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Report for the Stage 3 in-depth review of emission inventories submitted under the UNECE LRTAP Convention and EU National Emissions Ceilings Directive for:

LIECHTENSTEIN

CONTENT

INTRODUCTION

1. The mandate and overall objectives for the emission inventory review process under the LRTAP Convention is given by the UNECE document *"Methods and Procedures for the Technical Review of Air Pollutant Emission Inventories reported under the Convention and its Protocols"*[1] – hereafter referred to as the "Methods and Procedures" document. This year an updated version[2] of the "Methods and procedures" document proposed by the Task Force on Emission Inventories and Projections (TFEIP) was tested.

2. This annual review, has concentrated on SO_2, NO_x, NMVOC, NH_3, plus PM_{10} & $PM_{2.5}$ for the time series years 1990 – 2015 reflecting current priorities from EMEP Steering Body and the Task Force on Emission Inventories and Projections (TFEIP). HMs and POPs have been reviewed to the extent possible.

3. This report covers the stage 3 centralised reviews of the UNECE LRTAP Convention and EU NEC Directive inventories of Liechtenstein coordinated by the EMEP emission centre CEIP acting as review secretariat. The review took place from 19th June 2017 to 23th June 2017 in Copenhagen Denmark and was hosted by the European Environment Agency (EEA). The following team of nominated experts from the roster of experts performed the review: generalist – Eva Krtkova (CZ), energy - Glen Thistlethwaite (UK), transport – Giannis Papadimitriou(EU), industry & solvent - Neil Passant (UK) , agriculture - Hakam Al Hanbali (SE), waste - Intars Cakars (LV).

4. Jean-Pierre Chang (FR) was the lead reviewer. The review was coordinated by Katarina Marečková (EMEP Centre on Emission Inventories and Projections - CEIP).

[1] Methods and Procedures for the Technical Review of Air Pollutant Emission Inventories reported under the Convention and its Protocols. Note by the Task Force on Emission Inventories and Projections. ECE/EB.AIR/GE.1/2007/16 http://www.ceip.at/fileadmin/inhalte/emep/review/review_guidelines.pdf

[2] Proposal for updating the 'Methods and procedures' document laying down the process for the EMEP emission inventory review. Available at: http://www.unece.org/fileadmin/DAM/env/documents/2016/AIR/EMEP/Informal_Document/3_Methods_Procedures_update_proposal_May2016_ISSUE1_TFEIP.pdf

PART A: KEY REVIEW FINDINGS

5. Liechtenstein's inventory is generally in line with the *EMEP/EEA inventory guidebook* and UNECE Reporting Guidelines, making the inventory comparable with other Parties, which represents always a relatively important effort for small countries.

6. Liechtenstein's inventory is generally complete for the pollutants reviewed (except for the industry sector for which no emissions are reported). ERT noted particular needs for improvements concerning consistency between the IIR and the NFR tables (cf. e.g. energy sector) and concerning transparency (especially more detailed information on methodologies, activity data, EF and assumptions at sub-sector level, more information on recalculations, on improvement monitoring, etc.).

7. ERT also noted the need to increase the capacities for the CLRTAP inventory to further develop its quality and the completeness of its reporting (more detailed information, uncertainty assessment, KCA for more pollutants, activity data reporting, reinforcement of QA/QC procedures, etc.).

INVENTORY SUBMISSION

8. In the 2017 submission Lichtenstein has reported emissions for its Protocol base years (1990) and a full time series from 1990 to 2015 (the latest year) for its protocol pollutants in the NFR14 format. Liechtenstein did not reported gridded emissions for Gothenburg protocol pollutants. Liechtenstein also submitted an IIR.

KEY CATEGORIES

9. Liechtenstein has compiled and presented a level key source analysis (KCA) and trend assessment consistent with EMEP/CORINAIR Guidebook for NO_2, CO, NMVOC, SO_x, NH_3 and PM_{10}. The ERT encourages Liechtenstein to conduct a KCA also for other pollutants.

QUALITY

Transparency

10. The ERT recognises the level of effort undertaken by Liechtenstein in providing an inventory featuring a significant level of detail. Liechtenstein's IIR is well presented.

11. Nevertheless, the ERT recommends Liechtenstein to provide more information on methodologies, activity data, emissions factors, data sources, drivers and additional assumption used while compiling the inventory. Such explanation would increase transparency of the reporting.

12. The ERT recommends Liechtenstein to use latest available EMEP/EEA air pollutant emission inventory guidebook (2016 version).

Completeness

13. The ERT acknowledges the effort to which Liechtenstein has gone to provide estimates of emissions for all sub-sectors and all pollutants reviewed.

14. Liechtenstein's inventory for the pollutants reviewed is generally complete.

15. The ERT noted, that no information is reported for "Memo items". The ERT therefore recommends Liechtenstein to include information about "Memo items" in its future submissions.

16. The ERT however notes that gridded data, projections and LPS are no reported. The ERT therefore recommends Liechtenstein to include this information in the future inventories.

Consistency, including recalculations and time-series

17. Liechtenstein has undertaken a number of recalculations for the energy, and transport sector. However, no explanation of the recalculations is provided in the IIR, nor impacts of the recalculations on the trends and emission level. The ERT therefore encourage Liechtenstein to include explanations of recalculations in its future IIRs.

Comparability

18. The ERT notes that the inventory of Liechtenstein is comparable with those of other reporting parties. The allocation of source categories follows that of the EMEP/UNECE reporting Guidelines, but the use of the current version of the methodology is highly recommended.

CLRTAP/NECD comparability

19. Liechtenstein, as a non-EU country, does not report emissions under the NEC Directive.

Accuracy and uncertainties

20. Liechtenstein has not compiled an uncertainty analysis for its UNECE submission. The ERT encourages Liechtenstein to compile an uncertainty analysis for future submissions. Further, a qualitative approach might be undertaken for uncertainty assessment.

Verification and quality assurance/quality control approaches

21. Liechtenstein has developed a QA/QC plan which is following the obligations under UNFCCC. The main part of the plan is also valid for air pollution inventories. The ERT encourages Liechtenstein to include more information on specific QA/QC procedures for its national air emission inventory in its future IIRs.

FOLLOW-UP TO PREVIOUS REVIEWS

22. Liechtenstein provided limited responses to the questions raised during the review process. Further, there is no reference to the last Stage review 3 process in the IIR. The ERT encourages Liechtenstein to include information of improvement undertaken in response to the review process in its future IIRs.

AREAS FOR IMPROVEMENT IDENTIFIED BY LIECHTENSTEIN

23. The IIR identifies several areas for improvement. Further in its response to previous reviews and review stages this year, Liechtenstein indicates that it is working to improve its inventory. The improvements include:

(a) Calculation of the NH_3 - emissions of manure management from other poultry 3B4giv.

(b) Calculation of the dust-emissions from animal husbandry 3Dc.

(c) Calculation of the NH_3-emissions from the application of inorganic fertilizer 3Da1. It is the correction of the mentioned error in the current submission.

(d) It is planned to check the activity rates from the road traffic and, if necessary, to recalculate them.

(e) Update of emission factors to be consistent with 2006 Emission inventory guidebook

(f) Improvement of QA/QC procedures to increase consistency and accuracy of inventory.

24. During the review Liechtenstein answered to the initial questions, which were received till the beginning of the review week. Liechtenstein agreed that its IIR contains only little information on the methods (activity data, emission factors and information about the sources). Liechtenstein further informed the ERT, that due to the limited resources, Liechtenstein is not in the position to provide all this information in the IIR, that would respectively answer most of the ERT's questions. Liechtenstein is planning to improve the IIR step by step for the upcoming submissions, also on the basis of the issues raised during the review. For the submission 2018 Liechtenstein will analyse and evaluate which improvements are possible to implement. The ERT welcomes the information of planned improvements and encourages Liechtenstein to ensure relevant resources are available in the future in order to be able to implement all listed recommendations.

TECHNICAL CORRECTIONS CONSIDERED AND OR CALCULATED BY ERT

25. The ERT identified some significant over or under estimations in the inventory (i.e. above the 2% threshold compared to the national total) and proposed technical corrections during the review week for 2H2 food & beverages industry / wine

production and for 3B manure management. A synthesis of the different proposed technical corrections is given in the following table. For more detailed information please consider the sectoral chapters and annex I.

Table 1 Summary of potential technical corrections identified by ERT for the Party

NFR category (s)	Pollutants	Years	Calculated by country/ Calculated by ERT/ Not calculated	Potential correction to national total (%)
2H2 Food & Beverages Industry / Wine production	NMVOC	2015	ERT	7.27%
2H2 Food & Beverages Industry / Wine production	NMVOC	2010	ERT	6.66%
2H2 Food & Beverages Industry / Wine production	NMVOC	2005	ERT	7.18%
3B Manure management	PM2.5	2015	ERT	6.06%
3B Manure management	PM2.5	2010	ERT	6.60%
3B Manure management	PM2.5	2005	ERT	6.52%
3B Manure management	PM10	2015	ERT	8.91%
3B Manure management	PM10	2010	ERT	9.56%
3B Manure management	PM10	2005	ERT	9.19%

PART B: RECOMMENDATIONS FOR IMPROVEMENTS TO THE PARTY

CROSS CUTTING IMPROVEMENTS IDENTIFIED BY THE ERT

26. The ERT identified the following cross-cutting issues for improvement. The ERT:

(a) recommends improve transparency of reporting by more detailed description of methodologies, data sources, activity data used and emission factors in each sector.

(b) recommends Liechtenstein to use the latest available EMEP/EEA air pollutant emission inventory guidebook.

(c) encourages Liechtenstein to conduct key category analysis also for other pollutants, than for those presented in current inventory.

(d) encourages Liechtenstein to include an uncertainty analysis in its future submissions.

(e) recommends Liechtenstein to include a more detailed explanation of QA/QC process used specifically for the air pollution inventories.

(f) invites Liechtenstein to consider reporting of gridded data and particularly LPS emissions based on the 2014 CLRTAP Reporting Guidelines in its future submissions. The ERT is aware of the fact that under original Gothenburg Protocol, Liechtenstein was not required to report such data. However, under 2014 CLRTAP Reporting Guidelines the “EMEP grid” refers to a 0.1°×0.1° latitude-longitude projection in the geographic coordinate World Geodetic System (WGS) latest revision, WGS 84, which would be valid also for Liechtenstein. The 2014 CLRTAP Reporting Guidelines also state, that this information shall be reported every four years from 2017 onwards, therefore Liechtenstein is encouraged to include such data by the next appropriate deadline.

(g) encourages Liechtenstein to include information about projections following the 2014 CLRTAP Reporting Guidelines in its future submissions.

(h) encourages Liechtenstein to include an improvement plan in its future submissions, including a prioritisation of the improvements and also include Information on improvements implemented following the review process in the IIR.

(i) further recommends Liechtenstein to increase the capacities for the air pollution inventory team in order to manage transparent, complete, comparable, consistent and accurate inventories within deadlines set up in the UNECE reporting Guidelines. .

27. Recommended improvements relating to specific source categories are presented in the relevant sector sections of this report.

SECTOR SPECIFIC RECOMMENDATIONS FOR IMPROVEMENTS IDENTIFIED BY ERT

ENERGY

Review Scope

Pollutants Reviewed		SO_2, NO_x, NMVOC, NH_3, PM_{10} & $PM_{2.5}$, Cd, Hg, Pb, Dioxin, PAH		
Years		1990 – 2015		
Code	**Name**	**Reviewed**	**Not Reviewed**	**Recommendation Provided**
1A1a	Public electricity and heat production	X		X
1A1b	Petroleum refining	NO		
1A1c	Manufacture of solid fuels and other energy industries	NO		
1A2a	Iron and steel	NO		
1A2b	Non-ferrous metals	NO		
1A2c	Chemicals	NO		
1A2d	Pulp, Paper and Print	NO		
1A2e	Food processing, beverages and tobacco	X		
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	X		X
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	X		X
1A3ei	Pipeline transport	NO		
1A3eii	Other	NO		
1A4ai	Commercial/institutional: Stationary	X		X
1A4bi	Residential: Stationary	X		X
1A4ci	Agriculture/Forestry/Fishing: Stationary	X		
1A5a	Other stationary (including military)	NO		
1B1a	Fugitive emission from solid fuels: Coal mining and handling	NO		
1B1b	Fugitive emission from solid fuels: Solid fuel transformation	NO		
1B1c	Other fugitive emissions from solid fuels	NO		
1B2ai	Fugitive emissions oil: Exploration, production, transport	NO		
1B2aiv	Fugitive emissions oil: Refining / storage	NO		
1B2av	Distribution of oil products	X		
1B2b	Fugitive emissions from natural gas (exploration, production, processing, transmission, storage, distribution and other)	X		X
1B2c	Venting and flaring (oil, gas, combined oil and gas)	NO		
1B2d	Other fugitive emissions from energy production	NO		
Note: Where a sector has been partially reviewed (e.g. some of the NFR codes) please indicate which have and which have not in the respective columns.				

General recommendations on cross cutting issues

Transparency

28. Liechtenstein's IIR (section 1.3) indicates that the preparation of the CLRTAP submission is very closely connected to the preparation of the GHG inventory submitted to the UNFCCC, and Liechtenstein has responded in previous LRTAP reviews to confirm that common data sources are used for the activity data in the energy sector. The ERT commends Liechtenstein for the co-ordinated inventory compilation efforts, to minimise inconsistency between estimates reported to CLRTAP and the UNFCCC, and also on the detailed presentation and explanation of emission trends presented in section 2 of the IIR.

29. The ERT notes, however, that the CLRTAP submission does not include reported activity data in the NFR tables, and there is only a very limited description of the methods, AD and EFs within the IIR for all stationary combustion source categories. Furthermore, the Party responded partly to questions from the ERT, including a clarification that the description in the NIR regarding assumptions to derive AD for 1A2g for GHGs was not applicable for the CLRTAP submission. The ERT also notes that EF data that are presented in the IIR are not clearly referenced, and where country-specific EFs are applied there is only limited information provided to justify the EF selection, even for key categories. Therefore, even though the ERT also reviewed the information provided in the NIR as well as the IIR, the transparency of the CLRTAP submission is very limited; without details of the AD and EFs it is not possible for the ERT to fully assess the accuracy and completeness of the Liechtenstein submission.

30. The ERT re-iterates the findings of the previous Stage 3 review, and strongly recommends that Liechtenstein improves the method descriptions in the IIR, providing clear descriptions of methods, activity data and emission factors applied. The ERT encourages Liechtenstein to prioritise IIR improvements to method descriptions for key categories, and to include full details and references for country-specific EFs applied. To further improve transparency, the ERT recommends Liechtenstein to provide full details of all activity data within the NFR reporting template.

31. The ERT notes that Liechtenstein uses notation keys inconsistently in the NFR tables, for example reporting "NO" for some pollutants alongside reported emissions in the same source category for other pollutants, and reporting a mixture of "NA" and "NO" for different pollutants for a given source category where there are EFs available for all such pollutants in the latest EMEP-EEA Guidebook. The ERT encourages Liechtenstein to review the selection of notation keys in the NFR reporting tables, and to use the appropriate notation keys (e.g. "NO" where emissions are "Not Occurring" because the activity itself is not occurring, "NA" where activity occurs but the emissions are not applicable for a given pollutant, "NE" where emissions are "Not Estimates" and "IE" where emissions are "Included Elsewhere") for reporting where estimates are not available or necessary.

32. The ERT noted that the IIR contains several inconsistencies compared to the NFR tables. The Party did not respond to many questions during the review week and therefore the ERT was unable to determine which part of the submission was correct. For example, there are very low emissions reported under 1A2f in the NFR tables, and higher emissions reported under 1A2gviii, whilst the IIR section 3.2 states that all emissions related to manufacturing industries and construction are reported under 1A2f. There is no evidence of mineral industries in Liechtenstein, nor any emissions reported under 2A1 or 2A2, and therefore the ERT assumes that the IIR text may need updating to NFR-2014 categories. Similarly, section 3.4.3 of the IIR outlines a methodology for emissions in NFR 1A5 Other, whilst the NFR tables indicate that the source is "NO". The IIR section 3.2 also states that no key categories are to be found in 1A2, whilst the sum of 1A2f and 1A2g accounts for 45% of the national total of NO_X. To improve the transparency of the submission, the ERT recommends that Liechtenstein revises these sections of the IIR to match the NFR tables and the key category analysis, and improves the QA/QC between the IIR text and NFR tables in order to minimise the risk of such errors.

Completeness

33. Liechtenstein's submission is generally complete for the years 1990 to 2015, with emissions reported for all of the main pollutants (NO_X, NMVOC, SO_2, NH_3, CO), particulate matter (TSP, PM_{10} and $PM_{2.5}$), priority heavy metals (Pb, Cd, Hg) and POPs (Dioxins, total PAHs and individual PAH species: B-a-P, B-b-F, B-k-F and I-cd-P). As noted above, the NFR tables do not include any reporting of the under-pinning activity data, and the Party did not respond to ERT questions in the review week to provide activity data for the years 2005, 2010 and 2015, nor are there separate energy balance data available for Liechtenstein from the IEA. Therefore it is not possible for the ERT to fully assess the completeness, nor sector resolution of Liechtenstein's submission.

Consistency including recalculation and time series

34. The ERT notes that the 2017 CLRTAP submission includes many recalculations, whilst the IIR section 8.1 does not include all of the necessary explanations, stating only that the latest submission now applies "*time-variable EFs for stationary combustion plant*". The Party did not respond to questions of clarification during the review week and therefore the ERT cannot review the rationale and improvements that Liechtenstein has implemented, including for key categories in the stationary combustion sector. The ERT recommends that Liechtenstein improves the transparency of recalculations performed by documenting within the IIR the details of revisions to methods, AD and EFs, and to include the rationale, the impact on the sector and on the trends for the energy sector. The ERT encourages Liechtenstein to prioritise improvements in documentation of recalculations for key categories.

35. Despite the lack of a transparent description in the IIR, the ERT believes that Liechtenstein's inventory submission for stationary combustion is consistent, with the same methodologies used for all years. The ERT recommends that the Party

improves its description in the IIR of how it ensures consistent estimates for each source for all years of the time series, and specifically to provide details of the selection and use of EFs across the time series where time-variable EFs are applied, with clear referencing of the EFs used and justification of why they best reflect emissions from the local stock of combustion units over time. The ERT also encourages the Party to improve the description of where the CLRTAP submission is consistent with other international reporting obligations, notably to the UNFCCC and to clearly set out in the IIR where there are any deviations in activity data and source allocation between the CLRTAP and UNFCCC submissions.

Comparability

36. Despite the lack of a transparent description in the IIR, the ERT believes that Liechtenstein's inventory estimates for stationary combustion have been calculated in a manner broadly consistent with the methodologies described in the EMEP/EEA Guidebook. There are a number of key categories where the selection of country-specific EFs is not clearly described or justified, and a small number of potential gaps in the Liechtenstein inventory that are outlined in the sections below. The ERT recommends that Liechtenstein improves its description in the IIR of how the methods applied are consistent with the EMEP/EEA Guidelines, specifically for higher tier methods applied to key categories, in order to demonstrate that the inventory submission is comparable to those of other Parties.

Accuracy and uncertainties

37. Liechtenstein has not carried out an uncertainty analysis of the 2017 LRTAP submission, and the IIR section 8.2 indicates that there are no improvements planned for the energy sector. The ERT encourages Liechtenstein to undertake an uncertainty analysis for the energy Sector in order to help inform the improvement process and to provide an indication of the reliability of the inventory data.

38. The Liechtenstein IIR includes no details of QA/QC activities, but references the NIR. The QA/QC for the GHG submission includes some basic QA/QC checks, use of checklists for sector experts and report authors, and the findings are documented and checked to confirm that checks have been performed by the Quality Manager in the Office of Environment. It is not clear to the ERT whether the same system and organisational structure with roles and responsibilities as described for the GHG submission are also applied to the CLRTAP submission, nor whether there are any quality checks (e.g. on default and country-specific EFs applied, on the completeness of reporting across pollutants) or QA (such as peer review of methods) conducted that are specific to the CLRTAP inventory methods and estimates. The ERT encourages the Party to implement sector specific QA/QC procedures for all key categories and report in the IIR on progress and on the wider QA/QC system, including roles and responsibilities and checks specific to the CLRTAP submission.

Improvement

39. The ERT commends the Party for implementing improvements to estimates from stationary combustion plant, despite the lack of transparency of the changes

that have been made and on their impact to the inventory time series. As noted above, no improvements are planned for the energy sector according to the IIR, but in response to ERT questions the Party has stated its intention to improve its use of notation keys in the next submission and also to review the time series of EFs applied in the key categories of 1A4ai and 1A4bi in the next submission. The ERT encourages the Party to implement these planned improvements and provide details in the next submission.

Potential Technical Corrections

40. The ERT notes that the Liechtenstein inventory does not include any estimate of NMVOC emissions from leakage from the natural gas distribution system in 1B2b, despite reporting methane emissions from this source in the GHG inventory submission to the UNFCCC. The ERT notes that there are emission factors provided in the EMEP/EEA Guidebook, and further that natural gas compositional analysis may well be readily available for Liechtenstein, or from Switzerland or Austria, in order to derive a country-specific EF for this source. The ERT could not calculate an estimate based on the EMEP/EEA Guidebook method due to lack of activity data, so no technical correction was proposed, but using the methane estimate and scaling according to typical natural gas composition, the NMVOC leakage in Liechtenstein is likely to be around 2% of the reported national total in 2015. The ERT recommends that the Party develops a new estimate for this source of NMVOC and includes this in the next submission, to address this under-estimate.

Sub-Sector Specific Recommendations

Category issue 1: 1.A.1.a Public Electricity and Heat Production - All Pollutants

41. The IIR text does not provide any details on the method, activity data or emission factors applied for power generation in Liechtenstein, other than to provide insight that the power stations only use natural gas and biogas. The Party did not respond to questions from the ERT seeking clarifications on the number of power stations operating across the time series, the methods, activity data and emissions factors, and any emissions data available from power plant operators. The ERT strongly recommends that the Party includes all methodological details, activity data and emission factors in the next submission, including information on EFs applied across the time series to justify the selection of EFs applicable to the range of power generation units and fuels used within Liechtenstein.

Category issue 2: 1.A.2 Industrial Combustion - All Pollutants

42. The IIR text does not provide any details on the method, activity data or emission factors applied for the 1A2 industrial combustion sector in Liechtenstein, and states that no key categories are within this sub-sector. The IIR section 3.2 also states that all emissions in 1A2 are reported under 1A2f. In the NFR tables there are emissions reported within 1A2f and 1A2g, whilst in the NIR the sector 1A2f is stated

as “NO”. Furthermore, the NIR Table 3-18 indicates an assumption that 30% of diesel oil activity data are accounted in the 1A2g sector. During the review week, the Party clarified that the diesel oil assumption stated in the NIR did not apply to the CLRTAP submission, but did not respond to other questions to clarify the data, methods and reporting allocations in the 2017 submission. Noting that the emissions from 1A2 together constitute 45% of the national total for NO_X in 2015 and that the information in the IIR is incomplete and inconsistent with the NFR tables for this key category, the ERT strongly recommends that the Party includes all methodological details, activity data and emission factors in the next submission, and encourages the party to strengthen the QA/QC of the IIR and NFR tables to minimise inconsistencies.

Category issue 3: 1.A.4.ai Commercial Combustion and 1.A.4.bi Residential Combustion – All Pollutants

43. These two source categories are key categories for many pollutants in the Liechtenstein submission. The IIR includes limited details of the Tier 2 method applied, the expert judgement used to QC the activity data assumptions applied, and a summary table of EFs is provided to illustrate the variability of EFs for selected pollutants and fuels in 1990 and 2015 for each source category. However, the ERT notes that there is no information regarding the activity data for different fuels used in this sector, nor is there any supporting information provided to justify the selection of the EFs, which for several fuels and pollutants (e.g. wood combustion EFs for NMVOC, PM_{10}) are lower than the EMEP/EEA 2016 Guidebook defaults, and lower than the EFs applied for neighbouring countries. The Party responded to ERT questions to clarify that the EFs are taken from the Swiss EMIS dataset, and that the EFs will be reviewed for the 2018 submission. The ERT strongly recommends that the Party includes all methodological details, activity data and emission factors in the next submission, including to review the EFs applied and to provide information in the IIR to justify the selection of EFs across the time series.

44. The ERT understands that country-specific EFs from wood combustion in particular can vary considerably from Guidebook defaults. These two key categories underpin a large proportion of the national total emissions in Liechtenstein for many pollutants and also significantly impact upon the reported emission trends. Therefore the ERT encourages Liechtenstein to explain how the methods deliver accurate and time-series consistent estimates, and to provide details of the assumptions that underpin the choice of EFs to accurately reflect emissions from the local stock and utilisation of different combustion units (e.g. stoves, fireplaces, boilers), and fuels (e.g. seasoned wood, moisture and NCV levels) across the time series.

Category issue 4: 1.B.2b Fugitive emissions from natural gas – NMVOC

45. As noted in paragraph 13 above, the ERT notes that the Liechtenstein inventory does not include any estimate of NMVOC emissions from leakage from the natural gas distribution system in 1B2b, despite reporting methane emissions from this source in the GHG inventory submission to the UNFCCC. The ERT recommends that the Party develops a new estimate for this source of NMVOC and includes this in the next submission, to improve completeness.

TRANSPORT

Review Scope

Pollutants Reviewed		All		
Years		1990 – 2015		
Code	**Name**	**Reviewed**	**Not Reviewed**	**Recommendation Provided**
1A2gvii	Mobile Combustion in manufacturing industries and construction	X		X
1A3ai(i)	International aviation LTO (civil)	X		
1A3ai(ii)	International aviation cruise (civil)	X		
1A3aii(i)	Domestic aviation LTO (civil)	X		
1A3aii(ii)	Domestic aviation cruise (civil)	X		
1A3bi	Road transport: Passenger cars	X		
1A3bii	Road transport: Light duty vehicles	X		
1A3biii	Road transport: Heavy duty vehicles and buses	X		
1A3biv	Road transport: Mopeds & motorcycles	X		
1A3bv	Road transport: Gasoline evaporation	X		X
1A3bvi	Road transport: Automobile tyre and brake wear	X		
1A3bvii	Road transport: Automobile road abrasion	X		
1A3c	Railways	X		
1A3di(ii)	International inland waterways	X		
1A3dii	National navigation (shipping)	X		
1A4aii	Commercial/institutional: Mobile	X		X
1A4bii	Residential: Household and gardening (mobile)	X		X
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	X		X
1A4ciii	Agriculture/Forestry/Fishing: National fishing	X		
1A5b	Other, Mobile (including military, land based and recreational boats)	X		X
1A3di(i)	International maritime navigation	X		
1A3	Transport (fuel used)		X	
Note: Where a sector has been partially reviewed (e.g. some of the NFR codes) please indicate which have and which have not in the respective columns.				

General recommendations on cross cutting issues

Transparency

46. The ERT noted that only limited information on the emission factors and activity data is provided in the 2017 IIR, as in previous IIR submissions. ERT welcomes the plan of the Party to provide activity calculations in the transport sector as an improvement priority (IIR 2017, p. 10). In general, providing more details on the methodology, emission factors, and activity data used to calculate transport emissions is desirable in order to enhance the transparency of the transport sector emissions inventory.

Completeness

47. The ERT considers the transport sector of Liechtenstein's inventory to be in general complete, but there is still room for improvement with some recommendations for enhancing the completeness of the inventory provided below (i.e. no emissions reported for categories 1A4aii, 1A4bii, and 1A5b).

Consistency including recalculation and time series

48. Liechtenstein provides explanations and descriptions of key trends in its IIR. Moreover, the Party also provided satisfactory explanations for most of the questions during the current Stage 3 review process related to consistency of time series. Sector specific issues are reflected in the sub-sector specific recommendations below.

49. The ERT noted that there are significant recalculations (compared to 2016) for many pollutants (more than 10% or even higher) and a significant contributor to these recalculations is the transport sector. In the 2017 IIR, only a general justification is provided for these recalculations: "adjustment of emission factors in the transport sector". The ERT suggests that the Party provides more detailed and complete information on recalculations in its next submission.

Comparability

50. No activity data are provided, hence, it is not possible to calculate IEFs for comparison with other countries. Nevertheless, the ERT performed a comparison of the transport sector emissions of Liechtenstein to those of other countries. Some issues that were identified are described in category issue 5 below.

Accuracy and uncertainties

51. Liechtenstein has not provided a quantitative uncertainty assessment for any of the pollutants (IIR 2017, p. 18). The ERT encourages the Party to undertake an uncertainty analysis to help inform the improvement process and to provide an indication of the reliability of the inventory data.

52. Liechtenstein has performed QA/QC activities, which are presented in the NIR for the UNFCCC. Nevertheless, the ERT encourages the Party to describe QA/QC activities in the IIR as well as sector-specific QA/QC procedures.

Improvement

53. ERT welcomes the plan of the Party to provide activity calculations for the transport sector as an improvement priority (IIR 2017, p. 10) and also commends the Party for some improvements carried out within the transport sector, based on recommendations from the previous Stage 3 review in 2012. The ERT encourages the Party to further improve its inventory by considering the recommendations of the current Stage 3 review.

Potential technical corrections

54. During the Stage 3 review, the ERT identified the following 3 potential technical corrections, but did not make any calculations due to the lack of activity data provided by the Party. These findings are also described in more detail in the sub-sector specific recommendations below.

NFR category	Pollutants	Years	Not calculated by ERT due to lack of activity data	Potential correction to national total (%)
1A4cii, 1A5b	All	Whole time series	Category issue 1 (below)	Not estimated
1A4aii, 1A4bii	All	Whole time series	Category issue 3 (below)	Not estimated
1A3bv	NMVOC	2015	Category issue 4 (below)	Not estimated

Sub-Sector Specific Recommendations

Category issue 1: 1.A.4.c.ii, 1.A.5.b Off-road vehicles and other machinery from agriculture/forestry/fishing, Other mobile combustion including military, land based and recreational boats - All pollutants

55. The ERT noted that in the IIR (2017, p. 35-36) it is mentioned that the calculations for 1A4cii, 1A5b are based on EMEP/CORINAIR 2007. In the previous Stage 3 review (2012), it was recommended that the Party should use the most updated emission factors given in the EMEP/EEA Guidebook (2016 now, 2009 in the previous Stage 3 review) and recalculate the emissions. The Party answered that an implementation of new (updated) emission factors is examined for the 2018 submission. The ERT welcomes this plan and recommends that the Party uses the most updated emission factors and methodologies to calculate the emissions from the transport sector.

56. The ERT noted that emissions from 1A5b are not reported after all (notation keys “NA” / “NO” for all pollutants) and the Party answered that all off-road emissions taken into account are allocated to source 1A4cii. However, the ERT considers that there is an incompatibility of this answer with the description in IIR (section 3.4.3) and recommends that the Party checks this issue for its next submission.

Category issue 2: 1.A.3.b compared to 1.A.4.c.ii Road transport sector compared to Off-road vehicles and other machinery from agriculture/forestry/fishing - SO_x

57. Following up on question from previous Stage 3 review (2012, Transport, Category issue 7), the ERT noted again that SO_x emissions from the 1A3b road transport sector have decreased suddenly in 2004, but this kind of reduction is not observed in other sectors, i.e., 1A4cii. The Party answered (during previous and current Stage 3 reviews) that this is due to the EFs used from HBEFA (decline of SO2 emission factors by a factor of 10 from 2003 to 2004). The ERT acknowledges this answer for the 1A3b sector, but again recommends that the Party checks the

sulphur contents of fuel used in the calculations of other transport sectors, i.e., 1A4cii.

Category issue 3: 1.A.4.a.ii, 1.A.4.b.ii Commercial/institutional: mobile, residential: household and Gardening mobile - All pollutants

58. Following up on question from previous Stage 3 review (2012, Transport, Category issue 7), the ERT noted again that no emissions are reported for sub-sectors 1A4aii, 1A4bii, although it is acknowledged that their contribution is expected to be small. The Party answered (during previous and current Stage 3 reviews) that this issue has not yet been clarified and will be noted as planned improvement for the next submission. The ERT welcomes this plan.

Category issue 4: 1.A.3.b.v Road transport: gasoline evaporation - NMVOC

59. The ERT noted that no NMVOC emissions are reported for 1A3bv for the year 2015 (notation key “NO”), whilst being reported for previous years. The Party answered that this is due to a faulty reference in the calculation and this will be corrected for the next submission.

Category issue 5: 1.A.2.g.vii Mobile combustion in manufacturing industries and construction - Cd, CO, DIOX, NMVOC, NO_x, PM, SO_x

60. From a detailed data analysis (comparison with other countries), the ERT noted that in Cd emissions, the percentage contribution of 1A2gvii to national total is extremely high (>6% in 2015) compared to other countries and EU28 (~0-1%); similar observations have been made for other pollutants, i.e., CO, DIOX, NMVOC, NO_x, PMs, SO_x. The Party answered that in Liechtenstein there is no main source of Cd emissions and this makes the combustion of wood so relevant (no answer provided for other pollutants). The ERT acknowledges that such phenomena are not unusual in small countries (such as Liechtenstein), but, in any case, recommends that the Party checks the methodology and emission factors used in 1A2gvii (compared to other transport sub-sectors).

INDUSTRIAL PROCESSES

Review Scope

Pollutants Reviewed		SO_2, NO_x, NMVOC, NH_3, PM_{10} & $PM_{2.5}$		
Years		1990 – 2015 + (Protocol Years)		
Code	**Name**	**Reviewed**	**Not Reviewed**	**Recommendation Provided**
2A1	Cement production			
2A2	Lime production			
2A3	Glass production			
2A5a	Quarrying and mining of minerals other than coal			
2A5b	Construction and demolition	X		X
2A5c	Storage, handling and transport of mineral products			
2A6	Other mineral products			
2B1	Ammonia production			
2B2	Nitric acid production			
2B3	Adipic acid production			
2B5	Carbide production			
2B6	Titanium dioxide production			
2B7	Soda ash production			
2B10a	Chemical industry: Other			
2B10b	Storage, handling and transport of chemical products			
2C1	Iron and steel production			
2C2	Ferroalloys production			
2C3	Aluminium production			
2C4	Magnesium production			
2C5	Lead production			
2C6	Zinc production			
2C7a	Copper production			
2C7b	Nickel production			
2C7c	Other metal production			
2C7d	Storage, handling and transport of metal products			
2D3b	Road paving with asphalt			
2D3c	Asphalt roofing			
2H1	Pulp and paper industry			
2H2	Food and beverages industry	X		X
2H3	Other industrial processes			
2I	Wood processing	X		
2J	Production of POPs			
2K	Consumption of POPs and heavy metals (e.g. electrical and scientific equipment)			
2L	Other production, consumption, storage, transportation or handling of bulk products			
Note: Where a sector has been partially reviewed (e.g. some of the NFR codes please indicate which have and which have not in the respective columns.				

General recommendations on cross cutting issues

Transparency

61. The Party provides a full set of NFR tables with notation keys for all sectors within the industrial processes sector.

62. Liechtenstein's inventory does not include any estimates for any sources within the industrial processes sector and does not provide any information within the IIR.

Completeness

63. The Party does not include any estimates for any sources within the industrial processes sector, however the ERT consider that sources including 2A5b and 2H2 do occur in Liechtenstein and should be included in the inventory. Other sources such as 2I may occur. The ERT therefore consider the Liechtenstein inventory to be incomplete and recommends that the Party includes estimates for 2A5b and 2H2 in future submissions and investigates whether wood processing activities occur which would have an impact on emissions required to report under 2I.

Consistency including recalculation and time series

64. The Party does not include any estimates for any sources within the industrial process sector.

Comparability

65. The Party does not include any estimates for any sources within the industrial process sector.

Accuracy and uncertainties

66. The Party does not include any estimates for any sources within the industrial process sector.

Improvement

67. The Party does not mention any improvements for the industrial processes sector in the IIR.

Potential Technical Corrections

68. The ERT notes that Liechtenstein does not provide any estimates for 2A5b or 2H2. Of these two categories, 2A5b covers construction and demolition which is an ubiquitous activity and so the ERT believes that emissions are likely to occur in Liechtenstein and that emissions should be reported. However, no activity data are available and therefore no technical correction can be calculated.

69. For 2H2, Liechtenstein is a wine producing country and the ERT has also found evidence that at least two breweries and at least one distillery operate in Liechtenstein. The distillery seems to produce whisky as well as other spirits so

emissions of NMVOC during maturation of the whisky may be significant. The ERT has used activity data for wine production from the FAO to estimate a technical correction for NMVOC emissions from this sub-source within 2H2 (cf. also part 1 table 1, and annex I). No activity data were available for beer production or production of whisky and other spirits and so no technical correction can be made for those sub-sources.

70. The ERT believes that bread is baked in Liechtenstein, leading to NMVOC emissions. If Liechtenstein has similar per capita bread consumption as in EU countries and if that bread is produced in Liechtenstein, then the ERT estimates that bread production would be a significant (>2%) source of national NMVOC emissions in Liechtenstein, however no production data are available and so no technical correction can be made.

71. The ERT strongly encourages the Party to review and recalculate, include new information, implement planned improvements especially for those industrial emission sources (2A5b and 2H2)..

Sub-Sector Specific Recommendations

Category issue 1: 2.A.5.b Construction and demolition

72. The ERT notes that Liechtenstein does not provide any estimates for 2A5b – construction and demolition. Both construction and demolition activities are ubiquitous and so the ERT believes that these activities occur in Liechtenstein. The 2016 Guidebook provides emission factors for TSP, PM_{10}, and $PM_{2.5}$ and therefore the ERT recommends that emissions shall be estimated for these pollutants using the Guidebook methods, and that these emissions shall be reported in future submissions.

Category issue 2: 2.H.2 Food and beverages industry

73. The ERT notes that Liechtenstein does not provide any estimates for 2H2 food and beverages industry. However, Liechtenstein is a wine producing country and the ERT has also found evidence that at least two breweries and at least one distillery operate in Liechtenstein. The distillery seems to produce whisky as well as other spirits so emissions of NMVOC during maturation of the whisky may be significant. The ERT has used activity data for wine production from the FAO to estimate a technical correction for NMVOC emissions from this sub-source within 2H2. The ERT recommends that the Party reviews this estimate and either incorporates it into Liechtenstein's inventory for the next submission or provides revised numbers. No activity data were available for beer production or production of whisky and other spirits and so no technical correction can be made for those sub-sources, but ERT does recommend Liechtenstein to obtain such production data, if available. The 2016 Guidebook contains emission factors for NMVOC from production of wine, beer and spirits and the ERT recommends that emissions shall be estimated for NMVOC using the Guidebook methods, and that these emissions shall be reported in future submissions.

74. The ERT believes that bread is baked in Liechtenstein, leading to NMVOC emissions. If Liechtenstein has a similar per capita bread consumption as other EU

countries and if that bread is produced in Liechtenstein, then the ERT estimates that baking would be a significant (>2%) source of national NMVOC emissions. The 2016 Guidebook contains emission factors for NMVOC from bread baking and the ERT recommends that emissions shall be estimated for NMVOC using the Guidebook methods, and that these emissions shall be reported in future submissions.

Category issue 3: 2.I Wood processing

75. The ERT notes that Liechtenstein does not provide any estimates for 2I wood processing. The ERT has found evidence that forestry activities occur in Liechtenstein but it is not certain that these activities include processes that emit particulate matter. The ERT encourages the Party to investigate whether any wood processing occurs in Liechtenstein that would lead to emissions of particulate matter.

SOLVENTS

Review Scope

Pollutants Reviewed		SO_2, NO_x, NMVOC, NH_3, PM_{10} & $PM_{2.5}$		
Years		1990 – 2015 + (Protocol Years)		
Code	**Name**	**Reviewed**	**Not Reviewed**	**Recommendation Provided**
2D3a	Domestic solvent use including fungicides	X		X
2D3d	Coating applications	X		
2D3e	Degreasing	X		
2D3f	Dry cleaning	X		
2D3g	Chemical products	X		
2D3h	Printing	X		
2D3i	Other solvent use	X		
2G	Other product use	X		X
Note: Where a sector has been partially reviewed (e.g. some of the NFR codes please indicate which have and which have not in the respective columns.				

General recommendations on cross cutting issues

Transparency

76. The party provides a full set of NFR tables with emissions data or notation keys for all sectors within the solvent use sector.

77. The IIR includes some details on the methodology for some key sources within the solvent use sector, but not all. The ERT recommends that the Party includes descriptions of methods for 2D3a and 2D3h in future submissions.

Completeness

78. The ERT considers that Liechtenstein's inventory omits some source categories within 2G and has made recommendations below that the party remedies this in future submissions.

Consistency including recalculation and time series

79. Emissions are calculated for the full time-series and these seem to be consistent.

Comparability

80. Emissions from solvent use are calculated by extrapolation from data for Switzerland. The rationale for the use of Swiss data is that the general characteristics of the two countries are roughly the same. The ERT encourages the Party to either use Guidebook methods or to obtain country-specific data in the future.

Accuracy and uncertainties

81. No quantitative uncertainty assessment for any of the pollutants of Liechtenstein's emission inventory has been made.

Improvement

82. The IIR includes a section on planned improvements but does not specify any for the solvents sector.

Sub-Sector Specific Recommendations

Category issue 1: 2.D.3.a Domestic solvent use including fungicides

83. The IIR does not include any details on the methodology for this sector and the party has not provided further information during the review. In the absence of information, it is not possible to determine if methods are appropriate. The ERT notes that the 2016 Guidebook proposes a per capita, Tier 1 NMVOC emission factor for 2D3a and that this would yield significantly higher emission estimates for 2D3a than those provided by the Party. The ERT therefore recommends that the Party either uses a Guidebook method in future submissions or provides details of country-specific methods with justification of the approach.

Category issue 2: 2.D.3.d Coating applications, 2.D.3.e Degreasing, 2.D.3.f Dry cleaning, 2.D.3.g Chemical products

84. During the review, the Party stated that they calculate NMVOC emissions for this sector by first calculating a per capita emission factor from emissions data reported by Switzerland and then applying this to Liechtenstein. This is not clear from the IIR but the Party has stated they will clarify this in the IIR for the next submission. The ERT encourages the Party to do this, and to also give brief details of the methods used to generate the Swiss emissions, since these are used as the basis for their own estimates. The ERT also encourages the Party to either obtain country-specific activity data in future so that Guidebook emission factors can then be used, or to generate emission estimates from other country-specific data such as solvent consumption.

Category issue 3: 2.D.3.h Printing, 2.D.3.i Other solvent use

85. The IIR does not include any details of the methodology for this sector and the party has not provided further information during the review. In the absence of information, it is not possible to determine if methods are appropriate. The ERT encourages the party to either obtain country-specific activity data in future so that Guidebook emission factors can then be used, or to generate emission estimates from other country-specific data such as solvent consumption.

Category issue 4: 2.G Other product use

86. The ERT notes that Liechtenstein does not provide any estimates for 2G Other product use. This source category includes emissions from use of tobacco products. The ERT believes that tobacco use is ubiquitous and therefore occurs in Liechtenstein, leading to emissions. The 2016 Guidebook provides Tier 2 emission factors for numerous pollutants in Table 3.14 of the chapter covering 2D3i & 2G, and so the ERT recommends that emissions be estimated for all of these pollutants using the Guidebook factors, and that these emissions be reported in future submissions.

87. Sector 2.G also covers the use of fireworks. The ERT believes that fireworks are used in Liechtenstein and so emissions occur. The 2016 Guidebook provides Tier 2 emission factors for numerous pollutants in Table 3.13 of the chapter covering 2D3i & 2G, consequently the ERT recommends Liechtenstein to estimate emissions for all of these pollutants using the Guidebook factors, and to report these emissions in future submissions.

AGRICULTURE

Review Scope

Pollutants Reviewed		SO_2, NO_x, NMVOC, NH_3, PM_{10} & $PM_{2.5}$		
Years		1990 – 2015 + (Protocol Years)		
Code	**Name**	**Reviewed**	**Not Reviewed**	**Recommendation Provided**
3B1a	Dairy cattle	X		X
3B1b	Non-dairy cattle	X		X
3B2	Sheep	X		X
3B3	Swine	X		X
3B4a	Buffalo	X		
3B4d	Goats	X		X
3B4e	Horses	X		X
3B4f	Mules and asses	X		X
3B4gi	Laying hens	X		X
3B4gii	Broilers	X		
3B4giii	Turkeys	X		
3B4giv	Other poultry	X		
3B4h	Other animals	X		
3Da1	Inorganic N-fertilizers (includes also urea application)	X		X
3Da2a	Animal manure applied to soils	X		
3Da2b	Sewage sludge applied to soils	X		
3Da2c	Other organic fertilisers applied to soils (including compost)	X		
3Da3	Urine and dung deposited by grazing animals	X		
3Da4	Crop residues applied to soils	X		
3Db	Indirect emissions from managed soils	X		X
3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products	X		
3Dd	Off-farm storage, handling and transport of bulk agricultural products	X		
3De	Cultivated crops	X		
3Df	Use of pesticides	X		X
3F	Field burning of agricultural residues	X		
3I	Agriculture other	X		
11A	Volcanoes		X	
11B	Forest fires		X	
Note: Where a sector has been partially reviewed (e.g. some of the NFR codes please indicate which have and which have not in the respective columns.				

General recommendations on cross cutting issues

Transparency

88. The ERT finds that the transparency of the agriculture inventory described in the IIR could be improved. The IIR contains a short description of the methods, activity data and emission factors used for the calculation of agriculture emissions. In the IIR, on page 38 it is stated that “Ammonia, particulates and NMVOC emissions from animal manure are calculated using the methodology described in the

guidebook", but only NH_3 emissions were reported under 3B manure management. The emission trend of NH_3 was briefly described but no description of the main drivers that govern the trend was available. The ERT recommends that Liechtenstein describes the emission trends in more detail in order to improve the quality and transparency of its inventory in its next submission.

Completeness

89. The ERT does not consider the agriculture inventory of Liechtenstein to be complete. The ERT reminds the Party that the EMEP/EEA 2016 Guidebook offers a good framework for implementing Tier 1 or 2 methodologies. The ERT reiterates recommendations from the previous review report 2012 that Liechtenstein further improves its inventory by estimating air pollutant emissions (e.g., NO_x, NMVOC, particulate matter) from the most important sources of emissions (e.g., 3B manure management and 3D agriculture soils) in its next annual submission. See sub-sector specific recommendations.

Consistency including recalculation and time series

90. There is no reference to recalculations for the agriculture sector in the IIR. The ERT encourages Liechtenstein to undertake recalculations for the whole time series using the methodologies provided in the last EMEP/EEA Emission Inventory Guidebook (2016) and to include recalculated emissions in its next annual submission.

Comparability

91. Liechtenstein uses the EMEP/EEA Emission Inventory Guidebook 2013 Guidebook for estimating emissions of its agriculture inventory. The IIR does not provide detailed descriptions of the country specific methods for estimating agriculture emissions. The ERT recommends Liechtenstein to implement the methods of EMEP/EEA Emission Inventory Guidebook 2016 and to provide more information on country specific methods in its next annual submission.

Accuracy and uncertainties

92. Liechtenstein stated in its IIR (p. 17) that it has developed a QA/QC plan to fulfill the obligations set out in the United Nations Framework Convention on Climate Change (UNFCCC). Even though this plan is focused on greenhouse gas (GHG) emissions, the main part of the assessment criteria also applies for air pollutants. Detailed information on the QA/QC plan of Liechtenstein including all personnel and procedures is provided in the National Inventory Report (NIR), submission 2017. The ERT commends Liechtenstein for undertaking this approach but encourages Liechtenstein to further develop QA/QC procedures for the CLRTAP inventory and especially for the agriculture sector.

93. The ERT notes that Liechtenstein did undertake a quantitative uncertainty assessment for any of the pollutants of its inventory. The ERT encourages

Liechtenstein to undertake a quantitative uncertainty assessment for its inventory in future submissions.

Improvement

94. The ERT welcomes and commends Liechtenstein plans to implement to the following improvements in its next submission:

a) Calculation of the NH_3 emissions of manure management from other poultry 3B4giv.
b) Calculation of the dust emissions from animal husbandry 3Dc.
c) Calculation of the NH_3 emissions from the application of inorganic fertilizer 3Da1.

Potential Technical Corrections

95. Liechtenstein did not report AD for the agriculture sector. The Party reported emission of PM_{10} and $PM_{2.5}$ from 3B as not occurring ("NO"). The ERT asked the Party for the rational of using NO and also asked to provide AD. The Party explained during the review week that they will examine to submit emission data in future submissions. However, the ERT managed to retrieve activity data of 3B from the National Inventory Report for GHG that was submitted by the Party to the UNFCCC. A Technical correction has been proposed by the ERT and the ERT calculated the emissions of PM_{10} and $PM_{2.5}$ from 3B for the 2015 inventory (cf. part1 table 1 and annex I).

96. The ERT strongly recommends that Liechtenstein implements the technical correction in its next annual submission or provides own revised estimates.

Sub-Sector Specific Recommendations

Category issue 1: 3.B, 3.D - NO_x, NMVOC, PM and NH_3

97. The ERT notes that Liechtenstein does not provide estimates of NO_x, PM and MNVOC emissions from manure management (3B) although it is stated in the IIR that emissions of these pollutants are calculated using the methodologies described in the Guidebook. The Party reported emissions from this category as "NO" but the correct notation key is "NE" (not estimated) as these categories are key sources of these pollutants. The ERT reiterates the recommendations from the previous review report that Liechtenstein reports emission estimates of NMVOC, PMs and NO_x from 3B in its next annual submission.

Category issue 2: 3.B Manure management - PM_{10} and $PM_{2.5}$

98. Liechtenstein reported emission of PM_{10} and $PM_{2.5}$ from 3B as "NO". The ERT asked the Party for the rational of using the notation key "NO" and also asked to provide AD. The Party explained during the review week that they will examine to submit emission data in future submissions. The ERT recommends that the Party estimates these emissions in the next annual submission.

Category issue 3: Activity data

99. The ERT notes that the activity data that were used for estimating the emission inventory of the agriculture sector was not reported in the IIR or in the NFR tables. The ERT recommends that Liechtenstein provides AD in its next annual submission.

Category issue 4: 3.D.a.1 Agricultural Soils

100. The ERT recommends Liechtenstein to provide detailed information on the breakdown of the national fertilizer consumption into the relevant compounds that are in use, which are accounted for emission estimates under 3Da1 direct soil emissions in its next submission.

Category issue 5: 3.D.a.1 Agricultural Soils -- NH3

101. The ERT notes that emissions of NH_3 from 3Da1 were not reported in the NFR tables. In response to a question raised by the ERT during the review regarding this issue, Liechtenstein attributed this to a programming error. However the party provided the ERT with the whole time series of NH_3 emissions from this category. The ERT commends Liechtenstein for the quick answer and recommends that the Party includes these emissions in the NFR tables of its next submission in order to promote the transparency of its IIR.

Category issue 6: 3.D.a.1 Inorganic N-fertilizers - NO_x

102. The ERT notes that emissions of NO_x from 3Da1 are extremely low (0.0000298887182345985 kt). Liechtenstein attributed the very low emission to a comma error as the correct emissions are greater by a factor of 1000. The emission values will be corrected in the next submission. The ERT recommends that Liechtenstein enhances the application of QA/QC procedures for its inventory in order to avoid such errors in the future.

Category issue 7: 3.D.b Indirect emissions from managed soils - NMVOC

103. The ERT notes that emissions of NMVOC from 3Da1 are extremely low (3.6952568E-14 kt). Liechtenstein attributed the low emission to an error in the calculation that cannot be avoided. The calculation will be reviewed and adjusted during the submission 2018. The ERT recommends that Liechtenstein enhances the application of QA/QC procedures for its inventory in order to avoid such errors in the future.

Category issue 8: 3.D.f Use of pesticides - HCB

104. The ERT notes that Liechtenstein does not estimate emissions of HCB from the use of pesticides (3Df) as it was reported as not occurring (“NO”). However, the ERT informed the Party that the use of particular pesticides in agriculture can be a source of POP emissions due to the presence of HCB in some pesticides as a contaminant. In response to a question raised by the ERT during the review, the Party clarified that the use of pesticides is rare in Liechtenstein. Also, no reliable data

are available. For the next submission, an adaptation of the notation key will be checked. The ERT commends Liechtenstein for the quick answer on this issue.

WASTE

Review Scope

Pollutants Reviewed		All		
Years		1990 – 2015		
Code	**Name**	**Reviewed**	**Not Reviewed**	**Recommendation Provided**
5A	Solid waste disposal on land	X		X
5B1	Biological treatment of waste - Composting	X		X
5B2	Biological treatment of waste - Anaerobic digestion at biogas facilities	X		
5C1a	Municipal waste incineration	X		X
5C1bi	Industrial waste incineration	X		
5C1bii	Hazardous waste incineration	X		
5C1biii	Clinical waste incineration	X		
5C1biv	Sewage sludge incineration	X		
5C1bv	Cremation	X		
5C1bvi	Other waste incineration	X		
5C2	Open burning of waste	X		
5D1	Domestic wastewater handling	X		X
5D2	Industrial wastewater handling	X		
5D3	Other wastewater handling	X		
5E	Other waste	X		X
Note: Where a sector has been partially reviewed (e.g. some of the NFR codes please indicate which have and which have not in the respective columns.				

General recommendations on cross cutting issues

105. For the year 2015 Liechtenstein reports emissions for three out of 15 waste sub-sectors. Throughout the time series the coverage of sub-sectors is changing.. Emissions from 5A biological treatment of waste - solid waste disposal on land are only calculated till 2008.

Transparency

106. Liechtenstein's IIR does not provide descriptions on emissions factors and methodologies used to calculate the emissions. Also, activity data sources are only poorly described. The ERT recommends Liechtenstein to explain the calculation methods and provide information on emission factors and activity data sources in more detail. The description of QA/QC procedures and uncertainties for the waste sector could be more specific.

Completeness

107. The ERT notes that the waste sector is not complete and the methodology descriptions are not comprehensive. Liechtenstein reports "NO" for the sub-sector 5E other waste. In the EMEP/EEA Guidebook 2016 sludge spreading, car fires and building fires are described in this sub-sector. The ERT recommends Liechtenstein to improve the completeness of its inventory and in sub-sectors where it is possible.

Consistency, including recalculation and time series

108. Liechtenstein provided calculations for three subsectors which are consistent regarding emissions trends. As methodologies and EFs are not provided, it is not possible to check the correctness of calculations. Specific recalculations for waste sector are not mentioned in IIR. The ERT encourages the Party to provide an explanation about time series and recalculations in the IIR.

Comparability

109. As Liechtenstein does not provide methodologies and EFs it is not possible to check accuracy of calculations and to compare EFs or IEFs with the ones of other countries. The ERT encourages Liechtenstein to provide more detailed information about the methodologies and EF used.

Accuracy and uncertainties

110. Liechtenstein does not describe specific QA/QC procedures and uncertainty analyses for the waste sector. The ERT encourages Liechtenstein to undertake an uncertainty analysis for the waste sector and to describe the outcome in the IIR.

Improvement

111. There are no improvements mentioned for waste sector in Liechtenstein's IIR. The ERT encourages Liechtenstein to plan improvements for the waste sector regarding completeness and transparency of the inventory.

Sub-Sector Specific Recommendations

Category issue 1: 5.A Solid waste disposal on land

112. Disposal of waste in landfills has not been identified as a key source for Liechtenstein for any pollutant. The description of emission calculations is not transparent. The methodology is mentioned in IIR. The emissions of the main pollutants are calculated till 2008. Starting from the year 2009 the notation key "NO" is provided in the NFR tables. The ERT recommends Liechtenstein to provide clear explanations about landfilling activities and emission calculations, as well as methodologies used for pollutant estimations.

Category issue 2: 5.B Biological treatment of waste

113. Liechtenstein reports emissions from 5B1 Biological treatment of waste – Composting. There is no information available about methodology, EFs and activity data used in IIR and NFR tables. Reported NH_3 and NMVOC emissions are consistent through time series. The ERT assumes that estimates of composted waste amounts are used for emission estimations. The ERT recommends Liechtenstein to provide more detailed and clear information about the composting activities in the country.

Category issue 3: 5.C Incineration of waste

114. Liechtenstein reports emissions only for the sub-sector 5C1a municipal waste incineration. In the IIR the explanation is provided that only emissions from the illegal incineration of gardening and household wastes, as well as of open burning waste on construction sites are included in 5C1a. The ERT encourages Liechtenstein to provide EFs and methodologies for these calculations, including also activity data source descriptions. For other incineration sectors “NO” is reported.

Category issue 4: 5.D Wastewater handling

115. Liechtenstein calculates emissions only for the sub-sector 5D1 domestic wastewater handling. No explanation is provided about methodologies, EFs and activity data. The ERT recommends Liechtenstein to provide a clear description for domestic wastewater handling emission calculations, including also a description of latrine uses in the country.

Category issue 5: 5E Other waste

116. Liechtenstein uses the notation key “NO” for 5E. In the EMEP/EEA Guidebook 2016 sludge spreading, car fires and building fires emissions calculations are described in this sub-sector. The ERT encourages Liechtenstein to investigate the possibility to get activity data for car and building fires. Default emission factors could be used for calculations. In most European countries fire and rescue services collect information about fires. In the EMEP/EEA Guidebook 2016 EFs regarding number of fire accidents are provided.

MATERIALS USED BY THE REVIEW TEAM

1. Liechtenstein Stage 1 report 2017
2. Liechtenstein Stage 2 S&A report 2017
3. Previous Stage 3 Review Report of Liechtenstein (2012)
4. Data and tools developed by CEIP (http://unece-stage3.wikidot.com/data-analysis)

LIST OF ADDITIONAL MATERIALS PROVIDED BY THE COUNTRY DURING THE REVIEW

1. Liechtenstein's Inventory: Annex I 1990-2015 (Excel file) submission 5 May 2017
2. Lichtenstein's IIR 2017 (pdf) submission of 6 June 2017
3. Response to preliminary questions raised prior to the review (wiki)
4. Response to questions raised during the review (wiki)
5. Graph: "Number of dairy cattle in FL" (2017) (JPG, wiki)
6. Time series of NH_3 emissions from 3Da1 [t/a] (wiki)

1990 18.0
1991 17.1
1992 17.2
1993 17.2
1994 16.1
1995 15.3
1996 15.3
1997 14.9
1998 13.1
1999 13.2
2000 13.9
2001 13.8
2002 14.9
2003 14.6
2004 14.1
2005 14.2
2006 14.0
2007 13.7
2008 14.5
2009 13.8
2010 13.2
2011 15.3
2012 13.6
2013 13.2
2014 12.8
2015 14.5

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ANNEX I POTENTIAL TECHNICAL CORRECTIONS

Technical corrections have been proposed by the ERT during the review week in the frame of the trial 2017 "Technical Correction" exercise for the industry and agriculture sectors.

Detailed related information is documented in the 2 excel files: - TC-LI-2017-IPPU-1.xlsx and - TC-LI-2017-agri-1.xlsx and stored by CEIP.

Summary table – INDUSTRIAL PROCESSES

Description	Reference	Pollutant estimates (kt)		
		2015	2010	2005
NMVOC				
National total as reported 2017(row 141)		**0.237**	**0.263**	**0.288**
Difference between original estimate and technical correction deemed necessary by the ERT				
2.H.2 Food & Beverages Industry / Wine production		0.017	0.018	0.021
National total (row 141) including revised estimates and technical corrections accepted by MS	Calculated using data above	**0.255**	**0.280**	**0.309**

Summary table - AGRICULTURE

Description	Reference	Pollutant estimates (kt)		
		2015	2010	2005
PM10				
National total as reported 2017(row 141)	Annex I, 21/06/2017	**0.0395**	**0.0373**	**0.0361**
Difference between original estimate and technical correction deemed necessary by the ERT				
3.B Manure management	LI-3B-2017-0001	0.0035	0.0036	0.0033
National total (row 141) including revised estimates and technical corrections accepted by MS	Calculated using data above	**0.0430**	**0.0409**	**0.0394**
PM2.5				
National total as reported 2017(row 141)	Annex I, 21/06/2017	**0.0349**	**0.0328**	**0.0308**
Difference between original estimate and technical correction deemed necessary by the ERT				
3.B Manure management	LI-3B-2017-0002	0.0021	0.0022	0.0020
National total (row 141) including revised estimates and technical corrections accepted by MS	Calculated using data above	**0.0370**	**0.0350**	**0.0328**