet search-engine enquiry related to the country or city and to the main stakeholders, including government, business, NGOs, communities and media. The participants then play in character their allocated roles through the one or two-day simulation. They will then be given further confidential briefing notes, which are unique to their own particular circumstances, interests and viewpoints. This information may be exchanged, or traded, with other role-players, and forms the basis for negotiations, creation of alliances, and deal making.

A typical gaming negotiation exercise, called "*Discordia,*" based on an oil discovery in a West African country recovering from a recent civil war and world oil & natural gas price collapse, involves the following types of stakeholders: Government; Opposition Party; several Foreign Oil/Gas Companies; Local Community; several Non-Government Organizations (NGOs) concerned with Environment, Development, Human Rights, and anti-Corruption; US-based Think-Tank Institute on strategic issues; and four (4) different News Media organizations. Participants play out their roles over a full year of simulated time, negotiating and reacting to the behaviour of others, and to new information which is injected and leading up to the making of critical decision – or not.

5.2 Model-Based Quantitative Simulation:

The iSDG Model is intended as an interactive learning platform, giving policy-makers and planners the opportunity to learn and build intuition through virtual experiments or "what-if" scenarios within the complex SDG system. It is expected that this mode of experiential learning will help policy-makers identify trade-offs, synergies, and high leverage intervention points that will inform their policy decisions.

The iSDG Model contains 30 interlinked model sectors: 10 social sectors, 10 economic sectors, and 10 environmental sectors distributed within the three core dimensions of sustainability: society, economy, and environment. The model maps key feedback loops running between and within sectors as well as nonlinear relationships and time lags that generate the complex systemic behaviours characteristic of interactions between SDGs. Unlike static SDG indicators databases and indexes that provide a measure of where a country is, the iSDG Model focuses on the *interactions* within the SDG system to reveal the best *paths and progression* towards achieving the SDGs.

In cooperation with Nigerian higher educational institutions, the e-UN Group will train Nigerian personnel, students, workers, and government officers on the use and interpretation of results from the simulation iSDG Model. The objectives for this training by e-learning will be improved decision making on policies to lower carbon emissions, mitigation of climate change with increased energy efficiency and use of renewable energy for power generation and transport, and evaluation of impacts on all SDGs interlinked to clean energy (e.g. e-healthcare, e-learning, jobs, etc.) in remote rural areas.

We will train the users of the iSDG Model how to assess various scenarios for the short-term and longer-term impact of renewable energy. Specifically, we will teach the users of the Nigeria iSDG Model, how to develop "what if" scenarios to assess the impact from solar, wind, biomass, other renewable resources gradually replacing diesel, gasoline, natural gas or other carbon-based fuels in power generation, heating, lighting, cooking, and transport systems at existing and new sites in Nigeria from 2010 to 2030. The users of Nigeria's iSDG Model will learn how to evaluate: changing oil/gas production, energy technology & efficiency, reducing carbon emissions, mitigating climate change & improving the environment, clean water availability, population growth, e-healthcare & public health, rural & urban infrastructure, jobs & economic growth, e-learning education & vocational training, personal income, capital investment, gender equality, and other social, economic, and environmental Sustainable Development Goals (SDGs) which are interlinked to Clean Energy (SDG #7).

6. Consequential Benefits:

This project will foster logical thinking for justice, the central concept of democracy, among future policy-makers with the combined use of qualitative and quantitative models and analyses. This project framework will enact the bottom-up participatory democracy and global collaboration through the Internet. It will ultimately contribute to sustainability, mitigation of climate change, and avoidance of international conflicting issues by transforming adversaries to collaborators for confrontation-prone problems.

Making rational decisions requires both qualitative and quantitative skills. We need qualitative interpersonal skills to achieve the goal through negotiation and reach the optimal agreement for all participants. We also need quantitative skills to handle complex yet comprehensive data-based simulation models that are critical to find the optimal solution. Today, these two skills are imperative for rational decision-making by the policy-makers. Yet the training schemes for the future leaders have not coordinated these two skills in one package. This project will properly combine the two schemes to train decision-makers in both skills as a comprehensive program.

For smooth coordination, we will conduct videoconferences with parties every two months. We plan to conduct similar activities later with various major universities in ECOWAS countries, and elsewhere around the world. We have already made fact-finding trips to Nigeria and Ethiopia by visiting half dozen higher educational and healthcare institutions in each of those countries.

6.1 Simulator/Trainer for Policy Analysis and Decision-Making:

The repetitive mode of the model will create a simulator/trainer for daily policy analysis and decision-making, so that users in developing countries can participate with academic excellence around the world and unleash creativity with their brilliant brainpower in globally collaborative fashion. This scheme for decision-making exercises will also enable participation by the ordinary citizens with their cell phones at any public WiFi spot, thus promoting bottom-up participatory democracy based on facts and figures, rather than exclusively upon hunches, habits or traditions.

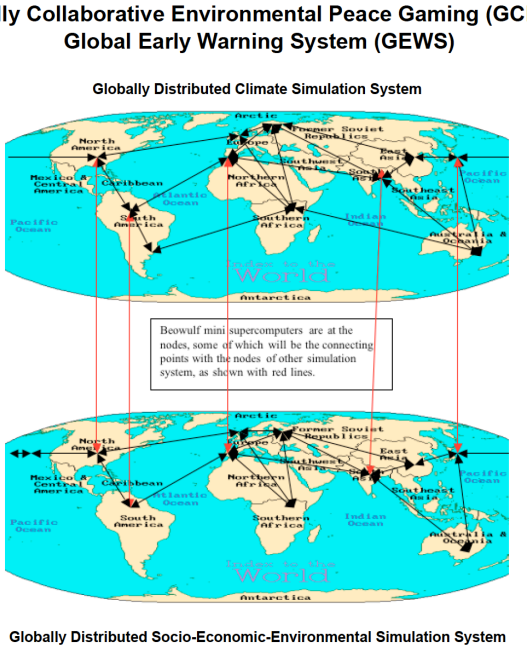

Figure 3: Globally Collaborative Environmental Peace Gaming (GCEPG) <http://tinyurl.com/cmcjsqw>
By nature of phenomena, the climate model has to ignore national boundaries, but the socio-economic-environmental models cannot ignore them.

This project will also promote globally collaborative democracy with our patent-pending procedure on the inter-linking mechanism of distributed socio-economic-energy-environmental simulation models in those participating countries together (Figure 2). These activities will then lead to the possible creation of "**Electronic African Union**" and eventually "**Electronic United Nations**" (Figure 3), as improving the FUGI world model of Soka University of Japan, which currently has 194 countries' sectors and 6 UN

sectors. This approach will be stark contrast to the conventional climate models, which aggregate every country by ignoring the national boundaries because of inevitable natural phenomena.

7. Unique Solutions:
Our solution is unique and different from other approaches, and offers the following:

7.1 Fusion of Humanity and Science:
The School of International and Public Affairs (SIPA) at Columbia University teaches role-playing qualitative negotiation (Reference (1)) on offshore oil and gas discovery in Nigeria. Making rational decisions requires qualitative and quantitative skills. We plan to combine the SIPA qualitative negotiation model with the iSDG quantitative simulation model (Reference (2)) along with the Nigerian Renewable Energy Transition Project by MI, EMI, C4UC, and GLOSAS/USA. We will later take a similar approach with other participating countries in ECOWAS, African Union, and United Nations.

7.2 Simulator/Trainer:
Our dynamic simulation models in a cloud system will be accessible publicly by cell phone in any WiFi area for analysis of policy parameters. This simulator/trainer center will assist government officers and young aspiring future leaders with hands-on experiential learning, guided by the adage "Knowledge with Action Becomes Wisdom." Such training center with real-time data will also provide pro-active features with execution of associated simulation models.

7.3 Globally Distributed Simulation:
In contrast to most global models, which aggregate countries by ignoring their national boundaries, our distributed simulation approach respects the countries' boundaries as interlinking models with our patent-pending procedures. Moreover, those models are more accurate, because experts in the participating countries and sectors will construct them. This in a sense will construct a virtual supercomputer over broadband Internet, while promoting partnership among participants.

8. Expected Outcomes:
8.1 Immediate Term:
(a) Construction of Systems Dynamic Simulation Quantitative Model for use of Renewable Resources in Power Generation, Transport, and Other Energy Systems in Nigeria during 2010-2030,
(b) Feasibility study for appropriate policies on the renewable Energy Transition Project, based on rigorous simulation analysis to meet the SDGs pledged by Nigeria.

8.2 Long Term:
(a) Global e-learning with the SIPA of Columbia University and Millennium Institute (MI) for capacity building of young government officers and aspiring future leaders in various fields in Nigeria, in collaboration with participants of other e-ECOWAS countries,
(b) Evaluation and recommendation of short list of vendors of equipment for renewable resources (solar, wind, biomass, other) used in power generation, transport, other energy sectors and for training, installation, and eventual manufacturing of such equipment in Nigeria.
(c) Evaluation and recommendation of certain Nigerian universities for on-site prototype renewable-energy equipment in entrepreneurship incubator laboratories, as well as e-learning education and training programs for students, workers, policy-makers, and government officers.
(d) Evaluation and contacts for obtaining Japanese ODA and other national and international agency sources of funding for investments in renewable energy in Nigeria and ECOWAS countries.

9. Implementation:
This Nigeria Energy Transition Project consists of the following sub-projects. The Ghanaian project and other ECOWAS countries' projects one by one will later follow this Nigerian Energy Transition Project.

9.1 Feasibility Study on Energy Transition:
This study will assess appropriate policies for the transition from fossil fuels to renewable energy resources for power, residential, commercial, industrial, and transport sectors in Nigeria. We will base the study on qualitative role-playing negotiation models and quantitative dynamic simulation models and analysis. We will conduct the study by the Millennium Institute (MI) collaborating with Energy Mentors International LLC (EMI), Center for Understanding Change (C4CU), GLOSAS/USA, Columbia University,

and Stevens Institute of Technology, with appropriate Nigerian higher educational institutions, all in combination with the e-UN Group mentioned above. Focus of the Nigeria iSDG Model will be on:

a. Urban areas of major cities in Nigeria (e.g. Lagos, Abuja, etc.) regarding the gradual transition to clean power generation, heating, cooling, lighting, cooking, and transport systems. Examples are fuel mega-stations, residential apartment buildings & houses, hospitals, universities, schools, hotels, and government, commercial & industrial buildings that now use expensive and polluting diesel, gasoline, natural gas or other carbon-based fuels for power generation, industrial, commercial, residential, and transportation sectors.
b. Rural remote areas in Nigeria regarding the gradual transition to clean power generation heating, cooling, lighting, cooking, and transport systems. Examples are large electric power plants (>500 MW each), universities, agricultural companies and farms that now use expensive and polluting diesel, gasoline, natural gas or other carbon-based fuels for power generation, industrial, commercial, residential, and transportation sectors.

The Nigeria simulation iSDG Model will evaluate the short-term and longer-term impact of the proposed solution for Nigeria's Energy Transition to Renewable Resources from 2010 (baseline) to 2030 by using a quantitative dynamic simulation model developed by MI as part of this Project.

In the Nigeria iSDG Model, solar, wind, biomass, and other renewable energy resources will co-locate, minimize, and eventually replace diesel, gasoline, natural gas or other carbon-based fuels in power generation, industrial, commercial, residential, and transportation sectors at existing and new sites from 2010 to 2030. The iSDG Model will evaluate the following Nigeria parameters: changing oil/gas production, energy technology & efficiency, reducing carbon emissions, mitigating climate change & improving the environment, clean water availability, population growth, e-healthcare & public health, rural & urban infrastructure, jobs & economic growth, e-learning education & vocational training, personal income, capital investment, gender equality, and other social, economic, and environmental Sustainable Development Goals (SDGs) which are interlinked to Clean Energy (SDG #7).

This simulation iSDG Model development will be an extension of the T21 simulation model constructed by the Nigerian Ministry of Environment in cooperation with the Millennium Institute. The results of this model were included in the Nigeria INDC submission in 2015. The T21 MI Model is an analytical tool for strategy development and policy analysis at the national level, focused on climate change Impacts and Adaptations. It integrates climate change with economic, social, and environmental considerations into a single, transparent computer model. A 9-minute video description of the T21 Model is here: https://www.youtube.com/watch?v=Kc9rBwtrV00.

9.2 Technology & Vendor Survey Study:

This Survey Study will include recommendations on energy-efficient and renewable energy (solar, wind, biomass, other) power and transport system technologies, equipment, purchase vs. lease, and selected vendor companies for imports, installation, manufacturing, and training of workers in Nigeria.

The e-UN Group, under the guidance of Energy Mentors International, will globally survey and collect information from short-listed technical vendors of energy-efficient and renewable energy equipment to minimize carbon emissions, lower costs, and maximize efficiency of energy use. We will evaluate and suggest improvements in urban and rural areas at fuel mega-stations, residential apartment buildings & houses, hospitals, universities, schools, hotels, and government, commercial & industrial buildings, and public & private transport systems in Nigeria. The main objectives of the survey will be to:

a. Recommend a short list of technical vendors who can measure and suggest improvements in urban and rural clean energy efficiency for cooking, heating, cooling, lighting, power generation, transportation, manufacturing, and carbon emissions at the various selected buildings, government, commercial or industrial facilities and public & private transport systems. We will also evaluate vendors for their ability to train, install, and manufacture renewable-energy equipment in Nigeria using local workers.
b. Recommend certain Nigerian universities to become prototypes with on-site entrepreneurship incubator laboratories that have operational renewable energy equipment and online e-learning. We will use these facilities for simulation studies, operations, on-campus and e-learning education on solar, wind, other renewable power generation, clean transport systems, and smart-grid installations. Quantitative measurements, tests, and computer operations will train Nigerian

personnel for better energy management, higher efficiency, lower costs, and lower carbon emissions.

10. Funding:

Evaluation of the possibilities and contacts for Nigeria to secure various sources of funding for the implementation and asset construction phases of this Nigeria Energy Transition Project, including:

- Nigerian Government, such as various Ministries and Agencies e.g.,
  National Information Technology Development Agency (NITDA),
  Nigeria National Petroleum Corporation (NNPC),
  Ministry of Science & Technology,
  Ministry of Petroleum,
  Ministry of Power,
  Ministry of Environment,
  Ministry of Education,
  Ministry of Labor and Employment,
  Ministry of Trade Investment and Industry,
  Ministry of Budget and National Planning,
  Ministry of Health, etc.
- Nigerian Commercial and Utility Companies
- Foreign Vendor/Partner Companies
- International Organizations and Agencies e.g., United Nations Development Program (UNDP), United Nations Environment Program (UNEP), United Nations Sustainable Development Dept. of Economic & Social Affairs (UNDESA), United Nations Convention to Combat Desertification (UNCCDP), United Nations Educational, Scientific, and Cultural Organization (UNESCO), World Bank, International Monetary Fund (IMF in Washington DC and Nigeria), Global Innovation Fund (GIF), etc.
- Regional Organizations and Agencies e.g., Conserve Africa Foundation (CAF), African Development Bank (ADB), etc.
- National Organizations and Agencies, e.g., Japan Official Development Assistance (ODA) (*), US Agency for International Development (USAID), US Ford Foundation, Carnegie Corporation of New York, National Science Foundation (NSF), etc.

  (*) On August 28, 2016 Mr. Abe, the Prime Minister of Japan, pledged US $30 billion, which includes funding for the capacity building of 10 million Africans at the TICAD6 in Nairobi, Kenya <http://www.mofa.go.jp/region/africa/ticad/>.

11. Past Accomplishments made during Preparation:

GLOSAS/USA initiated the globalization of the Internet, played a major pioneering role deregulating Japanese telecommunication policies to allow the use of Internet for e-mail (with help from late U.S. Secretary of Commerce Malcom Baldrige <http://tinyurl.com/2e2o7rc>), triggering the de-monopolization and privatization of the Japanese telecommunications industry. This was emulated in many other countries, so that today there are over 4.7 billion email and Voice Over IP (VOIP) cell phone users around the world (2 blogs at <http://tinyurl.com/cqgjsy7>), <http://tinyurl.com/bdcjha>. GLOSAS/USA conducted innovative "Global Lecture Hall (GLH)" videoconferences once or twice every year during 1980s to 1990s using hybrid technologies spanning the globe from Melbourne to Moscow by inter-connecting many universities, which initiated global e-learning movements (*). GLOSAS/USA also prepared broadband Internet, connecting:

a) Global Ring Network for Advanced Application Development (GLORIAD) for the northern hemisphere with $300 million from various governments, and
b) Africa Connect to Europe (ACE) for the western coast of Africa with $700 million from the European Union.

Africans can now reach numerous advanced research institutions, higher educational and healthcare institutions in Northern Hemisphere.

(*) In 1994 Dr. Utsumi of GLOSAS/USA received the prestigious Lord Perry Award for the Excellence in Distance Education (the highest award in distance education) from Lord Perry, the founder of the U.K. Open University <http://tinyurl.com/36amstr>.
The two-year senior recipient of the same award was Sir Arthur C. Clarke, the inventor of satellite telecommunications. This acknowledged his efforts since the early 1970s in developing and promoting global e-learning, often with his private funds.

We are building coalitions of higher education/healthcare institutions in ECOWAS countries to affiliate with Global University System of the UNESCO/Unitwin/Networking/Chair Program at the University of Tampere, Finland, which GLOSAS/USA created in the summer of 1999 with funds from the World Bank.

12. References:

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<https://www.dropbox.com/s/x9roe13f2dmhz3g/Guide to Navigating the T21 Nigeria AAP Model copy.pdf?dl=0>, and "integrated SDG" (iSDG) model of the Millennium Institute
<http://www.isdgs.org/#!documentation/kri3x>
(3) GLObal Systems Analysis and Simulation Association in the U.S.A. (GLOSAS/USA):
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(6) Columbia University, School of International and Public Affairs:
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<http://www.columbia.edu/>
<https://sipa.columbia.edu/>
<http://www.earthinstitute.columbia.edu/sections/view/9>
(7) Stevens Institute of Technology (Stevens):
Website with Teaching & Research Capabilities
<https://www.stevens.edu>
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(9) Synopsis of "Creating Electronic United Nations"
<https://www.dropbox.com/home/2016?preview=Synopsis+of+Creating+Electronic+United+Nations_v2.pdf>
(10) Creating the Electronic United Nations with Distributed Simulation for Decision-Making Video interview: <http://www.lightmillennium.org/lmtv/2016/dr-utsumi-creating-electronic-un.mp4>
(11) "Creating the Electronic United Nations," Technology Facilitation Mechanism, Sustainable Development Goals <http://tinyurl.com/j596dye>
(12) Background of GLOSAS/USA (12-16-14) http://tinyurl.com/j4vpmfv

ANNEX I

Project Personnel

I. Major Coalition Members:

1. The School of International and Public Affairs (SIPA) at Columbia University will conduct teaching with the combined use of normative gaming and quantitative simulation in international political science field focusing firstly on Nigeria and later ECOWAS and Nile River basin countries,
2. The Stevens Institute of Technology coordinates participating parties as organizing workshops twice annually, and maintains a central computer through which exogenous data will be exchanged among the participating parties' simulation models,
3. The Millennium Institute will provide the expertise on system dynamics simulation modelling,
4. The Center for Understanding Change will interlink sector models of iSDG of ECOWAS countries,
5. The Energy Mentors International LLC will provide the expertise in fossil fuels and transition to renewable energy systems, technologies, costs, and projects analysis, planning, and education,
6. The GLOSAS/USA will globally coordinate this project.

II. Collaborators (in random order)**:**

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Conduct a paradigm shift in international political science with the combined use of normative gaming and quantitative simulation, which will later be extended to ECOWAS and Nile River basin countries

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