STRATEGIC PLAN
2016 - 2021

International Energy Agency
Implementing Agreement for a Co-operative Programme for Assessing the Impacts of **High-Temperature Superconductivity** on the Electric Power Sector

SUPERCONDUCTIVITY
International Energy Agency

Strategic Plan 2016 - 2021

Foreword

This document is the Strategic Plan for the International Energy Agency (IEA) Implementing Agreement for a Co-operative Programme for Assessing the Impacts of High-Temperature Superconductivity on the Electric Power Sector (HTS IA). Its purpose is to provide direction and focus for the HTS IA during the next term, March 2016–February 2021.

It should be considered in association with the HTS IA End-of-Term report. This Strategic Plan was prepared by Brian Marchionini (HTS IA Operating Agent) with contributions from, and under the direction of, the HTS IA Executive Committee (Ex Co) and it was unanimously accepted by them on 09 July 2015.

9 July 2015

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Summary

This Implementing Agreement brings together institutions located in nine nations who are all leaders in the effort to develop innovative electric power equipment that incorporates high temperature superconductors. The focus is on equipment for the power sector, comprising electric utilities and their large energy consuming customers, as well as large stand-alone producers and consumers of electric energy. The implementing agreement's mission is to assess the state of efforts to advance superconductivity to devices that will significantly improve the generation, transmission, distribution and end use of electric power.

During the next term of the implementing agreement (IA), there are a number of activities the Implementing Agreement plans to undertake to help with meeting its mission. For instance, the IA will provide thought leadership to develop large-scale electric power projects that will help to reduce greenhouse gas emissions, reduce electric transmission and distribution losses, and help facilitate renewable integration.

1. Introduction

In May 2015, the Executive Committee (ExCo) met formally to discuss its strategic direction and the extension of the IEA HTS IA for another term. The ExCo enthusiastically supported an extension of the IA; it realizes the next five years are critical to high-temperature superconductivity (HTS) and have developed several new activities to meet the needs of its diverse stakeholders.

1.1 Background

The mission of the HTS IA is to evaluate the status and assess the prospects for future use of HTS by the electric power sector within the developed and developing world and to disseminate these results to decision makers in government, the private sector, and the research and development (R&D) community.

The HTS Implementing Agreement (HTS IA) has been operating since 1990, making it one of the longest standing in IEA. It has been in existence shortly after the discovery of HTS and now stands on the cusp of helping facilitate more widespread deployment of HTS technology in the electric power sector.

Under the IA, the responsibility to disseminate results entails vigorous outreach directed toward the following:

- *Electric utilities*, where decisions are made about adopting technology
- *Governments*, where decisions are made regarding policies, subsidies, and funding for research, development, and demonstration (RD&D)
- *Professional engineering community*, to which managers must turn for advice and implementation

- *RD&D community*, where the inclination to invent and innovate and solve complex problems resides

Furthermore, the HTS IA members see each of these four communities as sources of expertise that can inform the evaluations and assessments performed under the IA. The IA participants also recognize the importance of educating the next generation of students and young engineers and see this as part of their mission of dissemination.

The IA's unique mission has attracted worldwide co-operation. This mission is particularly important now and continuing over the next decade, because HTS demonstration projects have been successfully carried out and new RD&D projects are under way in Asia, Europe, and North America. The significance of this work, with its potential of better HTS material, conductors, products and devices, gives us much to consider at a time when governments seek impactful cost-effective RD&D and the power sector is subject to changing requirements, particularly because of the public's desire for green power and a sustainable environment.

The work done under the HTS IA reflects the concerns voiced by the electric power sector, as well as those of the RD&D community that makes innovation possible. Those concerns include cost, technical feasibility, reliability, energy efficiency, environmental compatibility, and sustainability. Examples of the HTS based applications for the electric grid that the IA will focus on include:

- **Cables** for higher current density, reduced right of way, and improved efficiency in electricity transmission and distribution
- **Fault current limiters** that act like grid surge protectors and operate with significantly lower losses than conventional technology
- **Superconducting magnetic energy storage** for high density stored power, that can be delivered instantaneously
- **Transformers**, which have much smaller size and weight of conventional devices, and do not use mineral oil as the cooling medium
- **Generators** more compact and efficient as compared to conventional rotating machines to be also applied in off shore wind power applications

2. Strategic Direction

The HTS IA's strategy has three complementary aspects:

1. *Focus on pre-competitive issues.* This allows the IA to focus on cutting-edge HTS research and technology that lies between fundamental basic research conducted mainly in universities and proprietary research performed by industry.

2. *Involve a wide range of stakeholders*. All IA country representatives are obliged to facilitate contacts with relevant persons and institutions in their home countries, provide relevant information, introduce relevant work, identify peer reviewers, furnish the

perspective of likely decision-makers, and disseminate results of the IA's work. The focus on pre-competitive topics of mutual interest made possible the cooperation that has been achieved. By focusing on cooperation and participation, information that might be withheld in other venues is brought forth and shared in this one.

3. P*ro-active outreach* to all leading participants in the development of HTS for ultimate use in the power sector. The IA engages experts whether or not they are located in IA member countries. These leading experts, usually either for-profit firms or research institutes, are asked for their perspective, based upon their own HTS and their broader business experience. They may also be asked to peer-review the IA's draft reports.

The HTS IA can be even more effective by doing the following activities:

- Conduct outreach toward the electric utilities, governments, the professional engineering community, and the RD&D community to confirm and communicate the potential benefits of HTS technology
- Develop position papers and strategic documents such as roadmaps and technical reports
- Provide expertise that can inform the evaluations and assessments performed under the IA
- Efficiently interact with other related IEA IAs to leverage synergies and opportunities
- Disseminate HTS IA work at international fora and workshops and educate students, young engineers, and scientists about HTS applications in the power sector
- Address and clarify perceived risks and hurdles to introduce a disruptive technology into a conservative industry (power technology)

The HTS IA's End-of-Term Report 2010–2016 demonstrated a close alignment of the current strategies of the International Energy Agency (IEA) Committee on Energy Research and Technology (CERT) and Working Party on Energy End-Use Technologies (EUWP), particularly in the following areas:

- Identifying technical challenges and needs for RD&D of superconducting equipment
- Building partnerships with key stakeholders and strengthening the technology network
- Seeking opportunities to collaborate with partner countries
- Considering national policy developments and technology trends
- Identifying technological barriers, defining priorities, and supporting the start of specific research and development activities

During the next term, the HTS IA will continue and expand these activities to strengthen communication with the EUWP and remain consistent with the aims of the CERT and EUWP.

3. Scope

The scope of the HTS IA has been broad, and the key activities to be continued in the next period are listed in section 3.1; several new activities for the new term are listed in section 3.2.

3.1 Action Plan for 2016–2021 Term

Organize meetings and workshops

- The main added value for HTS IA participants is to systematically receive updated information about HTS programs and present and future RD&D activities in all countries active in the HTS field
- Invite industry representatives and observers to join those events in order to share information and contribute, for example by replying to data requests to the strategic documents prepared by the HTS IA

Develop Reports on Subjects of Interest

- Identify topics about which the ExCo members propose to focus on and, after discussion with and agreement by the ExCo, prepare presentations and written reports on technical, policy or market topics for each of the two ExCo meetings each year. Potential topics under discussion include safety issues with HTS devices, environmental benefits of the technology and a "toolkit" for electric utilities that helps them understand the planning and installation requirements.
- Prepare briefing papers for senior managers/policy makers on matters touching HTS and the power sector. These will include both text and appealing graphics.

Enhance Website

- Enhance content of IA's website and keep it up to date. The public section of the website will be used to inform key stakeholders on the technology status and serve as a resource to highlight projects. The "members only" section of the website will continue to be a repository for ExCo members to get meeting minutes and presentations from meetings and workshops.

Document IA activities

- Prepare minutes for ExCo meetings and distribute them to ExCo and IEA
- Prepare two-pagers for the semi-annual meeting of the EUWP and submit the documents to the appropriate EUWP contact.
- Prepare an annual report (including mention of new projects and/or significant milestones of projects underway. This document will be roughly ten to fifteen pages for ExCo members' reference and use.
- Prepare entries for documents that the IEA Secretariat, in particular the Technology R&D Networks.

Be Cognizant of Relevant Considerations within the IEA Secretariat

- Maintain cordial, frequent, and effective relations with operating agents (OA's) of other relevant IAs
- Maintain cordial, frequent, and effective relations with the IEA desk officer for the IA and other desk officers of other relevant IAs
- Maintain good working relations with three distinct offices within the IEA Secretariat: the desk officer, the head of the Technology R&D Network, and the Office of Legal Counsel.
- Maintain good working relations with whomever the EUWP designates as the cognizant person for "electrical IAs."

Facilitate New Memberships

- Solicit new contracting parties and corporate sponsors
- Guide prospective new members through the process of joining that has been established by the IEA Secretariat.
- Prepare the paperwork that IEA requires of applicants for membership in IAs.

Support Individual Members' Efforts, as Appropriate

- Facilitate contacts among individual members of the IA and among these members and others as desired.
- Support individual members' efforts to advance goals compatible with IA's purpose and scope.

Be Cognizant of Other HTS Interest Groups

- Maintain awareness of and/or contact with other HTS interest groups such as the ones listed below:
  - ISTEC - International Superconductivity Technology Center
  - ESAS - European Society for Applied Superconductivity
  - CONECTUS - Consortium of European Companies Determined To Use Superconductivity
  - CCAS - Coalition for the Commercial Application of Superconductors
  - ISIS - International Superconductivity Industry Summit
  - CIGRE - International Council on Large Electric Systems; one of the ExCo members is a Convenor of working group D.1.38 "Emerging Test Techniques Common to High Temperature Superconducting (HTS) Power Applications" and member of working group A.3.23 "Application and feasibility of fault current limiters in power systems"
  - IEC - International Electrotechnical Commission, Technical Committee on Superconductivity (TC90)

Support in Promoting IA Visibility

- Promote IA participation at IEA meetings and workshops, HTS conferences, and other events.
- Prepare draft material to be presented as the IA's contribution to the above events.

3.2 New Activities for 2016–2021 Term

During the ExCo meeting in Montreal in May 2015, the ExCo convened a special session to discuss new activities it was interested in pursuing in the next term. Several of these items include the following:

- Develop a document based on real world examples of the economics of HTS.
- Develop a comprehensive overview of HTS based applications for the power sector.
- Develop a document that investigates the system behavior of HTS applications.
- Update roadmap on an as need basis.
- Develop technology readiness level diagrams for HTS power applications.
- Develop one special edition white paper on a specific topic such as safety, warranties, and standards with HTS applications; outline how superconductivity can play a role in a low carbon society.
- Organize workshops to help gain visibility with these other groups.
- Target experts in the cryogenics area to add technical resources.

3.3 Working Arrangement and Fees

Management of the HTS IA is vested in the ExCo, which meets twice a year. Members of the HTS IA are encouraged to participate in one or more tasks described by the program of work. There are currently two operating agents, one based in the United States and one in Japan, and they are managed by the ExCo whose duties are specified in a contract with the OAs and include provision of technical, secretarial, and other services as required for the organization. The HTS IA operation is supported by a combination of cost sharing, task sharing, and knowledge sharing. Members cover their travel expenses to attend ExCo meetings and bear all the costs incurred in conducting task activities, such as report writing and travel to meetings and workshops.

The ExCo Chairman, vice-chairman and operating agents prepare an annual work plan and associated annual budget for the calendar year, which are submitted for approval by the ExCo. The expenses associated with the operation of the HTS IA Secretariat and annual work plan, including the operating agent's time and travel and other joint costs of the ExCo are met from a Common Fund to which all HTS IA members contribute. As of July 2015, there are no changes foreseen in the working arrangement or current fee structure. The HTS IA is financially secure with the Common Fund, having had surplus for the past several years.

4. Contractual and Management Requirements

The ExCo consists of one voting member from each contracting party with an appointed alternate who may serve on the ExCo if the designated member is unable to do so. There are also two industry sponsors who do not have voting rights. The ExCo meets twice a year, and members and/or their alternates and sponsors are always eager and highly motivated to attend. The ExCo Chairman and Vice-Chairman(s), (in fact, for a significant time within the previous time

period there were two Vice-Chairs: one mainly focusing on HTS material and conductor aspects and the other more on HTS applications in the power sector). They are elected by the ExCo for a minimum term of one year. There are not any plans to revise this in the next term. The current Chairman is Luciano Martini, RSE and Vice-Chairman is Hiroyuki Ohsaki, University of Tokyo.

For the first time in the IA history, the ExCo also developed an operating agent contract and employed two OA's in 2014-2015. By having two operating agents it enables the ExCo to leverage the technical communications expertise from Energetics Incorporated in the United Stated and the extensive technical knowledge from the International Superconductivity Technology Center (ISTEC) in Japan. This unique combination of skill sets was a successful alternative to completing IA activities.

Clear and concise communication was used (and will be used in the next term) among the chairman, vice-chairman and operating agents to ensure there is not any overlap or duplication of activities. Action items for the operating agents are clearly identified with a lead operating agent and supporting role as well as the schedule. The lead operating agent will get input from the other operating agent and ExCo members as needed. With respect to reaching out to and coordinating with HTS stakeholders, the operating agents, chairman and vice-chairman will coordinate closely to ensure there is a clear lead for initiating contact. For instance, with stakeholders residing in Asia, the operating agent from ISETC will have the lead in coordinating with them. For North American stakeholders, the operating agent from Energetics will be the lead. For Europe and surrounding region the Chairman will have the lead in reaching out to those stakeholders, but may ask one of the operating agents to help specifically. The table below was developed to help show the distribution of work for the IA's Programme of Work Area tasks (from Section 3.1) between the operating agents.

Programme of Work Area Tasks	**Energetics**	**ISTEC**	**Notes**
	● high level effort on this task ◐ medium level effort on this task ○ low level effort on this task		
Report on Subjects of Interest	●	●	Technical report – 2 reports first year, one technical and one roadmap, etc., so each operating agent can take responsibility for one report.
Enhance Web-Site	●	○	Content will be provided by ExCo members. It will require more than just maintenance, and in the beginning it will need to have many updates. Energetics leads with ISTEC technical support.
Document IA activities	●	○	Minutes for the meetings, update two-pager, annual report and other communications

Cognizant of Relevant Considerations within IEA	○	◉	Maintain cordial and frequent relations with OA's of other IA's Energetics will connect with network of committees and prepare the documentation required to renew this implementing agreement.
Facilitate New Memberships	◉	◉	While both OAs will strive to do this, the ExCo will also help to make these connections.
Support Individual Members' Efforts	○	○	Both OAs would support on an ad hoc basis.
Cognizant of Other HTS Interests Groups	◉	◉	Both OAs would support on an ad hoc basis.
Manage Finances	○	○	Funding is linked to an RSE account and it can be distributed appropriately to the operating agents.
Support in Promoting IA Visibility	◉	◉	Both OAs could be responsible for this effort.
OA Coordination	●	●	Both OAs will need to closely coordinate before and after ExCo meetings and to develop deliverables and other activities to ensure the duties are being performed efficiently and effectively.

Another component of the contractual and management requirements is the annual report. The annual report is an important communications document that highlights the work conducted by the ExCo over the last year. It also provides a record of showing how the ExCo's activities are in alignment with the strategic direction and objectives.
The annual report will be compiled and edited by the operating agent from Energetics with input and review from the ISTEC operating agent and the ExCo. There are currently no plans to change this. The ExCo plans to improve the utility of the annual plan so that it maps the previous year's activities.

Examples of objectives of the HTS IA include the following:

- To support HTS technology transfer to the power sector, including large industrial consumers and other end-users, by creating and disseminating reliable, intelligible information.
- To contribute to the development of the technology by indicating technical areas that need further attention in order to serve potential future end users and by indicating important goals and evaluating technology, to encourage the steps (technical and institutional) needed for future commercialization of HTS.

- To facilitate the creation of research collaborations and information sharing among international experts in multi-disciplinary fields to address the complex problems of developing HTS technology.
- To support development of reliable, energy-efficient, cost-effective technologies and energy conversion technologies, including technologies that result in improved efficiency and reduced emissions.
- To enhance the appreciation of the opportunities in the electric sector made available by HTS and the challenges to their realization by both policy makers and the general public.

Financial Management

RSE is the account custodian for the implementing agreement responsible for several critical financial components. For instance, RSE's financial manager maintains the budget and general bookkeeping and sends/receives invoices to member countries. The accounting and the bookkeeping are straightforward since a bank account has been opened and is exclusively dedicated to all IEA HTS IA financial issues. The chairman will follow-up with member countries to ensure membership fees are current.

A Common Fund is established by the Executive Committee for the purpose of funding the obligations of the Operating Agent. Each Contracting Party makes an annual contribution to the Common Fund in an amount agreed upon by the Executive Committee. If significant changes in price levels occur, the Executive Committee, acting by unanimity, could decide whether to ensure that the necessary real resources will continue to be available or whether to adjust the Programme of Work to the available funds.

At present the total amount collected by the account custodian from members' annual fee for the common funding is US$207,331, which is apportioned as shown in the table below. This amount is sufficient to cover the Operating Agent estimates for the annual costs of carrying out the Task specified by the Executive Committee and the related travel and incidentals plus additional dissemination activities as approved by the Executive Committee.

IA-HTS TABLE OF CONTRIBUTIONS

Country	
Canada	15,025
Finland	8,195
Germany	30,050
Israel	9,500
Italy	21,700
Japan	49,575
Korea	9,385

Switzerland	9,826
United States	30,025
Sponsors	
Bruker HTS GmbH (Germany)	12,025
Columbus Superconductor (Italy)	12,025
Total	**US$ 207,331**

The HTS IA Fiscal Year is March 1st – February 28th. The present annual budget is sufficient to cover all foreseen IA-HTS tasks in a proper manner and is expected to remain stable in the near future. However, actions towards targeted new members (countries and sponsors) have been taken, thus resulting in a potential increase of the overall budget. Moreover, initial discussions on possible changes of the contracting parties annual fee have been made (e.g. towards a more uniform contribution), but this issue do not have yet a high priority for the ExCo members.

FY2016	FY2017	FY2018	FY2019	FY2020	FY2021
US$ 200,000	US$ 200,000	US$ 230,000	US$ 230,000	US$ 240,000	US$ 240,000

5. Contribution to Technology Evolution/Progress

The core technologies for HTS applications are the wire technology and cryogenics system. The wire technology needs a variety of materials science and process engineering advancement, which can be done wire companies, universities and/or academic societies. Industry requires reasonably low cost wire to be applied to applications such as cables, fault current limiters, which are being demonstrated in many several around the world. For the cryogenics system, it requires a reasonably low price and high reliability.

To help achieve these requirements, the HTS-IA plays an important role. For instance, many of the thought leaders in HTS are members of the IA. The IA then can package the collective knowledge from these experts to the HTS-IA can help disseminate advancements made in materials science and demonstration projects through technology studies and other forms of communication. These communications documents will target end users like utilities, but also policy makers and other interested stakeholders.

The HTS IA plans to continue its emphasis on promoting technological progress through the involvement of its public and private sector delegates, and through participation in meetings and workshops across the world. The HTS IA will also expand its reach by attending workshops and forums in which it does not typically participate. This could include International Workshops on Numerical Modelling of HTS and International Standards Development. The ExCo may host a

webinar on project updates, other technology breakthroughs, or high-level examples that are targeted at technical and non-technical audiences from utilities, industry manufacturers, research community and policy advisors.

6. Contribution to Technology Deployment/market Facilitation

The HTS IA has plans to increase its effort in technology/market facilitation in several ways. First, it plans to hold IEA seminars and workshops in association with its ExCo meetings on both general topics for educational purposes and on technical topics that examine HTS technology deployment issues. Examples include the following:

- *What is superconductivity and what are the environmental benefits of utilization, such as the contribution to mitigation of climate change?*
- *Creating a more reliable and resilient electric grid with superconductivity*

As outlined in the End-of-Term Report 2010–2016, the HTS IA recognizes the importance of dialogue with industry and has initiated very significant liaison with relevant industry sectors, including the organization of joint workshops, seminars, and briefings to help pave the way for fruitful information exchange and knowledge transfer. During the next term, HTS IA will seek to increase communication and active engagement with relevant industry sectors where appropriate, extending the distribution of policy recommendations and newsletters to a wider industry audience and holding more product-specific dialogues. An important audience for technology deployment and market facilitation is working with end-users such as electric utilities. Electric utilities are very conservative in their approach for installing devices on their grid. They need devices (such as cables and fault current limiters) that have long-term performance data to show they will not compromise the reliability of the grid.

Examples of significant conferences and symposiums the ExCo will attend include the following:

- Keynote presentations at the Applied Superconductivity Conference in 2016, 2018 &, and 2020
- Keynote address at the 27th International Symposium on Superconductivity in Japan
- Presentations at the European Conference on Applied Superconductivity in 2015, 2017, 2019, and 2021

The HTS-IA will help the technology reach the wide market adoption stage by doing several things 1) survey key stakeholders on the current status of wire and application development of HTS based electric power devices, 2) present the information collected to help inform decision makers about the technology status, and 3) foster discussion about developing cutting edge projects that seek to solve electric grid issues. In the HTS roadmap update, a survey was conducted with key suppliers and end users. The figure below is a typical example for the wire price expressed in US$/kiloAmp-meter (US$/kAm). Each of the dots indicates on response from a respondent's thought about what cost would need to be hit in order to reach a market penetration level. Widespread adoption would be achieved at a much lower price (around

10US$) in 2030 from the present price range (around 300US$). While some HTS devices are very cost competitive when compared to conventional solutions, a reduction in wire cost will accelerate market adoption. While wire cost is important, reliability, and utility acceptance are other important factors for wide market adoption.

"Second Generation" Wire Cost for wide market adoption (2015)

Price	Today	2020	2025	2030
US$ /kAm	Demonstration	Initial Market Penetration	Market Production	Wide Market Adoption
>300	●●			
100-300	●● ●●	●	●	
50-100	●●	●● ●		●
25-50		●● ●	●●	
10-25			●● ●	●● ●●
5-10				●● ●
<5				●

In summary, the HTS-IA will do the following to help contribution to technology deployment and market facilitation

1) Routinely collect data from industry and other key stakeholders to periodically update the roadmap with and information about core technology advances
2) Develop communications and outreach materials geared towards several audiences such as industry, academia and government.
3) Disseminate results to a wide range of stakeholders to help keep industry aware of ongoing efforts

7. Policy Relevance

The HTS IA is mindful of the importance of communicating with policy makers. There is nothing inevitable about either technical advance or the commercial adoption of its results. Policies should be developed to encourage both. In particular, even after successful demonstration, policy makers must understand the issues and risks related to commercialization and adoption. One of the goals for the Roadmap document is to provide information that could be used to convey results to national policy makers.

Outreach and dissemination of results concerning these topics will be undertaken via traditional

means (detailed reports and conference reports) and also by means (e.g., making the IA's website a resource for others, working with International Electric and Electronic Engineers (IEEE) publications groups, and bringing experts together in conjunction with related service on review panels). During the past two years, the IA has used its website to facilitate the public's appreciation of HTS progress. The IA strives to strike a balance between widely disseminating information and the need for particular value to be retained by member countries that have paid to be in the IA.

The ExCo will provide input for IEA Secretariat analysis on topics such as superconductor generators for large-scale wind turbines and other devices.

The IA's strategy takes a broad view of the topics in its field. If the potential of HTS is to be realized, attention must not be restricted to HTS materials or devices incorporating them. Attention must be paid to related technology such as cryogenics, the systems within which future HTS equipment will operate, the economic incentives that drive them, the legal and institutional rules (e.g., conformity to existing standards and the creation of appropriate new ones) under which these systems operate, and global concerns about reliable supply/delivery, fuel sources, and sustainable interactions with environment that affect the power sector in all countries. This includes system-oriented analysis of the network, large industrial/scientific facilities, local and global environmental consequences, and non-technical analyses targeting policy issues of vital interest for industry.

8. Contribution to Environmental Protection

During the next term, the HTS IA plans to continue to document environmental benefits from the future deployment of HTS power equipment. These benefits would occur both in generation and in transmission and distribution.

With respect to generation, HTS can make off shore wind turbines more economic and thus reduce the cost of the most widely available variable renewable. Today's materials and designs limit wind turbines to roughly 6 MW; more power would entail too much weight on the supporting tower. These towers are particularly expensive to construct and maintain when located off-shore. In general, off-shore locations can offer the most wind power. Because HTS promises to enable much smaller and lighter electrical generators, it also promises to lower the cost of off shore wind power. Lowering the cost of off shore wind energy will contribute to reducing the world's dependence on fossil fuels and improve the environment.

With respect to transmission and distribution, there are several applications that can help contribute to environmental protection including cables, fault current limiters, energy storage, and transformers. The IA has highlighted the benefits of improved environmental footprint, efficiency, and safety to benefits from these HTS applications.

- As HTS cables transport current with essentially no electrical resistance they can transmit up to 10 times more power than conventional copper cables (or can carry equivalent power at much lower voltages). In addition HTS cables and other devices require reduced space in urban environments and they do not produce a magnetic field or heat, which results in lower losses.
- Superconducting fault current limiters help to improve safety and reliability of power systems while helping to integrate variable and distributed generation sources.
- Energy storage systems such as flywheels and superconducting magnetic energy storage (SMES) have the potential to help integrate renewables such as wind and solar.
- HTS transformers use liquid nitrogen as a dielectric fluid and coolant instead of oil, which is used in conventional technologies. Since oil is flammable, whereas a fire hazard is removed and the possibility of contamination from oil leaks is avoided by using liquid nitrogen

9. Contribution to Information Dissemination

The HTS IA plans to continue its co-operation with other institutions serving the power sector and HTS communities. Several of these organizations were listed in section 3.1.

The IA will also seek opportunities for educating young engineers and scientists about superconductivity in the power sector. The first such action was taken about a decade ago, when IA ExCo members accepted the Superconductivity European network invitation to participate in a “summer school” for graduate students and post-docs. This activity has continued in recent years, when IA members organized and taught at the European Summer Schools for Superconductivity.

More opportunities will be sought during the next term. For example, one of the other successful activities that were undertaken late in the last term was to promote superconductivity to young researchers. The HTS IA planned for a special session at the International Symposium on Superconductivity in Tokyo Japan on 26 November 2014 for scientists and engineers under the age of 30 who were interested in superconductivity. Participants submitted abstracts and presented on various very innovative approaches and research topics. A peer review panel consisting of several HTS IA members evaluated the contributions by all presenters and choose a winner. A similar activity is planned during the Applied Superconductivity Conference in the United States in 2016.

One of the key forms of communications is the HTS IA website. This communications tool forms the cornerstone of the communications effort and has evolved significantly over the last term and there are plans for a website update in the next term. The HTS IA conducted a review of the

website and determined that several improvements will be made during the next term including the following:

- Improving technical content, presentation, and navigation
- Providing additional information for non-technical audiences about the benefits of HTS applications

Specifically, in the next term the ExCo will emphasize the following opportunities:

- Developing closer links with the IEA Secretariat in order to maximize the opportunity to use IEA products to help our outreach and engagement with non-member countries
- Strengthening communication with the IEA EUWP
- Establishing formal reporting and communication functions with other relevant organizations, including utilities
- Making better use of the existing linkages among ExCo member countries and relevant groups and organizations
- Developing processes for systematically identifying and communicating with key organizations; this could include updating the IA's fact sheet or developing a short newsletter which could highlight a recent technology innovation
- Continuing to develop relationships with other IEA ExCos such as the International Smart Grid Action Network (ISGAN) and the Hydrogen Implementing Agreement (HIA).

10. Outreach to IEA Member and Partner countries

Since inception, the HTS IA has reached out to IEA member and non-member countries. During the next term, the HTS IA plans to continue to reach out to non-members and get them interested in becoming a member. The ExCo has a goal to recruit new members from two additional continents in the next term. For instance, Brazil is one country that would be a welcome addition to the ExCo. Moreover, Australia and New Zealand would be a beneficial additional to the IA because of their work on HTS transformers. In the next term, the ExCo plans to also have discussions with at least two BRICS countries, and help lay the groundwork for having them join in the next term.

Institutions in several non-member countries have been willing and valuable, albeit unofficial, contributors to the IA. These groups provide information, peer reviews, and alerts to their national plans. The ExCo would prefer that these countries join and support the agreement, but various institutional and financial impediments remain to be surmounted.

The IA will also take action to try and bring back some of countries that withdrew from the HTS IA in past terms including the United Kingdom, Norway, and Sweden.

Countries that express an interest will be granted temporary observer status at ExCo meetings for a limited period while they decide whether to join. Non-member countries will still be able to benefit from the work of the HTS IA by accessing the majority of materials and attending workshops, seminars, and other events.

A summary of countries that the IA plans to reach out to for membership include Brazil, China, France, India, New Zealand, Norway, Russia, South Africa, Spain, Sweden, Turkey, and the United Kingdom.

11. Added Value

While the HTS IA does not directly fund R&D projects, it contributes to reducing the direct or indirect costs of research through collaborative efforts. For instance, by developing documents that contain information about technology type, best practices, economics, and safety of various projects around the world, the ExCo can help facilitate new project development.

The HTS IA is recognized as a major international forum for national groups to combine their efforts with those of industry. Such a combination increases capabilities well beyond those of the individual countries and organizations. There were several ground-breaking superconductivity-based demonstrations in the last term, and there is the potential for this growth to continue well into the future. To support this growth, it is necessary for the HTS IA to build on its achievements to date. Several specific projects where the HTS IA plans to add value are listed below.

- *Developing a roadmap that describes where the HTS industry is now and what steps it should take to realize widespread adoption of superconducting-based devices in the electric sector.* Today, the HTS community has achieved what many said would be impossible ten years ago. The state of the art has progressed to the point that pre-commercial but full-scale equipment is being built for demonstration projects in Asia, Europe, and North America. Now, the challenge is to pass from pre-commercial prototype to engineering material and commercial price and performance. The result is not a foregone conclusion, because many scientific and engineering challenges remain. This roadmap activity, by means of the developed questionnaire, will identify the most important among them, explain why they demand attention, and give the reasons for believing success is possible, including identifying promising lines for future RD&D. Emphasis will be placed on conductor development, AC loss reduction, and cryogenics development; advances in these areas will have broad impact. This will be presented in a way that is accessible to the interested, but not expert, reader, including RD&D decision makers.
- *Bridging the gap between technology developers and electric utility system planners*. Electric utilities system planners have to consider how to adapt their systems to meet future demands. The planners typically perform their tasks with the help of commercial computer programs and models; program is designed to simulate conventional power equipment on their system. Technology developers also use computer programs, but they use ones intended to perform very different tasks such as assisting in analysis of a single piece of equipment. Before adopting HTS equipment, utilities may wish to have modules that simulate the behavior of that equipment in the grid.