"Sustainable Development Policies and Decision-Making with Distributed Simulation on Transition to Clean Renewable Energy"

August 11, 2017

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PROJECT SUMMARY

1. Overview:

1.1 The Problem:

Fossil fuels that are a blessing and a curse for developing countries. They help develop the economy with foreign investments and local jobs and they generate revenues from exports. However, fossil fuels can also cause an enormous economic dependence at the expense of any other domestic development. Country revenues from fossil fuel exports are volatile with the world price of the fossil fuels. In addition, major foreign energy companies extract significant economic concessions from the developing countries in order to make attractive investments. In fossil fuels projects in developing countries the primary concerns of the foreign investor/operator companies are maximizing energy production, exports, and return on investment, even if at the expense of the country's social economic, and environmentally sustainable development goals. For example, the "Nigerian Government is conscious of the over-dependence on crude oil, which constitutes about 95% of the country's generated revenue" (Reference (1)). No policies have yet been implemented in ECOWAS for increasing clean renewable energy.

In spite of greenhouse gas (GHG) emissions from burning fossil fuels 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 leadership and framework for evaluating energy policy. This should be based on 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 on evaluating and implementing clean renewable energy policy.

The Paris climate accord 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 to meet the "Sustainable Development Goals" (17 SDGs, UN Reference (2)). This process requires the use of integrated dynamic simulation models combined with rigorous analysis and multiple "what if" scenarios to evaluate positive and negative impacts. The process also needs regular and transparent global cooperation with collective and shared responsibilities in a democratic fashion.

1.2 Our Proposed Solution:

Sustainable, efficient, and cost-effective clean renewable energy policies, technologies, and investments are key drivers to grow the local economy and improve peoples' education and health in developing countries. **Our Project and proposed solution focuses on developing dynamic simulation models and analyses for evaluating and implementing effective policies for transition to clean and renewable energy in ECOWAS countries in Africa by working closely with participating universities in ECOWAS and their experts.**

We plan to achieve this improved policy-making process by developing and using the integrated SDG (iSDG) model of the Millennium Institute (*). We will adapt the iSDG model for the sectors, factors, and SDGs specified by each ECOWAS country and their experts. Then we will interlink the sector models for each of the pertinent SDGs. We will use the "Center for Understanding Change (C4UC)" system with dynamics solver <http://tinyurl.com/hd9sb8h> and/or NASA's Distributed Observer Network (DON) (hereinafter C4UC's server and/or NASA's DON) to produce a single model for each participating country in ECOWAS. Then we plan to interlink those individual countries' comprehensive iSDG simulation models with the use of our patent-pending procedures through broadband Internet. This process will form the "**Electronic ECOWAS**," followed by the "**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) emissions by the end of this century.**"

(*) The "integrated SDG" (iSDG) model of the Millennium Institute <http://www.isdgs.org/#!documentation/kri3x> The end result of this Project will develop a strong network for e-learning and e-healthcare. The Project will evaluate proposed new policies on transition to renewable and clean energy for impact on jobs, sustainable cities and rural areas with clean electricity and transport systems, commercial trade, and economic growth. Clean renewable energy policies in Africa will be evaluated for less pollution from carbon and other emissions, and improvements on clean water, climate change, and public health.

1.3 The Policy-Making New Process:

Each country's energy policy impacts neighboring countries in terms of jobs and economic growth; resources like water, forests, oil/gas etc.; agriculture, food, and hunger; trade, exports, and imports; and health and epidemic disease. Energy policies impact several sectors of each country, the region, possibly the world. Education and training on the potential benefits and negative impacts of effective policies for transition to clean and renewable energy is necessary. However, most nations need to significantly improve their current pledges and plans for clean and renewable energy. Such ongoing plans, education, and training require new tools with rigorous simulation models and online e-learning to meet each country's stated most important Sustainable Development Goals (SDGs). Each country submitted its official pledge for SDGs (including Clean Energy SDG #7) to the United Nations in December 2015. This process requires regular and transparent global cooperation among all stakeholders with collective and shared responsibilities across countries.

We plan to develop for each ECOWAS country a dynamic simulation model tailored for the economic sectors and factors that are important to that specific country, by working with local in-country experts. We will interlink the sector models for Clean Energy and the few other SDGs important to each country with a system dynamics solver of the "Center for Understanding Change (C4UC)" and/or NASA's Distributed Observer Network (DON). We will produce a single country model for each ECOWAS country. The Pilot Case countries are Nigeria and Ghana, and we will then adapt the models of other ECOWAS countries. Then we plan to interlink those individual countries' simulation models with our proprietary technology through broadband Internet to form the aggregate model for "**Electronic ECOWAS.**" This simulation and education methodology for transition to clean and renewable energy in ECOWAS countries can be used as a prototype for assessment and policy-making for other developing countries and sectors e.g. agriculture, healthcare, epidemic disease etc., based on creating and using the appropriate models.

2. Our Request for Funding this Project:

We are requesting funding in the range of US $0.75 million (3 years duration) for this Project based on the scope and depth of study and simulation models to be mutually agreed with Grantor of funds.

3. 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. Our Project team is multi-disciplinary and multi-institutional and consists of academics, researchers, and business executives 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.

4. 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 "**Electronic African Union**" and eventually, the "**Electronic United Nations**."

5. Project Implementation:

Upon approval of this proposal, 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 start with Nigeria and later adapt this Energy Transition Project to Ghana (**) and then to other ECOWAS countries. This 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 based on supply and use of solar, wind, and biomass renewable energy as fuel, electricity, and transportation in urban and rural 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) submitted to the United Nations in December 2015. <http://www4.unfccc.int/submissions/indc/Submission%20Pages/submissions.aspx>.

(**) Ghana's INDC pledge also has a target for power generation from renewables.

NARRATIVE

1. The working group for this Project:

Our working group is collectively known as the "e-UN Group." It is a global collaboration of several universities, institutions, and companies with expertise in energy and business, environment and climate change, telecommunications and broadband, computer and energy engineering, education training and e-learning, public health and e-healthcare, economic analysis and project planning, role-playing negotiation qualitative energy models, and dynamic simulation quantitative models on energy systems and interlinked SDGs. The primary collaborating organizations in our working group 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 (SIPA) in New York,
- Millennium Institute (MI) in Washington, DC,
- Energy Mentors International LLC (EMI) in New Jersey,
- Center for Understanding Change (C4UC) in Maryland.
  Relevant work experience and credentials of all members of the e-UN Group are shown in the Reference section #12 and Annex I.

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 for Power Generation, Transport, and Other Energy Sectors in Nigeria". This Project will 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 United Nations 17 Sustainable Development Goals (SDGs, Reference (2)) are interlinked and are different for each country. For example, they may include clean energy (SDG #7), 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 an energy and environment program is to accept the interlinkage of Clean Energy with several of the other 17 SDGs that are important targets specifically for each country. We must simulate, measure, monitor, and evaluate the impacts the various proposed policies and target SDGs may have on each country and on the ECOWAS region. For example, energy affects the environment and climate change, but also impacts water quality, food supply, health, jobs & economic growth, infrastructure and urbanization, education, etc. Each country has its own specific goals and timing for clean energy, water & sanitation, food & agriculture, health, education, infrastructure, transportation, sustainable cities, technology innovations, and partnerships of companies & government agencies to achieve these interlinked SDGs through investments and projects in Sustainable Development. Cooperation and collaboration among policy-makers in various countries is essential for the success of all countries in the region.

3. System analysis and simulation model for policy evaluation:

3.1 The iSDG model

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>.

Similar to weather forecasting, simulation is an indispensable tool for "what if" scenario assessments, policy analysis and decision-making of complex global social behaviors. Our group called the "electronic United Nations Group" (e-UN Group) will conduct system analysis in each ECOWAS country to construct a simulation model adapted for each country by using 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/>.

The iSDG model enables decision-makers to use system dynamics thinking and tools to analyze and understand the interconnectedness between social, economic, energy, and 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. The development and use of iSDG models in many countries have helped to create greater and more open dialogue among stakeholders in the formulation of country and regional policies. The iSDG model supports looking into alternative future scenarios compared to 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.

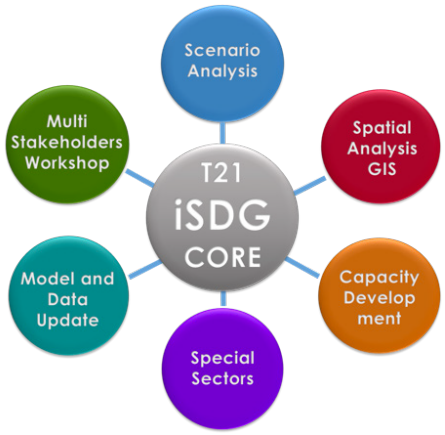

Figure 1: Integrated Sustainable Development Goals (iSDG) model

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

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

3.2 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.

3.3 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. The model offers the flexibility to address a wide range of development problems. The interface provides diagrams and descriptions that give insights into the structural causes of behavior to show the interconnectedness of the SDGs.

Recognizing 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.

3.4 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 unrecognized. 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.

3.5 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:

(a) Policy planning institutions (both government and non-government) that conduct research and analysis for policy decision-makers;
(b) Government officials and decision-makers who want to explore a range of alternative strategies and trade-offs to achieve desired outcomes;
(c) Stakeholders in multilateral and bilateral international development organizations, sustainable development experts, business managers and planners, 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 and national stakeholders. This approach ensures that the model reflects the unique development dynamics of each country and fits expressed needs and priorities.

3.6 Implementation of iSDG to Nigerian Energy Transition Project:
The e-UN Group will evaluate the proposed solution for supply and use of Clean and Renewable Energy in Power Generation, Transport Systems, and Other Economic Sectors of the Energy Transition Project. We will start with Nigeria (i.e., the Nigerian Energy Transition Project) during 2010-2030 by using the iSDG model. For the necessary local content and inclusion of opinions of all stakeholders, following higher educational institutions will actively participate in the development of their models;

1. Nigeria:
   Federal University of Technology (FUTO) in Owerri of Imo State, River State University of Science

and Technology, University of Port Harcourt in Port Harcourt, etc.

2. Burkina Faso:
   University of Ouagadougou,
3. Ghana:
   University of Ghana, Knust College of Science and Technology, and the Advanced Information Technology Institute (AITI)/India Kofi Annan Centre of Excellence in ICT, etc.
   We will then adapt these models to each of the other ECOWAS countries. The Nigeria, Ghana, and other ECOWAS country models will be developed by the e-UN Group in cooperation with local experts from the selected universities in the ECOWAS countries.

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 the 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. Example parameters for the users of the model to evaluate include: changing oil/gas production, new technology & energy efficiency, eliminating flaring of natural gas, reducing carbon emissions and other pollution, mitigating climate change, and improving the environment, population, e-healthcare and public health, rural & urban infrastructure, e-learning education & 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 clean and 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 interlinkage of each goal sector model:

The iSDG model, because of its integrated and transparent structure, 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.

No person can be the almighty by knowing in detail every sector and target of the SDGs for each country. The e-UN Group will assign country experts for each goal sector to construct their own simulation model with the use of iSDG model. This model will reside in their own computing unit (desktop, laptop, tablet etc.) located at their preferred locations. We will interlink the multiple, distributed goal sector models via Internet with the use of the C4UC's server and/or NASA's DON mentioned above, as an example of the **Beowulf Mini Super-Computer** approach.

The C4UC solver was created to solve the stakeholder challenge. 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, 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 interlinkage 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 interlinkage made on 17 SDG sector models by the C4UC's server and/or NASA's DON 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 interlinkage 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.

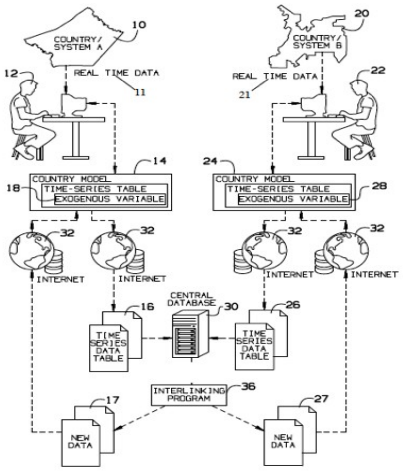

Figure 2: Interlinkage Mechanism for
Distributed Simulation models with Human Intervention
(US Patent Pending #61/764,843 <http://tinyurl.com/d4oj9py>)

5. Education & training program:

Columbia University (Reference (9)) uses qualitative role-playing normative gaming in international political science courses. We will combine that role-playing negotiation with the quantitative model-based simulation of Nigeria, which the Nigeria Ministry of Environment constructed with the Millennium Institute (Reference (3)). This combined program will be a significant paradigm shift in the international political science field with the fusion of humanity and science.

In successive stages we will invite major universities in Nigeria, Ghana, and other ECOWAS countries to participate. We will then produce video-based educational material on this simulation at Columbia University. This will 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 interlinkages of models among ECOWAS countries and later among Nile River basin countries. This will form a prototype of the "**Electronic African Union (e-AU)**." We plan to affiliate this e-AU with "**Smart Africa**" <http://tinyurl.com/jntgrz7>.

This education program for selected ECOWAS universities will educate and train young African entrepreneurs on Transition to Clean Renewable Power Generation, Transport, and Other Energy Systems in ECOWAS countries. We will offer the program to students, workers, government officers and aspiring future leaders in various fields. The education & training will be done by global e-learning with the ECOWAS universities.

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 allows participants to investigate how 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 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,*" (Reference (9)) is based on an oil discovery in a West African country recovering from a recent civil war and world oil & natural gas price collapse. This negotiation game 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 behavior 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 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. 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 core dimensions of society, economy, energy, 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 behaviors 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 ECOWAS higher educational institutions, the e-UN Group will train local 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 clean energy country policies. The policies will address how to lower carbon emissions; mitigate climate change with increased energy efficiency and use of renewable energy for power generation and transport; and evaluate the impacts on other target SDGs interlinked to clean energy (e.g. e-healthcare, e-learning, jobs, etc.) in urban and remote rural areas of each ECOWAS country.

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. For example, 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. Similar iSDG model-based simulations will be conducted for each ECOWAS country. The users of each iSDG country model will learn how to evaluate:

- change in oil/gas production,
- eliminate gas flaring and other energy waste,
- improve energy technology and efficiency,
- reduce carbon emissions,
- mitigate climate change.

The users of the iSDG model will also learn how to assess the impact of clean and renewable energy on:

- environment water availability and agriculture,
- population growth, public health and e-healthcare,
- rural and urban infrastructure, needed capital investment,
- jobs, wages, personal income, and economic growth,
- e-learning education and vocational training,
- gender equality, and other social, economic, and environmental Sustainable Development Goals (SDGs), which are important to each country and are interlinked to the goal of Clean Energy.

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. This new process will empower users in developing countries to participate with academic excellence around the world and unleash creativity with their brilliant brainpower in a 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, figures, and logic rather than exclusively based on hunches, habits, and traditions.

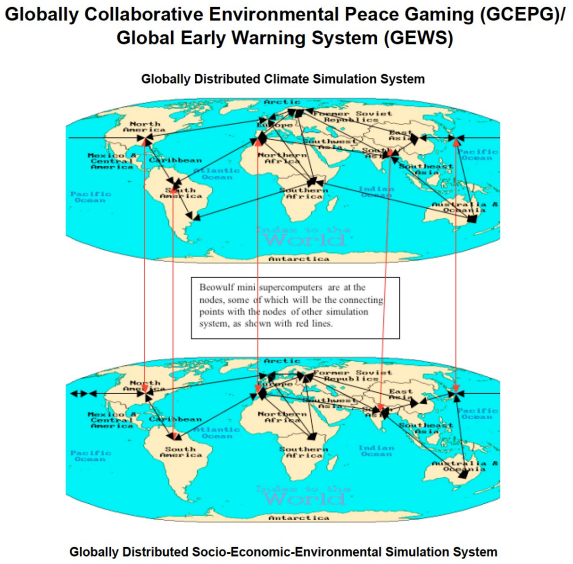

Figure 3: Globally Collaborative Environmental Peace Gaming (GCEPG) <http://tinyurl.com/cmcjsqw>

This Project will also promote globally collaborative democracy with our patent-pending procedure on the interlinking mechanism of distributed socio-economic-energy-environmental simulation models in participating countries (Figure 2). These activities will then lead to the possible creation of "**Electronic African Union**" and eventually "**Electronic United Nations**" (Figure 3). This effort would improve the FUGI world model of Soka University of Japan, which currently has 194 countries' sectors and 6 UN sectors. This approach will be in stark contrast to the conventional climate change conventional models, which aggregate every country by ignoring the national boundaries because of inevitable natural phenomena. On the other hand, our socio-economic-energy-environmental models will take into account country boundaries and priorities.

7. Unique solution:

Our solution is different from other approaches and offers these benefits:

7.1 Fusion of humanity and science:

The School of International and Public Affairs (SIPA) at Columbia University teaches a course on role-playing qualitative negotiations for offshore oil and gas discovery and development in Nigeria (Reference (9)). Making rational decisions requires qualitative and quantitative skills. We plan to combine the SIPA qualitative negotiation model with the iSDG quantitative simulation model (Reference (3)) 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 or laptop computer 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, the models of this Project 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) Construct the Systems Dynamic Simulation Quantitative iSDG model for Transition to Clean and Renewable Energy Resources in Power Generation, Transport, and Other Energy Systems during 2010-2030.

(b) Adapt the iSDG Energy Transition model for Nigeria, Ghana, and each of the other ECOWAS countries and universities participating in this Project.

(c) Conduct feasibility study for appropriate policies and capital investments on the renewable Energy Transition Project, based on rigorous simulation analysis to meet the SDGs pledged and specified by each ECOWAS country.

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 and other ECOWAS countries.

(c) Evaluation and recommendation of certain ECOWAS universities for on-site prototype renewable-energy equipment in entrepreneurship incubator laboratories, as well as e-learning and e-healthcare 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 clean and renewable energy in Nigeria and ECOWAS countries.

9. Project implementation:

When this proposal is awarded, we will embark on the implementation of the "Transition from Fossil Fuels to Renewable Energy" Project (hereinafter "Energy Transition Project"). The first initiative for our e-UN Group will be the "ECOWAS Energy Transition Project". We will initially develop the Energy Transition simulation models for Nigeria, then Ghana, and later adapt them to other participating ECOWAS countries. The ECOWAS Energy Transition Project will provide clean and renewable energy (solar, wind, biomass etc.) and reduce emissions of carbon dioxide and pollution, but will also help develop country policies to create new jobs and economic growth, e-learning education, and e-healthcare in cities and remote areas of ECOWAS Africa.

The following major institutions that are members of our e-UN Group will conduct and coordinate all four phases of this Project: The Millennium Institute (MI), Energy Mentors International (EMI), Center for Understanding Change (C4UC), GLOSAS/USA, Columbia University SIPA, NASA's Simulation Exploration Experience (SEE), and Stevens Institute of Technology,

(a) The Reference section #12 lists electronic links for descriptive and support information on the activities of all the Major Coalition Institutions who are currently part of our e-UN Group (References (3) to (17)).

(b) The Annex I of this document lists the e-UN Group Project Personnel: Major Coalition Institutions and the names and affiliations of all our Collaborators in the USA and overseas.

(c) The e-UN Group will conduct fact-finding missions to collect data and coordinate the simulation, analysis, and education work on this Project with country experts and participating higher education

institutions in the ECOWAS countries.

9.1 Phase 1: Develop dynamic simulation models for sustainable clean and renewable energy development in ECOWAS countries

We will develop dynamic simulation models using the iSDG model structure and methodology, adapted for each country's pertinent sectors and SDGs. The iSDG model structure will be developed for each country to transition from use of high-carbon fossil fuels in 2015-17 to low-carbon natural gas by 2020-25 and to zero-carbon renewables by 2030. We will simulate transition to clean and renewable energy by collecting and assessing various data inputs:

- Change fossil fuel capacity, production, consumption, and trade;
- Stop flaring natural gas and stop dumping energy and waste byproducts from industrial facilities;
- Decrease energy use in key sectors;
- Increase efficiency and capacity based on levelized cost of energy, industrial and transport use of fossil fuels;
- Increase energy efficiency and capacity;
- Lower cost of energy use for lighting, cooking, water and space heating in urban and rural areas;
- Integrate operations of oil/gas production, refining, chemicals, and agriculture;
- Co-locate solar, wind, and biomass capacity at natural gas power plants;
- Increase power generation from renewables by 2030 and lower electricity generation from fossil fuels;
- Locate sites in ECOWAS countries for manufacturing of equipment to produce renewable energy.

This simulation study will assess appropriate policies for the transition from fossil fuels to renewable energy resources for power generation, residential, commercial, industrial, and transport sectors in each ECOWAS country, starting with Nigeria and Ghana. We will base the study on quantitative dynamic simulation models and analysis. The focus of the ECOWAS iSDG country models will be on:

(a) **Urban areas** of major cities in ECOWAS countries (e.g. Lagos, Accra 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 ECOWAS countries regarding the gradual transition to clean power generation heating, cooling, lighting, cooking, and transport systems. Examples are large electric power plants (each >500 MW capacity), 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.

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

In the iSDG model of each ECOWAS country, solar, wind, biomass, and other energy renewables 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. Each iSDG country model will be structured and adapted by our e-UN Project Group working with ECOWAS country experts.

This 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 (MI). The results of this model were included in the Nigeria INDC submission to the United Nations 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 for each country. The MI model integrates climate change with social, economic, energy, and environmental considerations important to each country into a single, transparent computer country model. A 9-minute video description of the iSDG model is here: <https://www.youtube.com/watch?v=Kc9rBwtrV00>.

9.2 Phase 2: Use models to measure impacts from transition to clean and renewable energy in ECOWAS countries and region

We will run various cases of the dynamic simulation iSDG model for each ECOWAS country by working with the data from experts at each ECOWAS university. We will measure and evaluate the positive and negative impacts of transition to clean and renewable energy on other social, economic, and environmental Sustainable Development Goals (SDGs, United Nations Reference (2)) that are important targets for each ECOWAS country and the region. Depending on the requirements of each ECOWAS country, the SDGs impacted by clean and renewable energy (which is defined by the UN as SDG #7) may include:

- clean water, agriculture, and food supplies;
- carbon and other emissions, pollution, energy waste, climate change;
- good health and e-healthcare due to lower carbon emissions and less pollution;
- electricity and energy infrastructure; sustainable cities, rural areas and communities;
- jobs created and economic growth due to transition to clean energy;
- quality education, e-learning, and vocational training for clean energy; and
- government or business partnerships required to achieve these goals.

We will link the country models and their socio-economic-energy-environmental sectors to create the Africa ECOWAS model. Each of the ECOWAS country models will be interlinked for their collaborative international policy analysis, decision-making, and scientific thinking to assist government officials and aspiring leaders to further their co-prosperity.

9.3 Phase 3: Results of energy simulation models, role-playing negotiations, surveys and analysis of technologies and vendors of clean and renewable energy equipment

We will summarize the results of the iSDG simulation models and describe the positive benefits and negative side-effects for each country based on the proposed policies for transition to Clean and Renewable Energy. Columbia University SIPA has developed a role-playing course (Reference (9)) on Oil, Rights, and Development Negotiations in an ECOWAS country (e.g. Nigeria). In collaboration with Columbia University SIPA our e-UN Group will conduct qualitative role-playing negotiations on ECOWAS oil and energy development. We will compare the results of the negotiation exercise to the quantitative iSDG simulation models. We will then propose the investments and partnerships required for higher energy efficiency, lower carbon emissions and pollution, increased supply and use of renewable resources, e-learning and e-healthcare in ECOWAS countries, as related to clean and renewable energy.

We will survey and collect data from short-listed vendors of efficient and renewable energy equipment to maximize energy efficiency, minimize carbon emissions, and lower clean energy costs. We will evaluate and suggest improvements in urban and rural areas at fuel and industrial facilities, residential areas, hospitals, universities, government buildings, public and private transport systems.

Our survey study will include recommendations on energy-efficient and renewable energy (solar, wind, biomass, other) power and transport system, technologies, equipment purchase vs. lease decisions, and

vendors for partnering. We will collaborate with ECOWAS country experts and focus on each country's top priorities for energy use and equipment. This will include energy applications for cooking, heating, cooling, lighting, power generation, transportation, and manufacturing at low cost and low or zero carbon emissions. We will recommend vendor companies for their:

(a) Product quality, cost, and financial strength;
(b) Initial/temporary capacity to export clean and renewable energy equipment to ECOWAS countries;
(c) Ability to install energy equipment with local ECOWAS workers that they train;
(d) Willingness and capability to manufacture clean and renewable energy equipment, with trained local workers and management in ECOWAS countries to operate, own, and expand such facilities.

We will globally survey and collect information from short-listed technical vendors of efficient clean and renewable energy equipment to minimize carbon emissions, lower energy 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, Ghana, and other ECOWAS countries.

9.4 Phase 4: Educate and train via e-learning and e-healthcare modules

We will screen and recommend universities in ECOWAS countries to become prototypes with on-site entrepreneurship incubator laboratories that have operational renewable energy equipment, courses, and online e-learning. Quantitative measurements, tests, and computer operations will train and empower university students and local workers in ECOWAS countries for better jobs, energy management, higher efficiency, low energy costs, and reduced carbon emissions. We will propose educational programs at universities in ECOWAS countries based on courses and e-learning. This will include:

- role-playing qualitative negotiations used by US universities (e.g. Columbia University SIPA);
- quantitative simulation models used by US think-tank institutions (e.g. Millennium Institute) and policy-making government agencies (e.g. NASA-SEE, United Nations, and World Bank); and
- e-healthcare training modules (e.g. Mayo Clinic).

In the various training programs, educational courses, and e-learning modules, we will include "what if" scenarios to evaluate energy transition policies.

We will use the selected ECOWAS universities for teaching technical and business energy operations via on-campus and e-learning courses on renewable energy for power generation, clean transport systems, and smart grid installations. We will provide to ECOWAS countries global e-learning and e-healthcare training modules which will be available from these institutions:

- Columbia University SIPA, New York NY;
- Stevens Institute of Technology, Hoboken, NJ;
- Tandon School of Engineering of New York University, New York NY;
- University of California, Chico, CA;
- University of Tampere, Finland;
- Mayo Clinic, Rochester, MN;
- NASA (Simulation Exploration Experience & KSC), Melbourne, FL;
- International Research Society on Methodology of Societal Complexity, Amsterdam, The Netherlands;
- United Nations Development Economic and Social Affairs (UN-DESA), NY City, etc.;

Higher educational and healthcare institutions which would work with our Project would affiliate with the Global University System of the UNESCO Unitwin Chair-program at the University of Tampere, Finland.

10. Evaluation of potential funding sources for investments in clean and renewable energy projects in ECOWAS countries

Evaluation of the possibilities and contacts for various ECOWAS countries to potentially secure sources of funding for the implementation, asset construction, and facilities operation phases of this ECOWAS 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
- Other ECOWAS countries Government Ministries and Organizations
- Foreign Vendor/Partner Companies
- International Organizations and Agencies e.g.,
  - United Nations Development Program (UNDP),
  - United Nations Environment Program (UNEP),
  - United Nations Department. of Economic & Social Affairs (UNDESA),
  - United Nations Convention to Combat Desertification (UNCCDP),
  - United Nations Educational, Scientific, and Cultural Organization (UNESCO),
  - World Bank Group,
  - 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:

GLOSAS/USA initiated the globalization of the Internet and played a major pioneering role deregulating Japanese telecommunication policies. This deregulation was accomplished with help from the late US Secretary of Commerce Malcom Baldrige (<http://tinyurl.com/2e2o7rc>). The deregulation allowed the use of Internet for e-mail and triggered the de-monopolization and privatization of Japan's 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 the 1980s and 1990s. It used 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 (including $26 million from NSF) 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 the Northern Hemisphere.

(*) In 1994 Dr. Utsumi of GLOSAS/USA received the prestigious Lord Perry Award for Excellence in Distance Education (the highest award in distance education) from Lord Perry, the founder of the UK Open University <http://tinyurl.com/36amstr>.
The 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 and 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:

(1) Nigerian Economy <http://www.nigeriaembassyusa.org/index.php?page=economy>
(2) United Nations Sustainable Development Goals, Description and Details <http://www.un.org/sustainabledevelopment/>
(3) Millennium Institute, Guide to Navigating the T21-ˇPCM-ˇNigeria AAP model <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>
(4) Millennium Institute File <https://www.dropbox.com/s/r9aeogpc9u0v8ft/MI%20Endorsements_ENDORSEMENTS%20copy%202.pdf?dl=0>
(5) Energy Mentors International LLC: <https://www.dropbox.com/s/4fa9pkbwonn3eq0/2016-08-06 Slides mini-PDF GFA Simulation models %26 Analysis for Clean Energy, Renewables, PGen %26 Transport copy 2.pdf?dl=0>
(6) The Center for Understanding Change <http://www.c4uc.org/>
(7) Simulation Exploration Experience (SEE) & KSC, Center for Life Cycle Design, National Center for Simulation, NASA <https://www.exploresim.com/>
(8) Mayo Clinic, Rochester, Minnesota <https://www.mayoclinic.org>
(9) Columbia University SIPA Course INAF U4420: Oil, Rights, and Development <https://www.dropbox.com/s/j0gqe6galx86tcl/INAF%20U4420%20Oil%20copy.pdf?dl=0>
Also, download a file entitled "Understanding the Impact of Business through Role-Playing Simulations" (80 KB) at Section VII, #9 of <http://gu.friends-partners.org/Global_University/Global%20University%20System/Reference_web_sites.html>

(10) Columbia University, School of International and Public Affairs: Website Columbia University, Earth Institute, SIPA <http://www.columbia.edu/>, <https://sipa.columbia.edu/>, <http://www.earthinstitute.columbia.edu/sections/view/9>
(11) Stevens Institute of Technology (Stevens): Website with Teaching & Research Capabilities <https://www.stevens.edu>
(12) GLObal Systems Analysis and Simulation Association in the U.S.A. (GLOSAS/USA): File <Supporting Documentations of GLOSAS_v2 copy.docx> <https://www.dropbox.com/s/tu77a9cplwcjune/Supporting Documentations of GLOSAS_v2 copy.docx?dl=0>
(13) T. Utsumi, Slide presentation on "Creating Electronic United Nations" at the Inaugural Agora Conference "Transforming the World Through Sustainable Energy for All: Leaving No One Behind" at the United Nations Headquarters in New York, NY on June 6th 2016. <http://tinyurl.com/z2df6ve>
(14) Synopsis of "Creating Electronic United Nations" <https://www.dropbox.com/home/2016?preview=Synopsis+of+Creating+Electronic+United+Nations_v2.pdf>
(15) 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>
(16) "Creating the Electronic United Nations," Technology Facilitation Mechanism, Sustainable Development Goals <http://tinyurl.com/j596dye>
(17) Background of GLOSAS/USA (12-16-14) <http://tinyurl.com/j4vpmfv>

ANNEX I

Project Personnel

I. Major coalition institutions in the e-UN Group:

1. Stevens Institute of Technology coordinates and organizes computer simulation workshops twice annually, and maintains a central computer system through which exogenous data will be exchanged among the participating parties' simulation models.
2. GLOSAS/USA will globally coordinate this Project.
3. Millennium Institute has expertise on system dynamic simulation models.
4. Energy Mentors International LLC provides expertise on fossil fuels, clean and renewable energy systems, technologies, energy cost analysis, energy projects evaluation, energy planning, and education.
5. The Center for Understanding Change will interlink sector models of iSDG of the various ECOWAS countries,
6. Simulation Exploration Experience (SEE) & KSC,
   Center for Life Cycle Design, National Center for Simulation, NASA.
   The mission of the SEE initiative is to champion, challenge, and create collegiate-level simulation education globally. Faculty, students, government and industry partners work together as an international inter-university team. Each university team is faculty-led and chooses its own project with Solar Energy to be the next simulation challenge.
7. School of International and Public Affairs (SIPA) at Columbia University will conduct teaching policy courses with the combined use of normative gaming negotiations and quantitative simulation models in international political science field. The focus will be on Energy Development Policy, firstly for Nigeria and Ghana, followed by other ECOWAS and Nile River basin countries,

II. US collaborators (in random order)**:**

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Stevens Institute of Technology
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Supervise the global center of this Project, construct and maintain interlinkage program among distributed simulation models

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Supervise system dynamic model development and simulation

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Two-page bio <http://tinyurl.com/zyokryw> Full CV <http://tinyurl.com/zs83v5u>
Conduct and supervise analysis, simulation, surveys, and education on supply & use of fossil fuels and renewable energy systems & models, technologies, energy costs, capital projects, and screening of energy equipment companies. Assist Utsumi.

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Interlink sector models of iSDG model of ECOWAS countries

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Create collegiate-level simulation education programs globally

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Jenik Radon is also, a board member of Stevens Institute of Technology
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

Greg Cole, Director, Principal Investigator
Global Ring Network for Advanced Applications Development (GLORIAD)
Descriptive bio: <http://tinyurl.com/bg88ajl>,
Provide advice on broadband Internet

Ralph. C. Huntsinger, Ph.D.,
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CV: <http://tinyurl.com/28646fa>, Descriptive bio, Photo: <http://tinyurl.com/hfxq5sx>
Technical Director to supervise continuous and discrete simulation modeling,

Richard L. Field, Law Office of Richard Field
Descriptive bio, Photo: <http://tinyurl.com/hfxq5sx>
Assist Utsumi

Thomas Mensah, Lightwave and Wireless Systems Inc.
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Patel Ashokakumar, M.D.,
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P. Tapio Varis, GUS UNESCO Chair
University of Tampere, <Tapio.Varis@staff.uta.fi>
Provide advice on global e-learning

III. Overseas collaborators:

1. **Africa:**

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Benin System Dynamics Group: 7 members

Burkina Faso,
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Burkina Faso System Dynamics Group: 6 members

Burundi,
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Bujumbura, Address, Descriptive bio & Photo:
<http://tinyurl.com/hfxq5sx>

Cap Vert,
Cap Vert System Dynamics Group: 4 members

Cote D'Ivoire,
Cote D'Ivoire System Dynamics Group: 5 members

Democratic Republic of Congo (DRC),
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Gambia,
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University of The Gambia, Gambia System Dynamics Group: 6 members

Ghana,
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Advanced Information Technology Institute (AITI)/
Ghana-India Kofi Annan Centre of Excellence in ICT
<http://tinyurl.com/huyppho>
Professor Kwasi Obiri-Danso, Knust College of Science <http://vc@knust.edu.gh>
Ghana System Dynamics Group: 6 members

Guinee,
Guinee System Dynamics Group: 7 members

Guinea-Bissau,
Guinea-Bissau System Dynamics Group: 6 members

Kenya,
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Liberia,
Liberia System Dynamics Group: 7 members

Mali,
Mali System Dynamics Group: 6 members

Niger,
Niger System Dynamics Group: 6 members

Nigeria,
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River State University of Science and Technology in Port Harcourt of River State, and
Charles U. Eke, Infotex Systems, Inc. in Lagos,
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Peter O. Jack,
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<http://tinyurl.com/hfxq5sx> Nigerian System Dynamics Group:

a. ECOWAS Project Trainees: 7 members

b. Climate Change Adaptation Project Trainees: 4 members

Rwanda,
Prof. Etienne Ntagwirumugara, University of Rwanda,
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Sierra Leone,
Prof. Jinnah S Momoh, University of Sierra Leone,
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Sierra Leone System Dynamics Group: 6 members

Togo,
Togo System Dynamics Group: 5 members

Tanzania,
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2. **Japan:**
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To provide FUGI world model

3. **Canada:**
Allenna Leonard, Ph.D., International Society for Systems Science, Advisor

4. **Netherlands:**
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To provide advice on complex social system analysis

5. **Turkey:**
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To guide system dynamics simulation