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**Item 5 (g) of the provisional agenda**

**Methodological issues**

**Emission projections of Parties included in Annex I to the Convention**

**Report on the workshop on emission projections from Parties  
included in Annex I to the Convention**

**Note by the secretariat**

*Summary*

A workshop on greenhouse gas (GHG) projections from Parties included in Annex I to the Convention was organized to make a contribution to the preparation of fourth national communications from these Parties. The objectives were to discuss methods, assumptions, indicators, key parameters of models and sensitivity analysis, and dissemination of methodologies. Participants exchanged experiences in dealing with general and cross-cutting problems in GHG projections, as well as in addressing specific issues relating to all sources of emissions (energy, transport, industry, agriculture, land use, land-use change and forestry, and waste). They found this exchange of experiences useful, important and helpful for the preparation of the fourth national communications.

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## I. Introduction

### A. Mandate

1. The Conference of the Parties (COP), by its decision 4/CP.8, requested Parties included in Annex I to the Convention (Annex I Parties) to submit to the secretariat, in accordance with Article 12, paragraphs 1 and 2, a fourth national communication by 1 January 2006. These national communications are to be prepared in accordance with the UNFCCC reporting guidelines<sup>1</sup> adopted by decision 4/CP.5.
2. The Subsidiary Body for Scientific and Technological Advice (SBSTA), at its nineteenth session, requested the secretariat to organize a workshop on greenhouse gas (GHG) projections from Annex I Parties as a contribution to the preparation of the fourth national communications from Annex I Parties.<sup>2</sup> The objectives of the workshop were to discuss methods, assumptions, indicators, key parameters of models and sensitivity analysis, and dissemination of methodologies.

### B. Possible action by the Subsidiary Body for Scientific and Technological Advice

3. The SBSTA may wish to consider the output of the workshop contained in this report and, if needed, decide on any next steps.

## II. Proceedings

4. The workshop was organized by the secretariat in Bonn, Germany, from 6 to 8 September 2004.<sup>3</sup> Financial support was provided by the Government of Germany through the Bonn Fund. The workshop was co-chaired by Mr. Neil Ferry (Australia), Mr. Micheal Young (Ireland) and Mr. Hans-Joachim Ziesing (Germany) on behalf of the Chair of the SBSTA.
5. Fifty-nine experts from Parties and organizations attended the workshop. Forty-four representatives were nominated by Annex I Parties, including eight from Annex I Parties with economies in transition, and 10 by Parties not included in Annex I to the Convention (non-Annex I Parties). In addition, one representative from an international organization and four from non-governmental organizations attended the workshop.
6. The workshop addressed the issues identified in the mandate by focusing on the following broad sets of problems:
  - (a) General and cross-cutting issues in the preparation of GHG projections
  - (b) Specific issues for energy, transport, industry and waste management
  - (c) Specific issues for agriculture and land use, land-use change and forestry (LULUCF).
7. Mr. Ziesing facilitated the discussions on general and cross-cutting issues, which took place in a plenary session during the first day of the workshop. During the second day of the workshop, the discussions on the specific issues listed in paragraph 6 (b) and (c) above took place in two breakout groups, facilitated by Mr. Ferry and Mr. Young, respectively. The discussions during both days were based on working papers prepared by the secretariat before the workshop.

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<sup>1</sup> "Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part II: UNFCCC reporting guidelines on national communications" (FCCC/CP/1999/7, pages 80–100), hereinafter referred to as the UNFCCC reporting guidelines.

<sup>2</sup> FCCC/SBSTA/2003/15, paragraph 14 (f).

<sup>3</sup> The agenda and other documents prepared for the workshop are available on the secretariat web site <[http://unfccc.int/meetings/workshops/other\\_meetings/items/3129.php](http://unfccc.int/meetings/workshops/other_meetings/items/3129.php)>.

### III. Summary of discussions

#### A. General and cross-cutting issues

8. Eleven experts made presentations or provided oral reports on their experiences with the preparation of GHG projections. The presentations and the discussion that followed showed that Annex I Parties had made good progress in the preparation of their GHG projections as presented in their latest, usually third, national communications. There was a general agreement that for the fourth national communications Annex I Parties should continue their efforts to improve their GHG projections further and to adhere to the requirements on GHG projections laid out in the UNFCCC reporting guidelines.

##### 1. Reporting issues

9. No particular methodological issues were identified in relation to the deficiencies in reporting information on GHG projections observed in the third national communications. However, the participants made the following observations regarding the preparation of the fourth national communications based on the UNFCCC reporting guidelines.

10. **Consistent definition of projection scenarios.** A 'with measures' scenario should be provided and should be in accordance with the definition provided in the UNFCCC reporting guidelines. Annex I Parties should have a common understanding of what should be included in the 'with measures' scenario. In accordance with the UNFCCC reporting guidelines, the 'with measures' scenario should include all policies and measures currently in place, irrespective of whether their primary objective was the mitigation of GHG emissions or not.

11. Annex I Parties that wish to provide GHG projections data for a 'without measures' and/or a 'with additional measures' scenario were encouraged to make every effort to ensure that the GHG mitigation policies and measures included in these scenarios are clearly identified.

12. The preparation of the 'without measures' scenario was considered to be particularly challenging because of the counterfactual character of such a scenario and the difficulty of distinguishing between climate-related and non-climate-related measures in the past. However, if such scenario is prepared, it can provide useful information about the efficiency of past GHG mitigation measures. For those Annex I Parties that wish to indicate how they would meet their commitments under the Kyoto Protocol, the 'with additional measures' scenario may serve as a means to estimate how to close the 'gap' between the 'with measures' scenario and the emission reduction target considered.

13. **Transparent presentation of information on projections.** There is a need for the transparent presentation of information on GHG projections in national communications. Such information, presented within reasonable space limitations, would provide an insight to the reader on the methods/models used and would contribute to the transparency of the national communications. In this regard, the fourth national communications could contain:

- (a) GHG projections data both on a sectoral and on a gas-by-gas basis. For this purpose, Annex I Parties could use the template contained in the annex to this document
- (b) Summary information on the methodologies, models and key assumptions used for projections.

14. **Consistency with the latest available GHG inventory.** Participants generally agreed that there will probably not be enough time to ensure the consistency of GHG projections with the latest available GHG inventory data. Typically there is a two-year lag between the year of submission of the national communication and of the latest year for which GHG inventory data are available, and

projection studies may also have a time lag of the order of one–two years. However, although some inconsistency will be inevitable, in most cases this inconsistency would not have a critical impact on the credibility of projections. Generally, it would be useful to use a finalized version of the GHG inventory data. Furthermore, it may also be useful to use a similar breakdown by sectors in both inventories and projections, although this may not be possible in some cases due to the different sectoral representations used in models.

## 2. Methodological issues

15. There was a common understanding among the participants that Annex I Parties should continue to use those GHG projections methods and/or models that best suit their national circumstances. The participants made the following observations on methodological issues.

16. **Incorporation of technological progress into projection modelling.** Most technologically-oriented models integrate technological progress directly, usually through exogenous assumptions on changes in model parameters due to technological progress. Methods that represent technological progress endogenously seem to require further development.

17. **Integration of cross-country factors, impacts on other countries, and international market developments into national GHG projections.** Developing GHG projections is primarily a national exercise that relies on available national socio-economic data. From the information currently available no assessment can be made on whether and to what extent these factors are taken into consideration when GHG projections are prepared. Annex I Parties may wish to identify those areas of their economy that could be mostly affected and explore what effects these factors would have on their GHG projections. For some sectors, for example energy, statistical information may be readily available for this work. In addition, Annex I Parties could pay particular attention to transit traffic through their countries as it may have an effect on their GHG projections from the transport sector.

18. **Methods for assessing the uncertainty in projected GHG emissions.** The uncertainties of the projected levels of GHG emissions are primarily due to the use of assumptions about future behaviour of multiple variables which affect GHG emissions, to the uncertainty about the future effects of GHG-related policies and measures, and to the various inherent limitations of the models used. The most preferred method for estimating the uncertainty in projected GHG emissions has been the sensitivity analysis. Such analysis was considered useful, in particular because of the need to understand the impact of changes in key parameters and assumptions, such as gross domestic product (GDP) growth, on projected emission levels. For example, some Annex I Parties tried to determine the influence of different GDP-related assumptions through the use of ‘high’ and ‘low’ scenarios in addition to the ‘with measures’ scenario. Other Annex I Parties used, or planned to use, more elaborate techniques for uncertainty analysis, such as Monte-Carlo simulations and use of probability ranges for the costs of technologies. The workshop discussed the advantages of using a common set of defined parameters for sensitivity analysis, emphasized the value of uncertainty analysis, and recommended that, when possible, Annex I Parties should pay attention to such analyses in the preparation of the fourth national communication.

19. **Applicability and comparative advantages of various types of models.** National presentations revealed a wide diversity of models and methods used for GHG projections. It was not possible to indicate whether any modelling type could be particularly useful for a given aspect of GHG projection modelling. Although two participants suggested using a single model or a single approach for many Annex I Parties, such approach was generally found to be not feasible for many reasons, such as the importance of using those models that best fit particular national circumstances of a country; the importance of using those modelling tools that the modellers understand and master well; the importance of using country-specific data series accumulated in the models during the period of model development

in the country; the considerable resource and effort requirements for changing a model of the required high level of complexity; and the considerable investments already made in the models currently in use. Some participants also noted the value of using different models as a means to test the robustness of results.

20. **Possible means to facilitate comparability of national GHG projections.** The availability of information on a key set of assumptions (GDP growth, population growth, fuel prices, electricity exports/imports, etc.) could improve the comparability of GHG projections across Annex I Parties. The idea of using the same data for some parameters, such as fuel prices on the international market or global macroeconomic trends, was discussed, although the implementation of such an idea may be difficult.

### 3. Other issues

21. **Projection of macroeconomic costs and macroeconomic impacts of climate-related measures.** The UNFCCC reporting guidelines do not require Annex I Parties to provide information on such projections but some Annex I Parties provided such estimates in their national communications. Although information on macroeconomic costs and macroeconomic impacts may be useful for Annex I Parties, obtaining such information is a complex task that requires sophisticated studies, the results of which would need in-depth analysis and careful interpretation. Current collaborative research efforts to compare such information from different models have shown that results are model-dependent to a large extent. Those Annex I Parties that wish to provide such information in their fourth national communications could also provide information on how these costs and impacts were estimated in the framework of their projection studies.

22. **Methodologies relating to impacts on developing countries.** One participant proposed that the following issues should also be discussed during the workshop:<sup>4</sup>

- (a) Methodologies for implementing win-win policies and measures
- (b) Methodology for assessing terms of trade and socio-economic impacts on individual developing countries
- (c) Methodology for assessing the impacts on developing countries of policies already implemented by Annex I Parties
- (d) Methodologies for improving the guidelines for the preparation of national communications by Annex I Parties to include all activities relating to the impact of response measures adopted by decision 5/CP.7
- (e) Methodologies for assessing the spillover effects of Annex I Party response measures on non-Annex I Parties.

23. While recognizing that such methodological issues exist, the participants were not able to agree on whether or not they were within the mandate of this workshop.<sup>5</sup> It was noted that these issues might be considered by Parties under an appropriate agenda item at meetings of the subsidiary bodies.

24. **Dissemination of methodologies.** It was proposed that the participants who wish to do so may forward to the secretariat information on how their projections, models, methods could be accessed (e.g.

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<sup>4</sup> For more information, see FCCC/SBSTA/2004/MISC.10, pages 8 and 9.

<sup>5</sup> Some of these issues have been the subject of previous UNFCCC workshops, such as the workshop on the status of modelling activities to assess the adverse effects of climate change and the impact of implemented response measures (FCCC/SBI/2002/9).

web site address). The secretariat was asked to make this information available to all participants of the workshop.

## **B. Issues for energy, transport, industry and waste management**

25. Nine experts made presentations on their experiences with the preparation of GHG projections for the energy, transport, industry and waste management sectors. Participants considered the exchange of information through these presentations and subsequent discussions to be very useful and important, and a valuable outcome of the workshop that would allow them to take home useful information. Participants made the following observations based on this exchange of information.

### 1. General observations

26. **Transparent presentation of assumptions and data.** Transparent presentation of assumptions and data is very important. Clear presentation of key assumptions and critical data may be as important for the quality of GHG projections as the modelling process itself.

27. **Usefulness of sensitivity analysis.** It is useful to vary key assumptions and identify sensitivity of projected emissions. In this respect, varying views were expressed on how to estimate the impact of GDP-related assumptions, noting, in particular, that in some models GDP growth is not an exogenous variable but rather an internal parameter of the model. The importance of projecting structural changes in the GDP was also mentioned.

28. **Use of common assumptions.** Sharing information about 'international assumptions', such as assumptions on prices for oil, gas, or carbon, was considered to be useful but the use of common international data in national GHG projections did not appear to be easy because of a number of considerable practical difficulties, such as who will provide such data, whether this could be done in a timely manner given that national projections are usually not prepared simultaneously by different Parties, and whether national governments would agree to use particular international data for their countries.

29. **Use of common methodologies.** The presentations showed a wide range of methods and models used. Some Parties used multiple models in the preparation of projections for one sector (this was particularly relevant for the energy sector). Therefore, identifying 'best practices' for sectoral GHG projections was considered to be difficult. It was noted that GHG projections differed from GHG inventories where best practice could be more readily identified.

### 2. Observations on sectoral issues

30. **Stationary combustion – models.** In the discussion of various models used for the energy sector, some participants expressed the view that bottom-up models might be easier to adapt to the conditions of a particular country. However, concerns were expressed about the costs of such adaptation.

31. **Stationary combustion – modelling of policies and measures.** Policies and measures for GHG mitigation in the energy sector are modelled both exogenously and endogenously. The usefulness of having a 'without measures' scenario was discussed. It was noted that many countries focus on the 'with measures' and 'with additional measures' scenarios that are seen to be helpful for determining policy choices. One participant expressed the view that it was necessary to model spill-over effects of policies and measures on non-Annex I Parties and ways to have win-win policies.

32. **Stationary combustion – key factors for projections.** There was general support for the idea of using the results of key source analysis from the national GHG inventory in the preparation and analysis of GHG projections. For example, the knowledge of what the key sources are can help the modellers to focus on the analysis of future behaviour of these sources, both in the process of the

preparation of assumptions and data for projections, and in the process of interpreting and presenting results.

33. **Stationary combustion – energy balance.** Participants noted the importance of having a complete energy balance as part of projections data.

34. **Stationary combustion – emission trading and project-based mechanisms.** Participants discussed the problem of including emissions trading schemes and project-based mechanisms under the Kyoto Protocol (joint implementation and the clean development mechanism) in GHG projections. Some participants noted that such mechanisms do not change national emissions and thus do not have an impact on projections. Others noted, however, that early anticipation of the use of emission trading and project-based mechanisms may have an impact on policy choices and, consequently, on projections. With respect to the integration of the emissions trading scheme of the European Union into projections modelling, the participants felt that it might be too early to evaluate the impact of this scheme on emissions.

35. **Transport.** Projected GHG emissions from transport should be shown separately from the projected emissions for the rest of the energy sector. The importance of modelling individual transport modes and the selection among modes was mentioned. One participant remarked that emissions taxation in transport might have an impact on non-Annex I Parties that should be modelled. In the discussion of GHG projections for international bunker fuels, one participant said that it was premature to discuss the modelling of these emissions given that this issue is still under discussion under a SBSTA agenda item; another participant said that his country did not have methodological problems in projecting these emissions; one participant noted the need to have a complete energy balance for projecting such emissions.

36. **Industry and waste management.** For both of these sectors, two considerations were found to be particularly important: availability of robust data on activity levels and emission factors, and clear presentation of assumptions and results. Specifically for the modelling of hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride, it was noted that the relevant industries were changing quickly and it would be important to conduct a 'reality check' before projecting these emissions.

### C. Issues for agriculture and land use, land-use change and forestry

37. Four experts made presentations on their experiences with the preparation of GHG projections for these sectors. Expertise in the group was mainly from the agriculture sector, so the presentations and subsequent discussions focused largely on emission projections for agriculture. Participants made the following observations based on this exchange of information.

#### 1. Key methodological issues for agriculture

38. **Definition and projection of activity levels and emission factors.** Participants reviewed the approaches used for projecting activity levels and emission factors in agriculture. On emission factors, they discussed whether it is always appropriate to keep emission factors constant over time for the projections or whether it is better to use revised or updated emission factors. Generally, emission factors from the current inventory are applied for projections but it was recognized that these emission factors might change in the future. For example, increased livestock productivity can lead to changes in digestion levels and enteric fermentation, which could result in increases in methane (CH<sub>4</sub>) emission factors. However, it was noted that it would be better to keep emission factors used for projections consistent with inventory data until better information becomes available. Participants recognized the link between ammonia (NH<sub>3</sub>) emissions and nitrous oxide (N<sub>2</sub>O) emissions and agreed that it would be valuable to report on policies and measures to abate NH<sub>3</sub> emissions, given the potential influence on N<sub>2</sub>O emissions.



39. As the agriculture sector becomes more globalized, projections could become more sensitive to international economic variables, such as currency exchange rates. For example, reform of the European Community Common Agricultural Policy will likely make the agriculture sector more globalized and thus, more vulnerable to changes in such exchange rates. Participants noted that this strengthened the need for sensitivity analysis. Although changes in activity levels resulting from planned policies (e.g. reduced animal subsidies will act to reduce animal numbers) can be modelled, it was recognized that shocks and changes in natural conditions (e.g. food scarcity, changes in weather) could not be modelled.

40. Although the UNFCCC reporting guidelines request projections to 2020, the agriculture modelling community usually projects for 10 years into the future. A view was expressed that the increasing uncertainties in projections over 10 years meant that there was less value-added to longer-term projections. It was also noted that most of the models in use today were designed more than 10 years ago and are constantly being updated as data become available.

41. **Use of specialized agriculture models in projections.** Two models were highlighted, the Austrian Carbon Balance model and the New Zealand OVERSEER model. The expert from New Zealand briefly explained the OVERSEER model as a nutrient budgeting tool and noted that it was not necessarily best suited for estimating N<sub>2</sub>O emissions. Participants recommended that, if possible and where appropriate, data and models used in inventories should also be used in projections. This would ensure consistency between inventory and projections, particularly in developing a consistent time series. In general, participants agreed that a multi-model approach is desirable and were unable to recommend the use of any specific models. It was agreed that the focus should be on good scientific practice rather than on specialized models or models per se.

42. **Modelling of GHG-related factors particularly relevant to agriculture.** Participants discussed the approaches used for modelling the impact of policies and measures on GHG emissions in agriculture. They considered ways to generate a baseline forecast and estimate the effects of implementing certain policies. The irregularity of data collection and difficulty in getting detailed statistics for specific issues (e.g. manure management practices) were identified as problems. Without relevant data, it is difficult to incorporate appropriate mitigation measures in the modelling system. Participants understood the importance of good statistics but also realized the gaps which exist in statistical data sets. They questioned the need to update such data on a yearly basis and suggested that five-year data sets be provided. All agreed that it was difficult to find solutions to close gaps in statistical databases.

43. Participants also discussed the types of models for modelling GHG-related factors. They noted that the top-down approach was not the only way to incorporate policies and measures into the models but that a bottom-up approach could also be useful. Merging bottom-up and top-down approaches could increase the robustness of projections. In addition, iteration between models would allow consideration of policies and measures such as the European Community Common Agricultural Policy, World Trade Organization regulations and other international influences. Another issue raised was the need to consider the effects of 'softer' policies and measures but the difficulty of quantifying them and incorporating them into models was also noted. An example was the effect of 'raising awareness' for adopting good practice for nitrogen fertilizer use.

44. **Presentation of main drivers of projections of GHG emissions.** The UNFCCC reporting guidelines stipulate that "to provide the reader with an understanding of emission trends in the years 1990 to 2020, Parties shall present relevant information on factors and activities for each sector." Such information will increase the transparency and credibility of GHG projections for a particular sector.

45. There was a common understanding that it is important to consider drivers not only as they relate to projections but as they relate to inventories as well. It was suggested that an annex to the

national communications could be provided when it is deemed necessary to provide more detailed information. This would prevent the main document becoming too lengthy. In addition, participants called for assistance in using the UNFCCC reporting guidelines to prepare their national communications. For example, a glossary of terms, work examples and clarification of the scenario definitions could be provided. Several important physical drivers of projected GHG emissions were identified, such as area in rotation, number of cattle, animal housing type, and manure or mineral fertilizer use. Other drivers included area of rice cultivation and cultivation practices, which have an influence on CH<sub>4</sub> and N<sub>2</sub>O emissions. Participants suggested drafting a recommended list of physical emission drivers, with reference to key source analysis using the data provided in the common reporting format (CRF). The importance of providing textual information on key drivers (for example, why livestock numbers are falling) was noted. In this regard, participants questioned the level of detail of information that should be provided in the national communications. It was concluded that the lack of information on main drivers was not so much a methodological issue, but rather a reporting issue. Further clarification to the UNFCCC reporting guidelines may assist Parties in this regard and enhance transparency and comparability of projections.

## 2. Key methodological issues for land use, land-use change and forestry

46. **LULUCF-related challenges for reporting GHG projections.** The preparation of projections is a well-established exercise in the forest industry. LULUCF projections should be consistent with the LULUCF part of the GHG inventory. The degree of robustness of the inventory will have corresponding implications for projections. When there is a good inventory, projections are usually not an issue because changes in carbon stocks are often low.

47. Several challenges to LULUCF projections were identified. Some examples of parameters that are usually difficult to project are harvesting rate (because it depends on international timber prices) changes in soil carbon stocks due to changes in land use or management practices, effects of past measures, and defining areas of land use and tracking changes of carbon stock from land-use change. However, it was generally agreed that the Intergovernmental Panel on Climate Change *Good Practice Guidance for Land Use, Land-Use Change and Forestry*, which ensures that “estimates of carbon stock changes, emissions by sources and removals by sinks, even if uncertain, are bona fide estimates” in national inventories, will improve national inventories and thus also serve as a basis for improved projections. Problems with the activity data were also considered. Modellers are often faced with deciding whether to use official, but outdated, data from their National Statistics Office or data from international sources (e.g. the database of the Food and Agriculture Organization of the United Nations) to prepare projections.

48. **Drivers of projected GHG emissions in LULUCF.** Participants suggested that a list of key drivers (e.g. growth rates, tree density, biomass expansion factors, deforestation rates, rotation lengths, new forest plantings) be derived to guide better projections. Again, the importance of providing textual information interpreting the changes in key drivers was noted. Participants called once more for further clarification to the UNFCCC reporting guidelines as referred to in paragraph 45 above.

49. **Approaches, methods and sources of information and data.** The methods used by Parties to project GHG emissions and removals vary and are usually not comparable. Participants noted the benefits of an exchange of information on available methods, including models, for projecting GHG emissions from LULUCF. Participants also noted the need to consider the link between agriculture and forestry for modelling because policies and measures in agriculture could also have an impact on forestry, as both sectors considered opportunity costs of land use. Existing data sets from forest inventories, maps and remote sensing allow for simple extrapolation in projections. In addition, expert opinion should also be considered in projections modelling. Because of the stronger agriculture balance

of the group, participants were unable to elaborate further on LULUCF projections or to suggest solutions.

50. **Other issues.** Participants also raised the issue of institutional arrangements and the importance of cooperation between institutions. Cooperation between institutions could help overcome methodological issues and problems, facilitate evaluation of the effects of policies and measures and contribute to the preparation of projections. Specifically, institutional arrangements between agriculture and forestry teams working on models for projections in these sectors could improve projections for LULUCF.

Annex

**Proposal for a template to report greenhouse gas projections data  
in national communications**

**Scenario:** ('with measures', 'with additional measures', etc.)

**Year:** (2005, 2010, etc.)

Sector	Emissions (in Gg CO <sub>2</sub> equivalent)						
	CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O	HFCs	PFCs	SF <sub>6</sub>	Total
Energy							
Transport							
Industry <sup>a</sup>							
Agriculture							
LULUCF							
Waste							
<b>Total</b>							

<sup>a</sup> Annex I Parties may wish to indicate whether energy-related emissions are included here or under "Energy". Alternatively, Annex I Parties may show energy-related and process emissions from industry in separate entries under the "Industry" heading.

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