IEA IMPLEMENTING AGREEMENT FOR A CO-OPERATIVE PROGRAMME ON SMART GRIDS (ISGAN)

2014 EDITION:
SMART GRID DRIVERS AND TECHNOLOGIES BY COUNTRY, ECONOMIES, AND CONTINENT

ISGAN Framework of Assessment Report

ANNEX 1, Task 1

W-T. Paul Wang, Energy & Environmental Resources Group (USA)

29 September 2014

Verification: _____ Korea Smart Grid Institute (Operating Agent)
Approval: _____ ISGAN Executive Committee Chair or Vice Chair

From the ISGAN Annex 1 *Programme of Work*, Issue 5.0, revised March 2014:
"Summary report and analysis of the survey results, detailing the clustered driver/technology pairs of common interest and importance to Participants"

FOREWORD

The International Smart Grid Action Network (ISGAN) was launched at the first Clean Energy Ministerial (CEM) in 2010 and was subsequently organized as a task-shared International Energy Agency (IEA) Implementing Agreement for a Co-operative Programme on Smart Grids in 2011. The task-shared projects undertaken with ISGAN Participants' contributions are aimed toward multilateral government-to-government collaboration to advance the development and deployment of smarter electric grid technologies, practices, and systems. To date, ISGAN has established seven multilateral collaborative projects (or Annexes) to address the principal areas of smart grids where government collaborations can have the most impact.

Work in this report was conducted under ISGAN Annex 1: the Global Smart Grid Inventory project. Annex 1 has the objectives of: (1) identifying countries' specific motivating drivers for pursuing smart grids, (2) cataloging the wide range of smart grid activities underway, and (3) collecting and organizing the wealth of experience currently being generated into a resource available first to ISGAN Participants and then to a broader, global audience. The report begins with a description of the development and application of a unified framework for assessment. This unified assessment framework ensures a common assessment methodology for use by each ISGAN Participant both to accomplish objective 1 above and to allow groupings of countries' prioritized assessment results to unveil multinational assessment priorities of smart grid motivating drivers and technologies, such as by geographic regions or by the advanced state of countries' economies.

The national-level and multinational-level prioritized assessment results presented in this report are being used to guide further Annex 1 work toward fulfilling objectives 2 & 3 above. Specifically, each ISGAN country is applying the national-level prioritized assessment results to identify smart grid activities underway that meet, address, or respond to its prioritized motivating drivers and technologies. Data and information on the identified smart grid activities (or projects) are being collected, organized, and entered into the ISGAN Inventory that will serve as a global resource on smart grid activities across ISGAN Participants. Further, the multinational assessment priorities documented in this report will be used to sort and identify those smart grid activities, in the Inventory, of interest and priority to multiple nations. The activities identified to meet multinational assessment priorities will then be featured in the ISGAN Smart Grid Project Webinar series, during which their information will be shared with all interested parties for lessons learned. Lastly, the multinational assessment priorities are being considered by ISGAN Annex 2 to identify smart grid activities for case studies.

This report is the second edition of the assessment report of smart grid motivating drivers and technologies, and is based on analysis of the 2014 survey results. The first edition was published in December 2012 and is based on the survey results from that year. Comparison of driver and technology priorities analyzed from the two biennial sets of survey results are presented herein.

ABSTRACT

The biennial survey of ISGAN Participants on smart grid motivating drivers and technologies of priority was first conducted in 2012 and again in 2014. This report summarizes the unified assessment framework used in the 2014 survey, the analysis methodology, and the analysis results of smart grid motivating drivers and technologies at both the national level and multinational level. Building on the lists of smart grid motivating drivers and technologies that were used for the 2012 survey, the assessment framework in 2014 was developed with slight refinements to reflect review feedback from current ISGAN Participants. The refined framework (i.e., lists of drivers and technologies) was then programmed into an online survey tool for use by each Participant to complete the assessment. Each Participant's survey results were subjected to a validation process by that country's national coordinator for Annex 1. A clustering analysis methodology was developed and applied to derive the composite, national-level prioritized assessment results from survey results (those approved through validation, or completed but not yet validated) from multiple respondents for a country. The same methodology was further applied to groups of multiple Participants' prioritized assessment results to identify motivating drivers and technology priorities at a multinational level. Clustering analysis for the group of all ISGAN Participants, as well as of Participants grouped by economies (developed and developing) and by continent (Africa, Asia, Australia, Europe, and North America), was conducted; these multinational-level prioritized assessment results are provided herein. Lastly, application of national-level and multinational-level prioritized assessment results for selecting each country's smart grid projects for the ISGAN Inventory and for further information dissemination via the ISGAN Smart Grid Project Webinar Series is described.

CONTENTS

1.0 INTRODUCTION

The International Smart Grid Action Network (ISGAN), launched at the first Clean Energy Ministerial (CEM) in July 2010, creates a mechanism for multilateral collaboration to accelerate world-wide development and deployment of smarter electricity grids. ISGAN has launched key projects (known as Annexes) across its five principal areas of focus (Policies, Standards, and Regulation; Finance and Business Models; Technology and Systems Development; User and Consumer Engagement; and Workforce Skills and Knowledge). The Global Smart Grid Inventory project, that is, Annex 1, has the objectives of identifying countries' specific motivating drivers for pursuing smart grids, cataloguing the wide range of smart grid activities underway, and collecting and organizing the wealth of experience currently being generated into a resource available first to ISGAN Participants and then to a broader, global audience. These objectives and the associated scope of activities are described in the ISGAN Annex 1 *Programme of Work*, Issue 5.0 (revised March 2014). This paper summarizes work completed for Task 1, Framework for Assessment, under the Annex 1 *Programme of Work*.

The objective of Task 1 was to define the motivating drivers for smart grids and analyze the associated, contributing smart grid technologies. The Task involved developing and applying a unified ISGAN framework for assessing and prioritizing national-level smart grid motivating drivers and contributing smart grid technologies. It is expected that all ISGAN Participants will contribute data and information to this Annex. As of this report publication, 24 nations across the globe and the European Commission have signed on as ISGAN Participants (identified on the ISGAN website).

This paper documents the Annex 1 unified framework for assessment, prioritized assessment results by each Participant, purpose and methodology for multinational (or clustering) analysis, analysis results of common motivating drivers and driver-technology pairs of high priority at the national level as well as across all nations and to nations clustered by economies or by continent, and comparison of multinational prioritized assessment results between the 2012 and 2014 studies.

2.0 FRAMEWORK FOR ASSESSMENT

A unified framework for assessing smart grid motivating drivers and contributing technologies was developed, largely based on the same lists of drivers and technologies used in the 2012 survey. For the context of this Annex, the "motivating drivers" are defined as the driving forces for goal-oriented actions (encompassing planning, strategy development or strategic directions, and implementation) in the next three years; the "smart grid technologies" are defined here as those being developed or deployed today to support the driver.

Modifications to the 2012 motivating drivers and the matrix of drivers and contributing technologies were made as follows:

1) Deleting any technologies or drivers that were not selected by a *single* ISGAN respondent during the first round of surveys in 2012
2) Adding the technologies or drivers that were manually inputted by an ISGAN respondent during the first round of surveys in 2012
3) Consolidating the technologies by grouping related technologies as one

The draft version of the Excel template with the refined list of drivers and the refined matrix of drivers and contributing smart grid technologies was sent to the ISGAN Annex 1 national experts for review in December 2013. The final version was approved in early January 2014, ready for relaunch of the ISGAN survey.

A user interface was then developed for a web-based tool that was operated through an online service, SurveyGizmo; this service facilitated transformation of the final Excel version of the template into a survey form with features such as survey login, question and page piping, checkboxes, rating/Likert scale, flexibility in adding a user-specified driver or technology, and sending survey results via email. The web-based tool was internally tested at Energy & Environmental Resources Group, LLC (E2RG) before being officially sent to all ISGAN Participants.

The web-based tool was launched on January 31, 2014. Instructions on using the tool were sent to each Participant with a request to log on to the ISGAN Framework Survey site for survey completion. Each nation was extended the option of completing the survey up to five times for the purpose of allowing it to address varying national priorities based on diversity in geography, stakeholders, etc.; Mexico was an exception to this, completing the survey six times. Each survey completion prompted generation of an instant survey report in PDF format that was sent via email to the survey respondent for review. These reports contained an email link allowing respondents to return to their surveys to make changes if desired.

3.0 PRIORITIZED ASSESSMENT RESULTS BY EACH PARTICIPANT

The country representative on the Executive Committee again served as the primary coordinator of the online survey completion for each ISGAN Participant. The primary coordinator was responsible to ensure that the survey results reflect the priority of that country's motivating drivers and contributing technologies.

The prioritized assessment results by each Participant have since been collected through the completed responses via the survey website described above. Survey completion has been

requested from each ISGAN Participant; as a new nation joins ISGAN, a survey completion request will be made. Thus, the Annex 1 survey results will continue to evolve, with addition of new Participant results and incorporation of ongoing changes made to the completed surveys to reflect the most recent motivating drivers and contributing technologies of all Participants.

All completed survey results of an ISGAN Participant were subject to a validation process by the country's primary coordinator for acceptance as the prioritized assessment results for that nation. A validation form, along with all survey completion results, was sent to the primary coordinator on April 1, 2014; only those survey results marked with approval by the primary coordinator were deemed as validated. Austria, Belgium, and France manually submitted their surveys later.

Table 1 lists the status of survey completion and validation by ISGAN Participants. Twenty two of 25 ISGAN Participants have completed their surveys; nine have completed the survey multiple times (for those countries, the number of completions is indicated in parentheses following the country name in Table 1).

The 32 completed survey results from 22 nations that are highlighted in yellow in Table 1 were used for the analyses, described below, to derive the prioritized assessment results at the national and multinational level. Thus, with the exception of the nine survey results rejected during validation, all completed survey results, including those not yet validated, were included for clustering analyses.

Table 1. Status of Survey Completion and Validation by ISGAN Participants, as of 26 September 2014

Status of Survey Completion and Validation	ISGAN Participants
41 Completed surveys, from 22 nations	Australia, Austria, Belgium, Canada (5), China, Finland (2), France (2), Germany, India, Ireland, Italy (2), Japan (2), Republic of Korea, Mexico (6), Russia, Singapore, South Africa, Spain, Sweden (5), Switzerland, The Netherlands (2), United States (2)
27 Completed and validated surveys, from 18 nations	Australia, Austria, Belgium, Canada (3), Finland (2), France(2), Germany, Ireland, Italy (2), Japan, Republic of Korea, Mexico, Singapore, South Africa, Spain, Sweden (5), Switzerland, The Netherlands
5 Completed but not validated surveys, from 4 nations	China, India, Russia, United States (2)
9 Surveys rejected by countries' primary coordinators	Canada (2), Japan, Mexico (5), The Netherlands

Survey not yet submitted	Norway and United Kingdom

4.0 METHODOLOGY FOR CLUSTERING ANALYSIS AT NATIONAL LEVEL AND MULTINATIONAL LEVEL

For an ISGAN Participant with multiple completed surveys (approved through validation or still to be validated, as shown in Table 1), a method was applied to combine (or cluster) those multiple surveys into a single composite survey to represent that nation's prioritized assessment results. This method allowed each Participant's prioritized assessment results to be treated equally in multinational analyses, regardless of how many surveys were submitted by that Participant. The composite survey was then included in the subsequent clustering analyses to derive multinational-level prioritized assessment results (by combining prioritized results of each Participant in a group).

The methodology applied a simple weighting scheme to the motivating drivers and contributing technologies. The scheme involved assigning a point score for each driver; that is, a score of 6, 5, 4, 3, 2, and 1 for the top-1, -2, -3, -4, -5, and -6 ranked drivers, respectively. Similarly, the same point scoring system was applied to the top-priority technologies selected for a top-ranked driver; that is, a score of 5, 4, 3, 2, and 1 was applied to the top-1, -2, -3, -4, and -5 ranked technologies, respectively, for that driver. For clustering analysis, the top-6 priority drivers for a particular grouping (either of multiple surveys from a single Participant or of multiple countries' assessment results) were identified through computing the sum of all scoring points received for each of the drivers and then ranking them according to their overall scores. Similarly, the top-5 technologies for each of the top-6 drivers from a particular clustering analysis were derived by computing and ranking the overall scores received for the technologies.

To automate the clustering analyses, functions of computing/ranking/sorting scores for drivers and driver-technology pairs were coded in Microsoft Excel macros, along with the weighting scheme. In addition, each Participant was coded as having either a "developed" or "developing" economy (according to the International Monetary Fund's World Economic Outlook Report, April 2012) and as belonging to a continent (Asia, Australia, Europe, or North America). The Excel macros facilitated generation of prioritized assessment results at both national and multinational levels.

5.0 NATIONAL-LEVEL PRIORITIZED ASSESSMENT RESULTS

The prioritized assessment results for each Participant with completed survey(s) approved through validation or still to be validated are provided in the Appendix. For Participants with a single survey, that survey represents the country's prioritized assessment results. For Participants that completed the survey multiple times (i.e., Canada, Finland, France, Italy, Sweden, and the United States), the composite survey resulting from the respective clustering analysis is shown in the Appendix to represent each country's prioritized assessment results.

6.0 MULTINATIONAL-LEVEL PRIORITIZED ASSESSMENT RESULTS

Clustering analyses at the multinational level were conducted for the following groupings:

- All: inclusive of all Participants' results, either approved through validation or still to be validated
- Economies: developed and developing
- Continent: Africa, Asia, Australia, Europe, and North America

Participants for each grouping are shown in Figure 1, with the dark circle (●), the half-dark circle (◓), and the open circle (○) indicating that the Participant's results are completed and validated, are completed but not yet validated, or have not been completed, respectively.

Figure 1. Grouping of Participants for Multinational Clustering Analysis

● *Survey results validated* ◓ *Survey results completed but not validated* ○ *Survey results unavailable*

ISGAN Participants*	All	Economies		Continent				
		Developed	Developing	Africa	Asia	Australia	Europe	North America
Australia	●	●				●		
Austria	●	●					●	
Belgium	●	●					●	
Canada	●	●						●
China	◓		◓		◓			
Finland	●	●					●	
France	●	●					●	
Germany	●	●					●	
India	◓		◓		◓			
Ireland	●	●					●	
Italy	●	●					●	
Japan	●	●			●			
Republic of Korea	●	●			●			
Mexico	●		●					●
The Netherlands	●	●					●	
Norway	○	○					○	
Russia	◓		◓				◓	
Singapore	●	●			●			
South Africa	●		●	●				
Spain	●	●					●	
Sweden	●	●					●	
Switzerland	●	●					●	

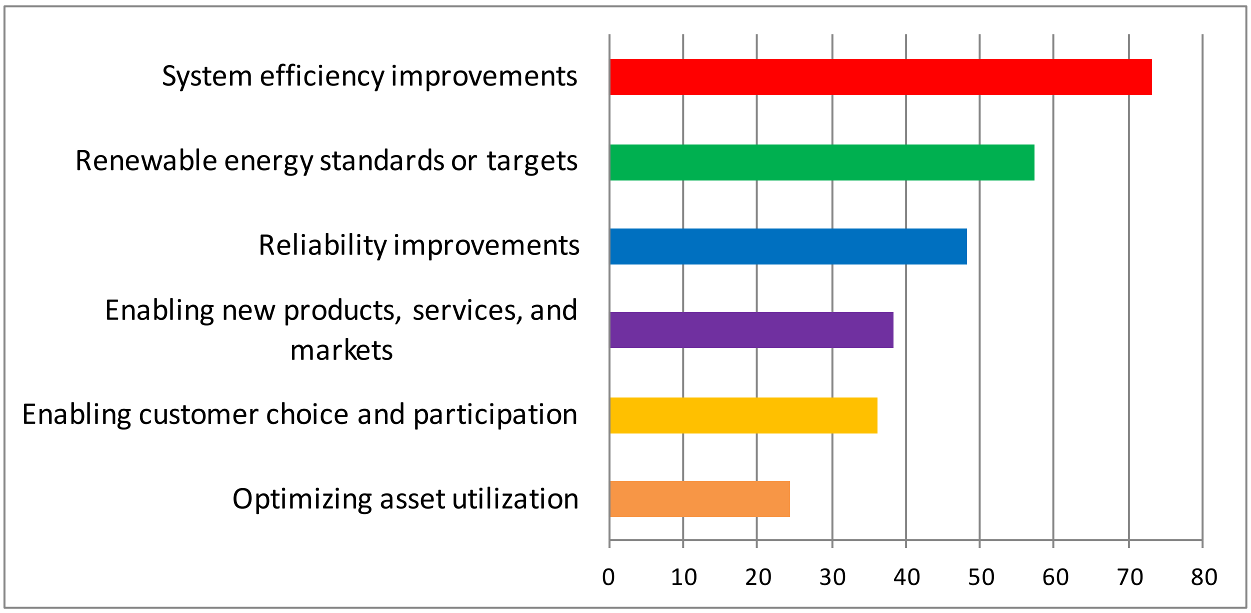
U.K.	◌	◌	◌	
U.S.	◓	◓		◓

* The European Commission, an ISGAN Participant, is not listed, as its results are reflected in those of participating countries in Europe.

6.1 Multinational Analysis Results of All Participants with Validated Results

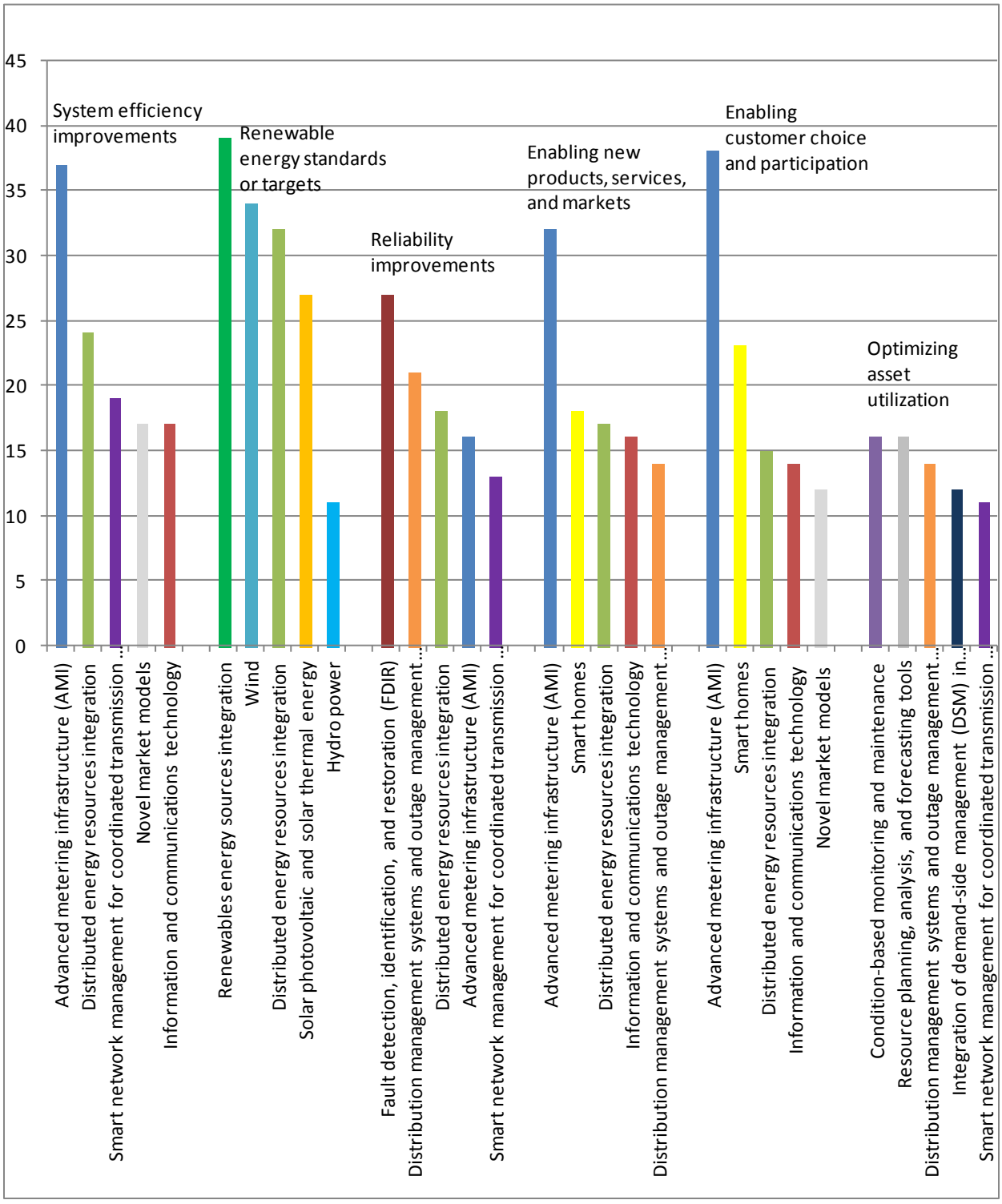
Clustering analyses of the results for the 32 surveys, highlighted in Table 1, from the 22 Participants with either ● or ◓ shown in Figure 1 were conducted. Figures 2 and 3 show the analysis results for the top-6 ranked drivers and the top-5 ranked technologies for each top-ranked driver, respectively. The x-axis scale in Figure 2 reflects the score of drivers from the clustering analysis.

Figure 2. Top-6 Ranked Motivating Drivers from Clustering Analysis of the 22 National-Level Results*



***** This analysis was based on the validated results from 18 ISGAN Participants and on the completed but not yet validated results from 4 ISGAN Participants.

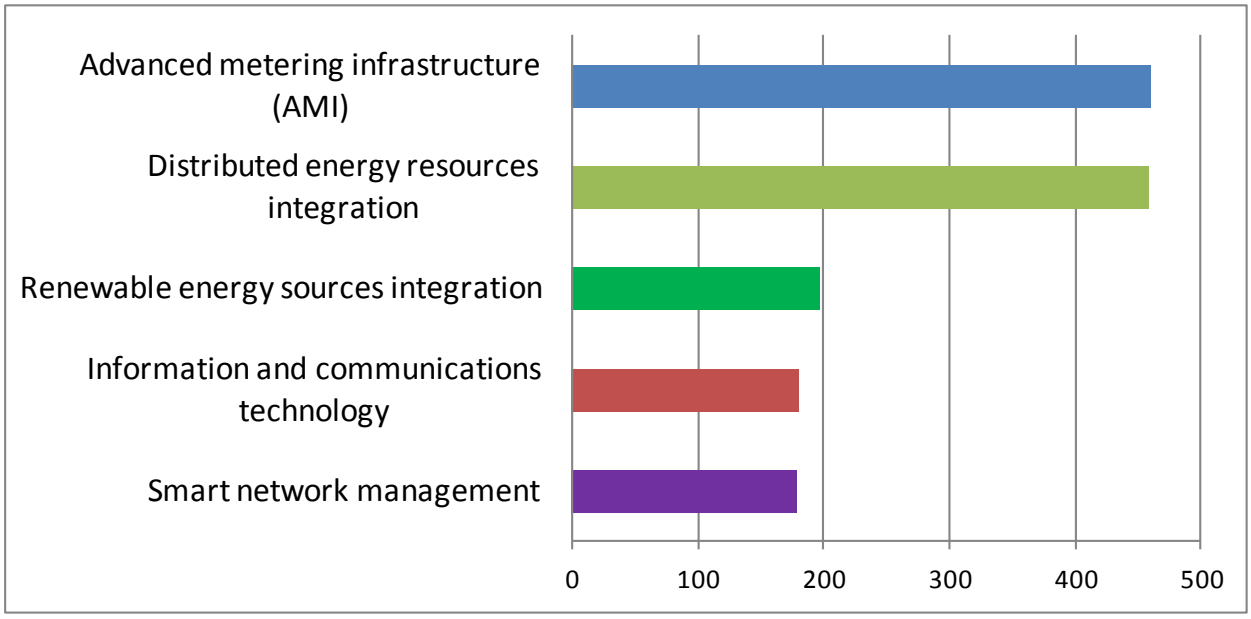
Figure 3. Top-5 Ranked Technologies for Each of the Top-6 Ranked Drivers (Shown in Figure 2)



Six groups of technologies are shown in Figure 3, and each group consists of the top-5 technologies ranked to support a driver (shown in the label) with technology scores in y-axis and technology names in x-axis. Thus, Figure 3 depicts the prioritized driver-technology pairs from the clustering analysis of the 22 national-level results.

A further analysis was made to identify technology priorities across all drivers. This involved a three-step process. The first step was to multiply the sum of scores calculated from the clustering analysis for each technology by a driver-weighted factor. This was followed by adding all multiplied (or weighted) scores of a technology across all drivers to derive the total score for that technology. The final step was to rank the total scores of all technologies to come up with the technology priorities across all drivers. The driver-weighted factors of 6, 5, 4, 3, 2, and 1 were used to multiply the sum of scores of a technology associated with the top-1, -2, -3, -4, -5, and -6 ranked driver. For example, advanced metering infrastructure (AMI) was shown in Figure 3 to be in the top-5 technologies for four of the top-6 drivers. It has a score of 37, 16, 32, and 38, associated with the top-1, -3, -4, and -5 ranked drivers. The total of driver-weighted scores for AMI was calculated to be 458 (i.e., 37*6+16*4+32*3+38*2). Since the score of 458 was the highest among all scores for all technologies, AMI is shown as the top technology priority in Figure 4 across all drivers. The four technologies with the next highest overall driver-weighted scores are also shown in Figure 4. The technology, Distributed energy resources integration, comes a close second with a score of 457.

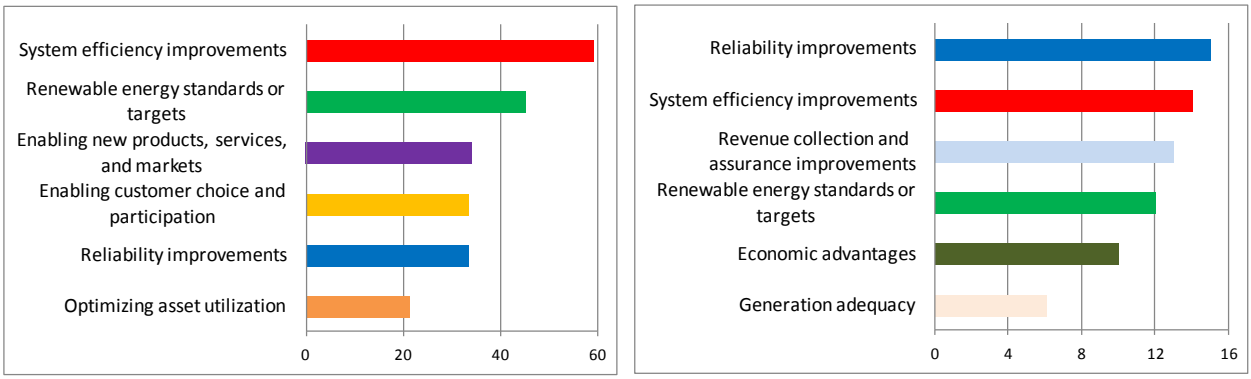
Figure 4. Technology Priorities across All Drivers from Analysis of the 22 National-Level Results



6.2 Multinational-Level Analysis Results by Economies

The top motivating drivers and the top technologies across all drivers for developed and developing economies from clustering analyses of multinational results are shown in Figure 5 and Figure 6, respectively. The left charts in both Figures show clustering analyses of the 17 developed economies' national-level results, and the right charts show clustering analyses of the 5 developing economies' national-level results. The identity of Participants in each grouping of economies is shown in Figure 1, with either ● or ◓.

Figure 5. Top-6 Ranked Motivating Drivers from Clustering Analysis by Economies
Developed Economies (left); Developing Economies (right)

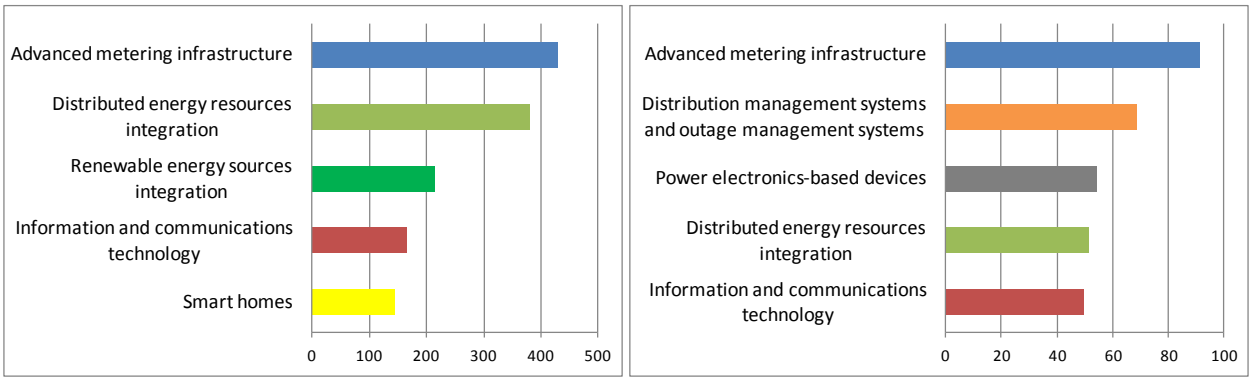


Three of the six top-ranked motivating drivers are common between developed and developing economies. These common drivers of priority are:

- System efficiency improvements
- Reliability improvements
- Renewable energy standards or targets

Beyond these common drivers of priority, the remaining drivers for developing economies are to improve the economic aspects (economic advantages, and revenue collection) and generation adequacy, while the remaining drivers for developed economies focus on the "enabling" characteristics of a smart grid (customer choice and participation, new products/services/markets) and optimizing asset utilization.

Figure 6. Technology Priorities across All Drivers from Analysis by Economies
Developed Economies (left); Developing Economies (right)



Three of the five top-ranked technologies are common between developed and developing economies. These common technologies of priority are:

- AMI
- Distributed energy resources integration
- Information and communications technology

The remaining priority technologies that differ by economy are Renewable energy sources integration and Smart Homes for developed economies, and Distribution management systems/outage management systems and Power electronics-based devices for developing economies.

6.3 Multinational-Level Analysis Results by Continent

Clustering analyses of multinational results show the top motivating drivers (Figure 7) and the top technologies across all drivers (Figure 8) for each of the five continents. The number of Participants in each continent is indicated as follows in parentheses: Africa (1); Asia (5); Australia (1); Europe (12); and North America (3). The identity of Participants in each continent is shown in Figure 1.

Figure 7. Top-6 Ranked Motivating Drivers from Clustering Analyses by Continent

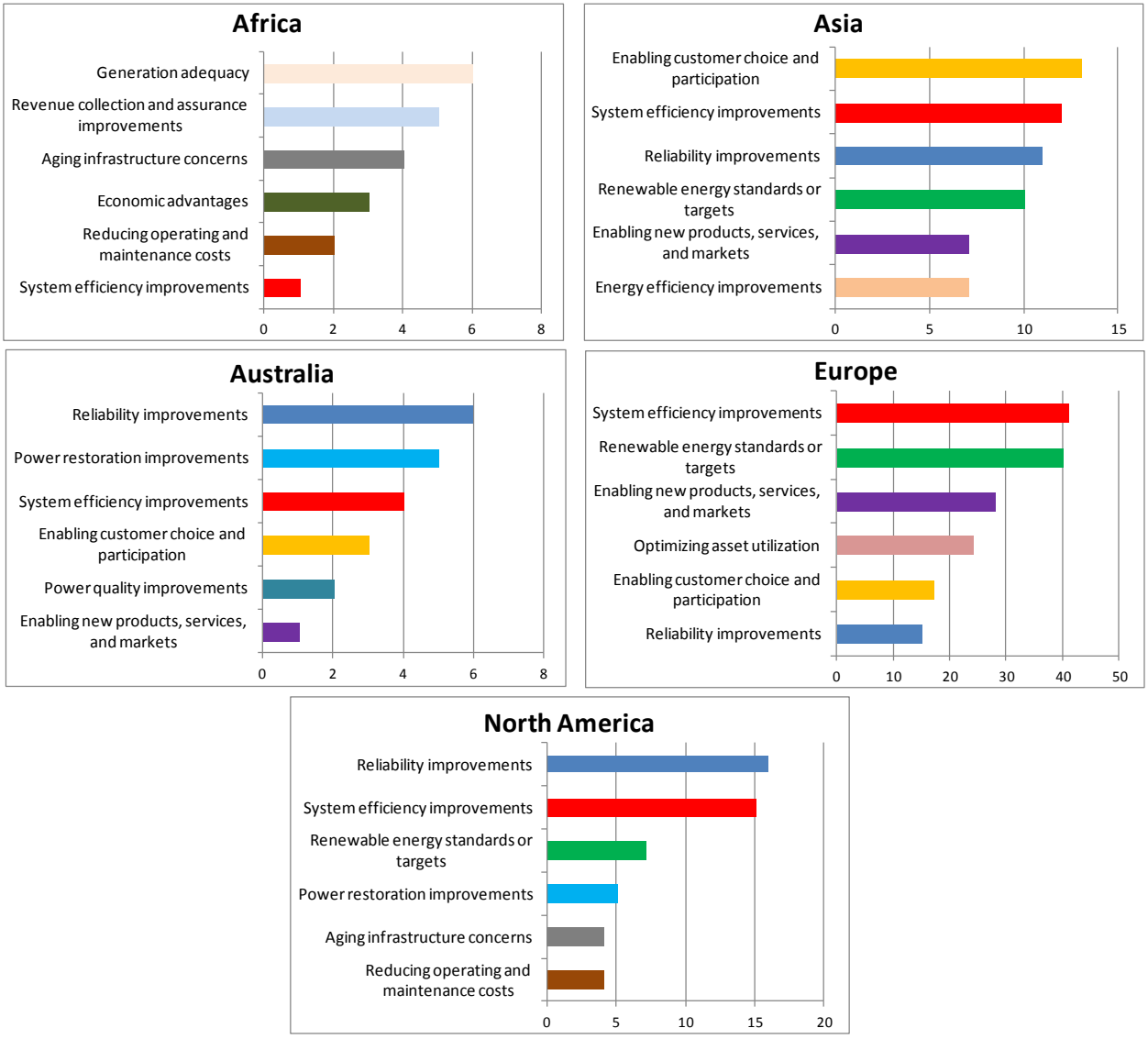
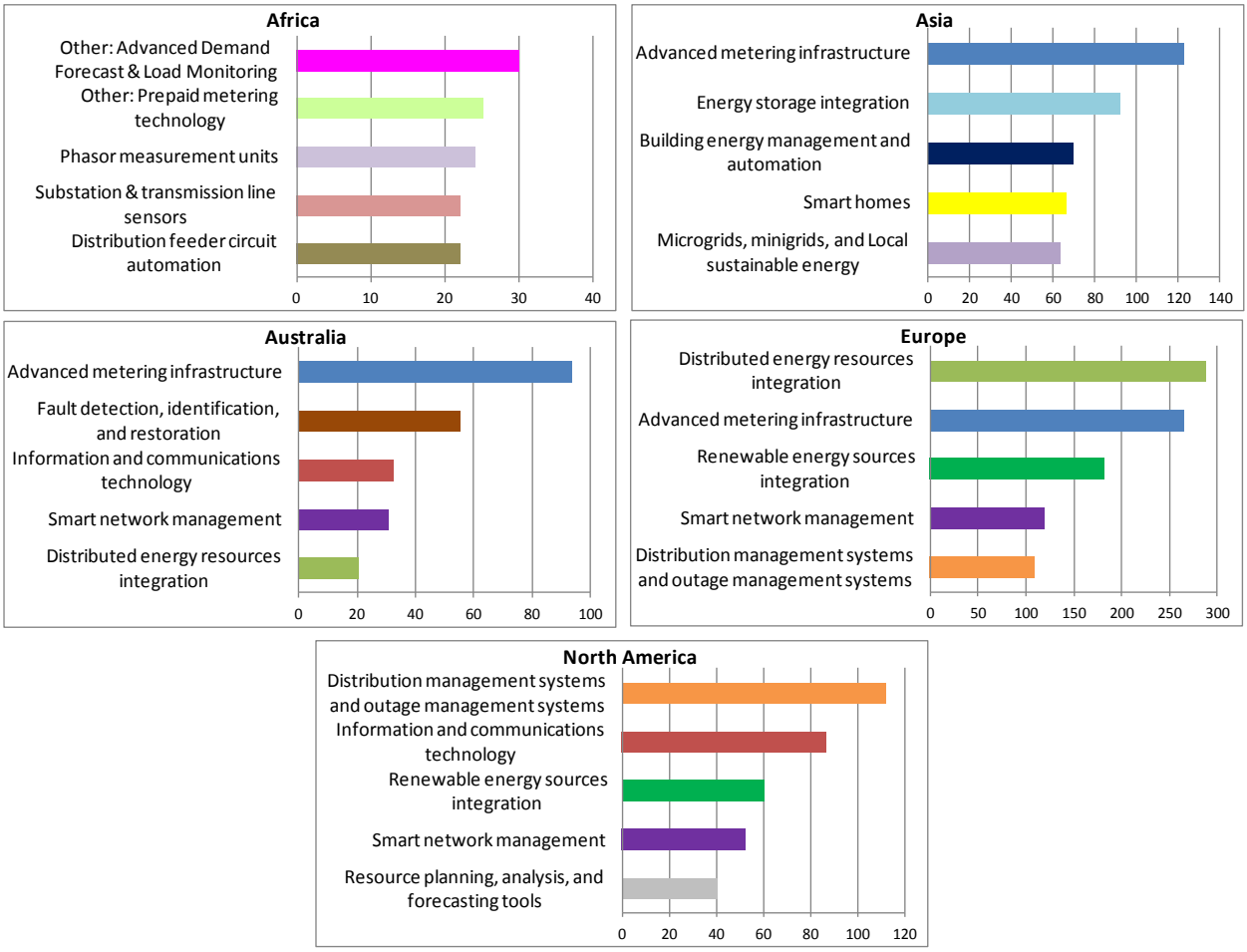


Figure 8. Technology Priorities across All Drivers by Continent



Common motivating drivers and technologies identified as being of priority to at least three of the five continents are presented in Table 2. As shown, System efficiency improvements is the only motivating driver of priority to all five continents; the next most common driver, i.e., of priority to four continents, is Reliability improvements. In regard to the common technologies, AMI and Smart network management are of priority to three continents.

Table 2. Motivating Drivers and Technologies Identified as a Priority to Three or More Continents

Motivating Driver	Priority to Continents
System efficiency improvements	All
Reliability improvements	Asia, Australia, Europe, North America
Enabling customer choice and participation	Asia, Australia, Europe
Enabling new products, services, and markets	Asia, Australia, Europe
Renewable energy standards or targets	Asia, Europe, North America
Technology	**Priority to Continents**
Advanced metering infrastructure (AMI)	Asia, Australia, Europe

Smart network management for coordinated transmission and distribution operations	Australia, Europe, North America

7.0 COMPARISON BETWEEN 2014 VERSUS 2012 SURVEY ANALYSES

The ISGAN assessment study is planned biennially, each accompanied by a survey to the current ISGAN Participants. Two assessment studies have been conducted to date, i.e., one in 2012 and this one in 2014. In between the two study periods, the roster of ISGAN Participants has grown from 22 to 25. New Participants introduce their own countries' prioritized assessment results for multinational-level analyses. In addition, the national-level smart grid motivating drivers and technology priorities have changed for the common Participants in both studies. Hence, assessment results in each study should be viewed as indicative of national-level and multinational-level priorities for that particular study period only and as dependent on the ISGAN Participants in the survey; in other words, assessment priorities are expected to change over time. The survey participants and assessment results of the top-ranked smart grid motivating drivers and technologies are shown comparatively in Table 3 for the 2014 and 2012 studies.

Table 3. Comparison between 2014 vs. 2012 Survey Analyses

Items shown in bold are common in both 2014 and 2012 analyses.

2014 Survey	2012 Survey
ISGAN Participants	
22 nations: Australia, Austria, Belgium, Canada, China, Finland, France, Germany, **India, Ireland, Italy, Japan, Republic of Korea, Mexico, The Netherlands, Russia,** Singapore, South Africa, **Spain, Sweden, Switzerland, United States**	**19 nations: Australia, Austria, Belgium, Canada, China, Finland, France**, **India, Ireland, Italy, Japan, Republic of Korea, Mexico, The Netherlands, Russia, Spain, Sweden, Switzerland, United States**
Top-6 Ranked Motivating Drivers	
System efficiency improvements	**Renewable energy standards or targets**
Renewable energy standards or targets	**System efficiency improvements**
Reliability improvements	**Reliability improvements**
Enabling new products, services, and markets	**Enabling customer choice and participation**
Enabling customer choice and participation	**Enabling new products, services, and markets**
Optimizing asset utilization	Energy efficiency improvements
Top-5 Ranked Technologies across All Drivers	
AMI	**AMI**

Distributed energy resources integration	Large size variable renewable energy sources integration
Renewable energy sources integration	Demand response
Information and communications technology	Wind
Smart network management	**Distributed energy resources**

All the nineteen 2012 survey Participants also participated in the 2014 survey. Additionally, there were three new participants for the 2014 study, namely, Germany, Singapore, and South Africa, as shown in Table 3.

Table 3 also shows that the top-6 ranked drivers from the 2014 and 2012 assessment studies exhibit great commonality, as evidenced by five of the top-6 ranked drivers being the same, albeit in a slightly different priority order.

In regard to the top-5 ranked technologies, the 2014 and 2012 assessment results share two common technologies, i.e., AMI and Distributed energy resources integration, with AMI being the top-ranked technology in both studies. Two versions of the AMI Case Book, 2.0 in 2014 and 1.0 in 2013, have been published under ISGAN Annex 2; this book presents case studies of AMI projects by select ISGAN Participants to document knowledge and experience gained, lessons learned, and best practices.

8.0 NEXT STEP: APPLICATION OF NATIONAL-LEVEL AND MULTINATIONAL-LEVEL PRIORITIZED ASSESSMENT RESULTS

National-level prioritized assessment results are being used as one of the selection criteria for projects to be included in the ISGAN Inventory (under Task 2 in the Annex 1 *Programme of Work*). The other selection criteria, as concurred on by Annex 1 Participants, include: demonstration and/or deployment project; government- or regulator-supported project; project scope addressing the ISGAN principal areas of focus; and near-term project duration. Projects included in the Inventory will be subject to further analysis by ISGAN Participants.

Multinational-level motivating drivers and technology priorities are being used to down select projects from those in the Inventory selected by each Participant to meet that country's prioritized assessment results and other criteria above. The down-selected projects will be targeted for information exchange and project collaboration (under Task 3 in the Annex 1 *Programme of Work*). One of the information exchange forums employed by Annex 1 is the ISGAN Smart Grid Project Webinar Series, which is being conducted in partnership with the Clean Energy Solutions Center (CESC) and the Global Smart Grid Federation (GSGF). To date, six smart grid webinars have been conducted, as shown in Table 4, each featuring a smart grid

project in the ISGAN Inventory and meeting multinational assessment priorities of smart grid motivating drivers and technologies from the 2012 study. The assessment results from the 2014 study as described in this report will be used to guide selection of projects for future webinars. Going forward, Annex 1 plans to conduct one ISGAN Smart Grid Project Webinar every one-to-two months.

Table 4. List of ISGAN Smart Grid Project Webinars Conducted or Scheduled as of 26 September 2014

Webinar Date	Smart Grid Project	Project Country (ISGAN Participant)
10 July 2013	Transactive Control	United States
5 December 2013	Salzburg Project	Austria
23 January 2014	Grid4EU Project	Europe-wide
6 March 2014	Jeju Field Trial Project	Republic of Korea
15 May 2014	Smart Community Demonstrate Project in Kita-Kyushu City	Japan
2 July 2014	The PowerShift Atlantic Smart Grid Demonstration of a Virtual Power Plant	Canada
9 October 2014	SmartSacramento	United States
January 2015	Swedish Smart Grid	Sweden

APPENDIX:
Tables of National-Level Prioritized Assessment Results of Motivating Drivers and Driver-Technology Pairs

Table A.1 **Australia**

Prioritized Assessment Results of Motivating Drivers and Driver-Technology Pairs (1 being highest priority)

Driver Rank	Driver / Technologies	Technology Rank
1	Reliability improvements	
	Fault detection, identification, and restoration (FDIR)	1
	Advanced metering infrastructure (AMI)	2
	Smart network management for coordinated transmission and distribution operations	3
	Distribution management systems	4
	Distributed energy resources integration	5
2	Power restoration improvements	
	Fault detection, identification, and restoration (FDIR)	1
	Advanced metering infrastructure (AMI)	2
	Information and communications technology	3
	Smart network management for coordinated transmission and distribution operations	4
	Distribution feeder circuit automation	5
3	System efficiency improvements	
	Advanced metering infrastructure (AMI)	1
	Information and communications technology	2
	Power electronics-based devices	3
	Distributed energy resources integration	4
	Renewables energy sources integration	5
4	Enabling customer choice and participation	
	Advanced metering infrastructure (AMI)	1
	Smart homes	2
	Direct load control	3
	Distributed energy resources integration	4
	Building energy management and automation	5
5	Power quality improvements	
	Advanced metering infrastructure (AMI)	1
	Voltage & VAR control	2
	Condition-based monitoring and maintenance	3
	Distribution management systems and outage management systems	4
	Substation & transmission line sensors	5
6	Enabling new products, services, and markets	
	Standards and conformance testing	1
	Advanced metering infrastructure (AMI)	2
	Distribution management systems and outage management systems	3
	Smart network management for coordinated transmission and distribution operations	4
	Information and communications technology	5

Table A.2 **Austria**

Prioritized Assessment Results of Motivating Drivers and Driver-Technology Pairs (1 being highest priority)

Driver Rank	Driver / Technologies	Technology Rank
1	Renewable energy standards or targets	
	Renewables energy sources integration	1
	Distributed energy resources integration	2
	Hydro power	3
	Solar photovoltaic and solar thermal energy	4
	Energy storage integration	5
2	Optimizing asset utilization	
	Distribution management systems and outage management systems	1
	Other: System wide monitoring, measurement, and control	2
	Resource planning, analysis, and forecasting tools	3
	Direct load control	4
	Smart network management for coordinated transmission and distribution operations	5
3	Enabling customer choice and participation	
	Distributed energy resources integration	1
	Direct load control	2
	Advanced metering infrastructure (AMI)	3
	Smart homes	4
	Building energy management and automation	5
4	Enabling new products, services, and markets	
	Distributed energy resources integration	1
	Information and communications technology	2
	Distribution management systems and outage management systems	3
	Building energy management and automation	4
	Advanced metering infrastructure (AMI)	5
5	Power quality improvements	
	Voltage & VAR control	1
	Resource planning, analysis, and forecasting tools	2
	Other: System wide monitoring, measurement, and control	3
	Power electronics-based devices	4
	Distribution feeder circuit automation	5
6	Economic advantages	
	Distributed energy resources integration	1
	Distribution management systems and outage management systems	2
	Advanced metering infrastructure (AMI)	3
	Direct load control	4
	Information and communications technology	5

Table A.3 **Belgium**

Prioritized Assessment Results of Motivating Drivers and Driver-Technology Pairs (1 being highest priority)

Driver Rank	Driver / Technologies	Technology Rank
1	Renewable energy standards or targets	
	Wind	1
	Solar photovoltaic and solar thermal energy	2
	Biomass	3
	Building energy management and automation	4
	Electric vehicles and associated supply equipment	5
2	Transmission adequacy	
	Novel market models	1
	Advanced conductors for transmission lines	2
	Energy storage integration	3
	High-voltage DC (HVDC) and High-voltage AC (HVAC) systems	4
	Dynamic-thermal circuit rating	5
3	System efficiency improvements	
	Other: Demand response	1
	Novel market models	2
	Electric vehicles and associated supply equipment	3
	Advanced metering infrastructure (AMI)	4
	Substation & transmission line sensors	5
4	Enabling customer choice and participation	
	Novel market models	1
	Energy storage integration	2
	Information and communications technology	3
	Advanced metering infrastructure (AMI)	4
	Electric vehicles and associated supply equipment	5
5	Government incentives	
	Wind	1
	Solar photovoltaic and solar thermal energy	2
	Biomass	3
	Electric vehicles and associated supply equipment	4
	Renewables energy sources integration	5
6	Aging infrastructure concerns	
	Distribution management systems and outage management systems	1
	Substation & transmission line sensors	2
	Other: Tools for planning, operation, analysis	3
	Power electronics-based devices	4
	System wide monitoring, measurement and control	5

Table A.4 **Canada**

Prioritized Assessment Results of Motivating Drivers and Driver-Technology Pairs (1 being highest priority)

Driver Rank	Driver / Technologies	Technology Rank
1	System efficiency improvements	
	Power electronics-based devices	1
	Enterprise back office system	2
	Resource planning, analysis, and forecasting tools	3
	Integration of demand-side management (DSM) in transmission operations	4
	Distribution feeder circuit automation	5
2	Power restoration improvements	
	Distribution management systems and outage management systems	1
	Fault detection, identification, and restoration (FDIR)	2
	Distribution feeder circuit automation	3
	Advanced metering infrastructure (AMI)	4
	Power electronics-based devices	5
3	Reliability improvements	
	Distribution management systems	1
	Distribution feeder circuit automation	2
	Voltage & VAR control	3
	Fault detection, identification, and restoration (FDIR)	4
	Distributed energy resources integration	5
4	Aging infrastructure concerns	
	Resource planning, analysis, and forecasting tools	1
	Phasor measurement systems	2
	Integration of demand-side management (DSM) in transmission operations	3
5	Renewable energy standards or targets	
	Renewables energy sources integration	1
	Microgrids, minigrids, and local sustainable energy	2
	Distributed energy resources integration	3
	Solar photovoltaic and solar thermal energy	4
	Wind	5
6	Revenue collection and assurance improvements	
	Advanced metering infrastructure (AMI)	1
	Enterprise back office system	2
	Information and communications technology	3

Table A.5 China

Prioritized Assessment Results of Motivating Drivers and Driver-Technology Pairs (1 being highest priority)

Driver Rank	Driver / Technologies	Technology Rank
1	Transmission adequacy	
	High-voltage DC (HVDC) and High-voltage AC (HVAC) systems	1
	Smart network management for coordinated transmission and distribution operations	2
	Renewables energy sources integration	3
	Energy storage integration	4
	Information and communications technology	5
2	National security concerns	
	Smart network management for coordinated transmission and distribution operations	1
	Resource planning, analysis, and forecasting tools	2
	Cyber security	3
	Distribution feeder circuit automation	4
	Fault detection, identification, and restoration (FDIR)	5
3	Renewable energy standards or targets	
	Wind	1
	Hydro power	2
	Solar photovoltaic and solar thermal energy	3
	Renewables energy sources integration	4
	Resource planning, analysis, and forecasting tools	5
4	Environmental advantages	
	Wind	1
	Hydro power	2
	Solar photovoltaic and solar thermal energy	3
	Biomass	4
	Biogas	5
5	Enabling new products, services, and markets	
	Distribution management systems and outage management systems	1
	Distributed energy resources integration	2
	Microgrids, minigrids, and local sustainable energy	3
	Advanced metering infrastructure (AMI)	4
	Novel market models	5
6	Economic advantages	
	Renewables energy sources integration	1
	Integration of demand-side management (DSM) in transmission operations	2
	Distribution management systems and outage management systems	3
	Ancillary services by distribution system operators	4
	Novel market models	5

Table A.6 Finland

Prioritized Assessment Results of Motivating Drivers and Driver-Technology Pairs (1 being highest priority)

Driver Rank	Driver / Technologies	Technology Rank
1	Reliability improvements	
	Fault detection, identification, and restoration (FDIR)	1
	Distribution feeder circuit automation	2
	Information and communications technology	3
	Enterprise back office system	4
	Power electronics-based devices	5
2	Enabling new products, services, and markets	
	Smart homes	1
	Advanced metering infrastructure (AMI)	2
	Electric vehicles and associated supply equipment	3
	Distributed energy resources integration	4
	Building energy management and automation	5
3	Optimizing asset utilization	
	Resource planning, analysis, and forecasting tools	1
	Condition-based monitoring and maintenance	2
	Direct load control	3
	Distribution management systems and outage management systems	4
	Ancillary services by distribution system operators	5
4	Enhanced power system resiliency to natural and human threats	
	Distribution management systems and outage management systems	1
	Enterprise back office system	2
	Distribution feeder circuit automation	3
	Substation & transmission line sensors	4
	Fault detection, identification, and restoration (FDIR)	5
5	Power restoration improvements	
	Enterprise back office system	1
	Information and communications technology	2
	Distribution management systems and outage management systems	3
	Power electronics-based devices	4
	Distribution feeder circuit automation	5
6	System efficiency improvements	
	Distribution management systems and outage management systems	1
	Enterprise back office system	2
	Distribution feeder circuit automation	3
	Advanced metering infrastructure (AMI)	4

Table A.7 **France**

Prioritized Assessment Results of Motivating Drivers and Driver-Technology Pairs (1 being highest priority)

Driver Rank	Driver / Technologies	Technology Rank
1	System efficiency improvements	
	Advanced metering infrastructure (AMI)	1
	Distributed energy resources integration	2
	Enterprise back office system	3
	Resource planning, analysis, and forecasting tools	4
	Distribution management systems and outage management systems	5
2	Renewable energy standards or targets	
	Distributed energy resources	1
	Large size variable renewables energy sources integration	2
	Distributed energy resources integration	3
	Resource planning, analysis, and forecasting tools	4
	Energy storage	5
3	Other Security	
	Distribution management systems and outage management systems	1
	Distribution feeder circuit automation	2
	Voltage & VAR control	3
	Advanced metering infrastructure (AMI)	4
	Enterprise back office system	5
4	Optimizing asset utilization	
	Demand response	1
	Condition-based monitoring and maintenance	2
	Tools for planning, operation, analysis	3
	Distribution feeder circuit automation	4
	Advanced metering infrastructure (AMI)	5
5	Enabling new products, services, and markets	
	Advanced metering infrastructure (AMI)	1
	Building energy management and automation	2
	Other: Demand response	3
	Smart homes	4
	Electric vehicles and associated supply equipment	5
6	Enabling customer choice and participation	
	Advanced metering infrastructure (AMI)	1
	Smart homes	2
	Other: Demand response	3
	Building energy management and automation	4
	Enterprise back office system	5

Table A.8 Germany

Prioritized Assessment Results of Motivating Drivers and Driver-Technology Pairs (1 being highest priority)

Driver Rank	Driver	Technologies	Technology Rank
1	Renewable energy standards or targets		
		Renewables energy sources integration	1
		Distributed energy resources integration	2
		Wind	3
		Solar photovoltaic and solar thermal energy	4
		Resource planning, analysis, and forecasting tools	5
2	Environmental advantages		
		Renewable energy sources integration	1
		Distributed energy resources integration	2
		Wind	3
		Solar photovoltaic and solar thermal energy	4
		Integration of demand-side management (DSM) in transmission operations	5
3	Energy efficiency improvements		
		Distributed energy resources integration	1
		Renewables energy sources integration	2
		Integration of demand-side management (DSM) in transmission operations	3
		High-voltage DC (HVDC) and High-voltage AC (HVAC) system technologies	4
		Information and communications technology	5
4	System efficiency improvements		
		Distributed energy resources integration	1
		Renewables energy sources integration	2
		High-voltage DC (HVDC) and High-voltage AC (HVAC) system technologies	3
		Smart network management for coordinated transmission and distribution operations	4
		Resource planning, analysis, and forecasting tools	5
5	Reliability improvements		
		Distributed energy resources integration	1
		Resource planning, analysis, and forecasting tools	2
		Smart network management for coordinated transmission and distribution operations	3
		Integration of demand-side management (DSM) in transmission operations	4
		Energy storage integration	5
6	Government incentives		
		Renewables energy sources integration	1
		Distributed energy resources integration	2
		Wind	3
		Solar photovoltaic and solar thermal energy	4
		High-voltage DC (HVDC) and High-voltage AC (HVAC) systems	5

Table A.9 **India**

Prioritized Assessment Results of Motivating Drivers and Driver-Technology Pairs (1 being highest priority)

Driver Rank	Driver / Technologies	Technology Rank
1	Revenue collection and assurance improvements	
	Advanced metering infrastructure (AMI)	1
	Enterprise back office system	2
	Information and communications technology	3
2	System efficiency improvements	
	Advanced metering infrastructure (AMI)	1
	Novel market models	2
	Resource planning, analysis, and forecasting tools	3
	Microgrids, minigrids, and local sustainable energy	4
	Electric vehicles and associated supply equipment	5
3	Reliability improvements	
	Distribution management systems	1
	Power electronics-based devices	2
	Fault detection, identification, and restoration (FDIR)	3
	Distributed energy resources integration	4
	Condition-based monitoring and maintenance	5
4	Renewable energy standards or targets	
	Distributed energy resources integration	1
	Renewables energy sources integration	2
	Solar photovoltaic and solar thermal energy	3
	Smart homes	4
	Electric vehicles and associated supply equipment	5
5	Power quality improvements	
	Voltage & VAR control	1
	Flexible alternating current transmission system (FACTS) devices	2
	Other: Harmonic filters	3
	Condition-based monitoring and maintenance	4
	Ancillary services by distribution system operators	5

Table A.10 Ireland

Prioritized Assessment Results of Motivating Drivers and Driver-Technology Pairs (1 being highest priority)

Driver Rank	Driver / Technologies	Technology Rank
1	Enabling new products, services, and markets	
	Information and communications technology	1
	Other: system wide monitoring, measurement, and control	2
	Distributed energy resources integration	3
	Distribution management systems and outage management systems	4
	Building energy management and automation	5
2	Renewable energy standards or targets	
	Distributed energy resources integration	1
	Wind	2
	Other: system wide monitoring, measurement, and control	3
	Integration of demand-side management (DSM) in transmission operations	4
	Renewables energy sources integration	5
3	Economic advantages	
	Distributed energy resources integration	1
	Other: system wide monitoring, measurement, and control	2
	Information and communications technology	3
	Renewables energy sources integration	4
	Integration of demand-side management (DSM) in transmission operations	5
4	System efficiency improvements	
	Distributed energy resources integration	1
	Other: system wide monitoring, measurement, and control	2
	Information and communications technology	3
	Advanced metering infrastructure (AMI)	4
	Building energy management and automation	5
5	Job creation	
	Distributed energy resources integration	1
	Other: system wide monitoring, measurement, and control	2
	Information and communications technology	3
	Advanced metering infrastructure (AMI)	4
	Building energy management and automation	5
6	Reliability improvements	
	Information and communications technology	1
	Phasor measurement systems	2
	Distributed energy resources integration	3
	Other: large scale variable renewable energy integration	4
	Resource planning, analysis, and forecasting tools	5

Table A.11 Italy

Prioritized Assessment Results of Motivating Drivers and Driver-Technology Pairs (1 being highest priority)

Driver Rank	Driver / Technologies	Technology Rank
1	Renewable energy standards or targets	
	Renewables energy sources integration	1
	Resource planning, analysis, and forecasting tools	2
	Solar photovoltaic and solar thermal energy	3
	Distributed energy resources integration	4
	Energy storage integration	5
2	National security concerns	
	Resource planning, analysis, and forecasting tools	1
	Smart network management for coordinated transmission and distribution operations	2
	Distribution management systems and outage management systems	3
	Fault detection, identification, and restoration (FDIR)	4
	Information and communications technology	5
3	Reducing operating and maintenance costs	
	Distribution management systems and outage management systems	1
	Advanced metering infrastructure (AMI)	2
	Condition-based monitoring and maintenance	3
	Substation & transmission line sensors	4
	Information and communications technology	5
4	System efficiency improvements	
	Advanced metering infrastructure (AMI)	1
	Distribution management systems and outage management systems	2
	Integration of demand-side management (DSM) in transmission operations	3
	Flexible alternating current transmission system (FACTS) devices	4
	Energy storage integration	5
5	Power quality improvements	
	Distribution management systems and outage management systems	1
	Distribution feeder circuit automation	2
	Fault detection, identification, and restoration (FDIR)	3
	Energy storage integration	4
	Information and communications technology	5
6	Economic advantages	
	Ancillary services by distribution system operators	1
	Novel market models	2
	Information and communications technology	3
	Dynamic-thermal circuit rating	4

Table A.12 Japan

Prioritized Assessment Results of Motivating Drivers and Driver-Technology Pairs (1 being highest priority)

Driver Rank	Driver / Technologies	Technology Rank
1	Reliability improvements	
	Building energy management and automation	1
	Distributed energy resources integration	2
	Energy storage integration	3
	Renewables energy sources integration	4
	Information and communications technology	5
2	Generation adequacy	
	Smart network management for coordinated transmission and distribution operations	1
	Natural gas combined cycle	2
	Resource planning, analysis, and forecasting tools	3
	Energy storage integration	4
	Information and communications technology	5
3	Power quality improvements	
	Smart homes	1
	Building energy management and automation	2
	Distribution management systems and outage management systems	3
	Energy storage integration	4
	Renewables energy sources integration	5
4	System efficiency improvements	
	Smart network management for coordinated transmission and distribution operations	1
	Resource planning, analysis, and forecasting tools	2
	Condition-based monitoring and maintenance	3
	Distributed energy resources integration	4
	Direct load control	5
5	Energy efficiency improvements	
	Advanced metering infrastructure (AMI)	1
	Smart homes	2
	Building energy management and automation	3
	High-voltage DC (HVDC) and High-voltage AC (HVAC) systems	4
	Energy storage integration	5
6	Enabling customer choice and participation	
	Smart homes	1
	Building energy management and automation	2
	Energy storage integration	3

Table A.13 Republic of Korea

Prioritized Assessment Results of Motivating Drivers and Driver-Technology Pairs (1 being highest priority)

Driver Rank	Driver	Technologies	Technology Rank
1	Enabling customer choice and participation		
		Advanced metering infrastructure (AMI)	1
		Energy storage integration	2
		Microgrids, minigrids, and local sustainable energy	3
		Building energy management and automation	4
		Electric vehicles and associated supply equipment	5
2	Energy efficiency improvements		
		Energy storage integration	1
		Microgrids, minigrids, and local sustainable energy	2
		Advanced metering infrastructure (AMI)	3
		Building energy management and automation	4
		Distributed energy resources integration	5
3	System efficiency improvements		
		Energy storage integration	1
		Microgrids, minigrids, and local sustainable energy	2
		Advanced metering infrastructure (AMI)	3
		Building energy management and automation	4
		Distributed energy resources integration	5
4	Renewable energy standards or targets		
		Wind	1
		Energy storage integration	2
		Microgrids, minigrids, and local sustainable energy	3
		Distributed energy resources integration	4
		Building energy management and automation	5
5	Government incentives		
		Energy storage integration	1
		Distributed energy resources integration	2
		Advanced metering infrastructure (AMI)	3
		Building energy management and automation	4
		Electric vehicles and associated supply equipment	5
6	Reliability improvements		
		Energy storage integration	1
		Advanced metering infrastructure (AMI)	2
		Microgrids, minigrids, and local sustainable energy	3
		Building energy management and automation	4
		Phasor measurement systems	5

Table A.14 Mexico

Prioritized Assessment Results of Motivating Drivers and Driver-Technology Pairs (1 being highest priority)

Driver Rank	Driver / Technologies	Technology Rank
1	Reliability improvements	
	Resource planning, analysis, and forecasting tools	1
	Smart network management for coordinated transmission and distribution operations	2
	Power electronics-based devices	3
	Distributed energy resources integration	4
	Distribution management systems	5
2	Renewable energy standards or targets	
	Renewables energy sources integration	1
	Distributed energy resources integration	2
	Integration of demand-side management (DSM) in transmission operations	3
	Wind	4
	Solar photovoltaic and solar thermal energy	5
3	System efficiency improvements	
	Information and communications technology	1
	Renewables energy sources integration	2
	Market simulation tools	3
	Distribution management systems and outage management systems	4
	Novel market models	5
4	Enabling customer choice and participation	
	Information and communications technology	1
	Cyber security	2
	Advanced metering infrastructure (AMI)	3
	Distributed energy resources integration	4
	Electric vehicles and associated supply equipment	5
5	Enabling new products, services, and markets	
	Novel market models	1
	Standards and conformance testing	2
	Advanced metering infrastructure (AMI)	3
	Cyber security	4
	Microgrids, minigrids, and local sustainable energy	5
6	Aging workforce concerns	
	Other: Educational programs for new specialists	1

Table A.15 The Netherlands

Prioritized Assessment Results of Motivating Drivers and Driver-Technology Pairs (1 being highest priority)

Driver Rank	Driver / Technologies	Technology Rank
1	Enabling new products, services, and markets	
	Market simulation tools	1
	Electric vehicles and associated supply equipment	2
	Smart homes	3
	Standards and conformance testing	4
	Building energy management and automation	5
2	System efficiency improvements	
	Distributed energy resources integration	1
	Power electronics-based devices	2
	Integration of demand-side management (DSM) in transmission operations	3
	Smart homes	4
	Electric vehicles and associated supply equipment	5
3	Aging infrastructure concerns	
	Smart network management for coordinated transmission and distribution operations	1
	Integration of demand-side management (DSM) in transmission operations	2
	Standards and conformance testing	3
4	Renewable energy standards or targets	
	Solar photovoltaic and solar thermal energy	1
	Wind	2
	Electric vehicles and associated supply equipment	3
	Building energy management and automation	4
	Smart homes	5
5	Optimizing asset utilization	
	Integration of demand-side management (DSM) in transmission operations	1
	Building energy management and automation	2
	Electric vehicles and associated supply equipment	3
	Microgrids, minigrids, and local sustainable energy	4
6	Transmission adequacy	
	Smart network management for coordinated transmission and distribution operations	1
	Integration of demand-side management (DSM) in transmission operations	2
	Renewables energy sources integration	3
	Market simulation tools	4

Table A.16 Russia

Prioritized Assessment Results of Motivating Drivers and Driver-Technology Pairs (1 being highest priority)

Driver Rank	Driver / Technologies	Technology Rank
1	Economic advantages	
	Advanced metering infrastructure (AMI)	1
	Distribution management systems and outage management systems	2
	Distribution feeder circuit automation	3
	Building energy management and automation	4
	Information and communications technology	5
2	Reliability improvements	
	Fault detection, identification, and restoration (FDIR)	1
	Advanced metering infrastructure (AMI)	2
	Distribution management systems	3
	Power electronics-based devices	4
	Cyber security	5
3	System efficiency improvements	
	Smart network management for coordinated transmission and distribution operations	1
	Integration of demand-side management (DSM) in transmission operations	2
	Building energy management and automation	3
	Distribution management systems and outage management systems	4
	Enterprise back office system	5
4	Optimizing asset utilization	
	Resource planning, analysis, and forecasting tools	1
	Condition-based monitoring and maintenance	2
	Integration of demand-side management (DSM) in transmission operations	3
	Distribution feeder circuit automation	4
5	Revenue collection and assurance improvements	
	Advanced metering infrastructure (AMI)	1
	Enterprise back office system	2
	Information and communications technology	3
6	Energy efficiency improvements	
	Integration of demand-side management (DSM) in transmission operations	1
	Advanced metering infrastructure (AMI)	2
	Resource planning, analysis, and forecasting tools	3
	Building energy management and automation	4
	Distributed energy resources integration	5

Table A.17 Singapore

Prioritized Assessment Results of Motivating Drivers and Driver-Technology Pairs (1 being highest priority)

Driver Rank	Driver / Technologies	Technology Rank
1	Enabling customer choice and participation	
	Advanced metering infrastructure (AMI)	1
	Smart homes	2
2	Enabling new products, services, and markets	
	Advanced metering infrastructure (AMI)	1
	Smart homes	2

Table A.18 South Africa

Prioritized Assessment Results of Motivating Drivers and Driver-Technology Pairs (1 being highest priority)

Driver Rank	Driver / Technologies	Technology Rank
1	Generation adequacy	
	Other: Advanced demand forecast & load monitoring	1
	Phasor measurement units	2
2	Revenue collection and assurance improvements	
	Other: Prepaid metering technology	1
	Advanced metering infrastructure (AMI)	2
	Other: Remote connect & disconnect	3
3	Aging infrastructure concerns	
	Distribution feeder circuit automation	1
	Substation & transmission line sensors	2
	Other: Dynamic equipment rating	3
	Other: Demand side management	4
4	Economic advantages	
	Direct load control	1
	Other: Optimized electrification design	2
	High-voltage DC (HVDC) and High-voltage AC (HVAC) systems	3
5	Reducing operating and maintenance costs	
	Condition-based monitoring and maintenance	1
	Other: Network automation	2
	Substation & transmission line sensors	3
6	System efficiency improvements	
	High-voltage DC (HVDC) and High-voltage AC (HVAC) systems	1
	Condition-based monitoring and maintenance	2
	Power electronics-based devices	3
	Distribution feeder circuit automation	4

Table A.19 Spain

Prioritized Assessment Results of Motivating Drivers and Driver-Technology Pairs (1 being highest priority)

Driver Rank	Driver	Technologies	Technology Rank
1	System efficiency improvements		
		Advanced metering infrastructure (AMI)	1
		Novel market models	2
		Renewables energy sources integration	3
		Smart network management for coordinated transmission and distribution operations	4
		Electric vehicles and associated supply equipment	5
2	Reducing operating and maintenance costs		
		Advanced metering infrastructure (AMI)	1
		Information and communications technology	2
3	Environmental advantages		
		Wind	1
		Natural gas combined cycle	2
		Solar photovoltaic and solar thermal energy	3
		Distributed energy resources integration	4
		Electric vehicles and associated supply equipment	5
4	Enabling customer choice and participation		
		Advanced metering infrastructure (AMI)	1
		Novel market models	2
		Distributed energy resources integration	3
		Information and communications technology	4
		Electric vehicles and associated supply equipment	5
5	Enabling new products, services, and markets		
		Advanced metering infrastructure (AMI)	1
		Novel market models	2
		Distributed energy resources integration	3
		Smart network management for coordinated transmission and distribution operations	4
		Information and communications technology	5
6	Economic advantages		
		Advanced metering infrastructure (AMI)	1
		Novel market models	2
		Distributed energy resources integration	3
		Renewables energy sources integration	4
		Information and communications technology	5

Table A.20 Sweden

Prioritized Assessment Results of Motivating Drivers and Driver-Technology Pairs (1 being highest priority)

Driver Rank	Driver / Technologies	Technology Rank
1	System efficiency improvements	
	Smart network management for coordinated transmission and distribution operations	1
	Renewables energy sources integration	2
	Advanced metering infrastructure (AMI)	3
	High-voltage DC (HVDC) and High-voltage AC (HVAC) systems	4
	Market simulation tools	5
2	Enabling customer choice and participation	
	Advanced metering infrastructure (AMI)	1
	Smart homes	2
	Novel market models	3
	Information and communications technology	4
	Cyber security	5
3	Enabling new products, services, and markets	
	Information and communications technology	1
	Smart homes	2
	Advanced metering infrastructure (AMI)	3
	Energy storage integration	4
	Distribution management systems and outage management systems	5
4	Renewable energy standards or targets	
	Wind	1
	Hydro power	2
	Renewables energy sources integration	3
	Solar photovoltaic and solar thermal energy	4
	Biomass	5
5	Optimizing asset utilization	
	Smart network management for coordinated transmission and distribution operations	1
	Integration of demand-side management (DSM) in transmission operations	2
	Distribution management systems and outage management systems	3
	Information and communications technology	4
	Condition-based monitoring and maintenance	5
6	Reliability improvements	
	Fault detection, identification, and restoration (FDIR)	1
	Advanced metering infrastructure (AMI)	2
	Condition-based monitoring and maintenance	3
	Standards and conformance testing	4
	Integration of demand-side management (DSM) in transmission operations	5

Table A.21 Switzerland

Prioritized Assessment Results of Motivating Drivers and Driver-Technology Pairs (1 being highest priority)

Driver Rank	Driver / Technologies	Technology Rank
1	Generation adequacy	
	Ancillary services by distribution system operators	1
	Solar photovoltaic and solar thermal energy	2
	Energy storage integration	3
	Natural gas combined cycle	4
	Novel market models	5
2	Optimizing asset utilization	
	Smart network management for coordinated transmission and distribution operations	1
	Distribution management systems and outage management systems	2
	Condition-based monitoring and maintenance	3
	Direct load control	4
	Information and communications technology	5
3	Transmission adequacy	
	Smart network management for coordinated transmission and distribution operations	1
	Energy storage integration	2
	Market simulation tools	3
	Novel market models	4
	High-voltage DC (HVDC) and High-voltage AC (HVAC) systems	5
4	Aging infrastructure concerns	
	Distribution management systems and outage management systems	1
	Information and communications technology	2
	Substation & transmission line sensors	3
5	Reducing operating and maintenance costs	
	Distribution management systems and outage management systems	1
	Condition-based monitoring and maintenance	2
	Distribution feeder circuit automation	3
	Advanced metering infrastructure (AMI)	4
6	Enabling customer choice and participation	
	Ancillary services by distribution system operators	1
	Integration of demand-side management (DSM) in transmission operations	2
	Distributed energy resources integration	3
	Information and communications technology	4
	Enterprise back office system	5

Table A.22 United States

Prioritized Assessment Results of Motivating Drivers and Driver-Technology Pairs (1 being highest priority)

Driver Rank	Driver / Technologies	Technology Rank
1	Reliability improvements	
	Distribution management systems	1
	Information and communications technology	2
	Smart network management for coordinated transmission and distribution operations	3
	Fault detection, identification, and restoration (FDIR)	4
	Microgrids, minigrids, and local sustainable energy	5
2	System efficiency improvements	
	Information and communications technology	1
	Novel market models	2
	Distribution management systems and outage management systems	3
	Building energy management and automation	4
	Distributed energy resources integration	5
3	Reducing operating and maintenance costs	
	Distribution management systems and outage management systems	1
	Information and communications technology	2
	Condition-based monitoring and maintenance	3
	Distribution feeder circuit automation	4
	Building energy management and automation	5
4	Enhanced power system resiliency to natural and human threats	
	Microgrids, minigrids, and local sustainable energy	1
	Distribution management systems and outage management systems	2
	Phasor measurement systems	3
	Power electronics-based devices	4
	Information and communications technology	5
5	Regulatory compliance	
	Renewable energy sources integration	1
	Ancillary services by distribution system operators	2
	Cyber security	3
	Standards and conformance testing	4
6	Aging infrastructure concerns	
	Smart network management for coordinated transmission and distribution operations	1
	Information and communications technology	2
	Power electronics-based devices	3
	Phasor measurement systems	4
	High-voltage DC (HVDC) and High-voltage AC (HVAC) systems	5