

Recent factors and constraints behind the development of quality in the Czech national greenhouse gas inventory system

Nejnovější faktory a omezení, které stojí za vývojem kvality v českém národním systému inventarizace skleníkových plynů

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Úloha mezinárodních a domácích procesů je zkoumána s cílem objasnit hnací síly a omezení, které stojí za změnami kvality v českém národním systému inventarizace skleníkových plynů (GHGI). Načasování článku je relevantní, protože svět se na konci letošního roku chystá podat zprávu v rámci Pařížské dohody a potřeba sdílení získaných zkušeností je akutní. Metoda a materiály: Jedná se o případovou studii vývoje české inventarizace skleníkových plynů. Hlubkové rozhovory s odborníky z daného sektoru, které vedly k přípravě vůbec první příručky kvality pro českou inventuru skleníkových plynů, poskytují vzhled do omezení a faktorů, jež ji umožňují, stejně jako poznámky z každoročního workshopu QAQC (WS) se slovenskými odborníky. Nedávné právní a vědecké změny již ovlivnily procesy vykazování v Česku a mezinárodní spolupráce v rámci Iniciativy pro budování kapacit v oblasti transparentnosti – CBIT a Mezinárodního hodnocení a přezkumu – IAR usnadnila pozitivní kvalitativní změny pro český národní systém GHGI. Výsledky: Hlavním materiálem pro hodnocení pokroku je sestavená tabulka doporučení pro přezkum UNFCCC, která byla Česku dána v posledních přezkumech, a sestavené připomínky z nástroje pro přezkum UNFCCC (iVTR) a nástroje EU pro přezkum (EMRT) v Česku. V sestavené tabulce výsledků přezkumu lze pozorovat vliv různých právních a vědeckých podnětů. Samotná doporučení přezkumu působí jako významný faktor pro vývoj inventarizace skleníkových plynů. Závěr: Nejvýznamnějším jednotlivým faktorem umožňujícím zlepšení byl národní výzkumný program THETA Technologické agentury ČR (TA ČR). Mezi identifikovaná omezení patří nejistota kontinuity dlouhodobého financování výzkumu pro realizaci plánovaných zlepšení a ztráta lidských zdrojů a know-how v důsledku vysoké fluktuace kvalifikovaných pracovníků v týmu GHGI.

KLÍČOVÁ SLOVA: Inventarizace skleníkových plynů – řízení kvality – přezkum UNFCCC – legislativa klimatická – Pařížská dohoda – CBIT – budování kapacit – IAR – oteplování globální – Česko

KEYWORDS: Greenhouse gas inventory – quality management – UNFCCC review – Climate legislation – Paris Agreement – CBIT – capacity building – IAR – global warming – Czechia

1. Introduction

Widespread and rapid changes in the atmosphere, ocean, cryosphere and biosphere by the human influenced global warming cause urgency for countries to accelerate their climate efforts (IPCC 2023). The Paris Agreement (PA) is an international treaty on climate change, which was adopted by almost 200 countries in 2015 (UNFCCC 2015). This year 2024 the world will be reporting the GHG emissions to the UNFCCC under the Paris Agreement and the Enhanced Transparency Framework (ETF) for the first time (UNFCCC 2018). Previously, countries reported GHG emissions under the Convention (UNFCCC 2013) and it's Kyoto Protocol (UNFCCC 2012), which set out obligations and reporting requirements for measurement, reporting and verification (MRV) system for both developed and developing countries while upholding the principle of common but differentiated responsibilities and respective capabilities (UNFCCC 2024a). Czechia is Annex I country with full reporting requirements without flexibility options. Czechia and Annex I countries continue reporting the GHGI in those years, when the Biennial Transparency Report (BTR) is not due (UNFCCC 2018). Need for sharing of best practices and lessons learned is acute among the reporting countries due to urgency of the climate change (IPCC 2023) and recent changes in climate law obligations (UNFCCC 2023).

Reporting under the ETF builds on the Convention and its MRV system (UNFCCC 2024b). Material compiled for this article are all from the time under the Convention reporting, but lessons learned will be implemented also under the ETF starting this transition year 2024. Results of the study are not only meant for internal use of the Czech GHGI team, but for everyone and especially for the developing country GHGI teams for improving their respective GHG inventories.

Quality of reporting and implemented improvements in the Czech GHGI have been evaluated by the International Assessment and Review (IAR) processes. The UNFCCC has created mechanisms to monitor and support countries to meet their reporting obligations under the Convention and now under the ETF (UNFCCC 2024b). The IAR for developed countries reviewed national documents (UNFCCC 2024c), and International Consultations and Analysis (ICA) for the developing countries conducted technical analysis for the same purpose (UNFCCC 2024d). In the second part of these processes, Facilitative Sharing of Views (FSV) (UNFCCC 2024e) and Multilateral Assessment (MA) (UNFCCC 2024f) monitored progress and facilitated discussions to increase comparability and transparency among the reporting countries (UNFCCC 2024c). Under the ETF, these processes will be simply Technical Expert Review (TER) and Facilitative Multilateral Consideration of Progress (FMCP) (UNFCCC 2015).

The UNFCCC and the Global Environment Facility (GEF) have launched massive support campaigns for the developing countries to ensure timely submission of developing country BTRs by the end of 2024 (UNFCCC 2024g). Although all the mentioned support is for the developing countries, Czechia national GHGI team is benefitting from cooperation in the CBIT (GEF 2024) by hosting CBIT Study Tour events in Prague annually 2021–2024 and sharing lessons learned experiences with the visiting country delegations.

In the CBIT events in Prague, realization has been that we share the same reporting obligations, but we also face the similar problems in developing the GHGI. Available resources need to match the increased reporting obligations. Long term steady resources are not needed only to prepare the GHGI submission, but to enable implementation of improvements recognized by the UNFCCC review and the national GHGI team itself (Saarikivi 2023).

The introduction of THETA MEMORESP research program by Czech Technology Agency in 2019 to support improvements in the Czech GHGI, was the additional resource in Czechia to match the increased pressure from the UN and the EU reviews (TACR 2024a). THETA program is still running, but does not have any more the GHGI reporting as one of the top priorities. Instead, Air Quality Research Assessment and Monitoring Integrated System or shortly ARAMIS is providing must needed continuity of research funding for the GHGI improvements (TACR, 2024b).

The article argues that without THETA, planned improvements would not have been implemented on time for the 2022 UN reviews, which focused on ensuring correct reporting on the 2020 emission reduction targets, and closing of KP-LULUCF at the end of the Kyoto Protocol 2nd commitment period (UNFCCC 2012).

2. Method and materials

The Article is based on qualitative case study research methodology. Materials for identifying drivers, enablers and constraints of recent improvements in the Czech GHG inventory are both national, international and also include developing country information for comparison and for discussions. Progress of the Czech GHGI shown in Figure 3 is due to the combined effect of all of them, although the results chapter focuses on the THETA research program as the main recent enabler.

2.1 In-depth interviews and the Quality manual

One data collection methodology has been an in-depth interview of the Czechia GHGI sector experts during a four-year process of preparing the Quality Manual for the Czech GHG Inventory during 2019–2022 (Cienciala 2021). Interviews were done between November 2019 and October 2020. Long time frame was selected to give opportunity for all the sector experts to participate to avoid any possibility of bias due to creating a small group of participants and unnecessary time constraints. Bias arising from a small set of questions was avoided by having a preset of questions and topics sent to participants two months before the 2h interview. Preset questions were first tested on and further developed with an experienced sector expert in October 2018 (Ondrušová 2019). Piloting the questions enlarged the scope of the in-depth interview to cover whole CZ GHGI development. Time in the interview itself was extended to 2h to capture the sector experts' views, which are the most valuable as they are the main actors in the CZ GHGI process. Participants were not bound to limited preset questions, but had freedom and were encouraged to bring up the points that needed development, further support or processes that should be outright eliminated. When need for documentation of guidance for preparing the GHGI submission and further clarification of the 2006 IPCC Guidelines became evident during the interviews (Esterlová 2020), the process for the Quality manual started in 2021.

Another data collection process has been constant on going collection of sector experts' experiences to identify and assess problems within the Czech GHGI system (Saarikivi 2023). Constant ongoing collection means that every time sector experts asks for new guidance that has not been documented, the written guidance goes to the Quality manual.

Development of the Quality Manual for the Czech GHG Inventory with sector experts' inputs was welcomed by the sector experts. Eight experts provided inputs for the Quality manual. The Czech manual is different from several European ones (Nielsen et al. 2020) as roughly half of it covers practical process guidance for preparing inventory according to the UNFCCC (UNFCCC 2023) and the IPCC requirements (IPCC 2006). In practice, real correspondence of the QAQC manager and sector experts were documented to the Quality manual for everyone to go back and refresh the memory or for new workers to get practical guidance how to do their tasks (Saarikivi 2023).

The main findings from the in-depth interviews with the sector experts for the preparation of the Quality manual for the Czech GHG inventory were (Saarikivi 2023);

- Sector experts cannot be left alone to face problems in activity data (AD) collection and especially if AD is lacking totally (Beranová 2021).
- Lack of AD is recognized as institutional problem, where solution can be researched by sector expert, coordinating institute or sector expert contacts statistical office, Ministry or the relevant data provider for them to enable data collection or in the most severe case, government introduces new law or regulation for specific data collection (Cienciala 2021).
- Coordinating institute facilitates cooperation and communication between the sector expert, AD provider and the responsible ministry of the sector (Beranová 2021).

- A peer-to-peer review is the most common QA process applied in the Czech GHGI team to guarantee methodological changes. It is also cost-efficient way compared to external audit. Responsibility cannot be left solely on a sector expert, but the coordinating institute has a role as facilitator and checking that the process is happening and if needed, supports in the QA process (Saarikivi 2023).
- Two sector experts in a sector would be ideal for submission preparation, QC checks and planning of improvements (Beranová 2021). This is not a case in all the sectors currently due to financial constraints, but every sector has a designated person for 2nd guarantee of QAQC checks.
- New workers should be introduced thoroughly to the GHGI preparation processes by the responsible organization for the sector with support of the coordinating institute (Veselá 2020). If this is not possible time wise or because of lack of experienced personnel, then coordinating institute steps in to support in key processes to ensure smooth and timely submission. Example of late key process is importing data by the sector expert to the UNFCCC electronic reporter with additional post import QC to verify successful import (Saarikivi 2023).
- Annual national in person QAQC meetings were perceived beneficial for coordination of the team and planning of improvements, both by the sector experts and the coordinating institute (Saarikivi 2023).
- Sector experts were asking to be connected again with the neighbouring country colleagues after Covid broke the continuity of the annual regional QAQC WS in person meetings (Beranová 2021).
- Documentation of QAQC processes and inventory preparation was perceived essential in passing knowhow between colleagues and to new workers (Saarikivi 2023).
- Lack of time was seen as one of the main problems in preparation of submission and doing QC activities properly between January and March (Ondrušová 2019). Czechia has dual reporting requirements and review requirements for both the EU and the UNFCCC and tight time schedule cannot be avoided in the submission months at the beginning of the year (Saarikivi 2023).
- UN review processes can be perceived stressful by the sector experts, but also as beneficial drivers for developing the quality of the inventory (Saarikivi 2023).
- QAQC manager of the Czech GHGI sees the UN review and the European ESR review as free capacity building for planning and implementing improvements with only cost being time resource (Saarikivi 2023).
- Once in two-year cycle for the UN review is perceived efficient by the sector experts and the coordinating institute. Once a year review cycle would be counterproductive by taking away scarce time resources from implementing improvements and solving the UN review recommendations (Cienciala 2021).
- From the coordinator institute side, the change of personnel in the Czech GHGI team is seen as a waste of knowhow and a risk to quality of submissions (Saarikivi 2023).

Finding and supporting further the identified enablers, has been prerequisite for successful planning and implementation of improvements in the GHGI preparation. Latest develop-

ment has been hiring a part time expert to support the LULUCF sector. Benefits of additional part time expert is reducing risks by redundancy, higher quality QC and smoother implementation of improvements. Unfortunately, Czechia has no additional resources to offer the same much needed support for the Agriculture sector. This was one of the main barriers raised by the experts during the interviews, and it is now only partly addressed (Cienciala 2021). Dialogue continues with the Ministry of Environment for updating the Czech NIS budget. It can be argued that hiring additional worker to LULUCF sector matched the increased demand for work caused by the KP review in 2022, and was one of the main factors with THETA research program for successfully meeting the KP obligations in 2022.

2.2 Bilateral quality assurance and quality check workshop

The annual bilateral quality assurance and quality check (QAQC) workshops (WS) with the Slovakian GHGI team are integral in developing the Czech GHGI and strengthening individual sector experts' skills. Annual QAQC meetings with the Slovaks are sometimes joined by inventory experts from nearby countries. Notes from the Quattro lateral QAQC meeting of CZ, HU, PL, SK and AT experts of National Inventory System (NIS) from 2019 are used to identify enablers in the Czech GHGI system (Rutkowski et al 2019).

To ensure continuity of the annual QAQC WS with the Slovaks and regional experts, the QAQC WS is in the core budget, which is provided by the Ministry of Environment to the coordinating institute. During the Covid, in person meetings were not possible and after a two-year gap, WS was launched online and last year it was first time held again in person in Prague. Before the Covid, also Hungarian and Polish GHGI experts participated in the QAQC WS. Plan for the 2024 WS is to be in Budapest with representatives participating in person from all the four national GHGI teams. Topics in the WS change every year according the need, and inventory workers from the air pollutant teams are welcomed with at least one topic being for the air pollutant experts in the agenda. The regional QAQC WS enables (Rutkowski et al 2019);

- Peer-to-peer QA to new implemented methodologies.
- Offer unofficial safe platform to discuss freely even sensitive topics related to the GHGI system thus facilitating sharing of lessons learned experiences and best practices.
- Harmonization of the GHGI and the air pollutant inventories by facilitating communication and planning of improvements between the two inventories, especially regarding the use of AD.

2.3 Capacity Building Initiative for Transparency – CBIT

By hosting UNDP-CBIT events in Prague for visiting developing country delegations, CHMI is showcasing the best Czech Republic technical expertise on the GHG inventories on the world level. Annual CBIT Study Tours in Prague 2020–2024 will be reported as technical capacity given by Czechia in the first ever BTR submitted by Czechia under the Paris Agreement in 2024.

- The CBIT Study Tours in Prague have supported planning of improvements in the Czech GHGI, especially regarding coordination of acquiring missing data from data providers (Saarikivi 2023).

Material from CBIT Prague events are video recordings of discussed topics and presentations, which can be accessed in CHMI eCloud (CHMI 2024). All the points identified in the Prague CBIT events apply to Czech GHGI system, except the flexibility point about BTR reporting, as Czechia is Annex 1 Party without flexibility options. Czechia also has high turnover of personnel in the coordination institute, but reasons are different than short term project funding identified in the CBIT Study Tours for the visiting developing countries. Below are the main points from the Prague CBIT visits during 2020–2024 (CHMI 2024);

- CBIT, any regional or bilateral WS is beneficial in exchanging ideas, good practices and facilitating peer to peer learning.
- Key to successful submission preparation is institutional arrangements that guarantee smooth and timely delivery of AD for the sector experts.
- In the law and regulations, both responsible organization of data collection and to whom the data is collected for, are named to ensure AD availability.
- Submission time constraints were seen as a risk and a problem for the quality of the GHGI.
- Increase in number of UN review observations and recommendations may not mean lower quality submission, but that implemented improvements are being thoroughly reviewed by the UNFCCC expert review team (ERT). Increase in recommendations may signal that improvements have been implemented, but they need further addressing before being in accordance with the UNFCCC requirements and the 2006 IPCC Guidelines (IPCC 2006).
- Short term and uncertain project funding has been seen as a problem by all four visiting countries. Uncertain short term project funding causes;
 - High turnover of workers affects the quality of the submission as the knowhow is lost.
 - Cycle of training new workers happens instead of able to keep and develop skills of the existing ones.
 - Losing team members hampers the whole team.
- Flexibility options of the BTR reporting, ETF tool and its CRF tables will help for a timely submission for the developing countries, but will need to be accompanied with a well-documented planned improvements and additional resources to overcome the use of flexibilities in the future.
- The most dialogue was created in the presentations that not only showed what has been the current model or methodology, but what model worked when institutional arrangements had not yet produced complete AD and the IPCC methodologies were not fully implemented due the lack of data or parameters. Pathways to follow were appreciated.
- Building the national MRV system is a process over multiple years. Available resources should reflect the reality of continuous improvement, especially in times when new reporting obligations are introduced.
- Larger visiting delegation was perceived beneficial as coordination of different stakeholders of MRV system is essential in setting up institutional arrangements. CBIT Prague events composition of visiting delegations included representatives from the UNDP – CBIT, Ministries, data providers, and coordinating organization for the MRV system,

compiler and experts of the GHGI. Some sector experts participated online.

2.4 International reviews – UNFCCC summary table 2, iVTR and EMRT tools

The main material in this study is a compilation of summary table 2 recommendations for Czechia in the UNFCCC review reports (ARR) from the last five reviews 2015–2022, which can be accessed in the UNFCCC website (UNFCCC 2024a). Review years 2018, 2021 and 2022 are focus of this study as all the recent improvements were first planned and then implemented during that time period. The review year 2019 is in the tables for completeness, but it should be disregarded as it was a lighter desk review year and others are full in country or centralized reviews. Recommendations in the summary table 2 are by topics instead of sectors. Summary table 2 was first introduced in the UNFCCC review reports to Czechia in 2015, and is also included only for completeness to the Figure 3. 2015 is too far back in the history of Czech GHGI to be considered recent in this study. Author started in the Czech GHGI team in 2018.

The UNFCCC reviews set international standard for internal development, provides a baseline for the quality and acts as driver for developments (UNFCCC 2024a). Changes in climate legislation on reporting obligations and developments in national circumstances in reporting ultimately materialize in the UNFCCC reviews as observation checks, and found issues may lead to recommendations to be given to the reviewed Party to solve the reporting issues.

Czech GHGI submissions for the UNFCCC that were reviewed have T-2 data, hence 2022 submission is reporting 2020-year as the latest year data with the complete time series being 1990–2020 (UNFCCC 2024a).

The UNFCCC recommendations aside, also the number of UNFCCC review observations 2021–2022 and the EU review observations 2018–2022 have been compiled to highlight the external pressure from reviews for these special years for the Czech GHGI. The UN data on number of observations is obtained from the UNFCCC iVTR review tool and its data for Czechia. The EU data on number of observations is obtained from the EU review tool EMRT and its data for Czechia. Observations from both iVTR and EMRT have been exported to the CHMI eCloud for public access.

3. Results and evaluation

Progress of improvements done in Czech national greenhouse gas inventory is presented by compiling the UNFCCC review recommendations given to Czechia in the review reports' summary table in 2017–2022 and examining both external and internal reasons for the developments.

Parties to the UNFCCC are subject to reporting and review requirements under the Convention and Kyoto Protocol through the Measurement, Reporting and Verification (MRV) system (UNFCCC 2023), and under the Paris Agreement through the Enhanced Transparency Framework (UNFCCC 2018).

Number of observations in the Figure 1, 2 and 3 demonstrate the extraordinary external pressure the Czechia GHGI team and its GHGI submission went through in the EU and UNFCCC reviews in 2020 and 2021.

The European Union (EU) Effort Sharing Decision (ESD) covered years 2013–2020 and more than 60% of total EU GHG emissions with the IPCC Assessment Report four (AR4) global warming potential (GWP) values. For 2021–2030, the Effort Sharing Regulation (ESR) (EU 2023) and AR5 GWP values replaced ESD and the AR4 values.

Year 2020 is clearly an outlier in Figure 1 for the European Union (EU) Effort Sharing Decision (ESD) Review observations. Observations jump from 17 in 2019 to 66 in 2020, and settle to more normal amounts of 35 and 36 observations for years 2021 and 2022. Reason for the outlier year is the EU 2020 emission targets and the ending of the ESD. The 2020 ESD review was supporting Member States to be able to report correctly in 2022 the T-2 data i.e. 2020 data. The EU GHGI is compiled from the Member States' (MS) GHGI data. The 2020 ESD review to the EU MSs was ensuring the correctness of the compiled EU GHGI and the ESD data. The thorough 2020 ESD review resulted in one technical correction for the Czechia. The

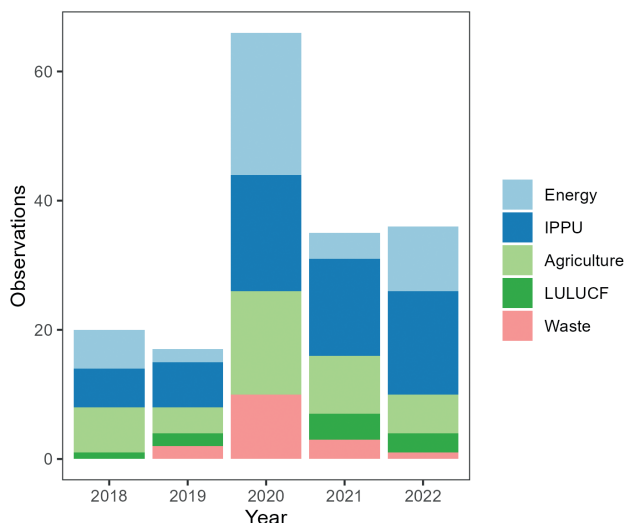


Fig. 1. Compiled 2018–2022 Czechia review observations from the ESD and ESR reviews.

Obr. 1 Souhrn výsledků přezkumů ESD a ESR České republiky v letech 2018–2022.

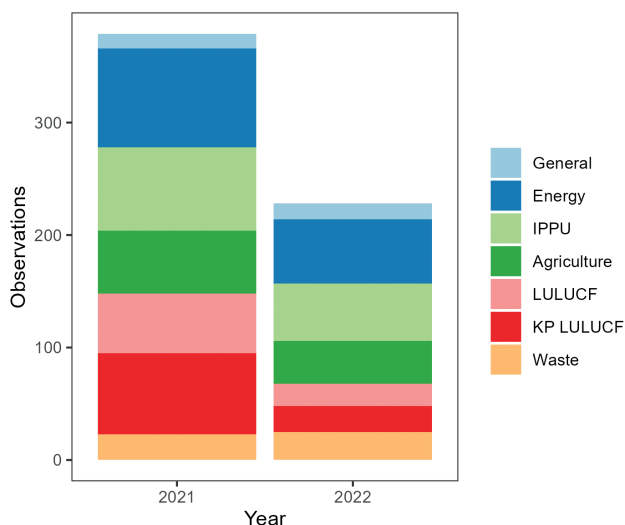


Fig. 2. Compiled 2021–2022 Czechia review observations from the UNFCCC review.

Obr. 2 Souhrn výsledků přezkumů UNFCCC České republiky za období 2021–2022.

next 2021 and 2022 reviews under the ESR did not produce recommendations to Czechia and observations also settled to business-as-usual levels.

Another reason for the EU observations peaking in 2020 review was supporting MSs for the ending of KP 2nd commitment period. Czechia volunteered for including KP-LULUCF sector for the review, which guided implementing of improvements and served as free capacity building. As a result, Figure 3 shows that Czechia has resolved all the KP-LULUCF UNFCCC recommendations in the 2022 UN review. In 2024 Czechia received final review report from the UNFCCC regarding the KP and ending of the 2nd commitment period, which stated that Czechia had fulfilled its obligations.

Czechia did not have UNFCCC review in 2020. Figure 2 shows how number of UNFCCC review observations have decreased from 378 in 2021 to 228 in 2022 review. 2021 was the high peak of observations and also personal stress for the sector experts, because the observations only seemed to increase regardless of efforts the sector experts were doing. This is a good example where number of observations may not represent low quality of GHGI, but instead the GHGI is undergoing major improvements, which the review teams are checking. Year 2022 supports above argument in the Figure 2 with business-as-usual number of observations.

Figure 3 shows the number of UNFCCC recommendations by topics in the summary table 2 of the UNFCCC review reports given to Czechia 2015–2022. These are the main indicators of progress in the Czech GHGI.

The state of the Czech GHGI submission in 2017 was 58 recommendations. Trend goes from 58 recommendations in 2017 to 48 in 2021, ending at lowest point in 2022 with only 28 remaining recommendations.

Same progress can be observed in the table 1 below in more detail. Recommendations regarding Methodology, EF and AD category have decreased by –20 from 2017 to 2022. Next one is the KP-LULUCF with decrease of –10 recommendation. Figu-

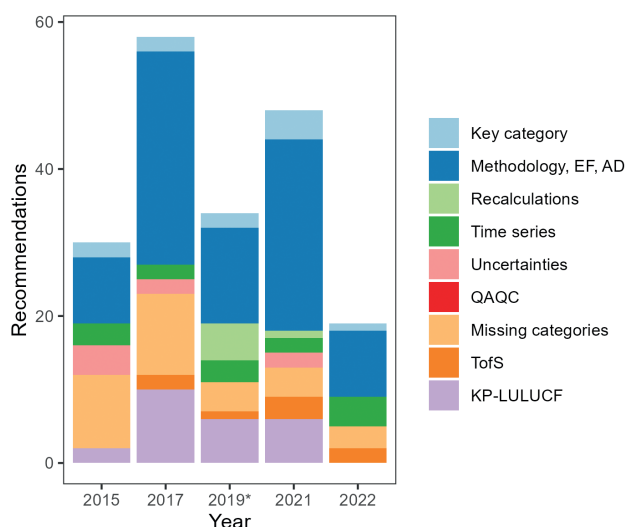


Fig. 3. Compilation of all the recommendations given to Czechia for 2015–2022 in summary Table 2 of the UNFCCC review reports.

Obr. 3 Souhrn všech doporučení udělených České republice v období 2015–2022 uvedených v tab. 2 souhrnných zpráv UNFCCC.

re 3 shows that no KP-LULUCF recommendations exist for Czechia anymore in 2022. Missing categories recommendations decreased by –8. Total decrease of recommendations being –39 in 2017–2022.

Figure 3 and Table 1 highlight the progress in Methodology, EF and AD. Also, Czech sector experts in their interviews and inputs to the Quality manual highlighted support needed for acquiring AD. Availability of AD was identified constraint by the Quattro lateral QAQC WS as well as the CBIT events in Prague.

Table 1. Reduction of the UNFCCC review recommendations given by the ERT to the Czechia in the summary Table 2 of the UNFCCC review report.

Tab. 1 Snížení počtu doporučení pro Českou republiku z přezkumů UNFCCC, které byly zpracovány expertním týmem UNFCCC a uvedeny v Tabulce 2 souhrnné hodnotící zprávy.

Recommendation	2017	2021	2022	Difference 2017–2022
Key category	2	4	1	–1
Methodology, EF, AD	29	26	9	–20
Recalculations	0	1	1	0
Time series	2	2	4	2
Uncertainties	2	2	0	–2
Missing categories	11	4	3	–8
TofS	2	3	2	0
KP-LULUCF	10	6	0	–10
Total	58	48	19	–39

Table 2. THETA research projects oriented for improving the Czech GHGI in the period of 2019–2022.

Tab. 2 Výzkumný projekt THETA zaměřený na zlepšení české GHGI v období 2019–2022.

General	Energy	IPPU	Agriculture	LULUCF	Waste	Total
2	9	2	4	3	6	26

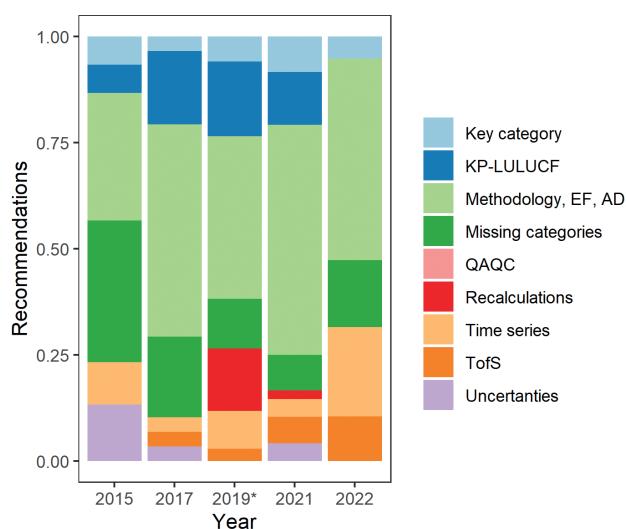


Fig. 4. Share of recommendations from summary Table 2 of the UNFCCC review reports to Czechia.

Obr. 4 Podíl doporučení uvedených v tabulce 2 souhrnných zpráv UNFCCC vztahujících se k České republice.

The main reason for the progress from the high peak of 2017 to success of 2022 is national research program THETA run by the Czech Technology Agency, and its major support for improving the Czech GHGI 2019–2022 (TACR 2024a). Table 2 below shows number of THETA research projects that directly or indirectly contributed to implementing improvements in the Czech GHGI 2019–2022.

THETA research program started with a planning and preparation stage, which would argue that THETA affected mostly GHGI in 2021 and 2022 as seen in Table 1. Comparing Table 1 and Table 2 results, THETA has contributed to 26 of 39 resolved recommendations in 2021 and 2022 by significantly boosting the implementation of planned improvements in the Czech GHGI.

Figure 4 shows share of recommendations by categories, which is useful for prioritizing and planning of next research and improvements. Although Figure 3 showed significant progress in Methodology, EF and AD category, the year 2022 in Figure 4 shows that Methodology, EF and AD has share of almost half of the remaining UNFCCC recommendations and should still be the main focus of planned improvements. Figure 3 and 4 are useful tools for the compiler and QAQC manager to keep track of progress of the GHGI submission.

4. Discussions

Every country is currently facing external reporting pressures arising from the Paris Agreement and the ETF, but are barriers and enablers identified for Czechia country specific or are there similarities with other countries? The International Assessment and Review (IAR) and International Consultations and Analysis (ICA) place lessons learned from Czechia into a global context. Below is a list of constraints and enablers identified in Dubai COP in 2023 for the developing countries.

Reporting constraints identified in the 15th session of FSV in Dubai COP in 2023 (UNFCCC 2024b);

- Weak institutional arrangements for data provisions due to lack of technical support, monitoring capabilities and funding for dedicated staff.
- Adherence to the UNFCCC reporting guidelines due to lack of data for preparation of the GHGI.
- Short term project funding.

Enablers identified in the 15th session of FSV in Dubai:

- Participation in the GEF funded CBIT program to improve MRV system and transit to the ETF.
- Global Environment Facility (GEF) funding for preparation of coming BTRs.
- FSV process for sharing lessons learned experiences
- Both conducting it and being subject to the technical analysis of the ICA.

In the UNFCCC 2024 Regional workshop on BTR, Africa and Europe region, Snezana Dragojevic from the UNDP presented key considerations relevant to BTR and GHGI (UNFCCC 2024g);

- Access to GEF resources; timely financial support by early request with regular communications and understanding of requirements for the financial support.

- Technical support for the BTR; use of bundled (2 BTRs + 1 NC) modality to avoid gap between reporting and sustained resources. GEF approves support for two instead of one BTR.
- Technical support on the GHG Inventories, quality reviews and support on responding to the recommendations of TER/FMCPs processes enables timely submission of GHGI and the BTR.
- In-country technical trainings to establish national expertise.
- Representation in the COPs and SBs climate negotiations.

Czechia identified also data availability as a constraint. Although Czechia had major progress in implementing improvements regarding the UNFCCC recommendations for issues with data in 2022, the figure 4 shows that based on remaining UN recommendations, the main focus still stays in improving data availability and data quality in Czech GHGI.

The main reason for problems in data availability in Czechia is not the weak institutional arrangements, Czechia has long time established, funded and mostly functional arrangements. Based on the interviews with the experts, the reason is historical. Data collection was not designed for the GHG emission purposes from the 1950s to 1990s, causing problem in time series consistency and in quality of data. The GHG relevant data is not always disaggregated enough for reporting according the 2006 IPCC guidelines and its higher Tier requirements for key categories. During the CBIT events in Prague 2020–2024, all the visiting delegations identified the same data availability problem and same reasons. Three out of four CBIT visitors to Prague highlighted weak institutional arrangements as root cause for the lack of data (CHMI 2024).

Recent developments have exposed one weakness in Czech institutional arrangements. Coordinating organization does not have contract with all the stakeholders responsible for sectors in the GHGI. Ministry of Environment (MoE) has allocated Waste sector responsibility to a public organization. Arrangement worked well until budget cuts were made by government to the respective organization forcing it to stop obliging with the task. Contract with a budget is the normal procedure in the Czech MRV system and will be a solution for this case too or the coordinating organization will take the responsibility with respective budget. Recalling lessons learned from the CBIT Prague events was that institutional arrangements should be based on legislation and contract should be given to organization and not to a person. Czech recent experiences with the Waste sector prove the point.

5. Conclusion

Using the amount of unresolved UNFCCC recommendations as an indicator to the quality of Czech GHG inventory shows impressive progress from 2017 to 2022. Czechia resolved 39 recommendations and only 19 from 58 recommendations are unresolved. Figure 4 also highlights AD and methodologies as the main category for remaining improvements and as a focus for new planned improvements that the rest of the recommendations can be resolved.

Study is not only a history lesson of Czech GHG inventory, but learning how to face exactly similar situation in 2028–2030. In 2028 the guiding principles and rules of the Paris Agreement are opened for negotiations again and will cause new

demands and changes to the GHG reporting. In 2030 and just before, the EU will step up review efforts to ensure correctness of its progress towards the 2030 GHG reduction targets. Hence, identifying constraints and enablers is prerequisite for developing quality of the GHG inventory to match the international obligations from the EU and the UNFCCC.

Identified constraints for Czechia are uncertainty of continuity of long-term research funding to implement planned long term improvements, losing of human resources and knowhow by high turnover of skilled workers in the GHGI compiler team and in the Waste sector. The core budget of the coordinating organization was sufficient to hire a part time support for the LULUCF sector, but not to the Agriculture sector to increase redundancy and enable improvements. The core funding has not been adjusted to inflation and increased costs by the budget provider Ministry of Environment.

Resources have to match the external pressures for improvements in the national GHGI system. Success of the THETA program signals that additional research resources are needed to implement planned improvements according the UN recommendations and when improvement needs are identified nationally. Additional resources are needed especially, when climate legislation and obligations are changing as was the case with the ending of the KP 2nd commitment period and meeting of the 2020 emission targets.

ARAMIS project brings continuity to the research funding after the THETA, but ARAMIS has reduced share of support for the GHG reporting. THETA focus has shifted on implementing mitigation and energy applications.

On the international level, amount and variety of support available for the BTR preparation is high for the developing countries currently, because of need for support for the first ever BTR submission in 2024. Will the capacity building support continue on sufficient levels, when developing countries later start implementing improvements identified by the UN reviews and research needs increase?

Experiences of the Czech GHG team show, that international cooperation is a means to extend resources – sharing lessons learned and best practices facilitates improvements in the Measurement, Reporting and Verification (MRV) system and will do the same under the ETF and the Paris Agreement. Article proposes that the UNFCCC or CBIT would compile a publicly available list of models' countries have perceived useful in different stages of their GHGI development; in the early stage, when complete AD has not yet been available and later, when country is ready to implement new methods and models due to new AD becoming available. Multistage approach would work better with country specific circumstances, especially if country has just started developing its MRV system.

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