

HeMiRiHa EcoPolicy Analysis Using LLM

Leveraging Large Language Models for Sustainable Policy Insights



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Introduction: why ML & LLM?

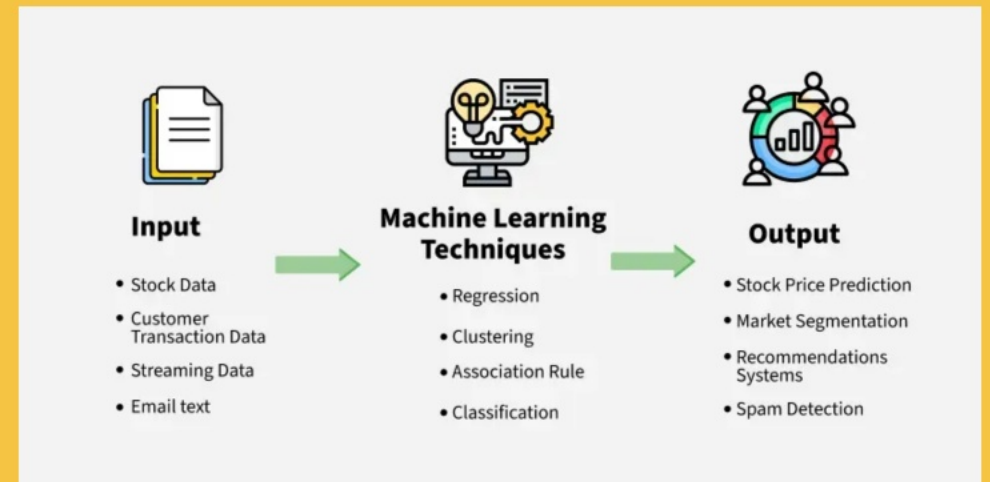
Rapidly process and synthesize large volumes of textual data from diverse sources

Efficiently identify key themes, insights, and emerging trends.

Generate clear summaries and visualizations of complex policy information.

Enhance transparency and accessibility of policy findings for policymakers, stakeholders, and the public.

Quickly perform policy analyses, scenario modeling, sentiment analysis, and impact assessments.



Two-paths research

RoBERTa Large based Policy
Filtering and clustering for trend
identification and similarity
analysis.

LLM-driven policy
analysis and
evaluation

RoBERTa Large based Policy Filtering

1.Filtering Criteria Applied:

Minimum length (50 characters)

Minimum tokens (10)

Minimum sentences (2)

Proper sentence ending

Semantic coherence score threshold (RoBERTa Large based) (-0.5)

2.Filtering Statistics:

Original policies: 26,750

Filtered policies: 8,348

Filtered out: 18,402 (about 68.8% of the original policies)

3.Quality of Filtered Policies:

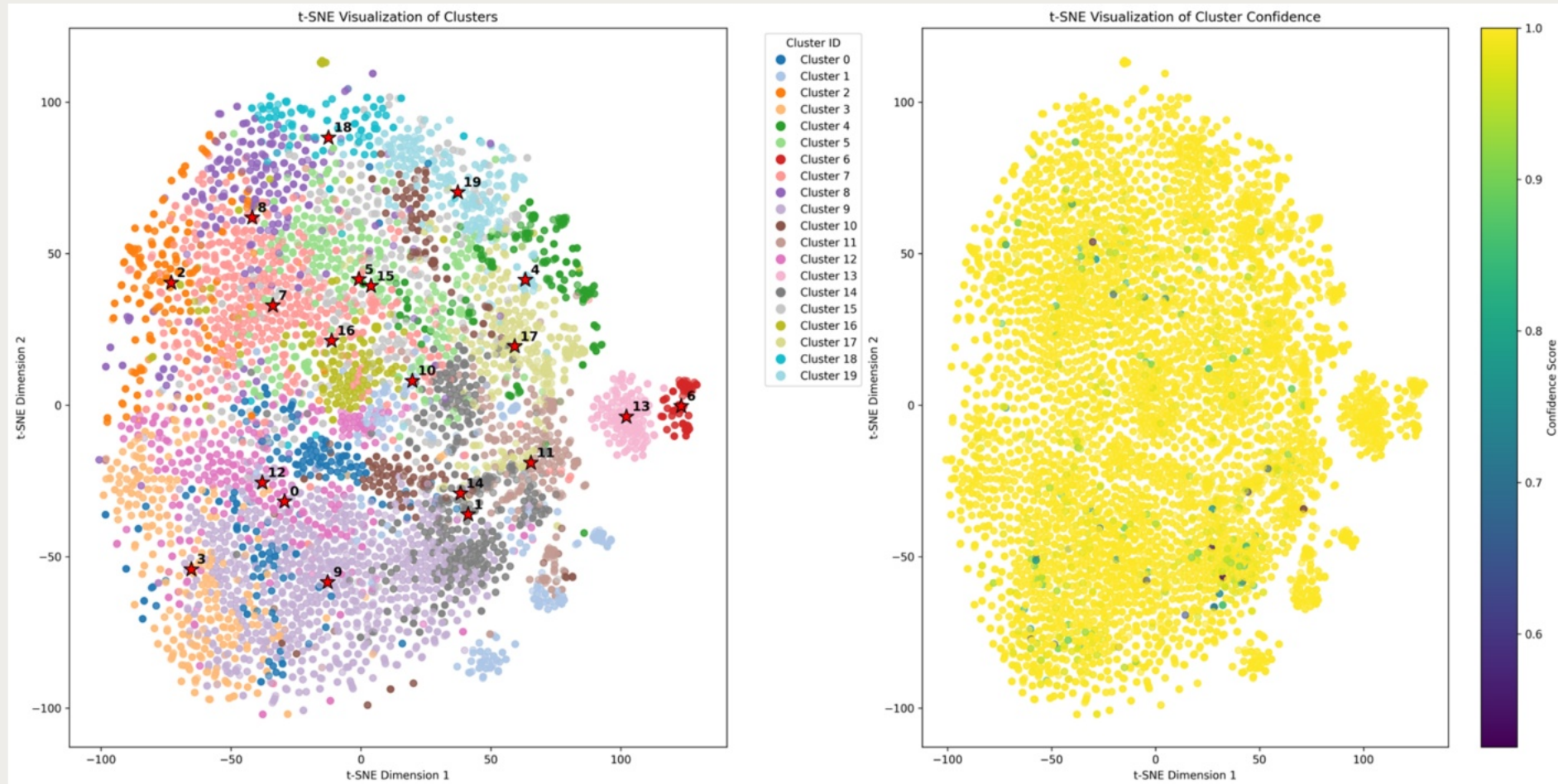
Complete sentences with proper punctuation

Meaningful content about sustainability and climate policy

Proper semantic coherence

Adequate length and structure

Cluster 2D Visualisation (t-SNE)



Cluster 13

Cluster 13 (228 policies):Content Theme:

Focused on sustainable development and renewable energy projects

Contains detailed technical documentation about greenhouse gas emissions and standards

Strong emphasis on specific targets (e.g., "67% by 2030" for renewable energy)

Features standardization systems and compliance with international standards (e.g., ISO 14064)

Distinctive Features:

Very high confidence scores (average 1.000)

Technical and standardization-focused language

Contains specific numerical targets and technical specifications

References to international standards and measurement protocols

Example Policy Types:

Municipal Strategic Plans for Sustainable Development

Technical standards for GHG emissions measurement

Renewable energy project documentation

Cluster 6

Cluster 6 (98 policies):Content Theme:

Focused on monitoring and evaluation frameworks

Contains structured, repetitive content about tracking climate targets

Administrative and progress reporting focused

Regional reporting structures (e.g., Hong Kong and Macao SAR reports)

Distinctive Features:

Smaller cluster size (98 policies)

Very high confidence scores (average 1.000)

Highly structured, formatted text with repeated patterns

Contains section headers and administrative content

Example Policy Types:

Monitoring and evaluation frameworks

Regional progress reports

Administrative tracking documents

Cluster 15

- United States: 25 policies (6.8%)
- Netherlands: 16 policies (4.3%)
- Norway: 11 policies (3.0%)
- Ireland: 11 policies (3.0%)
- Germany: 8 policies (2.2%)
- “Undertake measures to combat drought/water scarcity. Monitoring and warning services provided, leakages in water networks reduced, mapping and drought thresholds established, water storage capacity created.”

More on content differences

Policy Implementation (Cluster 19):

High frequency of emission and monitoring terms

Strong focus on policy and measures

Balanced tone with supportive elements

Adaptation Focus (Cluster 11):

High frequency of adaptation terms

Focus on ecosystem management

More neutral tone

Sentiment Evaluation

Overall Sentiment:

Most positive: Cluster 18 (0.079)

Most neutral: Cluster 19 (0.038)

Most negative: Cluster 11 (0.025)

Policy Tone:

Most aggressive: Cluster 15 (0.3 aggressive terms)

Most supportive: Cluster 19 (0.4 supportive terms)

Most neutral: Cluster 19 (0.7 neutral terms)

General properties

Cluster 13: Technical standards

Cluster 6: Monitoring and evaluation frameworks

Cluster 19: Comprehensive policy implementation

Cluster 18: Ambitious emission reduction targets

Cluster 11: Ecosystem-based adaptation

Cluster 15: Mitigation-focused policies

Cluster 16: Transport and waste management

Cluster 17: Climate change monitoring systems


```

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  "$300 million for community batteries and solar banks",
  "Up to $3 billion for renewables manufacturing",
  "Powering the Regions Fund",
  "Declining emissions baselines for major emitters",
  "National Electric Vehicle Strategy",
  "Net zero emissions for Commonwealth agencies by 2030",

```

How does each country perform in combating against climate change?

- Develop an API that could read, analyse and summarise the country policy.
- A systematic policy grading system.
- Deepseek V3 grade the policy, provide systematic mark scheme and store it in json file for data analysis.

Country Paris Alignment Scores

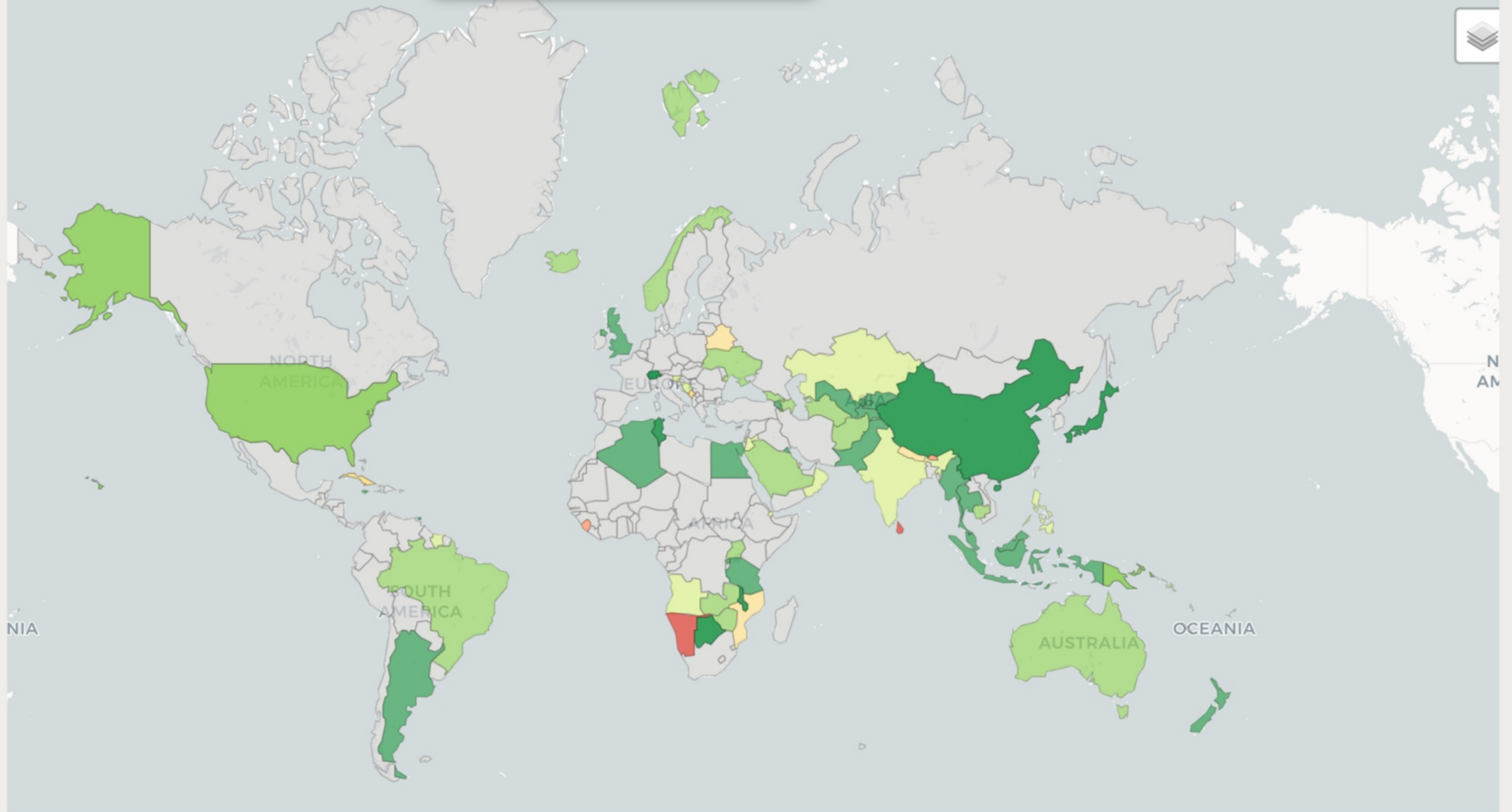
Assessing Country Alignment with Paris Goals: We analyzed each country's Nationally Determined Contribution (NDC) document to evaluate compliance with the Paris Agreement.

Baseline: We used the official Paris Agreement policy document as the benchmark group for comparison.

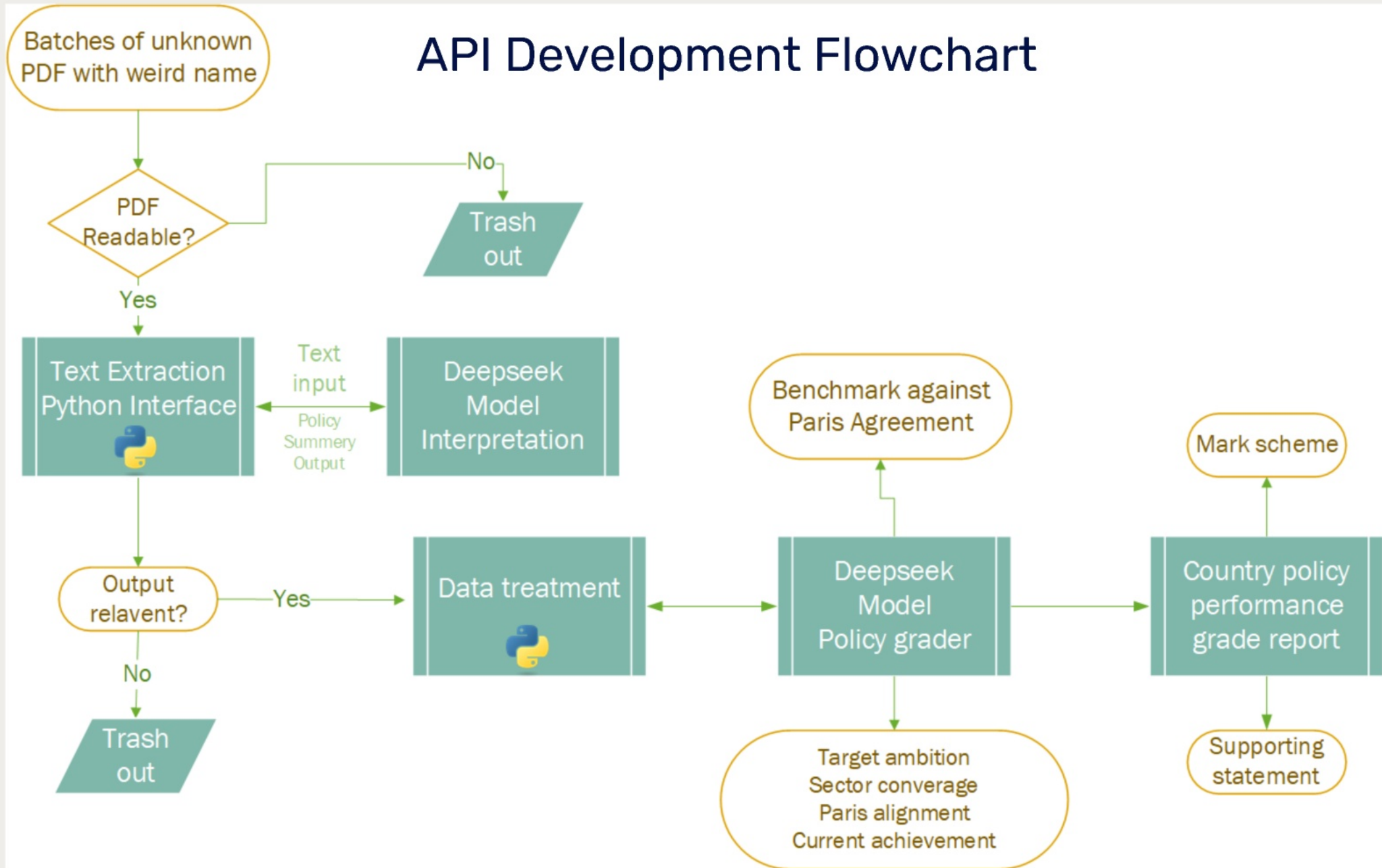
LLM-powered Analysis: We apply a zero-shot classification algorithm to assess alignment based various factors, including targets, ambition, specificity, and feasibility of plans.

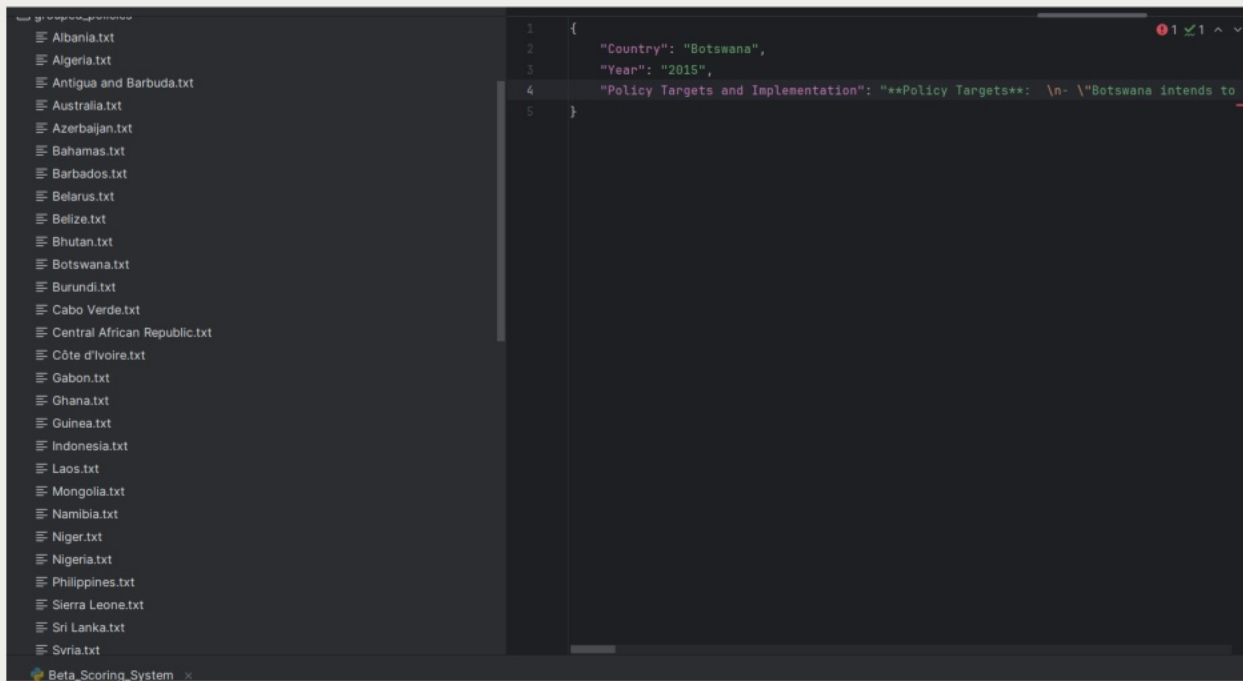
Country Alignment Score: Aggregate all sub-scores into an overall country-level alignment score for clear insights and comparisons.

NDC Alignment with Paris Agreement



API Development Flowchart





```

- **Policy Targets**:
  - Reduce greenhouse gas emissions **43% below 2005 levels by 2030**.
  - Achieve **net zero emissions by 2050**.
- **Implementation Proposed**:
  - **$20 billion investment in Australia's electricity grid** to accelerate renewable energy adoption.
  - **$300 million for community batteries and solar banks**.
  - **Up to $3 billion from the National Reconstruction Fund** for renewables manufacturing and low-emissions tech.
  - **Powering the Regions Fund** to support clean energy industries and workforce training (e.g., 10,000 New Energy Apprentices).
  - **Declining emissions baselines for major emitters** under the Safeguard Mechanism.
  - **National Electric Vehicle Strategy**, including $500 million for charging infrastructure and tax discounts.
  - **Net zero emissions for Commonwealth agencies by 2030** (excluding defense).
  - **Annual climate statement to Parliament** and legislative formalization of targets.
  - **Climate adaptation measures**, including disaster resilience ($200 million/year) and Great Barrier Reef protection ($194.5 million).

**Original Text Excerpts**:
> "Australia is increasing the ambition of its 2030 target, committing to reduce greenhouse gas emissions 43% below 2005 levels by 2030."
> "The Australian Government is implementing a substantial and rigorous suite of new policies across the economy to drive the transition to net zero."
> Policies listed include investments in renewables, electric vehicles, and industrial decarbonization (e.g., "declining emissions baselines for Australia"
```

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Conclusion and Future Directions

1. Develop a beta version API to process policy document in batches using Deepseek
2. Develop a policy grading system to evaluate country's performance
3. Policy report successfully generate for 29 countries, over 106 PDFs.

Research Opportunities

Future research could focus on integrating more diverse data sources into LLMs, enhancing predictive modeling for policy impacts. Collaboration across disciplines is essential to foster innovative policy solutions addressing climate change.

Potential integration between ML and LLM?

1. Accuracy testing of LLM interpreter and grader
2. Better data pretreatment process
3. Larger database for better clustering result
4. More policy accessing criteria
5. LLM interpreted result use in clustering