International Energy Agency TCP

Energy Conservation through Energy Storage (ECES)

"Flexible Sector Coupling by Energy Storage Implementation"

A new ECES Annex Proposal and possible collaborative action

Draft Work Plan

Version 13.05.2020

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1 Short Description of Annex 35

The main input of renewable energy to the future power grid will be renewable electricity by wind and photovoltaics. Reaching higher shares of fluctuating renewables in the power grid may cause a variety of problems. One option to tackle these challenges, by simultaneously further increasing the share of renewable electricity in the overall energy system, is to distribute renewable electricity to other sectors, mainly the heating/cooling and the mobility sector (all used pictograms in this chapter are from flaticon.com, author: Freepik).

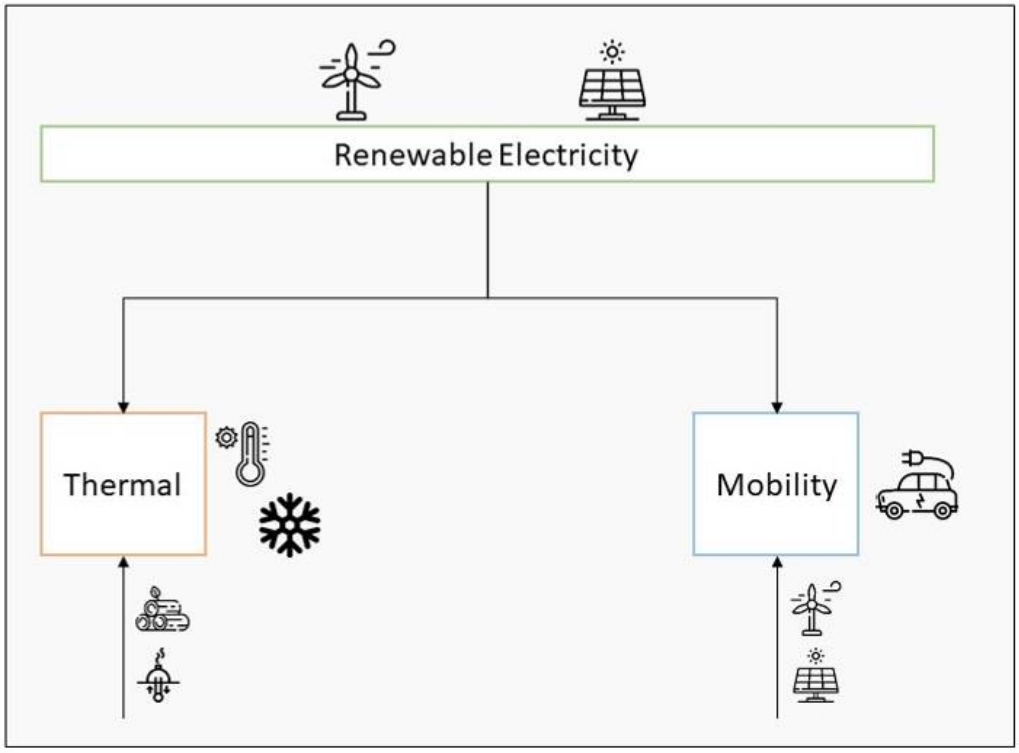

Figure 1: Overview of different sectors with their specific input from renewable energy sources.

Figure 1 shows the interaction of three sectors, namely electric, thermal (heating/cooling) and mobility without any storage technologies. Each sector can have its own direct input from a renewable energy source. However, most of the expected input will come from the electricity sector.

Figure 2 shows a qualitative approach of how an integration of flexible sector coupling with different storage technologies could look like. A perfect use case for energy storages is at the connection between different sectors. This way the energy is either stored in its input form or transformed to another energy form (e.g. electricity to heat/cooled, electricity to synthetic fuel, Power-to-Gas or Power-to-Heat). By doing so, the different demand patterns of the "consuming" sectors thermal and mobility can help to match the volatile energy supply to a specific demand. It is also worth mentioning that thermal storages are in most cases less expensive then electricity storages and that synthetic fuels allow for a mostly loss free storage of exceed wind and photovoltaic energy to couple the electricity and mobility sector. An application-specific ecological and economic evaluation, in order to quantify the advantages over an uncoupled system, should accompany all mentioned scenarios.

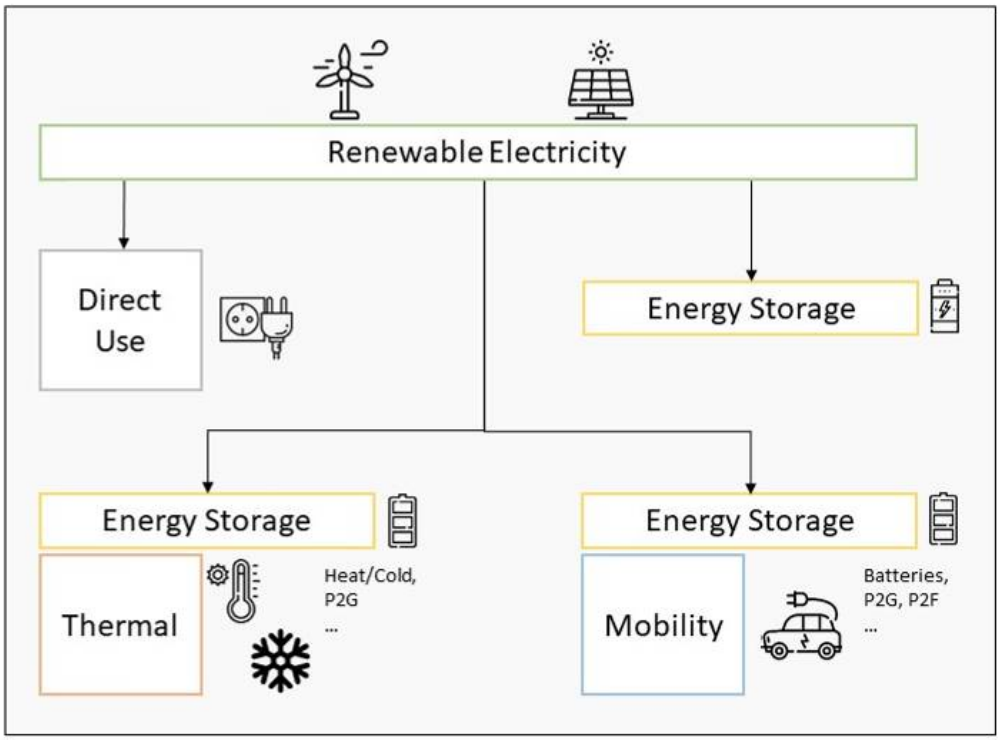

Figure 2: Conceptual overview of flexible sector coupling with different storage technologies.

By leveraging the potential of different energy storage technologies, it is possible to supply a sector with previously stored renewable electricity on demand. This approach can help to reduce the stress on the power grid at different levels (high, medium and low voltage). Possible energy storage technologies include thermal, chemical and electrical storages.

Some advantages of "Flexible Sector Coupling by Energy Storage Implementation" are:

- Energy storages are able to increase the share of renewable electricity in other sectors like heating/cooling and mobility sector.
- Energy storage can provide flexibility to all sectors ('renewables on demand').

1.1 Main Goal

Main Goal of the Annex is to clarify the possibilities and the impact of energy storage implementation in sector coupling.

1.2 Objectives

The key objectives of the proposed Annex are:

- Develop concepts of "Flexible Sector Coupling" and compile a White Paper on "Flexible Conversion of Renewable Electricity to the Thermal and Mobility Sector by Energy Storage Implementation"
- Identify non-technical barriers to energy storage implementation for "Flexible Sector Coupling"
- Identify energy storage technologies for actual sector coupling applications (paths in the picture) and their properties/requirements

- Prioritizing most promising storage configurations for sector coupling applications
- Potential for storage implementation for each path between electricity and heat and electricity and mobility
- Technical and economic comparison to “no-storage” sector coupling scenarios

1.3 Scope

The Annex shall deal with the impact of energy storage implementation between the sectors when it comes to sector coupling. It is important to focus strictly on energy storage only – energy in and energy out – in this proposed Annex and to neglect other options like power-to-X (chemical products not used as energy storage) or demand side management. This does not mean at all that these options are not appropriate, but it is necessary to limit the scope in order to provide a manageable workload.

The Annex shall work on:

- All energy storage technologies
- All applications in the heating and cooling sector (heating and cooling of all kind of buildings, DHW, process heat/cold for industry)
- All applications in the mobility sector (cars, trucks, busses…) and all propulsion technologies (EV, fuel cell, hydrogen, …)

2 Organisational structure

2.1 Subtask-Structure

The work of the Annex consists of four subtasks. Figure 3 shows the structure of this Annex and the scope of each subtask.

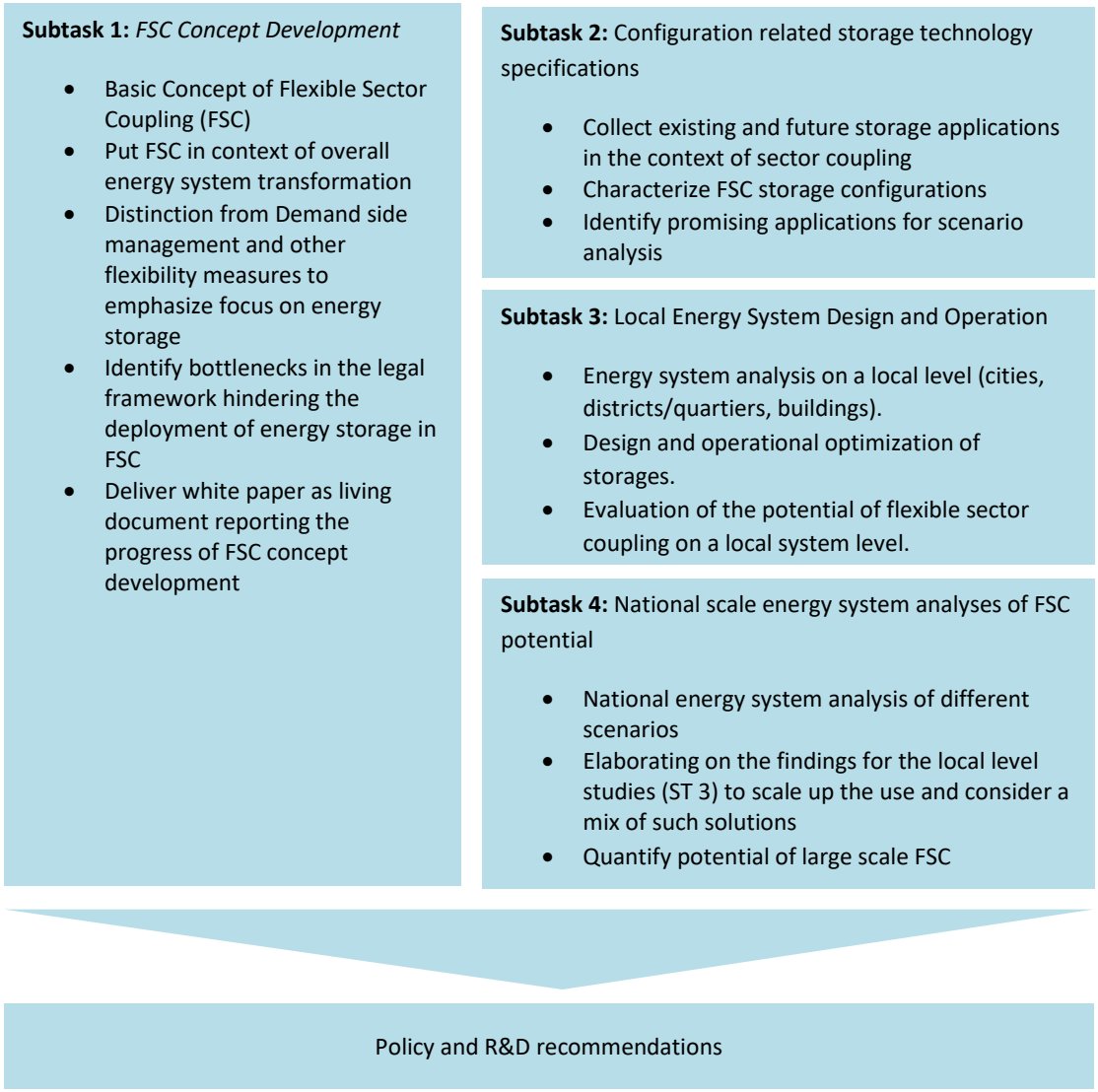

Figure 3: Annex 35 structure.

2.2 Other Interested Parties

Other related Technology Collaboration Platforms (TCPs) from the electricity, thermal and mobility sector such as Wind, PVPS, SolarPaces, DHC, EBC or HEV will be invited to the experts meetings and workshops. The District Heating and Cooling (DHC) TCP was present at the second task definition meeting in Graz. A cooperation of Annex 35 with DHC TS3 is foreseen. A collaboration with the IEA division System Integration of Renewables (SIR) is also planned for the Annex.

2.3 Work plan

2.3.1 Subtask 1: Flexible Sector Coupling (FSC) Concept Development

In close collaboration with the IEA division System Integration of Renewables (SIR) and other relevant parties like the German Energy Storage Association (BVES) and the European Association for Storage of Energy (EASE) the main concept of flexible sector coupling (FSC) will be developed.

At the same time this subtask shall also give a short overview of related activities on topics like demand side management, demand side integration, power-to-chemicals or power-to-X. Differences of these approaches to the actual focus of this Annex shall be made clear and flexible sector coupling will be described within the bigger picture of transforming energy systems.

The definition for the sectors and flexible sector coupling given in the introduction of this progress report will serve as a starting point for the concept development. Other existing definitions will be included and compared.

The regulatory frameworks play an important role when it comes to the deployment of actual FSC business cases. The collection and identification of non-technical barriers in these frameworks will therefore be part of this subtask.

A white paper on “Flexible Conversion of Renewable Electricity to the Thermal and Mobility Sector by Energy Storage Implementation” is, as a living document, continuously under development during the Annex. This shall clarify the above-mentioned scope of the Annex work.

The work plan of Subtask 1 comprises the following activities:

a. Set up a whitepaper as a delivery format to document the process of FSC concept development
b. Collect information on regulatory frameworks and identify bottlenecks
c. Give policy and R&D recommendations also including input from ST2 and ST3

2.3.2 Subtask 2: Configuration related storage technology specifications

Aim of Subtask 2 is to collect existing and future sector coupling storage configurations to show the variety of examples existing already today and the technical potential for the future. All storage technologies suited for sector coupling applications should be characterized technically within a certain configuration. Figure 4 shows a configuration, which consists of the storage technology in the respective application coupling the sectors (sector – storage – sector). Sector 1 is the electricity sector with its high share of renewables and sector 2 is either the thermal or the mobility sector as the energy consumer.

Figure 4: Conceptual coupling of two sectors by means of a storage.

This inventory will include all storage technologies (electrical, thermal and chemical) within all sector-coupling pathways. The collection of technical data on storage technologies can be

based on previous work within the ECES Implementing Agreement (e.g. Annex 28, Subtask 1 approach).

Since sector coupling is applicable in different market applications (residential, T&C, industry, private mobility, public transport …), the storage configurations shall be clustered accordingly.

Subtask 2 shall deliver the technical and economic data for the most promising storage configurations needed for the scenario analysis in Subtask 3.

The work plan of Subtask 2 comprises the following activities:

a. Collect and describe all relevant sector coupling storage configurations
b. Basic system description including working principle
c. Cluster configurations regarding market applications
d. Identify most promising configurations for ST3 scenario analysis

2.3.3 Subtask 3: Local Energy System Design and Operation

Subtask 3 aims at the assessment of the energy storage potential in sector coupling applications on a local system level. The evaluation will consider the heating (and cooling), electricity and mobility sectors. The synergies among these sectors will be assessed on a local system level, which comprises cities, districts/quarters and buildings. This subtask provides a holistic approach for storage integration since it includes both technical and economic aspects. The technical assessment will focus on the design and optimization of coupled networks, while the economic assessment will determine suitable business models, as well as the existing regulatory framework. The activities in subtask 3 will consider the storage configurations defined in subtask 2 and will establish a common basis for the activities in subtask 4, which will present a quantification of the potential of storages in FSC on a national system level.

The work plan of subtask 3 comprises the following activities:

- Definition of local energy systems
- Definition of scenarios (e.g. time horizon 2030 and 2050)
- Definition of techno-economic indicators for the assessment of the results
- Analysis of multi-domain systems on a local level
- Development of policy and R&D recommendations

2.3.4 Subtask 4: National scale energy system analyses of FSC potential

In this subtask, the goal is to analyse and quantify the potentials of energy storages in sector coupling from a national energy system perspective. The work will elaborate on the analysed scenarios in subtask 3 by putting them into the context of national energy system level and upscaling them to assess their potential in a large-scale application of FSC. In this work, energy system modelling software will be used to be able to model all sectors, with a range of sector coupling options, simultaneously with an hourly time resolution – thereby being able to analyse the sector coupling and the additional flexibility by introducing energy storages in a high degree of detail. The analyses will consider both present and future years, and multiple energy system contexts (e.g. different countries) for the analyses.

The work plan of Subtask 4 comprises the following activities:

- Define boundary conditions and national system assumptions

- Select relevant cases (e.g. countries) and define reference models for the national energy system level analyses
- Carry out national energy system analyses to quantify relevance/potentials for various key storages to enable renewables by means of FSC
- Derive Policy and R&D recommendations

2.3.5 Other interested parties

Other related Technology Collaboration Platforms from the electricity, thermal and mobility sector like Wind, PVPS, SolarPaces, DHC, EBC or HEV will be invited to the experts meetings and workshops. The District Heating and Cooling (DHC) TCP was present at the second task definition meeting in Graz. A cooperation of Annex 35 with DHC TS3 is foreseen. A collaboration with the IEA division System Integration of Renewables (SIR) is also planned for the Annex. First contact and discussion happened at the first task definition meeting in Paris Spring 2018.

3 Work Program - Main Activities and Time Schedule

This Annex shall commence first of July 2019 and remain in force until 31st of June 2022.

Phase 1: July – December 2019

- Kick-off workshop and Experts Meeting: 16th - 18th October 2019 in Bad Tölz, Germany
- Finalize decisions on the Subtask structure and the work programme
- Overview on the contributions from participating countries

Phase 2: January - July 2020

- Second Workshop and Experts Meeting: 1st and 21st April 2020, Web conference
- Overview on the contributions from other IAs
- Subtask 1 (according to workplan)
- Subtask 2 (according to workplan)
- Subtask 3 (according to workplan)
- Subtask 4 (according to workplan)

Phase 3: July – December 2020

- Third Workshop and Experts Meeting
- Subtask 1 Continue (according to workplan)
- Subtask 2 Continue (according to workplan)
- Subtask 3 (according to workplan)
- Subtask 4 (according to workplan)

Phase 4: January - July 2021

- 4th Workshop and Experts Meeting
- Subtask 1 Continue (according to workplan)
- Subtask 2 Continue (according to workplan)
- Subtask 3 (according to workplan)
- Subtask 4 (according to workplan)

Phase 5: July – December 2021

- 5th Workshop and Experts Meeting
- Subtask 1 Continue (according to workplan)
- Subtask 2 Continue (according to workplan)
- Subtask 3 (according to workplan)
- Subtask 4 (according to workplan)

Phase 6: January – July 2022

- 6th Workshop and Experts Meeting
- Subtasks compiling all results
- Preparation of the Final Report
- Final Open Workshop to deploy key findings

4 Results

The major outcomes of the proposed Annex will be:

a. Whitepaper reflecting the concept development of FSC
b. Description of existing bottlenecks in the legal frameworks
c. Overview and technical characterization of existing and future FSC storage configurations
d. Quantification of the potentials of energy storages in comparison to no storage sector coupling applications
e. Policy and R&D recommendations

5 Specific obligations and responsibilities of the Participants

Each participant shall

- provide the Operating Agent with detailed reports on the results of the work carried out
- collect, assess and report to the Operating Agent data on ongoing projects in the field of energy storage
- participate in the editing and review of draft reports on the Task
- be prepared to host semi-annual experts meetings and arrange work-shops
- cooperates positively on the technology transfer within participating and to non-participating countries
- participate in activities to enroll new members to the Annex by spreading information about the Annex and act in technology transfer to non-member countries where appropriate

6 Specific obligations and responsibilities of the Operating Agent

In addition to the obligations enumerated in Article 8 of this agreement, the Operating Agent shall:

- Prepare and distribute the results mentioned in Article 7 above
- At the request of the Executive Committee organize workshops, seminars, conferences and other meetings
- Provide the semi-annually and other periodic reports to the Executive Committee on the progress and the results of the work performed under the programme of work
- Provide to the Executive Committee within six month after completion of all work under the Task a final report for its approval and transmittal to the Agency
- In coordination with the Participants use its best effort to avoid duplication with activities of other related programs and projects implemented by or under the auspices of the Agency or by other competent bodies
- Provide the Participants with the necessary guidelines for the work they carry out assuring minimum duplication effort
- Coordinate the efforts of all Participants and ensure the flow of information in the Task

- Perform such additional services and actions as may be decided by the Executive Committee acting by unanimity

7 Funding

(a) Semi-annual meetings. The Participants shall be prepared to host semi-annual meetings. The cost of organizing and hosting meetings shall be borne by the host Participant.

(b) Publications. The Operating Agent shall meet the cost of publishing the reports and summary assessments described in Article 7 above.

(c) Individual financial obligations. Each Participant shall bear all the costs it incurs in carrying out the Task activities, including reporting and travel expenses.

(d) Task-Sharing requirements. The Operating Agent should devote 6 man-months per year to the work in the Annex. The Participants are expected to devote 3 man-months per year to the work in the Annex.

8 Operating Agent

Forschungszentrum Jülich GmbH, Germany acting through

- Dr. Andreas Hauer, Bavarian Center for Applied Energy Research, Germany

as designated Operating Agent.

9 Information and Intellectual Property

(a) Executive Committee's Powers.

The publication, distribution, handling, protection and ownership of information and intellectual property arising from this Annex shall be determined by the Executive Committee, acting by unanimity, in conformity with this Annex.

(b) Right to publish.

Subject only to copyright restriction described in Article 12(i) below, the Participants shall have the right to publish all information arising from this Task, except proprietary information, as defined in Article 12(c) below.

(c) Proprietary information.

The Participants and the Operating Agent shall take all necessary measures in accordance with this Article, the laws of their respective countries and international law to protect the proprietary information provided to, or arising from this Task. For the purpose of this Annex, proprietary information shall mean information of a confidential nature such as trade secrets and know-how which is appropriately marked provided that such information:

(1) Is not generally known or publicly available from other sources;

(2) Has not previously been made available by its owner(s) to others without obligation concerning its confidentiality;

(3) Is not already in the possession of the recipient Participant(s) without obligation concerning its confidentiality;

It shall be the responsibility of each Participant supplying such proprietary information and of the Operating Agent for developing proprietary information to identify each information as proprietary and to ensure that it is appropriately marked.

(d) Production of Relevant information by Governments.

The Operating Agent should encourage governments of all Agency Participating Countries to make available or identify to the Operating Agent all published or otherwise freely available information known to them that is relevant to the Task.

(e) Production of relevant information by Participants.

Each Participant agrees to provide to the Operating Agent all previously available information and information developed independently of the Task which can assist or is needed by the Operating Agent to carry out its function in this Task, which is freely at the disposal of the Participant and the transmission of which is not subject to nay contractual and/or legal limitations under the following conditions:

(1) If no substantial cost is incurred by the Participant in making such information available at no cost to the Task therefore;

(2) If substantial costs must be incurred by the Participant to make such information available at such charges to the Task as shall be agreed between the Operating Agent and the Participant with the approval of the Executive Committee;

(f) Use of confidential information.

If a Participant has access to confidential information which would be useful to the Operating Agent in carrying out the studies, assessments, analyses or evaluations called for in this Task, such information may be communicated to the Operating Agent but shall not become part of any report or other form of documentation issued as part of this Task, nor shall it be communicated to the Participants except as may be agreed between the Operating Agent and The Participant who supplies such information.

(g) Acquisition of Information for the Task.

Each Participant shall inform the Operating Agent of the existence of information that can be of value to the Task but which is not freely available and each Participant shall endeavor to make such information available to the Task under reasonable conditions in which event the Executive Committee may, acting by unanimity, decide to acquire each information.

(h) Reports on work performed under the Task.

The Operating Agent shall provide reports on all work performed under the Task and the result thereof including studies, assessments, analyses, evaluations and other documentation but excluding proprietary information in accordance with Article 12(c) above.

(i) Copyright.

The Operating Agent, or each Participant for its own result, may take appropriate measures necessary to protect copyrightable material generated under this Task. Copyrights obtained shall be the property of the Operating Agent, for the benefit of the Participants provided, however, that Participants may reproduce and distribute material, but shall not publish it with a view of profit, except as otherwise provided by the Executive Committee.

(j) Authors.

Each Participant shall, without prejudice to any rights of authors under its national laws, take necessary steps to provide the co-operation from its authors required to carry out the provisions of this Article. Each Participant shall assume the responsibility to pay awards or compensation required to be paid to its employees according to the laws of the country.