Asia-Pacific
Economic Cooperation

Advancing Free Trade
for Asia-Pacific Prosperity

APEC Workshop on Energy Statistical and Geographic Information Systems *Summary Report*

Mexico City, Mexico | 9-10 April 2018

APEC Energy Working Group

July 2018

APEC Project: EWG 16 2016A

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APEC#218-RE-04.4

Executive Summary

This project organised and hosted a two-day workshop to bring together policy makers, statisticians and energy experts to create collaboration, share best practices, information and recommendations between the APEC economies. During this workshop, the subjects of Energy Statistics and Geographic Information Systems (GIS) were discussed.

The workshop was held in Mexico City from 9 to 10 April 2018 and was organised by Mexico's Ministry of Energy (SENER) in cooperation with the Asia-Pacific Economic Cooperation (APEC). The objectives of the workshop were to:

1. Create synergies between participants at the workshop on energy statistics and GIS. As a result, the information that the economies submit to the Energy Working Group (EWG) would be more efficient and effective,
2. Help Mexico's Ministry of Energy to develop a more robust, reliable and timely Energy Information System (SIE).

The workshop is aligned with the energy data training program implemented by the Institute of Energy Economics Japan, and which aims to increase the knowledge of energy statisticians and improve APEC energy data quality through the cooperation of the member economies. Prior to the workshop, the project team analysed the energy sectors in Mexico that needed the most support by APEC to make a roadmap for the two-day meetings. This research identified opportunities for tailoring the discussion to be of most relevance for the participants**.**

The workshop consisted of three key elements:

1. An introduction to the changes in Mexico after the Energy Reform including the newly implemented SIE. A series of presentations by experts in the field were given to better explain each of these elements, i.e. geography statistics experts, hydrocarbon experts, renewable energy experts, among others;
2. An introduction to data; collection, processes, validation and knowledge sharing, and how to make energy statistics and GIS more timely and efficient through it. The economies of the United States (US); Japan; and Germany, as an external invitee, played key roles here;
3. Consideration of participants' needs for further support and how that should be provided. A roundtable discussion session was organised to facilitate the production of more focused results.

Including the project overseer and organisers, 89 individuals participated in the APEC workshop on Energy Statistical and Geographic Information Systems. Out of these attendees, 60 participated both days of the event. These participants answered a post-workshop survey to rate the overall effectiveness of it and to collect information on improvement strategies for future projects.

After a robust analysis of the surveys and overall success of the workshop, some recommendations were identified to build on future similar projects, such as:

- A more diverse participation of APEC member economies to extend the benefits of these encounters as far out as possible,
- Local evaluation resources (e.g., links to evaluations of programs and policies),
- Contacts of people interested in energy statistics and GIS,
- Discussion forum for member economies,
- Links to past conference proceedings and other materials that will be useful to evaluators,
- Developing liaisons and partnerships with existing evaluation organisations and other institutes,
- Developing a plan to work together in the next year or two to improve the quality of energy statistics and GIS in APEC economies.

As a side note, if gender issues are to remain a specific target for the APEC, it is advisable to include gender specific topics on the future project outline and agenda to ensure the participating economies are prepared to present and respond accordingly.

Table of Contents

List of Acronyms

APEC	Asia-Pacific Economic Cooperation
APERC	Asia Pacific Energy Research Centre
AZEL	Atlas of High Potential Clean Energy Zones
BAU	business as usual
BNE	Regional Energy Balance, in Mexico
CENAGAS	Natural Gas Control Centre, in Mexico
CENACE	Energy Control Centre, in Mexico
CFE	The Federal Energy Commission
Cleantech	Clean Energy Technologies
CNH	The Hydrocarbons Commission in Mexico
COP21	Conference of Parties, Climate Change Conference in Paris
CRE	The Energy Regulatory Commission, in Mexico
CTE-ISE	Technical Committee Specialised on Information of the Energy Sector
EIA	Energy Information Administration
EWG	Energy Working Group
GHG	greenhouse gas emissions
GIS	Geographic Information Systems
GSO	General Statistical Office
INEGI	Regional Institute for Statistics and Geography in Mexico
ITESM	Institute for Higher Education of Monterrey
IEVN	Institute of Energy Viet Nam
MEM	Wholesale Electricity Market, in Mexico
MoU	memorandum of understanding
NAEM	Energy Map of North America
NDC	Nationally Determined Contributions
OMW	Official Mexican Webpage
PEMEX	Mexican Petroleum
RES	Renewable Energy
SENER	Ministry of Energy in Mexico
SIE	Energy Information System
US	United States

List of participating Member Economies

CDA - Canada

CHL – Chile

PRC- China

JPN - Japan

MEX - Mexico

RUS - Russia

SGP - Singapore

US or USA - United States

VN - Viet Nam

A. Project Background:

Energy, Policies, Energy Statistics and Geographic Information Systems

In terms of energy, there is a geopolitical trilemma that governments must confront in order to make it sustainable whilst still encouraging development. They have to take into account the affordability of energy, mitigation of climate change through environmental targets and energy security (WEC, 2015). Governments use tools such as energy statistics and geographic information systems to map resource use and availability, promote investment, pursue the most efficient use of energy and enhance the knowledge of the interaction between energy supply and demand.

APEC and GIS for Energy mapping

Member economies of the APEC including China; the United States; Russia and Japan account for around two thirds of the world's energy demand. At present, 90% of the energy imports by the region is oil (IEA, 2017). Additionally, the 6th edition of the Asia Pacific Energy Research Centre (APERC) report shows that energy consumption levels are forecasted to increase by 35% from 2013 levels. In a business as usual (BAU) scenario, 80% of this energy demand will be met by fossil fuels, thus increasing GHG emissions. Hence the urgency for the members of APEC to work together towards achieving two main APEC's aspirational goals in terms of energy and sustainability: double the share of renewables in the APEC energy mix by 2030 from 2014 standards and to reduce APEC's aggregate energy intensity by 45% from 2005 levels by 2035 (APEC, 2017).

Based on the last goals revision in New Zealand in December 2017, APEC members charted their route of collaboration through energy projects. One of the products of this review is this latest workshop on Energy Statistics and Geographic Information Systems that took place in Mexico City in April 2018.

The Energy Reform in Mexico:

Mexico's oil, natural gas and electricity subsectors have begun a transformation due to the Energy Reform, which was officially enacted in 2013. The main aims of this reform are to attract investment and modernise the energy sector; aiming for an increased production of cleaner, cheaper energy, increased oil revenues, the creation of well-paid jobs and environmental protection. One of the main changes was to put an end to long-standing monopolies. Mexican Petroleum (PEMEX) and the Federal Energy Commission (CFE), the

large hydrocarbons and electric energy state-owned utilities respectively, have been transformed from parastate organisms to State Productive Companies. Thus, opening competition in many aspects of the oil and gas value chain as well as electric power generation. Through the Energy Reform, private investors can now participate alongside PEMEX and the CFE, in a wide range of activities in the energy industry and attract capital and technology investment to areas that need renewal (OMW, 2014; IEA, 2016).

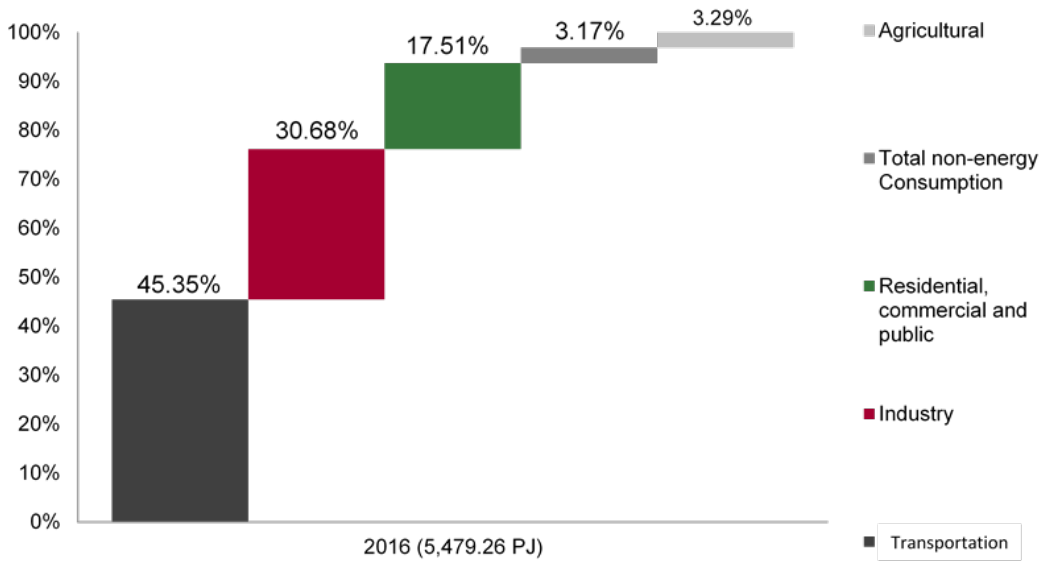

Figure 1: Mexico's Total Energy Consumption in 2016 (SIE, 2017).

Because of the Mexican Energy Reform, new models have been established and opened to the public to participate in industry activities such as the generation and commercialisation of electric power. Third parties are now involved in the exploration, extraction, transformation, transportation, storage and distribution of hydrocarbons, renewable energy (RES) and the electric power industry. Thus, leaving only the planning and control of the Regions Electric System and the distribution of electric power as strategic areas solely the Mexican state (Presidencia de la República, 2014).

The Hydrocarbons Commission (CNH) and the Energy Regulatory Commission (CRE) became the coordinated energy regulatory agencies. Along with the newly created Natural Gas Control Center (CENAGAS), in charge of the operation of the regional system of gas pipelines and storage facilities; and the relaunched Energy Control Centre (CENACE), responsible for the operation of the Electric System and the Wholesale Electricity Market (MEM), they became new public players in the Mexican energy sector, which added to the new private players, such as qualified users and electricity supply companies, resulted in more complex and robust energy information needs, collection processes, and flows.

Overall, the changes brought with the Energy Reform are designed to create a more dynamic and efficient sector, which is open to competition in both the hydrocarbons subsector and the electric power industries. As a result, the reform attracts new players and increases the amount of information coming from a growing array of actors. These changes urge SENER to act and guarantee the collection of relevant information that complies with high quality standards. The SIE is intended to be the tool to achieve the new energy statistical and GIS. Thus, the SIE is SENER's tool used to promote investment, pursue the most efficient use of energy and enhance the knowledge of the interaction between energy supply and demand (SENER, 2017).

Energy Information System (SIE) in Mexico

The improvement of energy statistics plan and development practices has been promoted due to the increase in the various sources of energy that emerged after the implementation of the new regulatory framework in Mexico. This opened the need for an informed energy market that promotes the participation of investments, both domestic and foreign, that collaborate in the economic development of the region. However, there is a lag in the tools for planning and disseminating information due to the accelerated evolution of the energy sector, the entry of new players and the delays in the restructuring of the information supply chain.

Energy statistics in Mexico were previously obtained through the sole two companies in the sector: PEMEX and the CFE. Both supplied information to SENER for the integration of the Energy Balance (BNE). However, the information gathered was insufficient due to the new demands of the sector after the energy reform. The creation of the SIE in February 2002 signified a change for energy statistics in Mexico. It became the main source of information for the energy sector. The SIE collects geo-referenced statistics of the sector which are open to the public, as it is an open source platform. This system is fed by governmental institutions and supported by the legal framework of the region's Geographic and Statistical Information System (INEGI), where the Technical Committee Specialised on Information of the Energy Sector (CTE-ISE), chaired by the Undersecretary of Planning and Energy Transition of SENER who is specified as the maximum authority over the SIE and has the participation of the institutes and the dependencies of the energy sector.

The SIE platform offers sections for statistical and geo-referenced information that allow the user to interact dynamically with the platform. The statistics section allows the user to perform basic or multiple information queries, perform unit conversions and calculate variations between periods. In addition, the platform offers add-ons to generate graphs, send reports by mail and export the query in Excel XLS format. The geo-referenced section offers the service

mounted on the Google Satellite layer with information on hydrocarbons and electricity infrastructure, with similar functions to the statistical section.

Although the SIE was considered a complete and well-developed system by the time it was created, the main software of its database has been working with the same resources from the beginning. Hence its limited capacity to receive and store information, which result in problems of limited compatibility with new systems that have been implemented within the institutions to gather information from new players in the sector.

The region's Institute for Statistics and Geography in Mexico (INEGI) oversaw the carrying out of the diagnosis of the SIE to determine its current condition by evaluating the components that integrate information technologies, computer infrastructure, software architecture and information security. The results of the diagnosis supported the need to renew the infrastructure of the System. Consequently, SENER decided to carry out a supportive evaluation, by learning from successful experiences in other member economies that would allow the incorporation of geo-referencing resources to the new version of the SIE. Similarly, the SIE was intended to establish a reference point for energy information systems in other parts of the world.

B. Objectives and Aims:

This workshop had two main objectives:

- The first was to create synergies between participants at the Workshop on energy statistical and geographic information systems. As a result, future information that member economies submit to the Energy Working Group (EWG) would be more efficient and effective.
- The second objective was to help Mexico's Ministry of Energy to develop a more robust, reliable and timely Energy Information System.

C. Workshop Description:

The APEC Workshop on Energy Statistical and Geographic Information Systems was held on 09th-10th April 2018 in Mexico City, Mexico, with 19 speakers. The workshop agenda is shown in Appendix 1. The agenda of the workshop on the first day consisted of five main sessions, welcoming remark and an introductory session as follows:

i) Workshop Opening Session: Where the current goals of the host organisation, SENER, were shown. A workshop introduction and an outline of the Atlas of Potential Clean Energy Zones in Mexico were also given;

ii) Mexican Energy Model: An outlook on the collaboration between academia and the public sector to improve the decision-making process on energy based on an in-depth analysis of different forecast scenarios through the Decision-Making Theatre tool;

iii) Session 1**:** Information on Mexico's Energy Information Systems and the topographic information on the Mexican territory;

iv) Session 2**:** Presentations on the Technological solutions for the hydrocarbons subsector in Mexico, protected areas and the current status of oil wells;

v) Session 3**:** Technical and Statistical Information of Exploration and Production in Mexico;

vi) Session 4**:** Interoperability, Big Data and Analytics for the Electricity Sub-Sector in Mexico;

vii) Session 5**:** The use of Digital Elevation Models derived from very high-resolution satellite images in the planning of oil exploitation and renewable energy sources, and the North American Energy Map as a three-way collaboration system.

The agenda on the second day emphasised the collaboration of APEC economies with five main sessions and a round table as follows:

i) Session 6: Energy Statistics in Viet Nam and improvement opportunities;

ii) Session 7: Energy Data Collection and Dissemination in Japan, best practices on analysing energy statistics;

iii) Session 8: Mapping Megawatts, GIS use at the Energy Information Administration (EIA), data collection methods and validation;

iv) Session 9: Energy Statistics, Energy Balances and Energy Indicators in Germany - The Flow of Data from Generation to Publication at the Example of a Federal State;

v) Session 10: Present and future of the PEMEX Institutional Database;

vi) Round Table: The future of the Mexican Energy Information System - next steps, cross member economies sharing of best practice approaches;

vii) Workshop Closing Session: reinforcing the importance of collaboration between the APEC economies.

D. Workshop Sessions' Review:

The APEC is a regional economic forum established in 1989 to leverage the growing interdependence of the Asia-Pacific. APEC's 21 members aim to create greater prosperity for the people of the region by promoting balanced, inclusive, sustainable, innovative and secure growth by accelerating regional economic integration (APEC, 2018).

Mexico's Panorama:

SENER conducts the region's energy policy. Within the current constitutional framework, the Ministry acts in order to guarantee a competitive, sufficient, high quality, economically viable and environmentally sustainable supply of energy that requires the development of economic life. Moreover, policy ought to be designed so that it promotes the efficient use of energy as well as research and technological development projects, within a framework of encouraging the use of alternative sources of energy (SENER, 2018).

Before and After the Energy Reform:

Mexico has been and continues to be a heavily oil dependent economy. At present, it produces almost 20bn barrels of oil per year, out of which 58.8% is heavy oil, 15.16% is medium oil, and 14.8% is light oil. Extra-heavy oil production accounts for only 3.1% and super-light oil only 6.1%. Mexico's natural gas reserve as of 2017 was nearly 29bn ft^3 (SENER, 2017). Nonetheless, Mexico still exports most of its petrol and needs to import gas due to a lack of infrastructure for a fit processing method.

Before the Energy Reform, Mexico's main energy source was fossil fuels. Urgent times that called for more sustainable energy sources, as well as economic resource scarcity to access native oil reserves, pushed for the lowering of barriers and welcoming foreign investment within Mexico's energy sector. With this reform, the Energy Transition Law was created to improve the energy mix of the region. The SENER uses seven energy models to assess the medium and long-term energy planning**:** Integrated Energy Modelling System (SIMISE); Balmorel Mexico; TIMES MX-Regional; ThreeMe, Simple E; Institute for Higher Education of Monterrey (ITESM) Model.

Examples of how these models work were demonstrated during the workshop. The Decision-Making Theatre tool implemented by ITESM is an example of a successful synergy between academia, the public sector and the Interamerican Development Bank. In this model, a simultaneous forecast and plans for the future can be made depending on the economic,

environmental and social needs of the region. Three example forecast scenarios where discussed. The first one showed BAU, which would mean a $10bn USD loss for Mexico; the second one with a heavy investment on Mexico's fossil fuels reserve, which would mean a $10bn USD surplus and the third scenario with heavy investment on clean energy, which would mean just above a break even for Mexico, but would mean being in-line with the NDC's signed and the greatest CO_{2e} sequestration scenario.

Figure 2: Decision making theatre tool application Mosaic (ITESM, 2018)

Another important model is the SIE information tool. Its main objective is to be the official data source among institutions in the energy sector. Collecting and providing data from all the responsible bodies within the energy mix in Mexico. To achieve this, the SIE collects energy reports and outlooks, energy statistics, GIS mapping and helps with unit conversion and brings web support. Thus, the SIE aims to provide information to all the relevant stakeholders, including the public sector, investors, researchers, policy makers and the general public (SIE, 2017).

Strengthening the SIE is one of the main objectives established by SENER to improve its reliability and provide more timely and accurate information. It is already run using a GIS platform, but the sharing of best practices will help better the way in which this information is distributed.

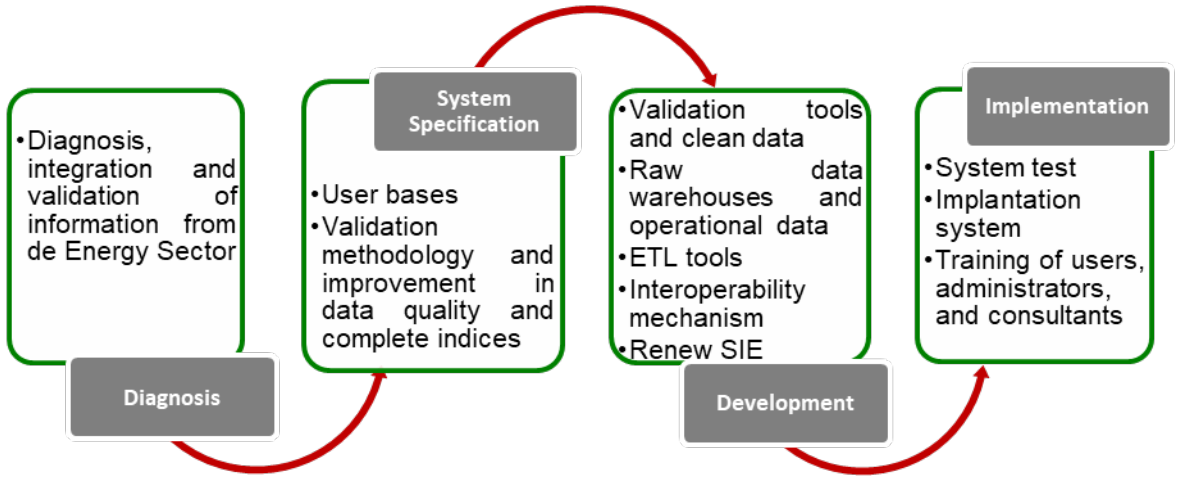

Figure 3: SIE model chart flow.

Clean Energy in Mexico

Mexico signed the COP21 Paris agreement in 2015 where they committed to use clean energy and hence lower their CO_{2e} emissions through the Energy Transition Law as follows:

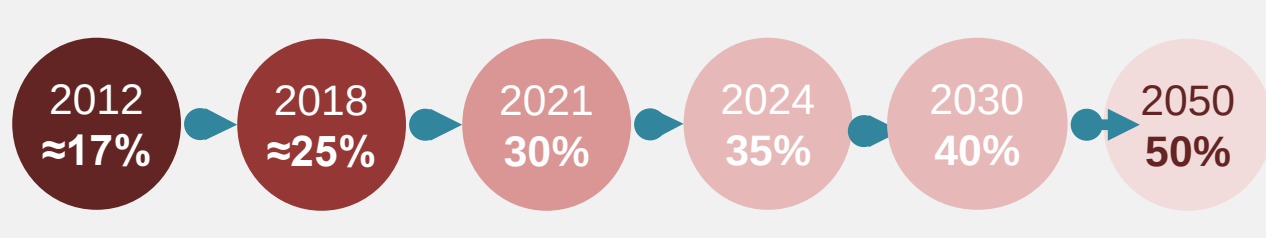

Figure 4: Clean Energy use targets for Mexico according to their submitted NDCs (OMW, 2014).

These targets are very ambitious, Mexico set an example at the COP21. Nevertheless, clean energy in Mexico encompasses more sources of energy than similar economies in Europe or Asia:

Clean generation includes the following generation technologies:
• Any fossil fuel-based plant that has carbon capture and storage technology. • Hydro. • Nuclear. • Geothermal and gas. • Any renewable energy source (wind, solar, bioenergy, among others). • Efficient cogeneration (the term applies to cogeneration plants that comply with the Energy Regulatory Commission definition).

F**igure 5:** Clean energy mix in Mexico (OMW, 2014).

Atlas of High Potential Clean Energy Zones:

The Atlas of High Potential Clean Energy Zones (AZEL) in Mexico offers two online platforms for investors: The region's *Inventory of Renewable Energies (2016) and The Atlas of High Clean Energy Potential Zones (2016).* AZEL is a geo-referenced platform intended to enhance power system planning with emphasis on transmission infrastructure development. It depicts zones with the highest potential for clean power generation, excluding restricted areas such as natural protected areas, archaeological sites, etc. At present, this tool incorporates information on solar, wind, geothermal and biomass technologies available in Mexico. Through GIS mapping, AZEL pinpoints areas with high potential for renewable energy (RES), geothermal and biomass project development (AZEL, 2016).

AZEL works with four scenarios in order to make the forecast of potential clean energy zones. The first scenario marks qualified zones disregarding their distance from the region's transmission grid. The second scenario marks the qualified zones within a 20km range from

the grid. The third scenario marks the qualified zones that are within a 2 Km range for solar and within a 10 km range for wind from the grid. The last scenario marks all the qualified zones that are well outside the 20km range from the grid (AZEL, 2016).

North America Energy Map and GIS

On 15 December 2014, a memorandum of understanding (MoU) was signed between the economies of Canada, the United States, and Mexico with the objective of exchanging information on energy. Each member economy has a specific area of expertise they focus on for more efficient knowledge sharing. Canada focuses on Foreign Trade in Energy, Mexico on Georeferenced Energy Information and the US on Energy Exchange Projections. The most successful result from the MoU is the Energy Map of North America (NAEM), which can simultaneously show information in either English, French, or Spanish. This map shows timely, relevant information available to the public in general (INEGI, 2018a).

NAEM allows the users to search and download information on the different layers of data offered per region: Canada 19, Mexico 15 and US 21. These layers contain information on refineries; processing plants, oil and gas; power plants, solar, wind, biomass, petroleum, nuclear, hydroelectric and pumped storage.

NAEM was developed using the MxSIG software platform. MxSIG is an open source platform with which the INEGI's Digital Map of Mexico was developed. To show validated data, the EIA collects information hourly from both the private and public sectors (primarily state agencies), and analyses the results to map, for example, gas stations in the US including updated oil prices per region.

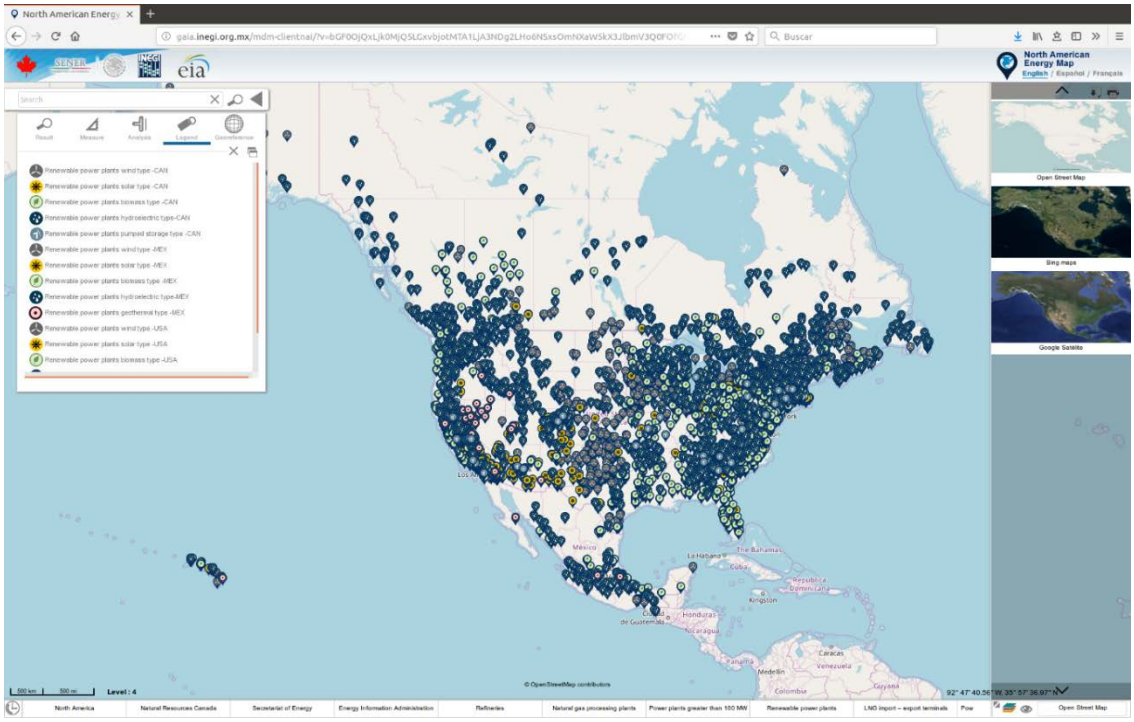

Figure 6*:* An example of a query made in the North American Energy Map (INEGI, 2018b)

As shown in Figure 6, the EIA uses GIS to manage and disseminate energy data. GIS is essential to EIA's core value of helping people understand energy, as it provides a powerful tool for sharing and connecting data across boundaries/borders. The data schema makes GIS an ideal tool to help paint a more complete picture of the energy world. As the world increasingly becomes connected through the "internet of things", GIS will play a central role in being able to capture and leverage energy data as well as increase the richness of that data (Yeksavich, 2018).

Viet Nam's Panorama:

Located in South-East Asia, Viet Nam is a region with a population of almost 92 million people and a 98% household electrification rate according to a 2015 census (Viet Nam Energy Statistics, 2016). Contrary to previous years, since 2015, Viet Nam's energy demand has caused them to import more energy than they export. In general, the information available on fossil fuels consumption and domestic use of energy is almost naught. The same issue occurs with the information available on the energy use in the transportation sector. In the field of renewables, Viet Nam hydroelectric power is one of their most developed energy sources due to its rivers landscape.

The General Statistical Office (GSO) and Institute of Energy Viet Nam (IEVN) are the two main data collection organisations in the region. However, they are somewhat limited in data processing. Data collection is mostly used on socio-economic population. For these reasons,

Viet Nam is very restricted in getting timely accurate data. Thus, the last statistics they have are from 2014, which were published in 2015 by the IEVN.

Japan's Energy Data Collection

One of the key members of the APERC.

In April 2009, Japan passed a new Statistics Act with strengthened penalties for those who use/provide information collected through statistical censuses and surveys for purposes other than compiling statistics and who violate confidentiality clauses (Statistics of Japan, 2018). Japan makes a monthly review of the energy consumption rate in the region through surveys. Examples of surveys made are on petroleum, gas, electricity supply and demand, transportation and general energy statistics, etc. Japan's energy data collection and dissemination process are one of the most thorough and complete of the APEC economies.

Germany

Germany participated in this particular workshop as an external economy. Their statistics data collection process is regionally decentralised and must be in line or approved by the law to be published. They way Germany gathers data seeks to comply with UN principles; neutrality, objectivity and scientific independence. They act in full compliance with the EIA and the European Commission. In Germany, the Federal Statistical Office oversees preparing and developing data collection methods, as well as technical implementation in close collaboration with the Länder offices. They then summarise each Länder result and collect it to form a federal result, which is published and is used as benchmark for foreign forums and reports (Wayand, 2018). In the Bremen Länder, surveys are made to companies and employees, but there is no current household surveying (Wayand, 2018).

According to Jürgen Wayand (2018), Germany does not use GIS for Energy Data Collection processes and data publishing. All their calculations and results are released through an Excel (spreadsheet) platform. An important remark made was that by obtaining their Energy Balance, Germany can also obtain their CO_{2e} Balance with the list of emission factors. In order to calculate the CO_{2e} emissions, Germany uses the following assumption: CO2 emissions are the product of energy consumption (TJ) and specific emission factors (t CO2/TJ). Additionally, they take temperature correction into account for their data processing and results.

Sharing Best Practices: Round Table

The round table session was divided into four main questions that were answered by each expert participant, who was carefully selected to ensure domestic and foreign coverage on all

relevant topics. For instance, Chile's representative is a government's energy expert; Japan's representative is an expert energy researcher; Germany's representative is an expert statistician; in Mexico, INEGI's representative is a GIS and statistics expert; PEMEX's representative is an expert on Mexico's history on energy information collection; and CNH's representative is a hydrocarbons economy expert. This session was believed one of the most relevant during the planning stage as the questions are tailored to help SENER nourish the SIE tool. The questions and answers are summarised below.

Participants:

Member Economies' participants:

Stefano Banfi, Economist–*Ministry of Energy,* Chile

Goichi Komori, Senior Researcher–*APERC,* Japan

Jürgen Wayand, Head of the Bremen State Statistics Office–*Statistisches landesamt-Freie Hansestadt Bremen,* Germany

Mexico's Participants:

Miguel del Avellano, Director of Environment Statistics–*INEGI*, Mexico

Raul Valdivieso, Institutional Information Integration Manager–*PEMEX*, Mexico

Isabel Simon, General Director of the Hydrocarbon Information Centre–*CNH*, Mexico

Moderator:

Rafael Alexandri Rionda, General Director for Energy Planning Information–S*ENER,* Mexico

Q1: Who are the stakeholders that should participate in the development of Energy Information Systems?

All the representatives agreed there are four main participants that should be involved in the development of Energy Information Systems, namely:

1. Public entities; The Ministry of Energy for public policy and energy programs; the Commission of Electricity for sector regulations; the third one is the Fuels and Hydrocarbons Department for the monitoring of services
2. The region's Statistics Institute; gather general information about the population and about the use and cost of energy in households. The Ministry of Finance can intervene here as well
3. Companies specialised on energy development; energy generation and distribution, hydrocarbons, gas, etc.
4. Companies that are the biggest energy consumers in the region; to better understand the path of progress on energy efficiency.

Scientific institutes, statisticians, politicians were also mentioned. The latter are the main users and receivers of data. Respondents should also play a special role in the process, making sure they understand the questions and if possible, get a 100% response rate. As data users, all stakeholders play a key role on information demand. Participants also mentioned academic and research centres, general public and final users. Additionally, the importance of data generators and technical users was discussed, because currently only 10% of the total information gathered is analysed due to a lack of capacity and infrastructure in Mexico. To make the data analysis process a more efficient one, statisticians must avoid data duplication and develop a consulting scheme to approach users. Users in general, at least in Mexico, are not used to look for statistics information. The end user data approach needs to be simplified.

Q2: Based on your experience on the management of statistical data, what are the standard recommendations or guidelines that apply to data processing and knowledge management?

The panel mostly agreed that one of the main problems is to ensure data quality and that the results are readily accessible and easy to understand by every user. To achieve that, researchers must find the origin of the data collected and have thorough objectives and guidelines. Another useful recommendation would be to standardise data publication and unit measurements. At present, the Eurostat and the EIA use different units of measurement for energy. Similarly, an oil well does not have the same meaning in different regions, even of the same region.

To avoid these data discrepancies, it was suggested to use the International Recommendation for Energy Statistics' code of practice and standard guidelines, as well as to create standard worldwide formats to request and capture data. One last recommendation would be to develop a legal framework that allows to request information to the stakeholders involved in the process.

Q3: How to determine the amount of Human Resources that should be dedicated to statistical analysis and administration of Energy Information Systems?

There is not a one size fits all answer approach. The participants agreed it depended mostly on the resources available, the workload and level of experience required for the job, as well as the data input and the amount of data to analyse. Moreover, the possible candidates should undergo training on energy data analysis and the best practices expected from their daily work.

Q4: In terms of resources, institutions, people, processes, that exist in your institutions or organisations, what are the goals or priorities needed to be worked altogether in the next couple of years?

Everyone agreed that better technology is needed for the documenting and validation processes. Big data gives a myriad of information, but if it is not treated wisely, it turns into "mess data". The APEC economies should find a way to replace manual labour with technology in data analysis. Additionally, the use of clean energy should be legally binding and widely treated in Congress.

Some representatives gave specific examples for collaboration. For instance, Chile pointed out they would like to incentivise the already developed solar energy system in Chile.

The representative for Germany, external invitee economy, differed from other participants in their opinion, asserting that energy production should be given priority rather than focusing efforts on making the results appealing to the public. He also mentioned that data validation is not necessary if the sources are trust worthy. Data in Germany is not currently validated. Machine learning could replace validation, with artificial intelligence there would be less need for human personnel.

E. Workshop Analysis:

Including the project overseer and organisers, 89 individuals participated in the APEC workshop on Energy Statistical and Geographic Information Systems. Out of these attendees, 60 participated both days of the event. Representatives from different economies participated both as spectators and speakers. The participants were from: Viet Nam; Japan; the United States; Chile; and Mexico; and Germany as a guest economy.

According to the results shown in the evaluation form, the quality of information shared by the participating economies, the APEC workshop on Energy Statistical and GIS met its objectives. Nonetheless, the expected attendance vs the actual attendance differed greatly in terms of diversity. 22 APEC economy experts representing each economy were expected. However, only five APEC member representatives were present plus an external representative economy, Germany.

The percentage of female participants was met, between 40-50%. Nonetheless, all the female participants were from Mexico. The same occurred with the number of female speakers at the

workshop, whom were all representing energy sectors and subsectors in Mexico. Other APEC economies had only male representatives. In terms of gender issues, there were no discussions regarding gender considerations in any of the energy sectors such as data collection or decision-making processes, nor of possible future policies to ensure greater gender equity and women's empowerment**.**

The workshop was divided into three categories; sessions related to data collection, to data processing and to knowledge management and information sharing. Each participating economy presented in the area they felt they had more expertise in, which helped the rest of the participants gather ideas and learn from each economy's best practices. The chart below explains the subject flow of the sessions:

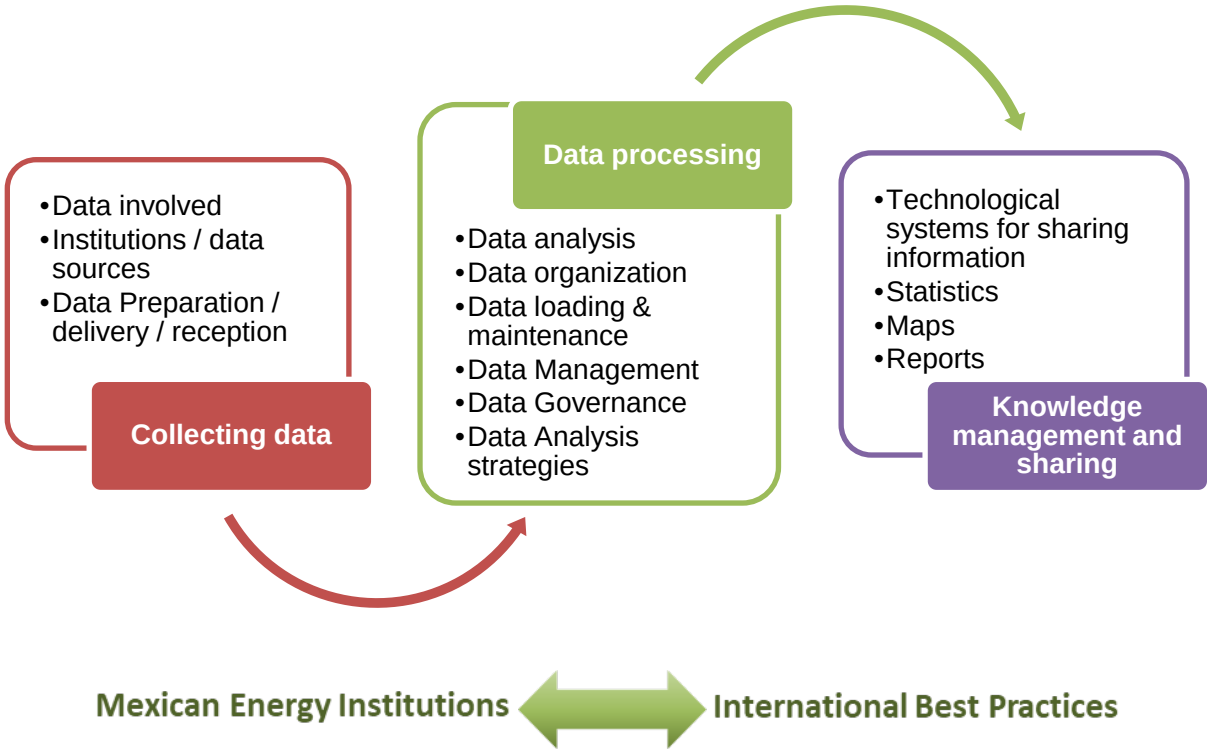

Figure 7: APEC Workshop sessions flow chart

Following the diagram, all participating member economies shared experiences on their current energy information systems highlighting their key benefits and achievements and the challenges and opportunities they currently faced. This sharing was achieved by a series of presentations and during the round table discussion.

Overall Observed Outcomes

1) Participants gained an understanding of the approaches and methodologies for data and metadata collection, according to the acceptable format and standards;

    1.1 All the participating economies shared their current methodologies for data collection as well as their caveats for validating the data and way forward,

2) Participants shared experiences on GIS implementation in their economies;

    2.1 All participating member economies shared their current experiences and/or reasons for using GIS for energy mapping purposes,

3) Increased knowledge of participants on supporting energy access through the use of energy statistical and geographic information systems;

    3.1 Participants shared their experiences and best practice approaches on using information to support energy statistics and GIS, as well as the services they currently use integrated energy statistics and GIS on, including a North American Energy Map and the EIA webpage. Both show timely information updated by the hour. One of the SIE's goals is to have a similar tool.

4) Participants shared experiences on developing master data plans;

    4.1 The United States and Germany, as a guest economy, were the major contributors by sharing their data collection processes and knowledge sharing applications,

5) Increased knowledge of participants on energy data gathering through the use of legal frame work;

    5.1 Japan and Germany were the major contributors in sharing their approaches and methods to ensure surveys are answered timely and with trusted information,

6) Participants shared experiences on Data Governance in their respective economies;

    6.1 Information of data ownership and data sharing was given by each participating member economy, as well as the usefulness for policy making and incentivising investment on clean-tech,

7) Participants worked together to improve the quality of energy statistics in APEC economies;

    7.1 Future possible collaborative work was discussed during the round table session mostly to help the APEC economies better their energy information systems and enhance their GIS use in the energy decision-making processes,

8) Consumers and producers of energy data in Mexico were brought together, as well as subsector specific experts (hydrocarbons, electricity and RES) to engage in a discussion on how best to coordinate to ensure the completeness, timeliness and quality of the data;

9) Improved understanding of the Mexican energy statistics data collection process and clarification of gaps or inconsistencies with reference to international standards in the data received from the Ministry of Energy (SENER);

9.1 Extensive sessions were given by the main government data collection players, namely: SENER, INEGI, CNH and PEMEX**,**

10) Enhanced co-operation and expert level contact to make it easier for day to day contact through email and telephone on an as needed basis when questions arise;

10.1 Contacts detail information was shared between participants and strategic networking sessions took place during the coffee breaks.

Delivered Outcomes

Forty-seven attendees out of 89 completed the APEC project evaluation surveys created by SENER, meaning a 53% response rate. They were asked to rate general aspects of the workshop using the agreement levels of 'Strongly Agree', 'Agree' and 'Disagree'.

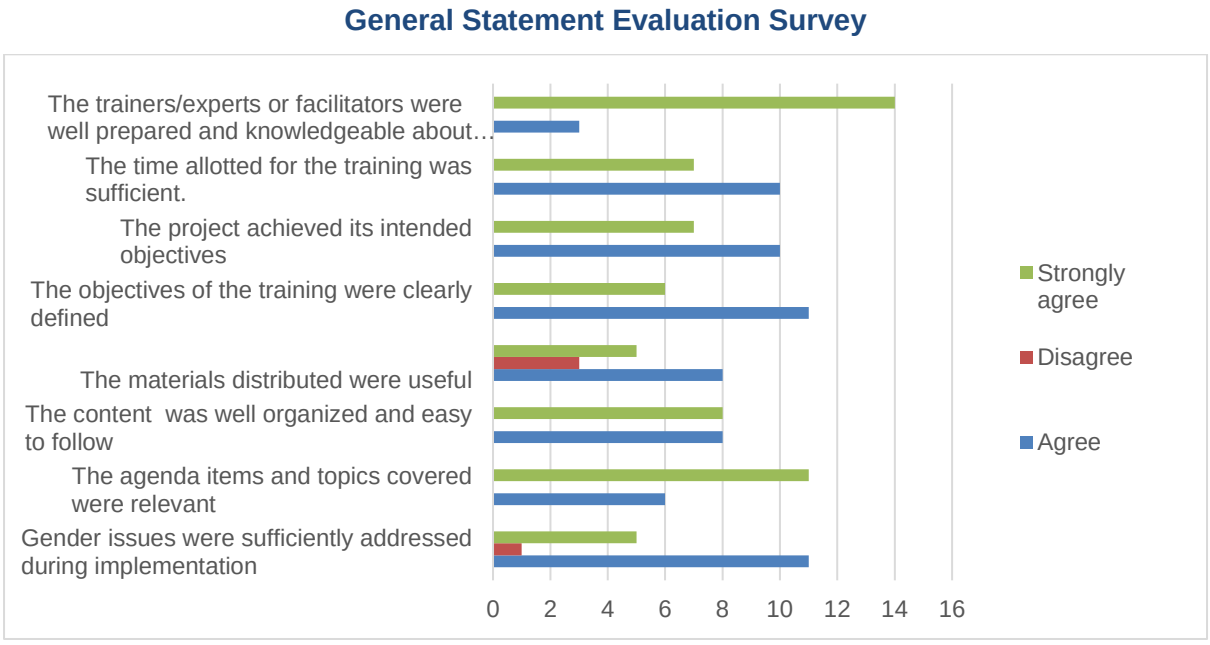

Figure 8: Statement Survey for general opinion on APEC Energy Workshop

According to the evaluation survey shown in Figure 8, the workshop objectives were clearly defined and had been achieved through relevant coverage of symposium agenda and topics.

The graph also shows that the expert facilitators were well prepared. The major discrepancies can be observed in the usefulness of materials distributed and the lack of gender issues addressed during the workshop. To further on the analysis, individual charts were made per open qualitative question. The overall analysis was done by looking for key words and repetition of such words. An example of the generated charts is shown below. However, for the more interactive version please refer to the link on Appendix 2.

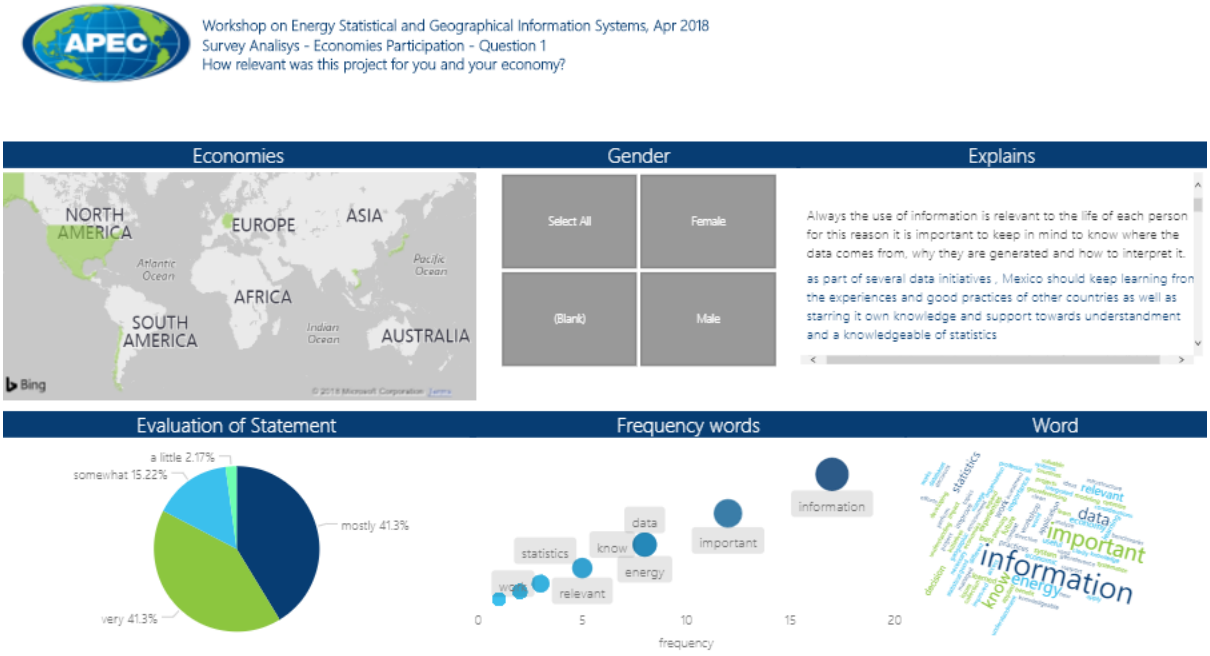

Figure 9: Q1 example of qualitative data graphs created for the APEC energy workshop in Mexico.

Figure 9 shows examples of the graphs obtained for each qualitative question. Namely, “How could this project have been improved? Please provide comments on how to improve the project, if relevant”; “In your view (sic) what were the project’s results/achievements?”; “What new skills and knowledge did you gain from this event?”; “How will you apply the project’s content and knowledge gained at your workplace?”; and “What needs to be done next by APEC? Are there plans to link the project’s outcomes to subsequent collective actions by fora (sic.) or individual actions by economies?”.

The general sentiment was that the workshop had useful information on energy analysis, but it could have had more relevant participation from all the member economies. The participants also rated this workshop as useful in sharing relevant experiences regarding the high-quality work that is done for improving the statistical and geographic information systems by the participating member economies. In terms of the usefulness of the project to apply what was shared during the workshop, most of the participants agreed they will be able to explore new

solutions to the statistics-based problems in their institutions, including the development of a plan to build their database for statistics modelling.

Some steps forwards for the APEC's EWG were discussed. The majority agreed on the continued collaboration and follow-up activities on these projects with the support from the APEC on other energy related issues. A number of participants agreed that international bodies should seek the standardisation of tools and measurements to make processes more efficient. Other participants went as far as to suggest the development of new international policies and laws to solve the issues mentioned during the workshop, including data standardisation and aid in data collection processes.

F. Caveats:

Overall, satisfactory results were obtained from the workshop. Participants agree this two-day encounter serves as roadmap for future collaboration between economies. Nonetheless, a higher rate of participation from the APEC economies would have benefitted the sharing of best practices and would have allowed more discussion panels for future projects.

There was a distinct lack of attendance amongst the head of departments from APEC economies, except from Mexico. Although perhaps not essential, their presence would have been useful to discuss alliances at the time, but contacts were made for future synergies and collaboration projects between APEC economies. In addition, some member economies present during the workshop did not present their panorama and their participation was done through the round table session solely.

This workshop was not specifically directed towards addressing gender issues in the energy sector. Some presenters touched on subjects such as vulnerable communities inhabiting potential areas of interest for RES investment. However, there was no mention of the lack of gender representation in all job levels in the energy sector nor in determining future policy and other decision-making processes regarding region investment and development. SENER's approach is pro-gender equity and they made sure that at least half the Mexican expert speakers were women. Nonetheless, no specific gender issues were included in the agenda. This is somewhat surprising given that all of the APEC members have agreed to Agenda 2030 and its demand for gender equality. Moreover, the incorporation of gender perspectives, especially in a workshop where data collection practices are discussed, would have helped in identifying best practices henceforward.

It is hoped that this workshop will result useful for women by providing information about how the energy sector works and on best practices on energy statistics. With this information, women on senior management positions are expected to be able to make better decisions in less time and to identify new areas of employment opportunity. These two last remarks would be subject to further studies that have not been contemplated on the writing of this report due to a constraint in resources such as time.

G. Conclusions and Next Steps:

The workshop brought together consumers and producers of energy data in Mexico, as well as subsector specific experts (coal, hydrocarbons, electricity and renewable energies) to engage in a discussion on how best to coordinate to ensure the completeness, timeliness and quality of the data.

Overall, participants gained an understanding of the approaches and methodologies for data and metadata collection, according to the acceptable format and standards. The workshops served as a platform for attendees both from the APEC and non-APEC economies, such as Germany, to share experiences on energy statistics and GIS implementation in their economies. It also increased knowledge of participants on supporting energy access through the use of energy statistical and geographic information systems, as well as increased knowledge of participants on energy data gathering through the use of legal frame work. Moreover, participants shared experiences on data governance in their respective economies. Hence the better understanding on the Mexican energy statistics data collection process and clarification of gaps or inconsistencies vis-à-vis international standards in the data received from SENER.

It is recommended for future collaborations to push the participation of more member economies of the APEC to extend the benefits of these encounters as far out as possible. If gender issues are to remain a specific target for the APEC, it is advisable to include gender specific topics on the future project outline and agenda to ensure the participating economies are prepared to present and respond accordingly.

By and large, the participating economies should develop a plan to work together in the next year or two to improve the quality of energy statistics in APEC economies. The EWG 16 2016A Workshop on Energy Statistical and Geographic Information Systems was a roadmap to

enhance co-operation and expert level contact to make it easier for day to day contact through email and telephone on an as needed basis when questions arise.

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Appendix:

Appendix 1: EWG 16 2016A Agenda

Asia-Pacific Economic Cooperation

2018- EWG 16 2016A-001

WORKSHOP AGENDA

EWG 16 2016A – Workshop on Energy Statistical and Geographical Information Systems

SENER
SECRETARÍA DE ENERGÍA

9-10 April 2018
Mexico City, Mexico

Introduction
The APEC Economies are working to develop policies that contribute to facilitate the cooperation of the member economies through information and data exchanges.

Mexico's energy reform has generated changes on the industrial activities and government institutions. Therefore, it is important for Mexico and Asia-Pacific region to have a system that establishes a data governance model and the institutional arrangement to ensure the value chain of the statistical and geographic information required by domestic and international institutions, in order to promote energy efficiency and better policies.

The workshop, on the margins of a EWG meeting, will convene APEC's and other economies to share experiences on energy statistics and geographic information systems. Experts that provide technical and analytical support for their energy statistics will be invited to share knowledge and experiences to implement a strong energy statistical and geographic information systems.

Objective
A particular objective of the workshop will be to address best practices to define roadmaps for statistical and geographic energy information systems.

Workshop Objectives
This workshop has two primary objectives:

a) Create synergies between participants at the Workshop on energy statistical and geographic information systems. As a result, the information that the economies submit to the Energy Working Group (EWG), will be more robust, reliable and timely.

b) Support the Ministry of Energy of Mexico to strengthen its Energy Information System (SIE), so that it is even more reliable and timely.

Venue
The Workshop will be held at the SENER Training Quality Center Auditorium (known as CECAL, for the Spanish initials). Address: Río Becerra 139, Col. San Pedro de los Pinos, 03810. Benito Juarez, Mexico City.

Workshop organizer
Ministry of Energy (SENER), Mexico.
Undersecretary for Planning and Energy Transition.
General Directorate for Energy Planning and Information.
Funded by APEC Funding and SENER Self-funding

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MONDAY, 9 April

08:00-09:00	Registration of Participants
09:00-9:30	**Workshop Opening Session** Rafael Alexandri Rionda, General Director for Energy Planning and Information. *Ministry of Energy, Mexico.*
9:30-10:00	**Atlas of Zones with High Potential of Clean Energies (AZEL)** Jessica Susana Rodriguez Aguilar, Director of Renewable Energy. *Ministry of Energy, Mexico.*
10:00-11:00	**Collaborative Decision Making Center for the Mexican Energy Sector** José Martín Molina Espinosa, Director of the Network of Decision Making Centers. *Technological Institute of Superior Studies of Monterrey (ITESM.)*
11:00-11:30	Break
11:30-12:30	**Session 1a Strategy for the improvement of the Mexican Energy Information System** Berenice Hernández Miranda, Deputy Director of Sectorial Information. *Ministry of Energy / General Directorate for Energy Planning and Information.* **Session 1b Topographic information, base of the knowledge of our territory** Abraham Antonio Guerrero Ruiz, Head of Department of Vector Extraction. *Institute of Statistic and Geography (INEGI).*
12:30-13:30	**Session 2 Technological solutions for the hydrocarbons sector** Juan Julián Ramirez Solis, Director of Oil Operations. Mayelli Hernandez Juarez, Director of Bid Areas Identification. *Ministry of Energy / General Directorate of Hydrocarbon Exploration and Production.*
13.30-15:00	Lunch
15:00-16:00	**Session 3 Technical and Statistical Information of Exploration and Production in Mexico** Maria Adamelia Burgueño Mercado, General Director of Statistics and Economic Evaluation. Ma Isabel Simon Velázquez, General Director of Hydrocarbon Information Center. *Hydrocarbons Commission (CNH).*
16:00-17:00	**Session 4 Interoperability, Big Data and Analytics for the Electricity Subsector** Alfredo Espinosa Reza, Manager of Integral Process Management. *Institute of Electricity and Clean Energies (INEEL).*
17:00-18:00	**Session 5a– The use of Digital Elevation Models derived from very high resolution satellite images in the planning of oil exploitation and renewable energy sources** Juan Javier Duron Diaz, Deputy Director of Continental and Submarine Relief. *Institute of Statistic and Geography (INEGI).* **Session 5b North American Energy Map** Jose Luis Mondragon Garibay, Director of Geomatics Solutions. *Institute of Statistic and Geography (INEGI).*

TUESDAY, 10 April

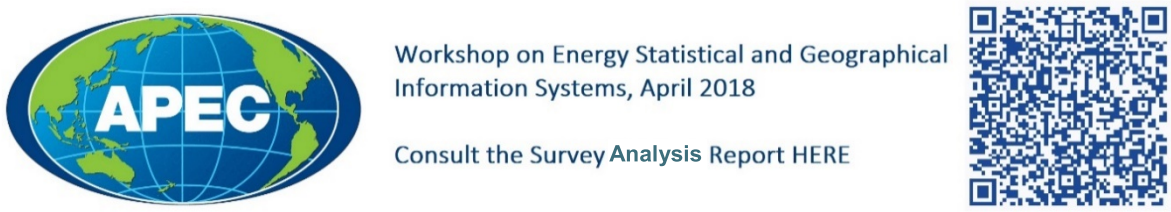
8:00-9:00	Registration of Participants.
9:00-10:00	**Session 6 Energy statistics in Viet Nam** Nguyen Hoang Anh, Researcher. *Institute of Energy, Viet Nam.*
10:00-11:00	**Session 7 Energy Data Collection and Dissemination in Japan** Goichi Komori, Senior Researcher. *Asia Pacific Energy Research Centre (APERC), Japan.*
11:00-11:30	Break
11:30-12:30	**Session 8 Mapping Megawatts: GIS Use at EIA** Yeksavich Jeramiah, Mathematical Statistician. *U.S. Energy Information Administration- EIA, USA.*
12:30-13:30	**Session 9 Energy Statistics, Energy Balances and Energy Indicators in Germany - The Flow of Data from Generation to Publication at the Example of a Federal State** Jürgen Wayand, Head of the Bremen State Statistics Office. *Statistisches Landesamt- Freie Hansestadt Bremen, Germany.*
13:30-15:00	Lunch
15:00-16:00	**Session 10 Present and future of the PEMEX Institutional Database** Fernando de Jesus Rodriguez Rivera, Institutional Information Integration Manager. *Petroleos Mexicanos, Mexico.*
16:00-18:00	**Round Table The future of the Mexican Energy Information System-Next Steps** Moderator: Rafael Alexandri Rionda- General Director for Energy Planning and Information-México

Panel Discussion:

- Miguel del Avellano Jaramillo – *Institute of Statistic and Geography (INEGI)*-México.
- Fernando de Jesus Rodríguez Rivera- *Petroleos Mexicanos (PEMEX)*-Mexico.
- Ma Isabel Simon Velazquez*, Hydrocarbons Commission (CNH)*-México.
- Goichi Komori – *Asia Pacific Energy Research Centre (APERC)*-Japan.
- Stefano Banfi Letelier – *Ministry of Energy*-Chile.
- Jürgen Wayand - *Statistisches landesamt- Freie Hansestadt Bremen*-Germany.

18:00-18:15	**Workshop Closing Session** Leonardo Beltran Rodríguez, Deputy Secretary of Planning and Energy Transition. *Ministry of Energy, Mexico.* Rafael Alexandri Rionda- *General Director for Energy Planning and Information* Ministry of Energy, Mexico.

Appendix 2: Post-Workshop Survey Analysis Report



***Note:** Hyperlink also embedded on the image.