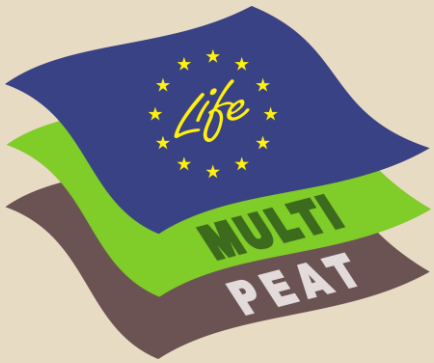




# PeatRAG: Toward Trustworthy Multilingual Policy Intelligence for Peatland Restoration

Power to the Peatlands Conference

Workshop Session: The European Peatland Policy Portal

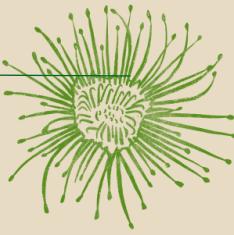
*Dr. Muhammad Imran, 2. Sept. 2026*



**Co-funded by  
the European Union**

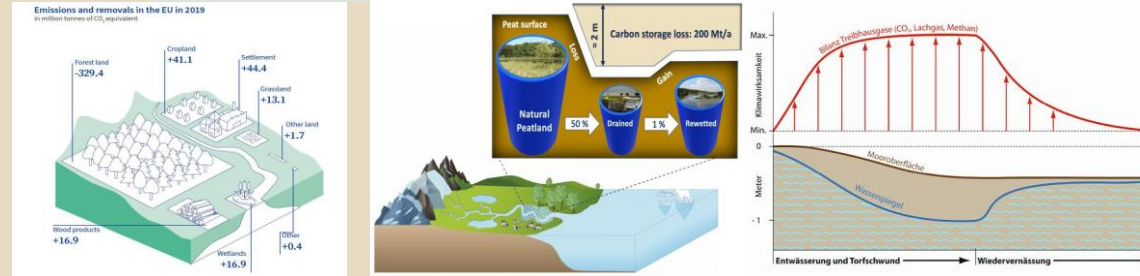


# Peatland Policy Analyses



## Climate & LULUCF

GHG mitigation • carbon sinks • land-use accounting



## Agriculture & CAP

Farm support • land management • paludiculture



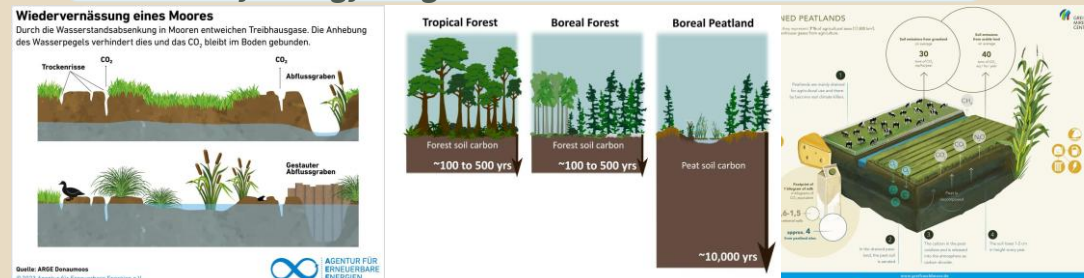
## Biodiversity & Nature Restoration

Habitat recovery • restoration targets • rewetting



## Water & Soil

Hydrology • Organic soils • Carbon removals



Dr. Muhammad Imran, 2. Sept. 2026



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## Limited Keyword Search

- Variation in vocabulary (synonyms besides "direct" translation)
- Variation in word forms (plurality, declension, etc)

## Limited Policy Analyses

- Frequency does not equal policy significance (e.g., exact restoration area targets)
- Temporal complexity (How does policy evolve? Dates?)
- Cross-document analysis (How does one document support or potentially conflict with another policy? Versioning?)
- Difficulty distinguishing legal strength (binding regulation versus recommendation, strategy or policy brief)



## Multilingual

- More than 500 policies spanning 22 different languages
- Long documents, some >1000 pages
- Multilingual descriptions

## Fragmentation

- Policy fragmentation
- Semantic fragmentation
- Spatial fragmentation

## Limited identifying policy synergies

- How can a peatland restoration simultaneously concern GHG mitigation, biodiversity, water regulation, soil protection and agricultural transition?





## 1 LLM Capability

- Understand meaning beyond exact vocabulary
- Useful for long, heterogeneous policy text
- Multilingual semantic matching supports cross-language discovery
- Can synthesize answers in natural language



## 2 Why LLMs alone are not enough

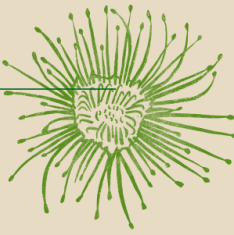
- LLMs may hallucinate or rely on stale internal knowledge
- Long PDFs, cross-references and document versions can hide decisive policies
- A plausible answer is not necessarily a legally grounded answer



## 3 Retrieval Augmented Generation (RAG)

- Hybrid retrieval: LLM + real and updated data
- Generic RAG still lacks the intelligence required for intent-aware, multilingual and provenance-driven policy analyses





## Standard RAG

(Generic)

From simple document retrieval to an intent-aware, multilingual and provenance-driven policy intelligence architecture

## PeatRAG

(Policy-Aware)

Generic LLM

**Reterival**

BM25 + semantic embeddings

Captures exact terms and meaning across languages

Simple Context

**Context**

Metadata-Aware Search

Country • Language •  
Governance level •  
Policy category  
**Appropriate policies**

Chunk-based

**Factuality**

Structured Fact Repository

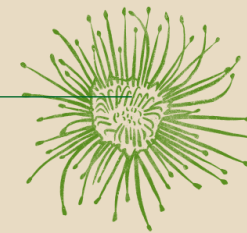
Targets • Dates • Values •  
Publishers  
**High-value policy facts**

Static, Uniform,  
Unverified

**Reasoning**

Version-Aware,  
Intent-Aware,  
Provenance-Aware,  
Verified

**Resolves outdated or  
conflicting provisions**

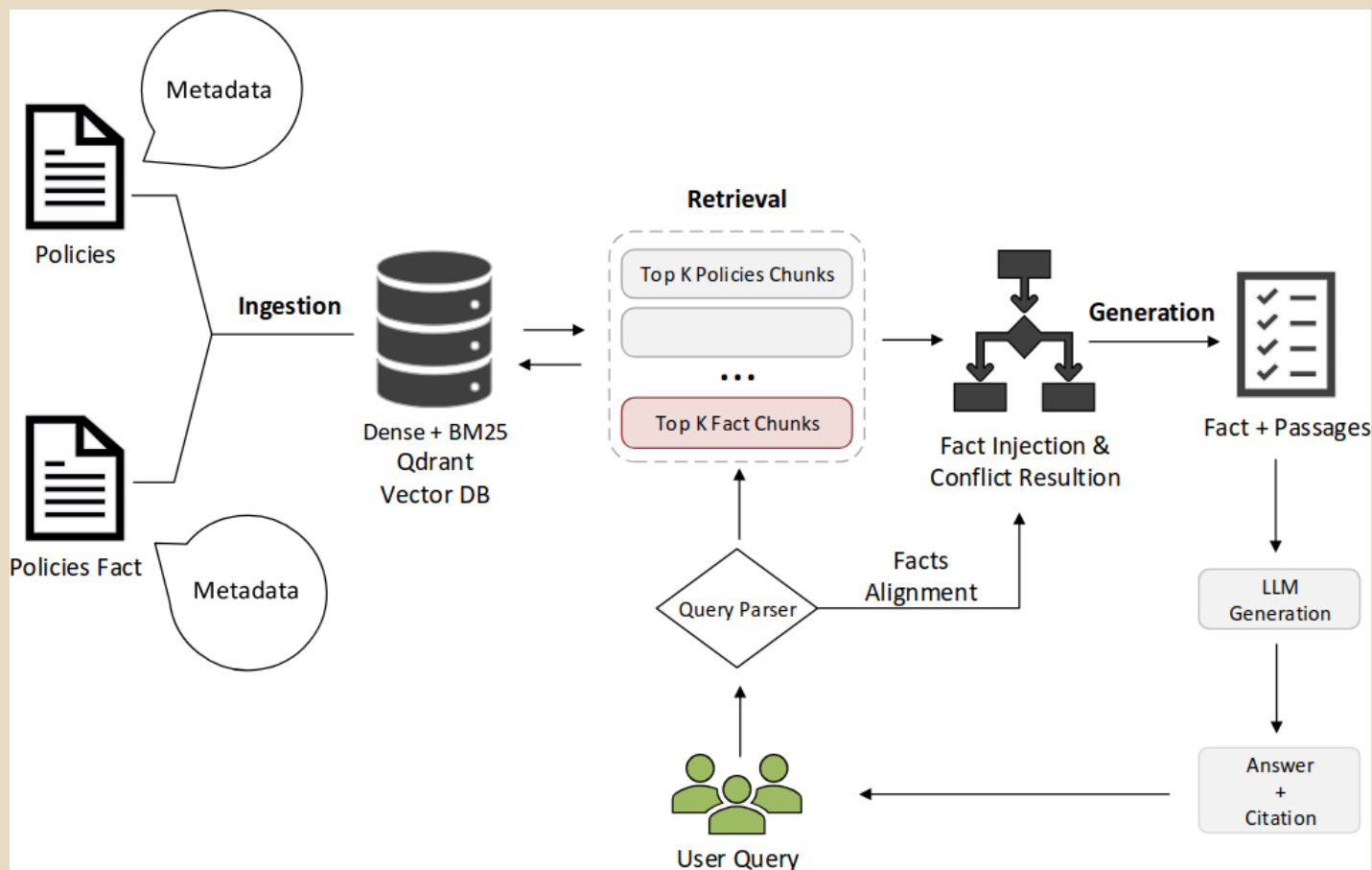


A multilingual hybrid RAG framework that improves attribution and factual accuracy in policy QA.

**Hybrid Retrieval:** Combines BM25 with dense multilingual embeddings and metadata filtering

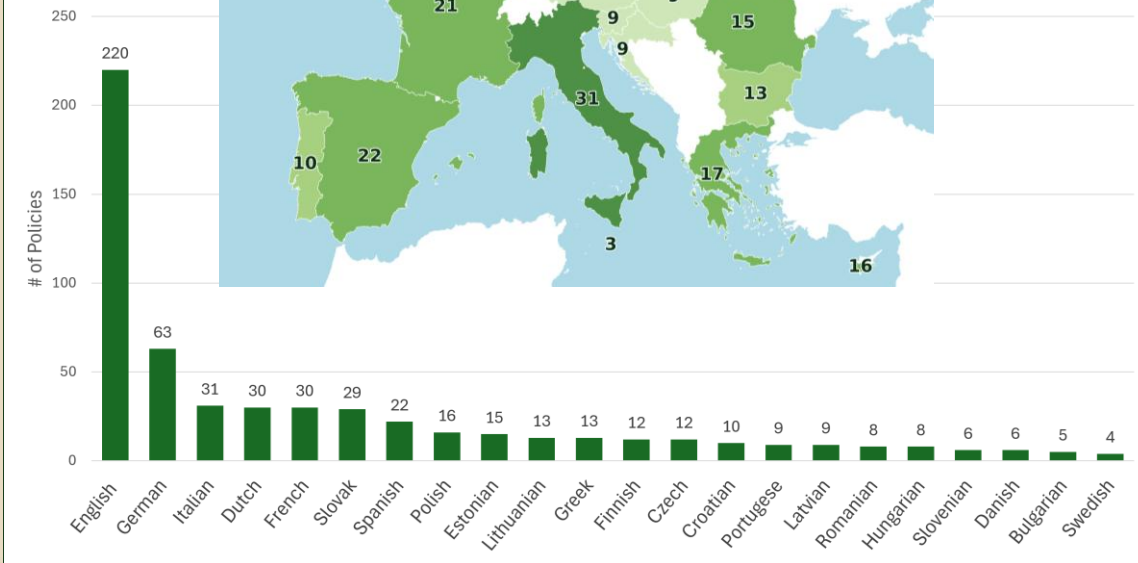
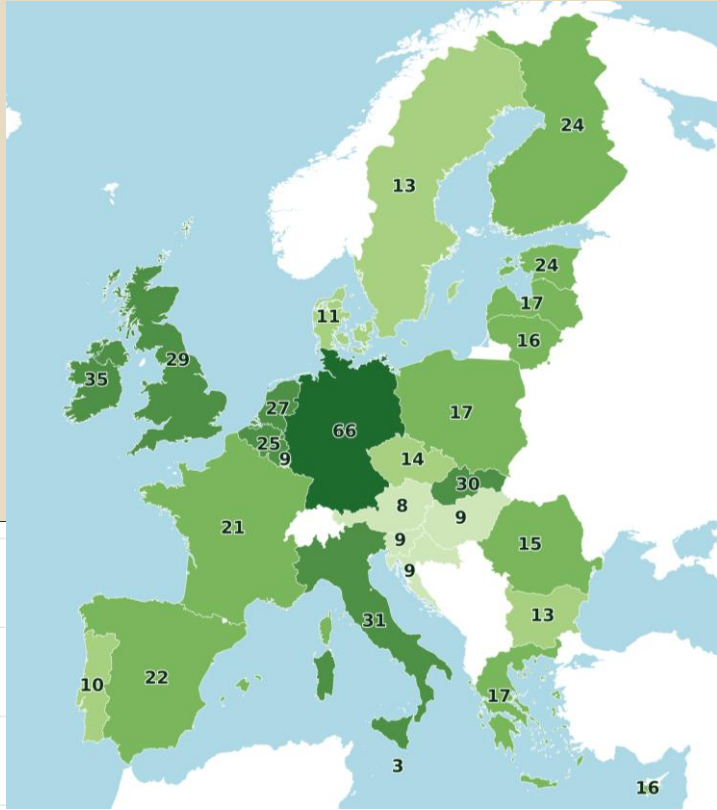
**Fact Repository:** Curated facts with versioning, confidence, and provenance

**Query Parser:** Detects fact-seeking intents and injects authoritative facts





- Peatland-affecting policies from multiple countries, in multiple languages.
- Curated facts with versioning, confidence, and provenance



### Related Policy Documents

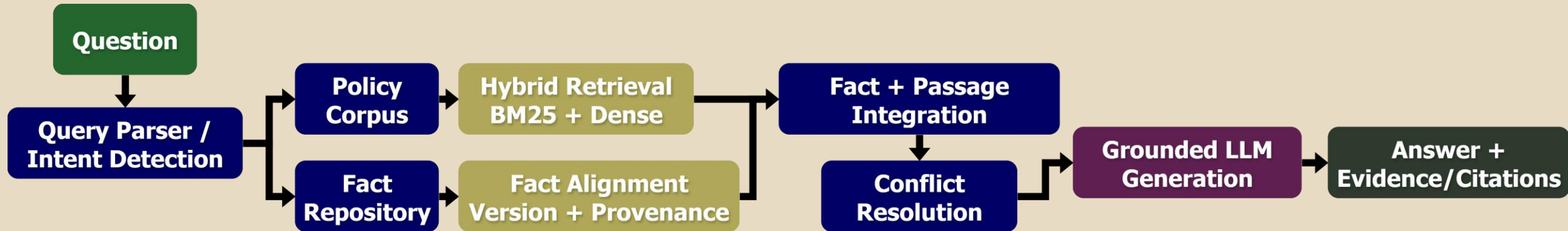
|                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                     |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  <p><b>Nature Implementation Programme (2020)</b></p> <p>📍 netherlands</p> <p>🗣️ Language: dutch / nederland</p> <p><a href="#">Read More</a></p>                                  |  <p><b>Provincial Development Plan (PIP) of the Wieden 2</b></p> <p>📍 netherlands</p> <p>🗣️ Language: dutch / nederland</p> <p><a href="#">Read More</a></p>                       |  <p><b>National Environment Vision (NOVI)</b></p> <p>📍 netherlands</p> <p>🗣️ Language: english (us)</p> <p><a href="#">Read More</a></p> |  <p><b>Formal designation Natura 2000 site no. 54 Witte Veen</b></p> <p>📍 netherlands</p> <p>🗣️ Language: dutch / nederland</p> <p><a href="#">Read More</a></p> |
|  <p><b>National Biodiversity Strategy &amp; Action Plan Netherlands 2025-2030</b></p> <p>📍 netherlands</p> <p>🗣️ Language: dutch / nederland</p> <p><a href="#">Read More</a></p> |  <p><b>Dutch National Environment Vision Implementation Programme (2021-2024)</b></p> <p>📍 netherlands</p> <p>🗣️ Language: dutch / nederland</p> <p><a href="#">Read More</a></p> |  <p><b>National Delta Programme 2025</b></p> <p>📍 netherlands</p> <p>🗣️ Language: english (us)</p> <p><a href="#">Read More</a></p>     |  <p><b>National Delta Programme 2025</b></p> <p>📍 netherlands</p> <p>🗣️ Language: english (us)</p> <p><a href="#">Read More</a></p>                             |



## Standard RAG



## PeatRAG





### Ask a Peatland Policy Question

Smart multilingual policy discovery with powerful filters and hybrid reasoning. If you would like to learn more about the AI behind this tool, please visit the [About Our AI](#) page.

Disclaimer: Performance of this tool depends on availability of the relevant information in our policy collection. This tool's response time will be a little longer than a normal LLM because the tool reduces hallucinations by grounding its answers in information retrieved from our policy collection.

Language

All

Category

All

Country

All

Governance Level

All

Type your policy question...

Ask

Or try:

EU Peatland Strategy

Restoration Barriers

National vs Regional Policy





| Question Type                    | Competency Questions                                                                                                |
|----------------------------------|---------------------------------------------------------------------------------------------------------------------|
| Numeric Targets / Area Goals     | What are the mandatory restoration area targets for peatland restoration according to the EU Biodiversity Strategy? |
|                                  | Which policies contain restoration area targets for 2030 across the EU and UK?                                      |
| Effective Dates / Versioning     | When was the EU Peatland Action Plan first published, and what are its key deadlines?                               |
| Legal Clause Extraction          | Which specific clauses in the UK Peatland Restoration Strategy outline financial mechanisms?                        |
| General / Descriptive Comparison | How do the legal frameworks for peatland restoration differ between the EU and the UK?                              |

## Evaluation Metrics (RAGAS Benchmark)

- **Factual Faithfulness:** Measures how well the generated answer is supported by the retrieved context. *(Crucial for policy)*
- **Context Precision:** Measures the relevance of the retrieved context to the query. *(How clean is the evidence?)*
- **Answer Relevance:** Measures if the answer directly addresses the question.



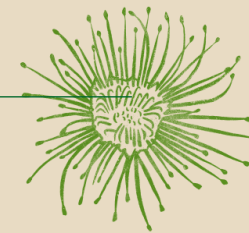
# PeatRAG: Evaluation results



| Method                                                                  | Faithfulness | Answer Relevancy | Context Relevancy | Context Precision |
|-------------------------------------------------------------------------|--------------|------------------|-------------------|-------------------|
| <b>Generic RAG</b> (BM25 only)<br><i>(Keyword-based lexical search)</i> | 0.61         | 0.68             | 0.66              | 0.49              |
| <b>PeatRAG</b><br><i>(Backend of our Policy AI tool)</i>                | <b>0.78</b>  | <b>0.82</b>      | <b>0.79</b>       | <b>0.69</b>       |

| Query Type                   | Faithfulness | Reason for Success                                                                                      |
|------------------------------|--------------|---------------------------------------------------------------------------------------------------------|
| Numeric Targets / Area Goals | +0.12        | The injected fact is an exact figure, preventing LLM from generating an aggregated or incorrect number. |
| Effective Dates / Versioning | +0.11        | The fact repository stores the latest version date, resolving ambiguity and document conflicts.         |
| Publisher/Source Provenance  | +0.09        | Authoritative source metadata is explicitly included, dramatically improving citation precision.        |
| Purpose/Definition (General) | +0.04        | Less gain, as hybrid retrieval is already effective for long-form, descriptive answers.                 |





## Fact Curation

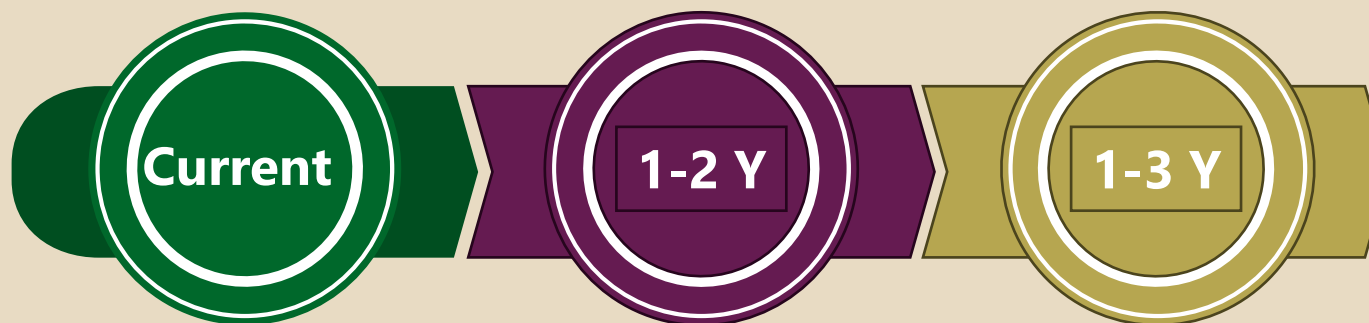
**Limitation:** Semi-automated  
**Work:** Use LLMs to automatically extract structured facts from new policy drafts.

**Impact:** Fully automated fact curation

## Improved Query Parser

**Limitation:** struggles with highly ambiguous queries.

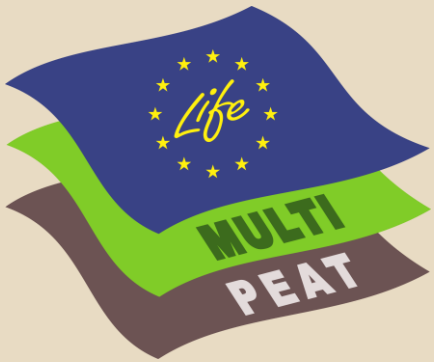
**Future Work:** Expand fact lookup beyond static database to use real-time structured sources (APIs)



## Precision Bias

**Limitation:** performs well with fact-based questions but struggles with broad, descriptive ones

**Future Work:** Integrate a confidence score for both the retrieved context and the injected fact



# Thank you!



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Learn more at: [\*\*www.multipeat.org\*\*](http://www.multipeat.org)

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