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Global Energy Assessment: Developing Policy Tools for Jointly Reducing Energy Poverty and Greenhouse Gas Emissions

Completion Report

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I. Introduction

This report provides a summary of the process, activities and outcomes achieved by the project in the period of July 2010 to May 2012

A. Background

In 2007, the IIASA established a working group with international partners to develop a global assessment of energy policy agenda (brochure attached) and contribute to the global debate on energy and climate change issues. The GEA has been a multi-year and multi-stakeholder activity that aims to help decision makers address the challenges of providing energy services for sustainable development throughout the world. The GEA has brought together approximately 200 analysts world-wide to contribute independent, scientifically based, integrated, policy-relevant analysis of current and emerging energy issues and options.)

In August 2009, a project to disseminate the tools generated by the GEA process was presented by UNIDO and IIASA to the GEF (Global Energy Assessment: Developing Policy Tools for Jointly Reducing Energy Poverty and Greenhouse Gas Emissions) for funding. The GEF CEO approved the project which envisioned development of specific tools, reports and technical analysis along with an implementation period from October 2009 to April 2011.

In January 2011, the GEF convened a meeting in Washington DC to review the progress made under the GEA project. This meeting was chaired by the GEF CC team Leader and attended by the UNIDO and IIASA GEA teams. Both project teams made detailed presentations on the present status of activities, strategic approaches and deliverables under the GEF project, which was followed by a thorough discussion. A number of useful comments and suggestions were made by the GEF CC team at later incorporated in the document. Finally, a tentative roadmap for completion of the project activities was discussed and agreed.

In April 2011, IIASA sent UNIDO a request seeking project extension to December of 2011, since the delays in the overall GEF report finalization have had repercussions in the implementation of the key activities under the GEF funded project (see Annex 1 Request for no-cost extension dated 20 April, 2011). From May to June of 2011 a full revision of the project planning was conducted and a new work plan established (see Annex 2).

B. Global Energy Assessment: Developing Policy Tools for Jointly Reducing Energy Poverty and Greenhouse Gas Emissions

UNIDO has developed a project jointly with the International Institute for Applied System Analysis (IIASA) which uses the GEA as a knowledge platform and develops specific analytical tools aimed at informing decision-makers on the scaling-up of low carbon energy technologies, achievement of reductions in greenhouse gas emissions, and the reduction of energy poverty. The outcome of the project is to create a better understanding among

decision makers of key technologies, technology transfer issues, policy instrument choice and major sustainable development issues.

The project specifically uses the scenarios and analysis obtained from the GEA to provide policymakers with tools for decision making. The workshop aims to present the tools and regional aspects of the project including two interactive PC-based tools, with the following characteristics

- Scenario analysis tool: designed to allow policy makers to rank their priorities for different policy objectives and see in real time the future implications for the global energy system, in terms of technology deployment, funding requirements, GHG emissions, air pollution and health impacts, and energy security.
- Energy access policy tool: model different energy access policies (subsidies and microfinance/grants) and their costs and benefits.

III. Scientific analysis in the GEA and policymaker advise under the GEF project

The following section explains how the technical analysis done by the IIASA experts was used as the basis of the analytical reports and tools developed for the GEF project

A. The Global Energy Assessment (GEA)

After 5 years of work, the Global Energy Assessment is now completed. The final product, a manuscript of some 1800 pages was delivered to the publisher, Cambridge University Press, in March 2012 for printing and publication. The report shall be formal launched at a session of Rio+20 where over 120 heads of state and government will be present.. Up to date, this will have been the most comprehensive energy assessment consisting of a collection and analysis of the most up to date peer-reviewed literature on the various topics covered by the report in its four clusters of topics.

The four clusters of GEA included: a review of the major challenges of the 21st century, an assessment of the technologies that we have available to address these challenges, a review of the options and pathways through which we have potential solutions, and a portfolio of policy recommendations and other measures to help make the urgently needed energy transformation possible. In sum, it is an assessment of how energy is either contributing to the problem or offering possible solutions.

B. Main Messages of the GEA Report

The overall message of the report is that, as currently configured, energy systems will need to be radically transformed. If not, energy, despite being a potential solution to the many challenges we face, will constitute a major hindrance and in some cases a major detriment to the efforts by many to address these global challenges. These challenges include: poverty eradication, global and national security, climate change, health, and the environment in general. Attached as key messages of the report (see Annex 3).

The GEA is not the usual energy sector report. Instead, this is an assessment that takes an in-depth look at every aspect of economic and social activity where energy is essential, and to

examine whether and how energy is delivering – or not – on the objectives behind these activities. This thorough and comprehensive analysis was undertaken by some 500 analysts from several countries in every region of the world.

D. Modeling Work developed under the GEA

Under the GEF project, a synthesis of the modeling work done for the GEA and its results. The intention was to translate the scientific finding into practical recommendations for energy decision makers .

The GEA explored several possible transformational pathways of the future global energy system with the overarching aim of assessing the technological feasibility as well as the economic implications of meeting a range of sustainable objectives simultaneously. As such, it aims at the integration across objectives, and thus goes beyond earlier assessments of the future energy system that have mostly focused on either specific topics or single objectives. Through its modeling work undertaken through the last few years, the team assessed technical measures, policies, and related costs and benefits for meeting the following objectives:

- Providing almost universal access to affordable clean cooking fuel and electricity for the poor;
- Limiting air pollution and health damages from energy use;
- Improving energy security throughout the world; and
- Limiting climate change.

The main outcome of this modeling work was to show that it is technically possible to achieve improved energy access, air quality, and energy security simultaneously while avoiding dangerous climate change. In fact, a number of alternative combinations of resources, technologies, and policies are found capable of attaining these objectives. From a large ensemble of possible transformations, three distinct groups of pathways (GEA-Supply, GEA-Mix, and GEA-Efficiency) have been identified and analyzed. Within each group, one pathway has been selected as “illustrative” in order to represent alternative evolutions of the energy system toward sustainable development.

The modeling work showed that achieving all objectives simultaneously remains an extremely ambitious task. Although a successful transformation is found to be technically possible, it will require the rapid introduction of policies and fundamental political changes toward concerted and coordinated efforts to integrate global concerns, such as climate change, into local and national policy priorities (such as health and pollution, energy access, and energy and security).

The transition, it is shown, can be achieved from different levels of energy demand as well through alternative combination of resources. An in-depth modeling sensitivity analysis showed, however, that efficiency improvements throughout the energy system are the most important options to achieve the transformation toward a more sustainable energy future.

The modeling work of GEA shows, similar to earlier assessments, that the transformation of the energy system would require dedicated efforts to increase global energy-related investments to between US\$1.7 trillion to US\$2.2 trillion annually, compared with about

US\$1.3 trillion in annual investments today. Out of this total, about US\$300 to US\$550 billion of efficiency-related investments are required on the demand-side. Investments into energy correspond to a small fraction (about 2%) of global gross domestic product (GDP).

The modeling work and pathways developed illustrate the importance of holistic and integrated approaches, leading to substantial economic co-benefits in the case that all objectives are met simultaneously:

- Achieving society's near-term pollution reduction and health objectives is greatly furthered by climate change mitigation, and similarly, stringent climate policy can help further the energy security goals of individual countries.
- The simultaneous achievement of climate change mitigation, energy security, and air pollution control comes at a significantly reduced total energy cost when the multiple economic benefits of are properly accounted for.

The modeling work shows that that the transformation toward sustainable objectives offers multiple benefits that cannot be assigned monetary values at a detailed level, but are nevertheless important to account for.

The following are some important non-pecuniary benefits of the transformation:

- Universal access to electricity and clean cooking energy increases the productivity of the poorest and thus contributes to overall well-being and more equitable economic growth. In addition, such access results in significant health benefits of more than 24 billion DALYs save in 2030.
- Pollution control policies consistent with WHO air quality guidelines result in health benefits on the order of 20 million DALYs saved in 2030.
- Limiting climate change to less than 2 degrees Celsius compared with preindustrial times reduces the risks of a number of different types of climate impacts, summarized by five main reasons of concern: the risk to unique or threatened systems; the risk of more frequent episodes of extreme weather events; an equitable distribution of impacts (given that some regions, countries, and populations may face greater harm from climate change); large aggregate damages; and the risk of large-scale discontinuities (i.e. tipping points)
- Rapid decarbonization and thus stronger reliance on efficiency improvements and low-carbon energy (e.g. renewable) may create job opportunities, thus providing additional economic benefits.

In sum, the analysis done through the modeling work of GEA, provided valuable insights of what is possible and what it takes to make these possible pathways a reality. Its work, therefore, was extremely influential in the overall GEA report and its findings. Under this contract, a synthesis of this work and its results is provided in a report with the title "The Energy Transition: transformative pathways, choice and opportunities".

E. Policies for Energy Access

In addition to the modeling work described above, three chapters provided the basis for a review of the progress to date, past policies and programs, and the development of future scenarios related to modern energy access. Providing universal access to modern energy is one of the most urgent but also difficult challenges of our time. Developing solutions to this challenge is one of the aims of the work of GEA and its analysis.

Under the GEF project, a synthesis of this work is provided in a report with the title “Access to Modern Energy Access: Assessment and Outlook for Developing and Emerging Regions”. The overarching objective of this report is to provide guidance on how to facilitate the achievement of universal access to clean-combusting cooking fuels and stoves, and rural electrification by 2030. This work is complemented by two inter-active web-based tools, which have been developed in support of this study.

Through the work undertaken under this rubric, the GEA offers some insights on achieving universal access by 2030 as follows:

- Improving energy access to modern cooking fuels has the potential to avert between 0.6 million and 1.8 million premature deaths, on average, every year until 2030, including between 0.4 and 0.6 million deaths per year of children below the age of five in sub-Saharan Africa, South Asia, and Pacific.
- From a technical and economic perspective, providing almost universal access to electricity and modern cooking fuels is achievable by 2030. This will require investments of US\$36-41 billion annually until 2030, which is approximately 3 percent of total energy infrastructural investments. At the high end of this estimate, about half will need to be spent on electricity access and rest in improving access to modern cooking fuels.
- This goal may have a negligible or even negative impact on greenhouse gas (GHG) emissions. This is due to the potential to replace inefficient biomass use with modern cooking fuels and kerosene for lighting with electricity. Current technologies that use traditional biomass are associated with significant emissions of GHG and aerosols due to incomplete combustion.
- Supporting policies that provide a combination of subsidies and microfinance are likely to be most successful and cost-effective in achieving universal access. In addition, government-supported investments toward energy access will need to be considerably ramped up, and targeted to rural and remote areas and poor urban communities. Increasing private sector involvement will also be crucial to reach the level of scale-up in access efforts required over the next decades.

The report lists the many challenges to achieving universal access (e.g. mobilizing \$40 billion in financing and putting in place the institutions to appropriately invest these finances), among which are: the fact that one in five people in the world still lives without access to any electricity and 40% still depends on solid fuels such as unprocessed biomass, coal, charcoal, for cooking and space heating, and the fact that in the absence of new policies by 2030 about 2.4 billion in Sub-Saharan Africa, South Asia and the Pacific will still be relying on solid fuels in their home, and over 800 million would still lack electricity.

The report also lists some of the success factors in energy access expansion, among which are the following:

- Strong supporting government role
- Integration of energy access and other development policies
- Responsive, accountable institutions with local involvement
- Innovative, solution-specific financing mechanisms, and
- Institutional support and capacity building

F. Policy Tools

Two web-based analytical tools were developed: 1) the IIASA Energy Access Tool (Energy-ENACT), which permits the assessment of alternative future policy scenarios, including an estimation of investment needs and impacts at the global and regional scales; and 2) the GEA Scenario Database, which documents the full suite of GEA pathways in great detail, allowing the user to explore the consequences of different supply and demand-side technology choices for the feasibility and costs of reaching multiple energy objectives at both global and regional levels.

The primary aims of the Energy-ENACT tool are to provide advice and visualize costs and benefits that each policy or a combination of policies could bring. By allowing a large number of alternate energy access futures to be compared within a common framework, analysis and decision-makers are able to gain a quick understanding of how alternate policies can shape the future of energy access in dramatically different ways, in terms of funding requirements, effectiveness, demand implications, greenhouse gas emissions, air pollution and health impacts.

The Energy-ENACT tool is a user friendly tool that gives users from diverse backgrounds and with varied interests a web-based platform to assess the effects of a subset of energy access policies by selecting different choices via an easy-to-use interface. This kind of multiple policy approach to energy access policy analysis is important, because the impacts on energy access objectives cannot be easily compared without detailed information on the effect they have on different groups of populations.

In addition, IIASA also developed the ENE-MCA – Energy –Multi Criteria Analysis Policy Tool. This tool is designed to assist national policy makers in their strategic policy planning processes. The tool extends work undertaken by the GEA and, as such, is built on the extensive set of global energy and environmental scenarios that have been generated as part of the GEA report.

As GEA concludes, the energy challenges facing society are as varied as they are great, and in charting a path toward a truly sustainable energy future, a number of different objectives will need to be fulfilled. These include:

- Avoiding dangerous climate change
- Achieving near-universal access to modern energy
- Improving energy security
- Reducing air and water pollution and the consequent impacts on human health and ecosystems
- Minimizing ancillary risks

- Maintaining the affordability and reliability of energy supplies for healthy socio-economic growth.

Simultaneously achieving each of these important targets is a major challenge for all societies, current and future. However, it is already quite evident that not all stakeholders (governments, private industry, and individual consumers) prioritize the multiple objectives in exactly the same way or to the same degree of importance. In fact, more often than not, the objectives seem to be competing for attention.

The primate aims of the ENE-MCA Tool are to add some analytical rigor and objectivity to the often subjective discussion surrounding the concept of energy sustainability and to do this in such a way that the specific needs and priorities of the decision maker are considered. Due to the enormous synergies and to a lesser extent, trade-offs between the various sustainability objectives, the tool takes a broad, systems approach. By allowing a large number of alternate energy-environment-economic futures to be compared within a common framework, analysts and decision makers are able to gain a quick understanding of how alternate worldviews can shape the future of the global energy system in dramatically different ways, in terms of technology deployment, funding requirements, greenhouse gas emissions and climate change, air pollution and health impacts, and energy security.

G. Overview of Deliverables

Deliverables	Status
1.1 GEA Scenario work and database allowing decision makers to view scenario outcomes for key energy variables	<p>Submitted – abridged version of Chapter 17 (UNIDO reviewed 20 October 2011)</p> <p>This work, like all others in this report, is based on the overall Global Energy Assessment (GEA) consisting of 25 chapters in 4 clusters undertaken by some 500 analysts. One of the main chapters of the GEA is the one on scenarios and pathways to sustainable energy. Some 60 pathways were examined with different combinations of demand and supply with different technologies. The deliverable consisted of a summarized reader-friendly version of this chapter for the general reader. In addition, the Global Energy Assessment prepared a comprehensive database that is available to researchers, policy makers and academia. It is one of the most comprehensive data bases on energy available to the public.</p>
1.2 Interactive PC-based scenario analysis tool designed to allow policy makers to rank their priorities	<p>Submitted to GEF on 13 September 2011</p> <p>This interactive PC-based tool is based on the scenario work of GEA and allows policy makers to examine consequences and tradeoffs in their decisions. The policy tool has now been tested in two workshops – one in Africa and one other in Asia and one to take place in Latin America later in the year. Feedback received during these workshops will be valuable for refining and adjusting the tool to be more useful to policy makers.</p>
2.1 Specific chapters on energy access of the major analytical report of the GEA	<p>Submitted to the GEF on 23 September 2011. (All Chapters under embargo): Chapter 17 Energy Pathways for Sustainable</p>

Deliverables	Status
	<p>Development, (Keywan Riahi) Chapter 19, Energy Access for Development (Shonali Pachauri)</p> <p>Submitted (3 October 2011) Chapter 2, Energy and society (Stephen Karekezi and Susan McDade) Chapter 23, Policies for Energy Access (Daniel Bouille)</p> <p>These four chapters have now gone through a thorough internal review- Peer Review – and approval by Review Editors. The manuscripts of the chapters are now with the publisher – Cambridge University Press – and expected to be ready for publication around June of 2012. Chapter 17 was a central piece of the GEA as it helped assess the various options for policy makers for decisions on sustainable energy and critical to the success of the overall report. Chapters 2, 19 and 23 were the main chapters dealing with poverty, development and energy access.</p>
<p>2.2 Energy access tool Recommendations on policies for energy access set within larger policy portfolios and written outputs for dissemination of GEA results. Obtaining feedback and providing guidance on the changes in energy systems needed to simultaneously attend to the challenges of the 21st Century</p>	<p>Completed fourth quarter 2011.</p> <p>The energy access tool is based on the analysis of all four chapters mentioned under point 2.1 and more specifically on the work of chapter 17 on pathways and chapters 19 on energy access and chapter 23 on policies for energy access. The energy access policy tool allows policy makers the possibility to examine the various options of policies as well as the consequences of the various combinations of policy portfolios. The tool has now been tested in two workshops (Africa and Asia) and one to take place later in Latin America. These workshops allow for feedback which will be valuable for refinements to the tool.</p>
<p>3.1 Recommendations on policies for energy access set within larger policy portfolios and written outputs for dissemination of GEA results.</p>	<p>Special access report analysis the implications for the GEF (UNIDO reviewed 20 October 2011.)</p> <p>A special report based on the four chapters –Chapter 17 on pathways, Chapter 2 on energy and development, Chapter 19 on energy access, and Chapter 23 on policies for energy access has been prepared. This is a synthesis of the analysis of these four chapters with some 400 pages and undertaken by over 50 analysts. The purpose of the report was to synthesize this work and to provide an easy-reader-access to the dense analysis provided in these key chapters of the GEA.</p>
<p>3.2 Obtaining feedback and providing guidance on three regional workshops - notionally one each for Africa, Asia and Latin</p>	<p>Reports submitted May 2012</p> <p>Two workshops have now been undertaken and one to take place later in the year <u>Africa</u>: Cape Verde workshop to the West Africa Regional</p>

Deliverables	Status
America.	<p>Programme Steering Committee meeting of 2012 has now been held successfully (April 2012)</p> <p><u>Asia</u>: Jointly undertaken with TERI in India, this workshop brought together researchers and policy makers (May 2012)</p> <p><u>Latin America and Caribbean</u>: To be organized jointly with OLADE- the Latin American Energy Organization in Quito, (to take place during the Summer of 2012). This workshop will bring energy specialists from the region as well as policy makers.</p> <p>Reports of these workshops and the feedback received are now being prepared. But most importantly is the feedback received during these that will help the authors and designers of the material and tools, to make adjustments and refinements for future and general use by policy makers.</p>

III. Summary of Contractual Aspects

The following section describes the contractual process between IIASA and UNIDO

A. Contract Duration and Timeline

The contract started on 1 July 2010 with an estimated completion date of 31 May 2011 as per the attached timeline. This timeline unfortunately was not possible to be met. As is normal in this type of projects of the magnitude and complexity of GEA, the project had to be extended. IIASA requested a no-cost extension in April, 2011.

The request was for an extension to 31 December 2011. At this time, a refined workplan was prepared with a new timeline and deliverables specified (Annex 2)

Reports and abridged versions of Chapters 2, 17, 19, 23, finalized September/October 2012

1. GEA Tools and Manuals finalized November/December 2012
2. Workshops held in Cape Verde on 11 April,
3. Workshops held in New Delhi, 8 May 2012,
4. Expected date of publication - June of 2012
5. Expected Launch of GEA at Rio+20 - 21 June 2012
6. Workshop in Eastern Europe June 2012

In terms of the GEA Report timeline during the most recent period, the GEA Council increased its oversight to ensure that both the timeline and the troubles encountered during the last phase were overcome and solved (see Annex 4, letter of Mr. Nebojsa Nakicenovic to Ms. Monique Barbut and Pradeep Monga dated 6 December, 2011).

As reflected in the letter, the period covered began with an extraordinary Council meeting of October 19, 2011, has been dedicated to a rigorous internal review of all the chapters in consultation with all the Convening Lead Authors and Lead Authors of the GEA.

Given these delays, the new timeline for the completion of the reports is as follows:

1. GEA council review of all the chapters: Spring 2010 to December 2011.
2. Submission of all the chapters to the Publishers - 29 February 2012
3. Page proofs reviewed by all members of Executive Committee and returned to publisher – 20 April 2012
4. Date of publication - June of 2012
5. Launch of GEA at Rio+20 - 21 June 2012

B. Progress Reports Submitted

The following reports were submitted to UNIDO on the dates specified:

First Progress Report October 2010 (Annex 5)

Second Progress Report December 2010 (Annex 6)

Third Progress Report November 2011 (Annex 7)

C. Financial Controls in place

IIASA activities are all funded by member countries and by external funding specifically targeted to projects. As such, it is obligated to maintain a rigorous control of its income and expenditures and these accounts are rigorously audited on an annual basis. IIASA maintains accounting controls and mechanisms such that all costs incurred or expended and/or any actions taken by IIASA on third party sponsored contracts and grants (so-called externally funded projects such as the one covered in the present contract) are tracked, monitored, and correctly allocated to those specific projects and recorded as such in IIASA's accounting records.

All costs are systematically documented to support and justify them. Internal control measures demonstrate and ensure that all costs attributed to a specific third-party sponsor are subject to an approval procedure and that any resulting financial statements and invoices are issued in accordance with contractual obligations and activities.

As mentioned above, IIASA accounts are audited annually by independent, external auditors PwC Osterreich GmbH in accordance with international standards on auditing and our financial statements are publicly available.