ENERGY DATA TRANSPARENCY AND MARKETS DIGITALISATION

Final Report

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A report from the International Energy Agency (IEA) to the G20 Energy Transitions Working Group (ETWG)

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Executive Summary[1]

All countries face unique challenges and decisions as they embark on their clean energy transitions. In developing new policies, countries will need to decide which sources of energy they wish to utilise and how energy can be consumed in the most efficient way. Making these decisions can be challenging, but having comprehensive, comparable and timely energy data will significantly help countries access policy options.

The transition to clean energy will require good polices as well as business and consumer involvement, and data insufficiency could lead to unfavourable policy choices. It is vital that high-quality energy data be available to all stakeholders: comprehensive and easily accessible energy data not only bolsters transparency and tracking, it enables businesses to invest wisely, make the correct decisions and innovate. Market transparency, which is not only about effective market operations, enables markets and consumers to make decisions in an informed manner.

An increasingly important aspect of transparency involves the way in which data and information being made available through digitalisation may be used, because such data have the potential to transform our understanding of energy markets. Governments embarking on clean energy transitions must also focus on data: enhancing the data they have; making that data open and transparent; and delivering the benefits of digital access to data while protecting confidentiality.

Timely, reliable and comprehensive energy data have always been necessary for effective decision making, whether by governments, businesses or consumers. As countries of the Group of Twenty (G20) and beyond face the challenges of achieving cleaner, more flexible and transparent energy systems, the need for open, transparent and consistent data is greater than ever to help governments and other stakeholders track progress towards energy transition goals, to enable evidence-based energy policy decisions, and to provide accountability and transparency on a nation's energy supply and its use and transition.

Many countries look to G20 members for leadership, and this is especially important in the area of energy data. Ensuring the comprehensiveness of energy data will not only lead to better decisions but will show all countries what is needed to promote progress in clean energy transitions globally. G20 members can support for this by openly sharing not only their data but their methodologies and by working with the IEA and other agencies to build tools that all countries can use. They can also help by supporting the capacity-building efforts of all international organisations.

Resources are essential to establish and maintain a national energy statistics system. Effective resource allocation will depend on how energy data are prioritised in relation to other statistical areas; how synergies can be exploited between energy and other policy areas; what priority is given to the monitoring component within the policy formulation process; and how resources are allocated across areas within the energy domain.

[1] This document has been produced by the International Energy Agency (IEA), at the request - and under the close guidance - of Argentina´s G20 Presidency 2018. Its contents have been discussed and enriched by the representatives of the G20 membership, but do not necessarily reflect their national or collective views.

Given the importance of energy transitions and the increasing complexity of energy systems, successful policies can only be forged based on high-quality data. The opportunities provided by digital data, such as those described in this paper, can only be realised if data are publicly available. What must be considered, however, is how to securely store anonymised data (data from smart meters, detailed grid operation data, etc.) in one place, accessible for research purposes. Policy guidelines and industry codes should make this data access possible by providing guidance on creating mechanisms and controls that will facilitate all parties to share the evolving digital data. Privacy must be guaranteed, however, to ensure that open data and the use of consumer data are publicly accepted.

1. Overview

All countries face unique challenges and decisions as they embark on their clean energy transitions. In developing new policies, countries will need to decide which sources of energy they wish to utilise and how energy can be consumed in the most efficient way. Making these decisions can be challenging, but having comprehensive, comparable and timely energy data will significantly help countries access policy options.

The transition to clean energy will require good polices as well as business and consumer involvement, and data insufficiency could lead to unfavourable policy choices. It is vital that high-quality energy data be available to all stakeholders: comprehensive and easily accessible energy data not only bolsters transparency and tracking, it enables businesses to invest wisely, make the correct decisions and innovate. Market transparency, which is not only about effective market operations, enables markets and consumers to make decisions in an informed manner. An increasingly important aspect of transparency involves the way in which data and information being made available through digitalisation may be used, because such data have the potential to transform our understanding of energy markets. Governments embarking on clean energy transitions must also focus on data: enhancing the data they have; making that data open and transparent; and delivering the benefits of digital access to data while protecting confidentiality.

Timely, reliable and comprehensive energy data have always been necessary for effective decision making, whether by governments, businesses or consumers. As countries of the Group of Twenty (G20) and beyond face the challenges of achieving cleaner, more flexible and transparent energy systems, the need for open, transparent and consistent data is greater than ever to help governments and other stakeholders track progress towards energy transition goals, to enable evidence-based energy policy decisions, and to provide accountability and transparency on a nation's energy supply and its use and transition.

The importance of robust national energy data systems is reflected in the major international initiatives and resources deployed to promote more consistent, high-quality and comparable energy data and statistics across countries. Key examples are the United Nations' (UN) International Recommendations for Energy Statistics (IRES), the Joint Organisations Data Initiative (JODI), the International Energy Agency's (IEA) *Energy Statistics* and *Energy Efficiency Indicators* Manuals, and UN work to develop indicators for its Sustainable Development Goals (SDGs).

To be of use to decision makers, energy data must be comprehensive – i.e. covering all aspects of energy supply and demand. It also has to be timely and of high quality so that results drawn from analysis may be accepted with confidence. Credible modelling, progress tracking and reporting all rely on accurate data that reflect the most recent state of an energy system.

National energy statistics are generally derived through a number of data collection and compilation practices, mainly surveys (of energy providers, households, businesses, etc.) and the use of administrative data (e.g. data collected for non-statistical purposes but with statistical value, such as a policy supporting solar photovoltaic [PV] installation), with the associated challenges of definitions and data sharing. While the comprehensiveness and level of detail of national energy data vary by country, historically the general principle is that as energy system complexity increases, so do institutional capacity and national data system costs. Likewise, given the time lag inherent in the process of collecting, processing, validating and disseminating data, higher collection and reporting frequency also adds complexity and cost to a national energy data system.

The effective functioning of national energy statistics systems depends on a sound data governance model for statistics overall (i.e. a legal framework with statistical acts, mandatory reporting requirements, data-sharing across ministries, etc.). Standardised statistical methodologies, transparent dissemination of data and protection of confidentiality, together with the professional independence of statistical agencies and the scientific competence and impartiality of their staff, are all needed for businesses and the wider public to consider official statistics trustworthy. The type of institutional arrangements and energy statistics system in place will also affect the flexibility to react to (and provide data for) changing policy priorities, and to adopt innovative technologies as they become available.

Energy data transparency is a strong driver in global energy and commodity markets. While progress is being made by companies in providing market-relevant data, the quality and scope have to adapt to the evolving needs of consumers and policy makers over time. Energy market transparency is one of the G20 Principles on Energy Collaboration. Work was carried out in 2015 by the IEA, the International Energy Forum (IEF) and the Organization of the Petroleum Exporting Countries (OPEC) on oil price formation and price-reporting agencies. Under JODI, the eight international JODI partner organisations (the Asia-Pacific Economic Cooperation (APEC), Eurostat, the Gas Exporting Countries Forum (GECF), the IEA, the IEF, the Latin-American Energy Organization (OLADE), OPEC and the UN Statistics Division (UNSD) have undertaken numerous actions to increase oil and gas data transparency, and are committed to further enhance the transparency of global energy data.

2. Challenges

2.1. Energy data coverage

G20 countries generally lead the way in having the most robust and comprehensive energy data. However, each country's data can vary considerably in 1) geographical coverage (national, regional and local); 2) temporal coverage (monthly, annual and multi-annual); 3) sectoral coverage (energy supply, transformation and demand by end-use sector); 4) reporting level (e.g. by fuel type, fuel sub-type, end use and technology); 5) political focus; and 6) coverage of various other energy system indicators. A comprehensive national energy data system will often include:

- Energy balances, which typically cover the production, import and export of primary energy sources; their transformation into fuels for final consumption; and final consumption by various high-level demand sectors, including the residential, commercial, industrial, agricultural and transport sectors.
- Energy efficiency data and indicators that express the relationship between end-use consumption and the various physical and economic activities in a country that drive consumption within each major demand sector.
- Energy-related environmental emissions, which can include carbon dioxide (CO_2), other combustion-related emissions, and non-CO_2 greenhouse gas (GHG) emissions.

- Fuel prices and taxes.
- Public energy technology research, development and demonstration (RD&D) investments.
- Development indicators such as national and local access to clean energy, or the use of traditional biomass for home heating and cooking.

2.2. Energy data governance

Before exploring technical and measurement challenges, it is important to address the need for good data governance, without which reliable energy data (or any other data) cannot be produced. The principles of good data governance are clearly set out in the UN Fundamental Principles of Official Statistics[2] as well as in the statistical codes of many countries, for example the Italian Statistical Code, France's 1951 law on requirements, co-ordination and confidentiality of statistics, and the UK Code of Practice. Some basic assumptions underly these documents: that statistics make a valuable contribution to debate and policy making, and as such should be produced according to high professional standards determined by statisticians; and that the methodologies and results should be made available to all, ideally following a pre-announced timetable. These guidance documents also recognise the need for statisticians to have access to both survey and administrative data, and refer to the importance of the legal framework for data collection and the essential task of ensuring data confidentiality and using it solely for statistical purposes (UN, 2011).

The benefits of accessing a wide range of data are illustrated below in an example from the UK National Energy Efficiency Data-Framework (NEED). In many countries, however, the lack of good data governance is a major barrier to producing high-quality data. Typical obstacles include: a lack of legal basis for data collection, or no enforcement of the legal basis (so companies do not provide data); an unwillingness to share data across ministries (so the power of the information held by a government is not utilised); and the sporadic release of data, which inspires little confidence among users (including investors) as to its accuracy. These types of issues affect both the national and the regional/local level, where the need for detailed data to advance policies is becoming greater.

2.3. Adapting to changing data needs

Technical innovation in energy is continuous and beneficial, but innovations create challenges for energy statistics to comprehensively measure the energy system. Innovations such as battery electricity storage, the increased use of hydrogen, etc., create quandaries on how they should be recorded in energy balances, if at all. Along with introducing technological innovations, most G20 countries are working to strengthen policies to raise energy efficiency. These policies generally focus on the final consumers of energy, and monitoring their impact is vital to understand whether a policy is working, needs to be adapted, or has unforeseen consequences (good or bad). End-use data are relatively weak, however, and good policy evaluation relies on detailed data. Demand-side data collection often incurs much higher costs, as large samples are required. Developments such as expanded digital data use and data matching could significantly enhance energy end-use knowledge.

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[2] https://unstats.un.org/unsd/dnss/gp/fundprinciples.aspx.

2.3.1. End-use data and energy efficiency

The Energy End-Use Data and Energy Efficiency Metrics (EEUDEEM) initiative, co-ordinated by the government of France and the IEA, was approved as part of the G20 Energy Efficiency Leading Programme during the People's Republic of China's G20 presidency in 2016. It addresses the growing interest of many countries in monitoring energy demand to assess the impact of energy efficiency policies, and to track progress towards targets or objectives (ADEME and IEA, 2017).

The initiative provides a forum for G20 countries to share knowledge, methodologies and experiences in collecting and using energy-demand and energy-efficiency data for policy making. An initial meeting held in Paris in December 2016[3] gathered ten G20 countries and five international organisations, and agreed on the areas of focus that were then adopted into the terms of reference. The goal was to ensure that countries benefit from developments in any other G20 country in the following areas: 1) technical (sharing information on topics such as data collection, mobilisation of partners and links between modelling and data gathering); 2) communication (strengthening the ability to explain data and indicators to policy makers, businesses and the public to maximise their impact); and 3) wider outreach (discussing how to ensure that efficiency go hand in hand with greater access to energy in emerging and developing economies).

The EEUDEEM initiative focuses on enhancing and complementing existing activities to maximise information sharing from such work. Country participation is voluntary, although the initiative would be most beneficial with the largest possible number of participants; participation of non-G20 countries is also welcomed. Possible deliverables include the production of methodological guidelines; the sharing of practices; training and capacity building; analysis of data consistency and quality; work on metrics for policy; dissemination of data; and benchmarking work.
The first workshop of the initiative took place in Argentina in February 2018, linked to the G20 Energy Transitions Working Group (ETWG) during which countries confirmed their strong interest in a knowledge-exchange platform on end-use energy data and energy efficiency metrics, with the overall objective of enhancing data for energy efficiency policy making. Interest from energy market stakeholders around the world proved that this multilateral data initiative has great potential to strengthen data knowledge across leading countries, despite their varied energy demand patterns and trends.

2.3.2. Off-grid electricity

One specific challenge for energy statistics systems is the growth in off-grid electricity generation. In many countries the falling costs of renewable technologies are bringing affordable off-grid power to more communities, enhancing the well-being of millions of people. However, this is still energy that needs to be measured and it is an area in which the International Renewable Energy Agency (IRENA) is taking the lead in developing methods, working alongside the IEA and other organisations. While the amount of electricity delivered from off-grid renewables is currently relatively small at the global level, these developments are expanding rapidly and can be significant in countries with limited electricity grids; as such, they should be counted in both the electricity generation and energy access statistics of these countries.

[3] Agenda and presentations available at: www.iea.org/workshops/g20-energy-end-use-data-and-energy-efficiency-metrics-initiative.html.

In developing ways to measure and estimate off-grid electricity generation, IRENA is examining data sources that would not normally be included in a country's energy data collection system. One source is solar panel import statistics in countries that have little or no recorded solar energy production: for example, many African countries report almost no solar PV capacity, but their recent trade statistics show solar panel imports amounting to several million US dollars each year. When these imports are converted to estimates of capacity, they suggest that about 320 megawatts (MW) of off-grid solar PV generation may currently be missing from national energy statistics in African countries.

More recently, IRENA has also collected detailed data from the Global Off-Grid Lighting Association (GOGLA), the Organisation for Economic Co-operation and Development's Development Assistance Committee (OECD-DAC) project database, members of various renewable energy networks (the Renewable Energy Policy Network for the 21st Century [REN21], the Alliance for Rural Electrification and Power for All) and commercial project developers. This information has confirmed the existence of about half of the off-grid solar PV capacity estimated from trade data, and has revealed many off-grid hydro, wind and bioenergy plants not recorded in national statistics. This rich dataset also highlights the many ways that renewables are contributing to other development goals through the off-grid electrification of schools, clinics, water pumping, communication towers and public lighting.

The main lesson learned from these efforts is that the distinction between electricity producers and consumers is becoming increasingly blurred and energy data collection needs to expand and become more flexible to cover the non-traditional promotion of renewables. This includes the private developers now entering the market (including retailers of solar devices) as well as agencies working in sectors such as health, education, rural development and agriculture that are investing in renewable energy infrastructure.

2.3.3. Tracking the energy transition in real time

One example of a G20 country that has begun to consistently monitor and track the energy transition in real time in its electricity sector is Germany. The *Strommarktdaten* (SMARD) electricity market platform shows the contributions of renewable energy and fossil fuels to consumption in the electricity market in an open, accessible and transparent way. The online platform[4] helps visitors visualise the interaction and overall impacts of policy and technology on an energy system (and energy market) in real time. This helps policy makers, the public and businesses understand what is working, and in what areas further policy action is warranted. However, as examples in the next section demonstrate, countries (supported by international organisations) are adopting a wide range of technical solutions to meet the increasing need for sound energy data.

[4] www.bmwi-energiewende.de/EWD/Redaktion/EN/Newsletter/2017/12/Meldung/topthema.html;jsessionid=7689042F0BD3AC25C4258E4379DBC6F9.

3. Opportunities

3.1. Energy data transparency

National energy data systems serve multiple energy policy activities involving both public and private stakeholders. For example, policy makers need to have a detailed understanding of the current state of national energy supplies, energy demand by sector, usage trends, prices and energy efficiencies to craft policies that deliver energy security, energy access and efficient, affordable energy services. These data subsequently enable the tracking of progress towards these goals and the effectiveness of policies over time.

Energy modellers rely on accurate data for countries, sectors, fuels and technologies to analyse technology and policy options to meet national energy goals over different time scales. Investors and development banks require credible and reliable national energy data to invest and identify the technology RD&D opportunities that offer the greatest chances for market success, while the public need solid data to make informed choices and to judge the impact of government policies.

The absence of data is a significant obstacle to sound and efficient decision making by policy makers, energy modellers and investors. Many G20 countries have therefore embraced open data and are working to improve access to energy data to make it available to everyone.

3.1.1. Open data

"Open data" can have many definitions and uses, but the core principle is that data should be made available in a way that is reusable. This concept can refer to very detailed but anonymised record-level data that can be used by academics and others for research (which can assist policy making) or by businesses such as application designers to make tools to help the public (one example is an app that shows the lowest price for motor fuels). Opening up data in this way can create many opportunities for businesses to operate energy service models through which they interact with energy companies to provide the energy service the energy user wants. As this distances users from the energy they consume, however, it potentially creates yet more challenges for collecting energy data. The open data concept can also apply to aggregated, more traditional statistics for which the driving principle is to make data easy to use so that they are accessed more often; tools such as the application programming interfaces (APIs) being developed by the US Energy Information Administration (EIA) are one example. Market regulators are equally expected to enhance the availability of their data: when they publish reports and data they are adding real value to market understanding.

Robust national energy data systems are also becoming more important for tracking the progress of developing countries in meeting the goals of major international initiatives and agreements aimed at sustainable development and international climate action (for example, the UN's SDGs, particularly SDG 7, which relies on data from national energy data systems related to energy access, renewable energy shares, energy efficiency, and energy system and technology investments) as highlighted in the IEA new presentation of this work linking data to forecasts (IEA, 2017a)[5].

[5] https://www.iea.org/sdg/

3.1.2. JODI case study

One clear example of how data transparency can assist energy market operations is JODI, which originally started with oil but now also covers gas. The original call for JODI data was motivated by rising energy market uncertainty, which was assumed to have resulted from poor data collection and compilation. Subsequently, JODI partner organisations and their members worked to establish a monthly data-provision mechanism that offers vital benchmark data to energy market participants today.

Through co-operation and commitment, the eight JODI partners achieved numerous milestones that have been distilled into the four key pillars of the Initiative: 1) an improved political profile for energy statistics; 2) sustained monthly reporting of key oil and gas supply/demand data; 3) a well-established capacity-building programme; and 4) enhanced JODI stakeholder community engagement.

JODI originated from a call from energy ministers at the IEF Ministerial Meeting in 2000 to improve energy data transparency, and has received strong political support since its inception. Energy data transparency in association with JODI has been a key item of policy agendas at various ministerial forums, including those of the IEF, the Group of Eight (G8) and the G20.

The JODI World Database now features more than 100 countries, representing around 90% of global hydrocarbon supply and demand data. In 2017, around 60 countries submitted JODI-Oil data and 50 submitted JODI-Gas data on a reference-month-plus-30-days basis.

Capacity building has been a key pillar of the data transparency initiative. JODI partner organisations, through the JODI Training Workshop series, have trained more than 600 energy data professionals involved in JODI. Efforts to compile JODI manuals (oil and gas) added momentum to the establishment of common energy definitions, which helped create the IRES guide. More than 10 000 copies of the two JODI manuals have been downloaded in the past ten years.

JODI also engages with its global data-user community through regular regional meetings and conferences that encourage user feedback to enhance overall energy data transparency. The initiative is unique in its ability to incite co-operation all along the length of the data supply chain and across government, industrial, organisational and national boundaries.

The International JODI Conference series and the new JODI Information Seminar series convene stakeholders contributing to enhanced energy data transparency at various stages of the JODI data supply chain. They include industry representatives, professionals from national administrations, JODI partners themselves, and other JODI data users from around the world. Sustained and enhanced interaction within this diverse and growing group is vital to the ongoing success of the Initiative.

The Energy Data Transparency Exhibition, initially held at the 2017 JODI conference in London, raised awareness of the wealth of data available to the public through the data dissemination efforts of national administrations, international organisations and commercial data redistribution agencies. The event provided a unique opportunity for dynamic idea exchange among data providers and users, and government and industrial suppliers of analytical tools and services. Based on the four key pillars of the Initiative, in

2016 JODI partner organisations established the JODI Five-Year Action Plan toward 2020. The plan identifies seven key objectives on which the activities of JODI partners and other key stakeholders should focus to 2020:

- Objective 1: Continue to enhance the quality of JODI data
- Objective 2: Improve the timeliness of data reporting mechanisms
- Objective 3: Continue to strengthen capacity-building efforts
- Objective 4: Strengthen engagement with JODI user/energy data analytics community
- Objective 5: Raise JODI brand awareness
- Objective 6: Consider improvement of data transparency for other forms of energy
- Objective 7: Identify and engage with JODI champions.

To date, JODI partners have undertaken numerous actions in line with the plan. They have made significant progress towards meeting its objectives, and are committed to further improving global energy data transparency.

3.2. Digitalisation

Data is at the heart of digitalisation. Effective digital data use is already changing the way our energy systems work, but many businesses and policy makers are just beginning to understand and adapt to its potential as set out in the *Digitalization and Energy* report (IEA, 2017b), which also covers the important issue of emerging electricity security challenges. The same is true for opportunities to use digital data to better understand the energy system: harnessing digital data could revolutionise our understanding of energy and throw a new and vital light on how and why energy is used. Many businesses have recognised these opportunities and are adapting to them, but many more need to. Equally, the world of energy statistics needs to adapt and, with the support of business, work to maximise digital data potential.

Digitalisation has the potential to enhance the quality, timeliness and availability of energy data – and thus of official energy statistics. For example, if all power generators had digital maps of their generation plants, they would possess real-time information in a digital format that could be supplied, under the right conditions, to official energy statistics institutions, making it possible for all stakeholders to have access to official, near-real-time generation and fuel-input data. The application and use of digitalisation should make more data more easily available and, in some cases, offer new ways to collect data. Geospatial imaging and image analysis, for instance, may allow statisticians to collect better information on forest/biomass production and consumption by permitting comparisons of images at different times.

Because data is a widely used term with many meanings, digital data can also have different meanings. Digital data has the potential to contain many values, so it is often associated with "big data". A key difference, however, is that digital data is usually structured, and thus potentially ready to be used for precise statistical purposes. All existing data types are already valuable for understanding energy and serve many useful purposes, but digitalisation allows the fusing of these data types to gain advantages beyond the simple sum of their benefits. There are currently two main trends in data fusion: developing geographic information systems (GISs) and data aggregation. GISs are developing at a rapid rate globally, allowing different data to be combined simultaneously as layers on a single map. Imagine a map that can display an average wind speed in different heights or solar radiation, along with the electricity grid, transport infrastructure, cadastre information, a map of protected areas, etc. Combining these data on a single map means it takes much less time to evaluate potential new energy projects and the results are very precise, speeding up investment and decreasing risk. Examples of energy-related GISs are:

- Switzerland: https://map.geo.admin.ch
- Australia: http://nationalmap.gov.au/renewables/
- The Netherlands: http://www.nationaleenergieatlas.nl/en/kaarten
- Canada: http://geoappext.nrcan.gc.ca/GeoCanViz/map/nacei-cnaie/en/index.html
- Argentina: https://sig.se.gob.ar/visor/visorsig.php
- Chile: http://energiamaps.cne.cl/
- Korea http://kredc.kier.re.kr/kier_eng/index.asp
- IRENA: https://irena.masdar.ac.ae/gallery/#gallery

Data aggregation aims to merge and manage different data sources and use them to provide an enhanced understanding of the energy system, such as work undertaken by both the United Kingdom and the Netherlands to link annual consumption of electricity and/or gas at a very granular level (city district) with information on building stocks (building types, floor area, age of buildings, etc.), energy audits and socio-economic indicators for the area (disposable income, education structure, etc.). The resulting analysis can be used to produce better knowledge of a sector (for example, the commercial sector in the Netherlands) or to understand the impact of policies and target them much more precisely to maximise their effect, as demonstrated by the United Kingdom in their work on the National Energy Efficiency Data-framework (NEED)[6] to support energy efficiency policies.

Box 1. The United Kingdom's National Energy Efficiency Data-framework (NEED)

NEED matches annual gas and electricity consumption data at the property level with information on the energy efficiency measures installed in the homes, the property attributes and household characteristics. It provides insight into how energy consumption varies by household type, and provides estimates of the real impact of energy efficiency measures. The latest NEED report was published on 27 July 2017.

Example findings:

- Typical gas consumption savings from installing cavity wall insulation was 9.5% (1 300 kilowatt hours [kWh]).
- Homes with solar PV showed a typical savings in mains (network) electricity demand of 10% (500 kWh).
- In estimated gas consumption savings from a combination of measures, a typical

[6] www.gov.uk/government/collections/national-energy-efficiency-data-need-framework.

savings of 25% (3 500 kWh) was achieved when a property combined cavity wall insulation, loft insulation and a new condensing boiler.

Data sets created through the integration of data stills need to be repeatable (that is, they need to conform to statistical norms that the methodology is constant); they also require validation and meta-data to explain their derivation, use and coverage and will still be subject to some uncertainty. However, expanded digital data use by both businesses and governments will reinforce the information frame in which decisions are taken.

In the domain of energy commodity market analysis, tanker tracking has become a common practice to obtain direct energy trade flow information. Numerous commercial entities have engaged in this type of data collection since the time when they literally counted the number of ships passing strategical sea lanes such as the Bosporus Strait, for example. Real-time GIS information from tankers, along with satellite images, enhances timeliness, accuracy and coverage, as well as level of detail, such as stock level estimations. Official data, with a time lag, has authoritative value to crosscheck and validate such direct estimations; however, national administrations may also have the resources to adopt techniques such as tracking that have been established by commercial entities.

The growth of "smart systems" may present opportunities to generate myriad point-of-use energy data that can enhance and improve national energy data systems. While many technology components used in smart energy systems are already generating data used in traditional national energy data collection reporting systems (e.g. surveys), the growth of smart systems for energy should lead to new point-of-use data. These technologies could be important in building up energy data collection capacity in developing countries while serving other important development goals such as improving clean energy access through smart grids.

As potential for the use of more detailed and personal data increases, so does the need for protection. Finding a balance between the value of new opportunities and privacy and data ownership is essential and needs to be reflected in legal and regulatory frameworks. Many approaches from the statistics domain may be used, such as data aggregation, delayed data availability, data normalisation, etc. For example, a time lag of three to six months for the statistical use of anonymised data from smart meters would significantly improve energy-use knowledge while addressing genuine concerns about access to current data. Statistics also need to take into account changes in energy systems, whereby the energy "suppliers" may no longer be energy companies but the consumers themselves.

4. Co-operation

The ability to compare energy data across countries is vital and is at the heart of IEA statistical outputs such as the *World Energy Balances* (IEA, 2017c), *Energy Efficiency Indicators* (IEA, 2017d), *CO_2 Emissions from Combustion* (IEA, 2017e), *and Energy Prices and Taxes* (IEA, 2017f). For countries, being able to see how various policies are changing energy supply or demand elsewhere can be instrumental in helping them determine the best course of action. This means, of course, that policies must be effectively monitored and the results published, and that all countries adopt a similar and open approach to reporting energy data.

International organisations also have a key role in ensuring that the data they collect are comparable globally. One example of work in this area is InterEnerStat, an initiative gathering together more than 20 organisations and chaired by the IEA, whose objective is to improve the overall quality of global energy statistics through strengthening international co-operation. Since 2005, organisations participating in InterEnerStat have successfully negotiated harmonised energy product and value-chain definitions, which have been endorsed by the UNSD as part of its IRES guide.

The energy divisions of the five UN Regional Commissions (the Economic Commission for Latin America [ECLAC], the UN Economic and Social Commission for Asia and the Pacific [UNESCAP], the UN Economic and Social Commission for Western Asia [ESCWA], the UN Economic Commission for Africa [UNECA] and the UN Economic Commission for Europe [UNECE]) also meet to co-ordinate joint actions. During 2017, the five Regional Commissions participated in developing the regional chapters of the 2017 *Global Tracking Framework* report co-ordinated by the World Bank (World Bank, 2017). This co-ordination also occurs at the regional level, for example through the Regional Energy Agenda of Latin America and the Caribbean. This initiative brings together a number of regional organisations: Latin American Integration Association (ALADI), Regional Association of Oil, Gas and Biofuels Sector Companies in Latin America and the Caribbean (ARPEL), Development Bank of Latin America (CAF), Economic Commission for Latin America and the Caribbean (ECLAC), Regional Energy Integration Commission (CIER), the Organization of American States (OAS), OLADE and the World Energy Council (WEC), in addition to the co-ordination the International Development Bank (IDB) has been developing with other regional agencies under the Sustainable Energy for All (SEforALL) initiative (Latin America and Caribbean Hub). Additionally, OLADE has collaborative relations with the co-operation agencies of Canada, Austria and Germany as well as with the IDB and World Bank. Since late 2017, with IDB financing and support from the IEA, OLADE has been developing a project to harmonise its methodology for presenting energy balances for Latin American and Caribbean countries with international standards. This is a major development that could make reporting on energy data substantially more consistent, and is a move towards achieving the goal of common energy data reporting from all countries.

There is no prescribed fast-track recipe to promote regional and international collaboration and co-ordination among agencies. What is certain, however, is that countries have asked for greater levels of co-ordination and collaboration. That is why in Latin America, for example, agencies have concentrated their dissemination activities into Energy Week, an annual multi-agency meeting in which policy makers have the opportunity to meet and discuss issues related to the sector.

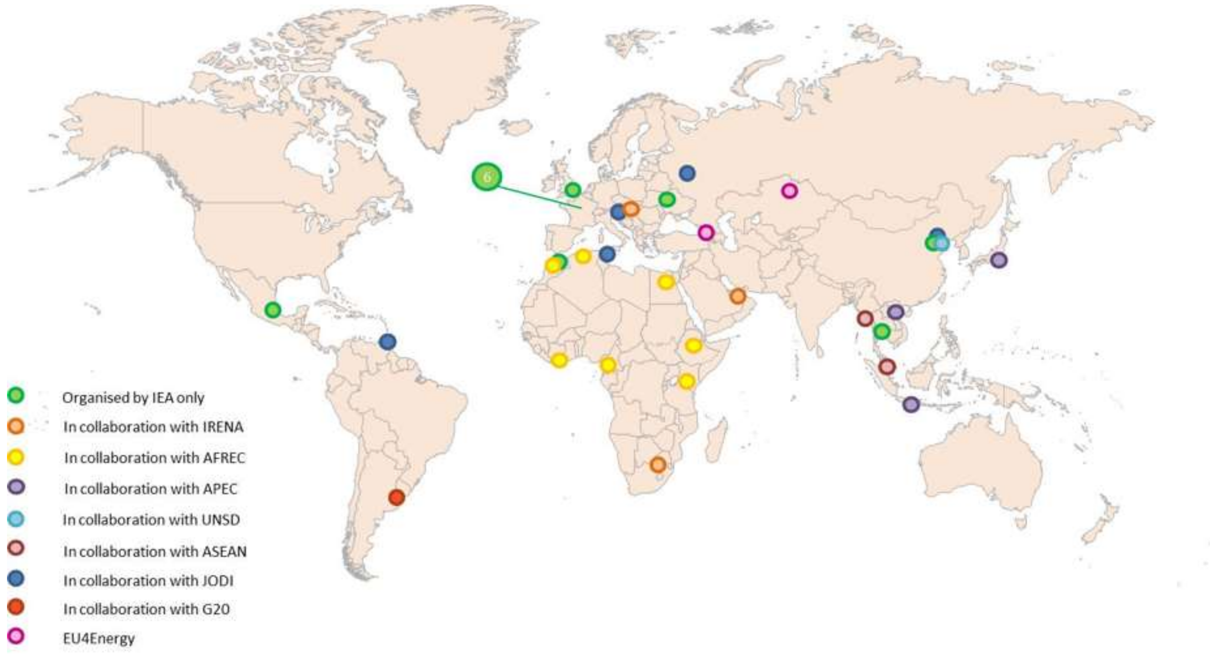
5. Training and capacity building

At the technical level, it is very important to develop and maintain skills and knowledge among the statisticians responsible for collecting, compiling and disseminating data. To assist this effort, several international initiatives have been aimed at capacity building, training and knowledge sharing to support official energy data systems. Recent examples include the IEA energy statistics training events and the energy statistics initiative of INOGATE (which focuses on capacity building in Eastern Europe, the Caucasus and

Central Asia, and is now led by the IEA EU4Energy programme). Delivering capacity building is a key task for many international organisations that work both collectively and on individual topics, and these efforts are resulting in more data being obtained/collected from many parts of the world.

Like other organisations, the IEA is also enhancing the way it provides training by launching online videos that can be accessed by anyone, and is working to translate these videos and all energy statistical manuals into key international languages such as Chinese, Spanish, Arabic, French and Russian in addition to the English versions. International organisations with a focus on energy data are working together more closely to integrate their training and capacity-building activities at the practical level, where they have the greatest benefit at lowest cost. The map below illustrates some of the many collaborative IEA activities in this field since 2015 (Figure 1). Co-operation through JODI training dates back to 2004 (the partner organisations have now performed 18 JODI training workshops).

Figure 1. Energy statistics training events in collaboration with international energy organisations and initiatives, 2015-2018



This map, as well as any data included herein are without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

Notes: AFREC = Afican Energy Commission; ASEAN = Association of Southeast Asian Nations.

Source: IEA Energy Data Centre.

6. Conclusions

Many countries look to G20 members for leadership, and this is especially important in the area of energy data. Ensuring the comprehensiveness of energy data will not only lead to better decisions but will show all countries what is needed to promote progress in clean energy transitions globally. G20 members can support for this by openly sharing not only their data but their methodologies and by working with the IEA and other agencies to build tools that all countries can use. They can also help by supporting the capacity-building efforts of all international organisations.

Resources are essential to establish and maintain a national energy statistics system. Effective resource allocation will depend on how energy data are prioritised in relation to other statistical areas; how synergies can be exploited between energy and other policy areas; what priority is given to the monitoring component within the policy formulation process; and how resources are allocated across areas within the energy domain.

Given the importance of energy transitions and the increasing complexity of energy systems, successful policies can only be forged based on high-quality data. The opportunities provided by digital data, such as those described in this paper, can only be realised if data are publicly available. What must be considered, however, is how to securely store anonymised data (data from smart meters, detailed grid operation data, etc.) in one place, accessible for research purposes. Policy guidelines and industry codes should make this data access possible by providing guidance on creating mechanisms and controls that will facilitate all parties to share the evolving digital data. Privacy must be guaranteed, however, to ensure that open data and the use of consumer data are publicly accepted. Equally as the borders between producers and consumers are beginning to disappear: current data collection procedures must be adjusted to cover this market development.

Further work is needed to cultivate productive relationships among statistical offices, utilities and relevant smart system data suppliers. Partnerships with key stakeholders must also be established to facilitate data acquisition, and effective data storage and processing capacity must be designed to accommodate new data. Further research should assess the potential benefits of smart system data and how they can be combined with traditional survey data to produce comprehensive energy statistics.

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