

Summary of:

IANAS Energy Program Workshop

April 17-19, 2012

La Paz, Bolivia

The third workshop of the IANAS Energy Program was held April 16-19, 2012, at Lake Titikaka, near La Paz, Bolivia, hosted by the National Academy of Sciences of Bolivia. Gonzalo Taboada Lopez, President of the Bolivian Academy, welcomed the participants to Bolivia to continue their work on sustainable energy in the Americas. Juan Pedro Laclette, Co-Chair, IANAS, provided an overview of the InterAcademy Panel on International Issues and the InterAcademy Council which provide global scientific leadership. The IAP/IAC work with regional networks: IANAS in the Americas and networks in Africa and Asia. He described the Energy Program's important links to other IANAS programs: Women for Science, Water, Capacity Building and Energy Education.

John Millhone, Chair, Energy Program, set forth the goals of the workshop. The first two workshops held Dec. 6-7, 2010, and June 9-12, 2011, in Bogota, Colombia, provided excellent opportunities get to know each other, the energy challenges in our countries, the activities of our academies and scientific organizations and to identify opportunities and draft recommendations. The challenge now is to identify the highest priorities and targeted actions. The workshop format has three sections: First, to take a closer look at energy for unserved populations; second, to hear country reports and updates; and third, to hear summary updates on our priorities and then to discuss and identify specific program directions.

The workshop was attended by representatives from the science academies and organizations of Bolivia, Brazil, Canada, Colombia, Guatemala, Ecuador, Jamaica, Mexico, Nicaragua, Panama, Peru, USA, and Venezuela. In addition, there was participation from Bolivian and international organizations. (A list of the participants and their organizations is attached.)

Energy for unserved populations.

The morning of the first day was devoted to a closer review of the priority of energy for unserved populations with presentations on the programs in Bolivia, Canada and Ecuador.

Bolivia program. The program was described Gizela Ulloa, Manager, SUNIA, who linked on-the-ground efforts to provide energy to rural communities with related renewable energy, gender and climate change issues.¹ Worldwide, 2,000 million people lack access to modern energy, she said; 47 million in Latin America and the Caribbean (LAC). In Bolivia in 2007, electricity was provided 71% of the population; 89% in urban areas; 39% rural. Three million were without electricity; nearly 4 million still used firewood for cooking and heating. The absence of modern energy affects the quality of peoples' lives and their chances for sustainable development.

She described recent progress in Bolivia. In the last 10 years, 20,000 solar PV systems have been installed using micro credit and subsidies. In the last 20 years, 50 micro hydropower plants have been installed, generating electricity for nearly 6,000 families. Wind power

¹ We owe thanks to the IANAS Women for Science Program and its point of contact in Bolivia, Monica Moraes, for arranging Ms. Ulloa's participation.

remains in an introductory process, slowed by legal barriers. Biogas is spreading in the highlands as an organic fertilizer and as fuel for cooking.

Poverty is a barrier to modern energy services, Ms. Ulloa said. The cost of a unit of electricity in rural areas is double the price in urban areas and the quality is worse. The market for batteries, candles and lighters raises the cost. Modern energy can claim up to 75% of a family's expenses.

She pointed out that women and children bear the brunt of the lack of modern energy sources and of the impacts of climate change. About two-thirds of the world's populations living in poverty are women. They are more dependent on natural resources. Women and children are far more vulnerable to natural disasters. In the aftermath of a disaster, their lack of ownership titles leaves them unable to acquire new plots of land.

She also pointed out that women can play a decisive role in addressing energy and climate change challenges. Mitigation and adaptation measures offer opportunities to empower women. They are already active in mitigation areas. They provide energy for the household. They benefit from the health benefits of clean cookstoves, as do their children. The expansion of renewable energy in Bolivia's rural communities would reduce energy costs; improve health and opportunities, particularly for women and children; and address climate change priorities.

Canada presentation. David Layzell, Executive Director, Institute for Sustainable Energy, Environment and Economy, University of Calgary, described the activities of a number of Canadian researchers have a strong interest in developing clean energy solutions for the developing world.

For example, in the 1990's Dr. David Irvine-Halliday (Electrical Engineering, U Calgary) shifted his research program to develop solar-LED systems for families with no electrical power. He eventually set up a not-for-profit foundation (<http://www.lutw.org/>) that operates throughout the developing world (including the Americas) to provide lighting to remote communities.

A professor of Mechanical Engineering, David Wood, is currently designing a small wind turbine that could be made by local communities and used to provide community level power.

In addition to technology development, there is a strong interest in understanding the decision-making process by developing communities around energy-environment choices. Dr. Joe Arvai is an expert in this area (<http://haskayne.ucalgary.ca/profiles/joseph-arvai>).

There is also an interest in how developing communities respond when they are faced with oil and gas development on their traditional lands. Dr. Lertzman (<http://haskayne.ucalgary.ca/profiles/david-lertzman>) is carrying out a comparative study of a community from Northern Alberta and one from Ecuador.

Ecuador presentation. Melio Sáenz, Centre Latinamericain de Calcul Scientifique et d'Informatique Industrielle, Ecuador, described bringing modern energy to unserved communities services in a larger context—as a transition from social exclusion to social

inclusion. Social exclusion is applied to the most marginalized sectors of society, the poorest with the most remote lifestyles.

The transition to social inclusion is multi-dimensional based on six forces: social, political, economic, technological, environmental and legal. Communities without modern energy sources occupy territories that are difficult and much more in contact with nature, creating a respect and integration with nature which must be recognized, learned and preserved in energy access programs. .

Saenz said scientific and technical interventions must be agreed to by the recipient community, must improve the living conditions of the population, and must follow a systems approach with policies, strategies, tactics and tasks in harmony with the historic and natural experience of the communities.

Discussion: The discussion was wide-ranging, but a common theme was that the experiences, successes and insights from the IANAS participants can make an important contribution to an issue that is getting increasing global attention. With some foresight, the IAC recognized this priority five years ago in *Lighting the way...*

The biggest challenge, most frequently encountered with PV solar sources, is sustainable projects that provide durable, lasting benefits and encourage replication. This requires respecting, collaborating with and securing a sense of “buy in” from rural communities—an approach that combines, economic, cultural and technologies factors; capacity building to ensure the continued successful operation of the equipment; and competent implementation, monitoring evaluation and reporting of the projects.

The presentations described programs with these features. The later country reports from Nicaragua, Peru and Guatemala also reflected these qualities. (See below)

The primary recommendation from the discussion was that we explore the organization of a future event that would highlight the approach and experience of these successful projects.

[Comment: The value of a future event was mentioned by several participants. We need to create a follow-up subcommittee to work on this. Some issues: Who would be invited? Would it be limited to the current Program participants or extended to other LAC countries with significant populations with unserved populations? Who would pay for it? Where would it be held? When? The topic also received attention at the 6th Summit of the Americas in the “Connecting the Americas 2022” initiative. One information source is the U.S. State Department website: <http://www.state.gov/r/pa/prs/ps/2012/04/187875.htm> Colombia deserves credit for this initiative.—Millhone]

Country reports.

The second half of the first day was devoted to the participants’ country reports. The informative reports were a mix of updates of earlier reports, overviews of national sustainable energy issues and focused presentations on national high priority topics. Copies of the reports will be available on the IANAS Energy Program website.

- Bolivia. The presentation, above, by Gizela Ulloa provided a significant insight into Bolivia’s program on energy for unserved populations. Other workshop participants from

Bolivia provided information on the country's activities in the other priority areas. A later presentation by Andrés Trepp, a former director of Bolivia's Institute of Energy, gave a historic overview of the nation's science programs (see below).

Canada. David Layzell pointed out that Canada is one of the few developed nations of the world that is a net energy exporter, and the nation has the potential for greatly increasing the recovery and export of its fossil fuel resources. However, there has been controversy around the environmental impacts of energy production and use, especially on greenhouse gas emissions, water and land use.

As a result of this controversy, critical policy and investment decisions around energy-environment choices are not being made. This has resulted in a rising consensus among industry, government and environmental groups for the need to take an 'energy systems' approach in developing a Canadian energy strategy.

An energy system analysis approach includes technology and policy assessment, detailed modeling of the regional and national energy system, and an understanding of the factors behind how people make decision related to energy-environment issues.

Colombia. José Rincón, representing the Colombian academy, gave a report on the Latin American network on the use of organic waste to produce bioenergy. The network currently includes representatives from Mexico, Cuba, Nicaragua, Costa Rica, Venezuela, Colombia, Brazil and Bolivia.

The network's objectives are to identify technologies that use wastes to generate power and/or as liquid fuels, to identify the useful wastes in the participating countries, to support feasibility studies and pilot projects, and to develop outreach programs. The network is establishing a data base on current uses of wastes, identifying effective technologies for using different waste streams, organizing interdisciplinary groups in each network country, promoting training programs, and exchanging information through a website and real and virtual meetings.

Rincón presented information on the rapid increase in the use of energy pellets in some European countries and China as evidence for the potential rapid growth in the LAC countries. Proposed projects include using wastes from market places to generate thermal energy, waste-to-energy projects using garbage, and pelletizing palm wastes for use in rural kitchens.

Ecuador. Melio Sáenz described the energy history of Ecuador and its activities toward a diversified energy matrix. Oil production and exports are dominant in Ecuador, providing about half its export earnings and one-third of its tax earnings. Thermal energy provided 46% of its power generation capacity in 2011; hydropower 40%, solar 2% and the remaining 12% was imported.

He cited information on future Ecuadorian sources and plans. The largest addition to new power generation would be in hydropower, dominated by the 1,500 MW Coca Codo Sinclair project, where construction recently got underway. Sáenz also cited past and projected reductions in the price of renewable technologies, indicating their contributions are expected to increase. A priority is being given to reducing electricity transmission and distribution losses, which were above 22% in 2006 and are projected to halved by 2016.

Guatemala. A presentation linking ancient Mayan wisdom with modern climate change alarms was presented by Mario Hernandez, Executive Director, Guatemala's Rijatzul Q'il (Sun Seed) program. Hernandez and Ivan Azurdia-Bravo, who represented Guatemalan at an earlier workshop, authored the presentation.

The common links are "resilient adaptation" and "synchronized technologies." Resilient adaptation is the ability of an individual or social system to adapt to adversity and continue their life journeys. A successful journey requires synchronizing a new technology system that is functional and adapted to the changing world.

The presentation had a gallery of pictures which humanized these abstract concepts. Children in a rural school are pictured next to photovoltaic panels that are bringing access to lighting and computers. Villagers are shown carrying a turbine to a new micro-hydropower plant. Women are shown viewing a clean cooker that vents smoke through a ceiling stovepipe. Artisans are shown using electric sewing and weaving machines to produce traditional Mayan tapestries.

Jamaica. Anthony Clayton, Professor at the University of the West Indies, provided a succinct update on the importance of energy reforms in Jamaica and the tepid government response. A small island nation with a population of 2.6 million, Jamaica depends on imported oil for about 91% of its energy. The rest is renewables—more than half fuelwood, one quarter bagasse, and the rest ethanol, hydro, wind and solar.

Clayton pointed out that Jamaica has significant potential solar, wind and ocean current renewable resources, but has done little to develop them. While energy efficiency has been rising in most countries, Jamaica has gone the other way, now requiring four times more energy to produce a dollar of economic output than the global average.

Jamaica has adopted an ambitious energy timetable: Increasing renewables' share from 9% to 20% by 2030; increasing the alternatives to oil from 9% to 70%; and reducing the energy intensity index from more than 20,000 Btus per U.S. dollar to 6,000 Btus—which would still leave it above the current global figure. The problems are poor governance, high public debt, little evidence-based decision-making, lack of strategic analysis and a short-term perspective. He expanded his analysis later in his presentation on innovation (see below)

Mexico. Arturo Fernandez, representing the Academia Mexicana de Ciencias, provided an informative overview of the Mexico's energy uses, history and current policies. Fossil fuels dominate—largely oil and natural gas—dominate the country's energy sources. Oil provides 89% of the country's energy; 74% of its installed power capacity. Two monopolies—PEMEX in hydrocarbons and CFE in electricity—have dominated programs, hindering the development of distributed and local power systems.

Renewable energy provides 9.4% of the country's energy, about half of that is hydropower, traditional wood and bagasse, 4%; and small amounts from geothermal, wind and solar. In the electricity sector, renewables provide 19.1% of the sources, largely hydropower. In final energy consumption, renewables provide 6%, mainly for fire wood and bagasse in the sugar industry.

Mexico's energy supply picture is providing growing recognition of the need for change. The country's proven oil reserves are estimated at 10.8 years at current consumption rates. And while renewable contribution currently is small, the renewable resources are huge in hydropower, wind, geothermal, solar and biomass. This has Climate Change implications. Mexico emits 430 million tonnes of CO₂ equivalent—13th globally. However, because of the environmental impacts on soils, rivers and forests, Mexico ranks 43rd in the Environmental Performance Index.

Mexico began addressing this challenge in 2008 when it enacted three laws: the Law on the Promotion and Development of Bioenergy (LPDB), which emphasizes the production of bioethanol and biodiesel; the Law on the Sustainable Use of Energy (LASE), which promotes efficiency and renewables in government buildings; and the Law on the Use of Renewable Energy and Energy Transition Funding (LAERFTE), which promotes the use of renewable energy to generate electricity. A snapshot was given of several recent projects.

Fernandez offered some of the lessons learned: Gain commitments from local governments and institutions; maintain collaboration with CFE, the power sector monopoly; ensure the project has sustainable local development; gain social acceptance through clarity and transparency with local people; and facilitate partnerships among government agencies, decentralized partners and energy companies.

Nicaragua. Claudio Wheelock, Director, Solar Station Vadstena, Central American University, Managua, Nicaragua, described how university-based science and technology are developing energy projects in his country—the experience and challenges. The university and Nicaraguan academy work together as partners.

Firewood is the dominant energy source in Nicaragua, accounting for 69.9% of the country's primary energy and 47.8% of its final energy consumption. As a result, the woodland cover losses are large, an estimated 70,000 hectares a year.

The national grid serves only around 60% of the population. Some rural communities in areas accessible to the grid are still without access. Thermal plants generate about 70% of the electricity; the remainder divided primarily among geothermal, hydropower and bagasse sugarcane (in private plants) with a small, 3%, contribution from wind. Nicaragua's hydro, geothermal, wind and biomass capacity is estimated at 258 MW; only 6 MW is used.

The country's General Directorate of Energy Policy has set forth an ambitious change in the electricity generation matrix from 2010 to 2017. Thermal sources would shrink from 66% to 4%; biomass from 9% to 4%; hydro would grow from 11% to 43%; geothermal, 9% to 36%; and wind, 5% to 13%.

The university works with the academy on education, research and social service programs. Wheelock presented case studies in the use of PV systems in homes and micro-industry. He offered key observations: 1) Use participation by local institutions, e.g. agricultural cooperatives; 2) Make adoption of PV technologies a personal, family or community decision; 3) A passive reception is rarely sustained, active participation in installation and maintenance sustains results; 4) Participation by recipients empowers users; 5) Costs are still high for some, pico-systems can be the solution; and 6) donors' visions must connect with the priority needs of impoverished families.

Peru. Manfred Horn, Universidad Nacional de Ingenieria, Lima, Peru, presented a report on solar energy in rural Andean areas. He noted that 16% of Peruvian, mostly in rural areas, are without electricity. The policy assumption: “Without energy, particularly without electrical energy, there is no equity, no development or welfare, and therefore no democracy.”

Peru is blessed with solar energy, especially in the Andes, with year around high mean solar radiation. With its location in the tropics, horizontal surfaces receive more energy than vertical walls. Trombe wall projects are failures. Mann gave examples of successful thermal and PV projects. lar thermal V applications.

Solar water heaters are used for both productive and domestic heating—important in the high Andean regions—and in greenhouses, solar driers and solar cookers. An example is San Francisco de Rayumina, where family and community greenhouses produce organic flours, aromatic herbs, processed cheese and attracted ecotourism. . . .

PV applications range in size from large installations for schools, health centers and community workshops to small, inexpensive “pico PV” that meet minimal electricity needs, especially when paired with LED lighting.

Horn’s conclusions include: “...rural energizing is necessary to maintain social peace...photovoltaic electricity is today in many cases the best option...to avoid repeating the mistakes made in previous projects new projects should be evaluated with great care...you cannot supply power to remote rural regions with costs similar to those in urban areas...[but] the most expensive energy is the energy that you do not have.”

Venezuela. José Manuel Aller, Academia de Ciencias de Venezuela, provided an informative and candid update on the country’s abundant energy resources and the challenges it is facing.

Citing data from Corpoelec, the state-owned electricity company, Venezuela’s installed capacity has increased more than 20% in the last 14 years; however, the available electric power has increased only slightly and has failed to meet the rising demand and caused outages and lost revenues. A reduction in oil production has been a factor, leading to an increase in diesel fuel imports to close the gap in unmet electricity demands. On the plus side, Venezuela has large hydropower potential that could double the electricity generation from this source.

Venezuela has recognized the growing role of renewable resources by the construction of a 100 MW wind farm on the Paraguaná peninsula, although the technology is outdated and it hasn’t been effectively integrated into the power grid. Major energy efficiency laws have been approved including measures on the residential sector, public buildings, the private sector, an improved power factor and lighting. The impact of the measures is still uncertain.

Wednesday, April 18. During the second day of the workshop, sessions were held on the renewable energy, bioenergy, energy efficiency and innovation and development priorities. Topical overview presentations were followed by discussion of future actions.

Renewable energy.

Arturo Fernandez, a member of the leadership team for the renewable priority, began the session by providing an overview of the renewable energy recommendations from the first two workshops.

The first workshop made recommendations for policy-makers and academics. The recommendations for policy makers include increased level of both public and private investment in energy RD&D; support for a transparent, efficient and orderly international markets; the harmonization of technical standards for renewable technologies; expansion of the training programs for engineers and technicians; and establishment of a network of trusted laboratories.

The recommendations for academics and science organization include ensuring universal access to accurate, reliable and impartial technical information on renewable energy options and technologies; identifying the technical issues involved in developing renewable energy technologies; encouraging and sharing information on best practices and successful programs; encouraging collaborative research in key areas; and providing policy-makers with accurate, neutral advice.

The second workshop condensed this broad advice into three more specific recommendations.

- First, the creation of a renewable energy information network that focuses on renewable energy resources, evaluates renewable energy resources, and exchanges this information among research groups, centers and universities. The network also would develop the legal and regulatory measures needed to promote renewables in the Americas
- Second, a case study of the transition of a country to an expanded use of renewable energy. Mexico was proposed as the test country because of its abundant mix of renewable sources and heavy reliance on fossil fuels. The study would be monitored and evaluated by other countries to help guide them in their own future renewable plans.
- Third, establish a Center of Excellence for training renewable energy professionals at the highest level on the scientific, technical, economic and environmental issues as they relate to renewable energy policies, legal and regulatory issues.

The discussion affirmed and expanded on the directions outlined in the earlier workshops. The participants explored the options for moving ahead with the exchange of information on the potential of different renewable resources, the role that could be played by different organizations, the related activities already underway and the organization and use of internet resources in a Center for Excellence.

Bioenergy.

Luis Cortez, a leader of the bioenergy team, opened this session with a presentation, “Developing a bioenergy plan in Latin America & Caribbean that incorporates advanced technologies.” The presentation drew on information in the draft chapter written by the team for inclusion in the planned Energy Program publication.

The presentation is a rich source of information on the development of bioenergy in the Americas. The data shows that traditional biomass provides nearly two-thirds of the world’s renewable energy. Not traded commercially, this current, dominant role of traditional biomass often goes unnoticed in statistical reports.

The slides from the draft chapter show the production of biodiesel and ethanol in leading countries, biofuel policies in the LAC, biofuels role in energy security and food security, sugar production in selected LAC countries, agriculture and oil dependence in LAC countries, gasoline and grains (in)dependence, and bioethanol production in LAC countries. The breadth of information in the slides can't be adequately communicated in this summary.

The material presented by Cortez provides strong documentation for a bioenergy plan for the LAC that incorporates advanced technologies. He and his colleagues at the Sao Paulo Research Foundation (FAPESP) have prepared a research agenda for the Latin America, the Caribbean, and Africa (LACAf). The covered countries collectively have an estimated 60% of the world's available land that could be used to produce bioenergy. The proposal is connected to the Global Sustainable Bioenergy (GSB) initiative, which is testing the hypothesis that it is physically possible for bioenergy to sustainably supply a quarter of the global transportation energy by 2050.

Curtis said a decision on the plan was anticipated in the near future. The methodology would include regional meetings and studies of the physical potential, land use and integration with pasture land and other crops with sugarcane.

The strategic considerations are: To enhance energy security by decreasing fuel imports; to improve food security by increasing production; to improve social conditions; to protect biodiversity by maintaining ecological sanctuaries; and to promote economic development. Curtis concluded that there are excellent opportunities for bioenergy in Latin America including available land around 250 Mha for bioenergy production. The region already has a large and successful experiment with biofuels in Brazil (bioethanol) and Argentina and Colombia (biodiesel). There is a need to understand the specific situations for selected countries to determine the IANAS/FAPESP contribution to the GSB project, including verifying their potential and constraints.

Much of the discussion dealt with balancing large-scale commercial crop production with preserving small-scale, family-sized agriculture. On one hand, large-scale efficiencies are necessary to be competitive in the global market. On the other hand, the disruption of traditional farming has some painful human impacts. The discussion again raised the issue of balancing economic, political, physical and social science insights and priorities.

Energy Efficiency.

John Millhone, the lead on the energy efficiency team, initiated the session with a summary of the draft chapter on energy efficiency in the planned Energy Program's publication. The chapter cites the priority given energy efficiency in the IAC report, *Lighting the way...*, the recommendations from the past workshops, defines the scope of energy efficiency from sources to final end uses, surveys current activities, and proposes a role for the IANAS program.

Lighting the way... gives a high priority to energy efficiency, pointing to the contrast between the potential for cost-effective efficiencies and those actual realized. The report identifies the obstacles — wariness toward new technologies, lack of incentives, and limited professional and technical personnel. It also identifies the opportunities for “leapfrog” improvements in developing countries, i.e. many countries in the Americas.

The energy workshops set forth basic recommendations: Expand R&D on technologies that are high priorities for the Americas; improve data from sources to end uses to identify the highest priorities; expand education of scientists, engineers and technology experts; cooperate with government, financial and private sector allies; and use the upgraded IANAS website, intranet and virtual meetings to identify specific cooperative actions.

The scope of efficiency used by IANAS is wider than often portrayed, extending through three stages from sources to final end uses, e.g. from production, to a country's Total Primary Energy Supply (TPES), to its Total Final Energy Consumption, divided into buildings, industry and transportation end uses. Fast payback, energy-saving opportunities are available in each link of this energy chain.

The role of the IANAS program was described as fostering communication among the academies and science organizations, strengthening the influence of the science communities within their countries, and providing a productive, multi-country perspective on sustainable energy issues.

Much of the discussion dealt with linking numeric tables with graphics to raise the understanding of energy saving opportunities.² The LAC energy data would be used in the Sanki graphics that David Layzell used to show Canada's flow of energy from sources to end uses. The approach would make it easier to visualize the energy systems of neighboring countries and multi-country regions under different future scenarios. This could be a powerful tool for showing political decision-makers and the general public the options available to them.

There also was a brief discussion of the negative impact of energy subsidies in some LAC countries. Large subsidies on gasoline, natural gas and electricity can have a severe impacts on energy efficiency in some countries, encouraging smuggling and discouraging long-term energy-saving investments. This is one of the barriers mentioned in *Lighting the way...*

Innovation and Development.

Under the general theme of capacity building, Anthony Clayton led us through a thought-provoking session on innovation and development globally and in the Americas and the implications for the science community.

Taking the long view, he noted, the world is getting rich, a trend projected for the future. Science and technology play the dominant role. Innovation now generates more than 50% of the economic growth in the advanced economies. The pace of innovation is accelerating.

The LAC countries need to recognize the driving role of innovation to share in this growth in development. Stronger LAC universities are critical to the region's success. They now score low on global rankings, e.g. fewer LAC published papers than from the universities in sub-Saharan Africa. A misguided urge to protect the status quo is a large problem. In science and

² Millhone distributed a table on the three stages in energy use from a report he did on Russia. He described the table as analogous to a medical physical, showing the vulnerability of Russia due to its large oil exports and the huge energy losses from the country's 17,000 district heating systems, most dating from the Soviet era. For more information see Millhone, John P. "Russia's Neglected Energy Reserves." Carnegie Endowment for International Peace. Washington, D.C. 2010. p. 21. Available on the Carnegie website.

technology, there is no status quo. Governments should not protect obsolete technologies and uncompetitive industries. Instead, innovation networks should be encouraged.

Knowledge networks are the key to rapid development. They link researchers, investors, financiers, entrepreneurs, and government agencies. They need foresight on the critical emerging issues, e.g. economic development and increasing wealth and inequality, scientific advances, global power shifts, environmental restraints and demographic changes.

There are mapping and planning tools that can address these issues. Clayton described how the Delphi method might be applied to energy policy. In the example, a change in the price of oil would have rippling effects. Current conditions are compared with the anticipated future conditions. A strategic plan would be drafted and implemented to prepare for the changed conditions.

Clayton's presentation aroused a lively discussion on how the countries of the Americas could modernized their policies and programs to respond to the innovation and development realities that are shaping the future. While no effort was made to reach a consensus on immediate action by the Energy Program, here's a summary of some of the comments that could lead in that direction. Representatives from many countries expressed interest in exploring the changes described in the presentation. Many recognized that protectionist policies were constraining their countries future economic growth. Interest was shown in identifying capacity building education and technology areas beneficial under a diverse mix of different economic futures.

Bolivian Science Programs

The workshop also provided an opportunity to learn more about the science programs of Bolivia from a presentation by Andrés Trepp del Carpio, a member of the Bolivian National Academy of Sciences and Former Director of the Institute of Science.

The Institute of Energy (IDE) of the Bolivian National Academy of Sciences initiated its activities in the 80's of the past century and has covered a wide range of topics related to energy analysis and planning as well as studies and the use of renewable energies in Bolivia. These studies and analysis have centered in the relationship between the supply and demand from the particular point of view of the consumers and not from the supply alone or from the official sector or private producers of energy.

Brief summaries of some of the IDE studies conducted during the last 26 years had been presented and discussed at the IANAS meeting, and covered the following activities: Analysis and Energy Planning, Use of Firewood, Economy of Renewable Energies, Solar Energy Technologies, Meteorology, Climatology and Atmosphere, Climate Change, Rational Use and Conservation of Energy, Technology and Development, Science, Technology and Society and Organization, Complexity, Chaos and Evolution. All these reports and publications can be requested from the presenter at treppcen@entelnet.bo .

Crosscutting topics

In the priority sessions, two future cross-cutting Program activities were mentioned several times—the publication of a book on the IANAS Energy Program and the identification of

topics for papers—for example post-doctoral analyses—on topics that would enrich the available information on the program’s priorities.

The initial publication plan was on a tight schedule for an interim description of the Energy Program priorities. The schedule was unrealistic. The recent publication of a book on the IANAS Water Program and the rapid and large number of readers it has attracted is seen as a model for the Energy Program. A realistic schedule for the publication of the book is about a year from now. The proposed material for the book would not be focused only on our priority activities but also would include a broader range of articles on priority topics, such as country or regional programs or analyses of issues related to these priorities. On this content issue, the Water publication is a good guide.

In our priority discussions, we frequently touched on issues that are highly relevant and yet the available information and analysis is limited. Unfortunately, although many of us would like to research and report these issues, we don’t have the time. The suggestion was made that we assemble a list of these topics. The list would be made available to those seeking to write papers on currently relevant topics. The proposal is being considered by participants who are in positions in educational institutions.

Thursday, Apr. 19

The last day provided generous rewards for the two days the participants had spent working to address the daunting challenges facing the Americas. The Bolivian academy arranged for a morning boat ride for the participants to the Floating Islands on Lake Titikaka. Nature cooperated as the sun sparkled across the beautiful lake, fluffy clouds crept across a pure blue sky against a background of lofty, snow-topped mountains.

Later in the day, we returned to La Paz for a farewell dinner hosted by the Bolivian academy. Academy President Gonzalo Taboada Lopez thanked the IANAS for bringing the Energy Program workshop to his country. IANAS Cochair Juan Pedro Leclette expressed his appreciation to President Taboada and the Bolivian academy. Energy Program chair Millhone also expressed appreciation to President Taboada for the generous support given the workshop, to the Academy’s Hernan Vera Ruiz, who co-managed the workshop, to all Bolivian participants and to the many country participants for successful workshop.

Attachment:

PARTICIPANTS

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United States of America: John Millhone, Program Manager, U.S. Department of Energy
(retired); U.S. National Academy of Sciences

Venezuela: José Manuel Aller, Universidad Simón Bolívar; Caracas, Venezuela; Academia
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Guests:

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