IEA Wind Task 41 Annual Progress Reports for IEA Wind TCP ExCo Meeting 87

Task 41: Enabling Wind to Contribute to a Distributed Energy Future

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1 Background and Goals

Task Description:

The purpose of IEA Wind TCP Task 41, "Enabling Wind to Contribute to a Distributed Energy Future," is to expand, coordinate, and facilitate international research on wind as a distributed energy resource to lower its costs and deployment barriers. While large-scale wind project costs have decreased over time, the distributed wind system costs have not seen this same decrease. Task 41 was initiated in January 2019 and will be completed in December 2022 to advance wind technology as a cost-effective and reliable distributed energy resource.

This task work plan is divided into five work packages (WPs):

1. **Standards**: Identification and coordination of research to support an update of international and national technical standards for small and mid-sized wind turbines, allowing expanded innovation.
2. **Data Catalog**: Create an information sharing platform for distributed wind research and data.
3. **Integration**: Expanding international collaboration to enable efficient and reliable integration of wind technology into evolving electricity systems.
4. **Outreach and Collaboration**: Facilitate and coordinate distributed wind research with other IEA tasks and international organizations.
5. **Innovation and Downscaling of Large-Scale Wind Technology**: Apply advances of large-scale wind technology to smaller-scale wind technology.

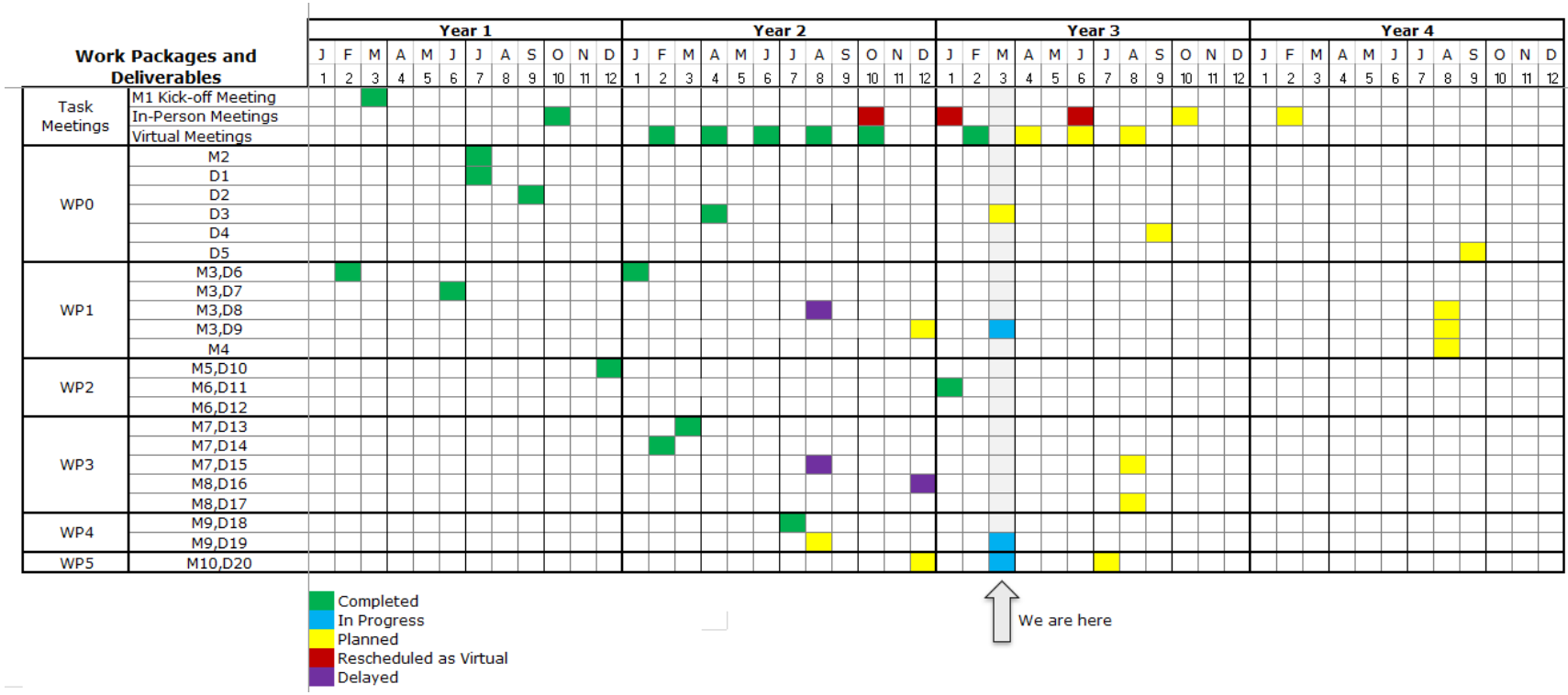
Task Time Plan and Milestones:

The milestones associated with each of these WPs, as well as the lead organizers and contributors, are shown in Table 1. The task schedule for milestones and deliverables is shown in Figure 1. The delayed Milestone 7 is expected to be completed in Summer 2021. The in progress Milestone 10 is expected to be completed in Summer 2021.

Table 1: Milestone Table: Work Plan Milestones, Contributors, and Due Dates

No.	Milestone	Milestone Description	Lead Organizations & Contributors	Milestone Due Date	Milestone Completion
WP0	M1	Project kick-off meeting.	Austria, China, Denmark, Ireland, Poland, South Korea, Spain, United States	Winter 2019	✓
	M2	Launch Task 41 web site	NREL, PNNL	Spring 2019 New web site: Winter 2021	✓
WP1	M3	Wind turbine standards report	NREL	Winter 2020	✓
	M4	Compendium of standards recommendations	NREL	Summer 2022	
WP2	M5	Specification of data sharing catalog	PNNL, DTU, All	December 2019	✓
	M6	Completion of initial implementation of DW data catalog	PNNL, DTU, All	December 2020	✓
WP3	M7	A review document of control and communication for advanced wind system integration	NREL	Summer 2020	Delayed
	M8	State of the industry report on isolated microgrid power systems	NREL	Fall 2021	
WP4	M9	Implementation of IEA Wind TCP task outreach and engagement plan	All	Fall 2019	✓
WP5	M10	Report on downscaling opportunities for mid and small-scale wind turbines	CIEMAT	Fall 2020	In progress

Figure 1 – Task 41 Schedule: Work Packages, Deliverables, Dates



Milestones for past 6 months (October 2020 – March 2021):

- **Milestone 3, Deliverable 9** - Report on recommendations for potential standards changes that will be used to drive additional international research
    - Not achieved, progress delayed pending in anticipation of Asian standards forum
    - Draft document developed based on Europe and American forms, update of U.S. standard, to be published in spring of 2021.
    - Final document planned for summer 2022 following Asian standards forum. Likely to include expanded thinking on VAWT, micro-turbines, and building integrated wind.
- **Milestone 6, Deliverable 11** - Development of data sharing, storage and if needed security protocols for meta data to be stored on the platform. Specification of a potential data sharing portal that expands on the catalog
    - Completed.
- **Milestone 8, Deliverable 16** - Design or best practice guide for the design of high renewable contribution isolated power systems
    - Not achieved, research focus has shifted.
    - This milestone and deliverable may be modified to better fit Task 41 research direction.
- **Milestone 10, Deliverable 20** - Report on the potential opportunities for cost reductions in mid and small scale wind technology based on current LCOE lowering technology innovations being applied to large and offshore turbine technologies
    - Not achieved. Initial work on this task in 2019 stalled due to lack of resources at member organizations to support topic screening.
    - The timeline for this milestone and deliverable has shifted based on the development of a distributed wind University Research Collaboration.
    - Meetings were held in November 2020 and ten specific research challenges were identified. The deliverable report is expected to be formalized and finalized in Summer 2021. More detail is provided in the ‘Progress in WP5’ section of this report.

2 Progress Toward Goals

Progress in WP1

A second North American International Standards Assessment Forum was held virtually in August and September 2020. Planning for the Asian International Standards Assessment Forum was implemented for the summer of 2019 but needed to be delayed and is now being planned for the summer of 2022 in Inner Mongolia. A full standards research report (M3 D9) is being delayed until after the Asian forum.

Discussion topics from the North American forum included conformity assessment, power performance results, aeroelastic models, simplified loads models, and the new U.S. draft standard, the American Clean Power Association (ACPA) Small Wind Technical Standard (SWT)-1 (2021). Detailed discussion of these topics focused on needed research to improve the next revision of the IEC Small Wind Turbine standard, IEC 61400-2. Some of these research needs can be addressed through multi-year contributions from Task 41 experts with the opportunity to empower collaborative targeted research with results available in 2024. These

results can be used for consideration by standards experts working on the fourth revision of IEC 61400-2, currently planned to be revised starting in 2022 or 2023.

Two technical papers are currently being developed by task members, the first provides the justification for updates included in the U.S. ACPA SWT-1 standard and the second is a standards research needs report based on European and North American standards forums. This paper highlights the challenges identified and proposed research needs identified to date. Both papers are expected to be published in the Spring of 2021.

Progress in WP2

Deliverable D11 was completed in January 2021. This report covers the requirements for data sharing, storage, and security protocols for the metadata catalog created and the specification of a potential data sharing portal. The next steps are to explore hosting the metadata on a data sharing portal and identifying the best platform for such a portal. For now, the Task 41 metadata catalog is on the Task 41 SharePoint site as a simple Excel spreadsheet.

Progress in WP3

The remaining deliverables in WP3 focus on controls and isolated power systems. The efforts in this WP are mainly being led by NREL and DTU. During the October 2020 and Feburary 2021 virtual task meetings, Task 41 members discussed how to address these deliverables and if they were still of interest to the Task. Deliverable 16 is of interest and will likely be pursued. Deliverable 15 and Deliverable 17 are still under consideration, but their scopes may shift. Although there is still research ongoing in high contribution islanded energy systems, much of the current work is focused on the integration of distributed wind in front of meter applications, specifically around integrated energy systems. Further there is expanded interest in collaborating on distributed wind hybrid power systems research and the valuation of those hybrids, especially at the MW scale but below that of hybrid power plants that is being proposed as a separate topic area. That topic could replace one of the remaining deliverables.

Progress in WP4

Task 41 members from the Dundalk Institute of Technology and the University of Perugia collaborated on research of wind turbine performance deterioration with age of the 850-kW Vestas V52 wind turbine installed on the Dundalk Institute of Technology campus. This research was published in the open access journal Energies in April 2020 [1] and February 2021 [2].

Task 41 completed its successful transition to the new website platform in Winter 2021. An expanded process to share distributed wind photos between members has also been developed as has some outreach documents.

Task members completed the development of an Implementation of IEA Wind TCP task outreach and engagement plan (M9, D18) and have initiated formal engagement with IEA Task 26 and 28. Discussions with Task 19 are underway and OA's have engaged in several multi-TCP discussions. More work in collaboration with outside organizations as detailed in the outreach and engagement plan need to take place but is limited by member time and the current conditions.

Progress in WP5

The distributed wind community is looking specifically for opportunities to both down-scale from large wind turbine design and refine small wind turbine design, all with a goal of reducing the levelized lifecycle cost of energy (LCOE). Following an initial introduction of research areas at the Fall 2019 Task meeting it was largely determined that the partnering organizations did not have the resources to conduct the initial screening studies required to further elucidate potential down-scale opportunities.

Understanding that these initial screening studies are quite appropriate for graduate student research and to expand the amount of distributed wind research being conducted in general, a pilot project under Work Package 5 was developed to engage academicians in distributed wind research challenges, expand the research community (i.e., students, professors, research institutes, etc.) and encourage technical publications. A new University Research Collaboration group was formed to take advantage of the current abilities to communicate virtually and globally to develop research partnerships.

Since the goal of Work Package 5 is to explore MW+ wind turbine design advances and consider their applicability for distributed wind turbine designs, any known professors involved in land-based wind turbine research were included in our contact list.

Invitations were sent to over 150 academicians and 33 registered for one of three virtual meetings held in November 2020. These meetings were held across three days with each meeting at a different time of day to accommodate academicians from Europe, Asia/Australia, and the Americus.

These meetings further refined the list of identified research challenges, identifying 10 of which should be the focus of current efforts. Not all of these challenges related directly to wind turbine design or downscaling. And there is wide general interest on other topics such as microgrids, VAWT design, standards development, and grid integration. These areas of interest overlap with other Task 41 Work Packages but were beyond the scope of Work Package 5, so received a lower priority. From these meetings, four projects from Murdoch University, RMIT University, and University of Massachusetts have been identified to be part of the University Research Collaboration pilot project with a final virtual sharing of different research results in July 2021. Based on the interest and engagement of academia in this concept, another round of research collaboration is planned for the 2021-2022 academic year with initial engagement being planned for August of 2021, which should allow expanded university participation.

Based on the results of the July presentations and further discussions, a report identifying the nominally 10 research challenges will be developed and shared widely. This document will be a starting point for the fall University Research Collaboration. It is also expected that some of the specific research projects will be published, providing an excellent source on non-proprietary studies that will provide direct industry guidance.

3 List of Participants

Table 2 gives a list of Task 41 participants and their organizations over the past year.

Table 2 – Task 41 Participants

Country	Contacts	Organization
Austria	Mauro Peppoloni	University of Applied Sciences Technikum Wien
	Kurt Leonhartsberger	University of Applied Sciences Technikum Wien
Belgium	Mark Runacres	Vrije Universiteit Brussel
Canada	David Wood	University of Calgary
	Sergio Gualteros	Nergica
China	Charlie Dou	Chinese Wind Energy Association
	Bian Qiying	Chinese General Certification Center
	Jia Yan	Inner Mongolia University of Technology
	Zhang Liru	Inner Mongolia University of Technology
	Keqilao Meng	Inner Mongolia University of Technology
	Wang Jianwen	Inner Mongolia University of Technology
Denmark	Tonny Brink	Nordic Folkecenter for Renewable Energy
	Anca Hansen	Technical University of Denmark
	Kaushik Das	Technical University of Denmark
	Matti Koivisto	Technical University of Denmark
	Anna Maria Sempreviva	Technical University of Denmark
	Mark Kelly	Technical University of Denmark
	Thomas Cronin	Technical University of Denmark
	Aeishwarya Umesh Baviskar	Technical University of Denmark
	Witold Skrzypiński	Technical University of Denmark
Germany	Immanuel Dorn	Observer
Greece	Nikos Stefanatos	Center for Renewable Energy Sources and Saving (CRES)
	Eftihia Tzen	Center for Renewable Energy Sources and Saving (CRES)
Ireland	Raymond Byrne	Dundalk Institute of Technology
	Paul Mac Artain	Dundalk Institute of Technology
Italy	Francesco Castellani	University of Perugia
Poland	Maciej Karczewski	Observer from Windtak
Singapore	Narasimalu Srikanth	Observer from Energy Research Institute at Nanyang Technological University
South Korea	Seokwoo Kim	Korea Institute of Energy Technology Evaluation and Planning
Spain	Ignacio Cruz	CIEMAT
	Luis Cano	CIEMAT
Taiwan	Chung-Chun (Wallace) Hsu	Taiwan SMWA, Advisor to TIER

United States	Robert Preus	National Renewable Energy Laboratory
	Jeroen van Dam	National Renewable Energy Laboratory
	Ian Baring-Gould	National Renewable Energy Laboratory
	DiLea Bindel	National Renewable Energy Laboratory
	Eric Lantz	National Renewable Energy Laboratory
	Jim Reilly	National Renewable Energy Laboratory
	Heidi Tinnesand	National Renewable Energy Laboratory
	Brent Summerville	Small Wind Certification Council
	Trudy Forsyth	Wind Advisors Team
	Danielle Preziuso	Pacific Northwest National Laboratory
	Sarah Barrows	Pacific Northwest National Laboratory
	Raj Rai	Pacific Northwest National Laboratory
	Bethel Tarekegne	Pacific Northwest National Laboratory
	Alice Orrell	Pacific Northwest National Laboratory
	Bret Barker	U.S. Department of Energy
	Dimitrios Fytanidis	Argonne National Laboratory
	Nicolas Duboc	Los Alamos National Laboratory
	Rod Linn	Los Alamos National Laboratory
	Matthew Nelson	Los Alamos National Laboratory

4 Statement of Accounts and Value of Contributions

Status of accounts

Operating Agent costs for PNNL and NREL are paid by the U.S. Department of Energy, therefore there are no revenues and cost of participating to report. The U.S. DOE operates on a fiscal year cycle.

Expenses:

Costs	Total Budget (Oct 2020-Sept 2021)	Actual to Date (Apr 2020-Mar 2021)
Labour		US$93,000
Travel		
Other costs		
TOTAL	US$150,000	US$93,000

Value of in-kind activities

Table 3 presents the estimated national in-kind labor person months per country (observers are marked with an asterisk). Individual labor hour estimates were provided by task participants and

relate specifically to in kind support provided to Task 41. Research efforts being implemented by participating organizations that align with Task 41 efforts but do not directly support Task 41 outcomes are not included. Assuming a labor hour value of US$200 per hour, 8 hours per day, 20 days per month, and a combined total of 13.09 person-months, the value of the in-kind labor is US$420,000 for April 2020 through March 2021.

Table 3: Estimated National In-Kind Labour Person Months

Country	In-Kind Labour Person-Months
Austria	0.8
Belgium	0.1
Canada	1.0
China / Tawain	0.2
Denmark	3.9
Germany*	0.04
Greece	1.0
Ireland	0.3
Italy	0.2
Poland*	0.08
Singapore*	0.03
South Korea	0.04
Spain	0.2
United States	5.2

5 New Developments Since Last Report

Greece, represented by the Center for Renewable Energy Sources and Saving (CRES), joined Task 41 in June 2020. Otherwise, new developments since Task 41's last progress report presented at ExCo 85 in May 2020 are captured in Figure 1 and described in Section 2.

6 Future Milestones

Plans and Deliverables for the Coming Year

Table 4 lists all deliverables, showing their status and planned completion. Deliverables 8 and 9 support Milestone 4 which is tied to having the Asian International Standards Assessment Forum in Summer 2022. Deliverables 15 and 16 are under consideration for modification. Task 41 is treating Deliverable 19 as ongoing. Deliverable 20 supports the in progress Milestone 10.

Table 4: Deliverables Table

No.	Deliverable	Deliverable Description	Lead Organizations & Contributors	Deliverable Due Date	Deliverable Completion
WP0	D1	Development of general IEA Task 41 and distributed wind PowerPoint presentation for use by members	NREL/PNNL	Spring 2019	✓
	D2	First annual progress report	NREL/PNNL	Fall 2019	✓
	D3	Second annual progress report	NREL/PNNL	Spring 2020	✓
	D4	Third annual progress report	NREL/PNNL	Spring 2021	✓
	D5	Final Report	NREL/PNNL	Fall 2022	
WP1	D6	Stakeholder forum to engage wind industry around the effectiveness or modifications of current standards for small and mid-sized turbines in the U.S.	NREL	Winter 2019	✓
	D7	Stakeholder forum to engage wind industry around the effectiveness or modifications of current standards for small and mid-sized turbines in the Europe	Austria, Denmark, Ireland, South Korea, Spain, Taiwan, United States, Germany	Summer 2019	✓
	D8	Stakeholder forum to engage wind industry around the effectiveness or modifications of current standards for small and mid-sized turbines in the Asia	NREL, China	Fall 2019	Planned for Summer 2022
	D9	Report on recommendations for potential standards changes that will be used to drive additional national and international research	NREL	Winter 2020	In Progress
WP2	D10	Specification of a data sharing catalog; including a review of needs, what meta data should be collected, and potential options for hosting the catalog	PNNL, DTU, All	Fall 2019	✓
	D11	Development of data sharing, storage and if needed security protocols for meta data to be stored on the platform. Specification of a potential data sharing portal that expands on the catalog	PNNL, DTU, All	Fall 2020	✓
	D12	Development of a data instruction guide for the DW data catalog	PNNL. DTU, All	Spring 2021	
WP3	D13	Summation of relevant international and defined national electrical standards, operational practices that would be applicable to DW looking from the grid or microgrid perspective with a specific consideration of turbine size and complexity	China, Denmark, Germany, Ireland, Spain, United States	Fall 2019	✓
	D14	Based on initial work completed in the U.S., review how DW is	PNNL	Fall 2019	✓

		modelled in distributed grid and microgrid systems, the availability of design tools and models and an assessment of the modeling methods used for wind energy			
	D15	Assessment of different levels of DW system control, including a classification for DW control strategies for high contribution distributed grids, including different capabilities of grid support and likely data needs for future wind systems	NREL	Summer 2020	Delayed
	D16	Design or best practice guide for the design of high renewable contribution isolated power systems	NREL	Fall 2020	Delayed
	D17	State of the industry report for isolated microgrid power systems	NREL	Fall 2021	
WP4	D18	Development of a specific IEA Wind TCP task engagement plan to be reviewed by Task. This will include DW focused research efforts that could be incorporated into future task proposals, allowing the specific consideration of DW topics within other IEA Wind TPC efforts	All	Fall 2019	✓
	D19	Identification of specific, high priority non-IEA Wind TCP stakeholders that could be a source for additional targeted engagement	All	Summer 2020	In Progress
WP5	D20	Report on the potential opportunities for cost reductions in mid and small scale wind technology based on current LCOE lowering technology innovations being applied to large and offshore turbine technologies	CIEMAT	Fall 2020	In Progress

7 Detailed work plan for coming year

WP 1

- Publication of interim standards research report (DTU & NREL)
- Implementation of several research projects by participating organizations to address key challenges, including work on an assessment of aeroelastic models. Several meetings are planned that will be open to Task 41 members and stakeholders.
- Organization of the Asian International Standards Assessment Forum is planned for the summer of 2022 in Inner Mongolia, which has been delayed due to COVID (D8).

WP 2

- Deliverable 12 will be completed.

WP 3

- Deliverables 15, 16, and 17 will be reconsidered and addressed.
- Collaboration on distributed wind hybrid power systems will be expanded.

WP 4

- Virtual short-length task meetings are scheduled for April 2021, July 2021, and August 2021

- The joint in-person meeting with Wind TCP Tasks 19 and 32 was being considered again for October 2021 in Vienna after being cancelled in 2020 because of Covid, but the Tasks have agreed to delay this meeting again.

WP 5

- The student researchers participating in the University Research Collaboration pilot project will share their results at a virtual July 2021 meeting.
- A second round of University Research Collaboration research projects will be implemented in the fall of 2021 with results expected in spring of 2022.
- Deliverable 20 will be completed summer of 2021.

8 Publications, presentations, dissemination

Publications, presentations, dissemination

[1] Byrne, R., Astolfi, D., Castellani, F., and Hewitt, N.J. (2020). A Study of Wind Turbine Performance Decline with Age through Operation Data Analysis. Download from https://www.mdpi.com/1996-1073/13/8/2086.

[2] Astolfi, D., Byrne, R., Castellani, F. (2021). Estimation of the Performance Aging of the Vestas V52 Wind Turbine through Comparative Test Case Analysis. Download from https://www.mdpi.com/1996-1073/14/4/915.

Participation in the Task meetings

Virtual meeting participation has been strong. For the October 2020 virtual meeting, all participating task members submitted country reports in advance of the meeting so the meeting time could be used for discussion, rather than presentation, of those reports. We also had presentations from PNNL, NREL, CIEMAT, DTU, Inner Mongolia University of Technology, and Taiwan Institute of Economic Research. At the February 2021 virtual meeting, we had presentations from PNNL, NREL, CIEMAT, DTU, and University of Applied Sciences Technikum Wien. Meetings have been held over several days and at different times to help engage representatives from different timezones.

The task has also held shorter vertual meetings every other month, largely focused on a single work package or research effort. This meetings have also had strong member participation from members, though engagement by Asian task members has been more limited.

Industry participation

Task 41 did not have industry participation this past year beyond the participation of our Poland and Germany observers. The task has however worked to hold forums and meetings that are open to a wider audience. Forums such as the second North American Standards Forum had extensive industry participation and the University Research Collaboration has engaged with many academic organizations outside of member countries. Efforts will be made to expand industry participation in the University Research Collaboration research symposium. Industry is also quite engaged in specific research efforts conducted by member nations but are not directly engaged in Task 41 discussions.