



MEECC's 'global' net-zero claim relies on excluding countries without solutions

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This preprint reports a replication and assessment of selected numerical results from the Model for Energy Equity and Climate Compatibility (MEECC), using the publicly released code and data. It contains the main manuscript and Supplementary Information and has been submitted to npj Climate Action as a Matters Arising. The manuscript has not yet been peer reviewed and may be revised during the editorial process. Any subsequent journal publication will be linked to this record. We welcome comments, questions and independent feedback.

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Abstract

Kanitkar et al. present the Model for Energy Equity and Climate Compatibility (MEECC) as a way to explore how sharing the remaining carbon budget affects national emissions pathways. Several published results cannot be reproduced from the released code and data. Countries for which the model finds no pathway are excluded from totals labelled World. In one 1.5 °C scenario, these countries account for 65% of modelled 2020 emissions, yet the paper reports a 96% global reduction by 2050. The stated peak-to-net-zero timing rules are not implemented as described, and published counts of countries without solutions and most national net-zero years cannot be reproduced. National pathways also fail for different reasons: some countries exhaust their allocated budgets, while others fail the timing screen. The reported World results therefore cover only countries receiving a solution, leaving an incomplete global emissions pathway.

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1 Main

Kanitkar, Jayaraman and Lavanyaa (henceforth KJL) present MEECC_V.1 in npj Climate Action as an analytical framework for exploring energy equity, climate equity and national mitigation pathways under carbon budgets associated with 1.5 °C, 1.7 °C and 2 °C warming.[1] The three scenarios vary their equity assumptions: SEA-1 includes both energy and climate equity, SEA-2 energy equity only, and SEA-3 neither; G1-G5 denote development groups from most to least developed.

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2 World emissions use an incomplete country set

For 1.5 °C, their Table 2 reports 2050 net-CO₂ reductions of 96%, 100% and 100% across the three scenarios, and the text describes "net-zero CO₂ emissions globally by 2050".[1] The paper later states that countries for which the model finds no pathway under its carbon-budget and timing rules (a "no solution" result) are excluded from aggregated emissions; the authors call this a modelling artifact and conclude that "there are no feasible solutions that do not leave out a substantial number of countries".[1] Table 2 does not identify the excluded countries or their share of emissions.

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The public code repository v1.3 applies this exclusion to the World emissions series, and the same filtering remains in v1.3.1. Using their Supplementary Table S3 country grouping, the no-solution sets in v1.3 contain 40, 65 and 64 countries in SEA-1, SEA-2 and SEA-3, accounting for 65.0%, 14.5% and 14.3% of model-world 2020 baseline net-CO₂ emissions. Table 1 separates the published 2050 values from reductions computed only over countries receiving a model solution. For SEA-1, released v1.3 gives 85.0% against the published 96%. SEA-2 and SEA-3 reproduce the published 100% values over countries receiving solutions; the 65 and 64 no-solution countries are absent from those totals. KJL also report no solution

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for G1-G2 under SEA-1 at 1.5 °C. Together these groups account for 40.3% of model-world 2020 baseline net-CO₂ emissions, a different set from the v1.3 exclusions.

40 **Table 1 | Published 1.5 °C / 50% results and released-v1.3 accounting over countries receiving a solution. Released calculations use their Supplementary Table S3 grouping. The final column is the share of model-world 2020 baseline net-CO₂ emissions represented by countries excluded from the released World data.**

Scenario	Published 2050 reduction	v1.3 reduction among countries with solutions	No-solution count paper / v1.3	v1.3 excluded set share of 2020 emissions
SEA-1	96%	85.0%	99 / 40	65.0%
SEA-2	100%	100.0%	103 / 65	14.5%
SEA-3	100%	100.0%	110 / 64	14.3%

The article also states that global reductions across the three alternatives "do not differ too widely" for a given temperature target.[1] In the released calculation, the omitted 2020 emissions shares range from 14.3% to 65.0%. The 1.5 °C World results therefore cover only the countries that receive a solution in each scenario and do not establish that global net-zero CO₂ is reached by 2050.

3 Feasibility rules change who is counted

MEECC constructs each post-peak emissions pathway as a straight-line decline from peak emissions to zero. A country receives "no solution" when its allocated budget has been exhausted by the selected peak or when a positive remaining budget implies a peak-to-net-zero interval that fails the timing screen. Their Methods state that the lowest possible gap is 10 years and the highest is 50 years. Released v1.3 rejects rounded gaps of ten years or less and has no 50-year ceiling. Released v1.3.1 replaces the fixed lower threshold with a user-selected value, defaulting to five years, and still has no ceiling. Their Table 5 includes feasible intervals of 9, 52, 53, 76, 77 and 108 years.

Adding only the stated 50-year ceiling to the v1.3 code changes 2 °C SEA-1 from 4 to 123 no-solution countries. The reported 2050 reduction among countries receiving a solution rises at the same time, from 65.4% to 87.0%, because the newly failed countries are removed from the World series. With this ceiling applied, 123, 121 and 114 out of 179 countries receive no solution in SEA-1, SEA-2 and SEA-3 at 2 °C. In all three 2 °C alternatives, the 50-year ceiling rejects a majority of pathways accepted by released v1.3.

4 Published solution sets cannot be reproduced

KJL's Figure 7 reports 99, 103 and 110 no-solution countries at 1.5 °C. Released v1.3 gives 40, 65 and 64 using their Supplementary Table S3; v1.3.1 at its released five-year default gives 18, 56 and 54; and the authors' bundled results archive gives 41, 65 and 60 under its own grouping. None of these public records reproduces the published count pattern. The bundled World data also fails to reproduce their full Table 2 grid; the released SEA-2 and SEA-3 2050 values match the published 100%.

Released v1.3 reproduces only 1 of the 28 national net-zero years in KJL's Tables 5 and 6; for Germany, all nine calculated years are two years later than published. The accompanying documentation refers to a budget beginning in 2020 but to emissions deductions beginning in 2019. Deducting 2019 net CO₂ reproduces all nine German entries and 27 of the 28 national values after rounding, although neither released code version includes this step (Supplementary Note 4).

For India under SEA-1 at 1.5 °C with a 2035 peak, KJL's Table 5 reports 2044 as feasible, a nine-year interval. Released v1.3 calculates 2045 but rejects that ten-year interval; neither public release reproduces the published result (Supplementary Note 4).



5 The national interpretation does not match the released calculation

For SEA-2 at 1.5 °C, the paper explains the G4-G5 no-solution outcomes through later peak years and the ten-year minimum between peak emissions and net zero.[1] In released v1.3, 34 of the 41 G4-G5 cases have already exhausted their allocated budget by the selected peak, so no positive residual budget remains at that peak. Changing the timing threshold does not affect those cases at that peak. In the paper's 2025 case, the peak itself is moved earlier, leaving more of the allocated budget available.

In SEA-1, 19 of 21 G1-G2 no-solution cases retain a positive residual budget and fail the timing screen. Changing only the lower threshold from ten to five years turns 10 of those 21 cases into solutions.

6 Implications

The numerical record needs to be corrected. The calculation used to produce the published tables and figures should be identified and archived, and the feasibility rule needs to be transparently reconciled. World emissions should either be recomputed over all 179 modelled countries or explicitly described as subtotals over countries receiving a solution; in the latter case, the excluded share of emissions should be stated. National no-solution results should distinguish exhausted budgets from rejection by the timing screen.

KJL propose MEECC for ex ante target setting and ex post assessment on the basis of equity and the best available science. [1] MEECC can serve as an illustrative tool to demonstrate how allocation rules redistribute a carbon budget. On the current public record, however, its published numerical outputs do not establish which countries or global pathways are feasible and consistent with 1.5 °C, 1.7 °C and 2 °C warming. They therefore cannot reliably be used as evidence for setting or assessing climate targets or in scientific assessments of mitigation feasibility.

References

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2. Kanitkar, T., Lavanyaa, V. P. & Jayaraman, T. Tejal-NIAS/MEECC-V.1: Model for Energy Equity and Climate Compatibility. Version MEECC-V.1.3. Zenodo (9 February 2026). <https://doi.org/10.5281/zenodo.18532397>.
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Data availability. The underlying MEECC code and input data are available in the authors' archived releases (<https://doi.org/10.5281/zenodo.18532397>, <https://doi.org/10.5281/zenodo.21278878>). The country grouping used for calculations reported here is transcribed from the published Supplementary Table S3. Outputs supporting this analysis are available at Zenodo: <https://doi.org/10.5281/zenodo.23303358>.

Code availability. The replication materials at <https://doi.org/10.5281/zenodo.23303358> contain a runner that executes the authors' released code with the published country grouping, arithmetic checks, the sensitivity patches, source hashes and output data. The original MEECC source code is not redistributed and is available from refs. 2 and 3.

Competing interests. The authors declare the following competing interests: both authors are integrated assessment modelers, and serve *pro bono* on the Integrated Assessment Modeling Consortium's Scientific Working Groups. The authors declare no financial competing interests.



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Supplementary Information

for “MEECC’s global net-zero claim relies on excluding countries without solutions”

115 **Supplementary Note 1 | Materials and replication setup**

The replication used four author-released records: the published article and Supplementary Information; release v1.3 dated 9 February 2026, which was current when the article was accepted on 19 March 2026; release v1.3.1 dated 9 July 2026; and the scenario-results archive bundled with v1.3.1. Release v1.3 was the primary replication target. Release v1.3.1 recorded later changes. The bundled archive was treated separately because neither released source contains the batch-export code that generated it. The article states that an interactive Excel-based model is available on request. We examined the public archival record, not that Excel implementation.

Calculations use the published Supplementary Table S3 country grouping unless stated otherwise and retain v1.3’s zero-filling of missing inputs. For command-line replication, dashboard dependencies were bypassed and country groups supplied directly rather than rerunning UMAP; the scenario calculation path was unchanged. With the archive’s own grouping, the runner reproduced the bundled World series to displayed precision for all nine scenario-target combinations.

125 **Supplementary Note 2 | World aggregation and published Table 2**

Released v1.3 assigns placeholder mitigation trajectories to countries receiving no solution and removes those countries from emissions-related group and World time series (MEECC_V.1_revision.py, lines 780, 909-920 and 931-932). The article explicitly acknowledges this exclusion as a modelling artifact; the same filtering is present in v1.3.1. GDP and primary-energy panels retain all 179 countries. At 1.5 °C/50% using the published Supplementary Table S3 grouping, the excluded sets account for 65.0%, 14.5% and 14.3% of model-world 2020 baseline net-CO₂ emissions in SEA-1, SEA-2 and SEA-3. KJL report G1-G2 countries as having no solution in SEA-1; together these groups account for 40.3% of model-world 2020 baseline net-CO₂ emissions under the published S3 grouping, distinct from the v1.3 excluded set.

At 2050, the released reductions among countries receiving solutions in SEA-2 and SEA-3 match the published 100%; SEA-1 gives 85.0% against the published 96%. The authors’ bundled World series does not reproduce their full Table 2 grid. The endpoint cases in Supplementary Table S1 show the size of the emissions term left undefined when a country receives no solution.

140 **Supplementary Table S1 | Released-v1.3 results over countries receiving a solution and fixed-country diagnostic cases at 1.5 °C/50%. The final three columns retain every solved trajectory, use the full 179-country 2020 denominator, and assign no-solution countries the stated reduction relative to their own 2050 MEECC baseline. These are diagnostic endpoint cases, not proposed pathways.**

Scenario	v1.3 no-solution count	v1.3 2050 reduction among countries with solutions	No-solution share of 2020 emissions	No-solution at 100% cut	No-solution at 50% cut	No-solution at 0% cut
SEA-1	40	85.0%	65.0%	94.8%	65.3%	35.8%
SEA-2	65	100.0%	14.5%	100.0%	69.0%	38.0%
SEA-3	64	100.0%	14.3%	100.0%	82.2%	64.4%

Supplementary Note 3 | Feasibility rule and national interpretation

Their Methods state that the lowest possible peak-to-net-zero gap is 10 years and the highest is 50 years. Release v1.3 rounds the net-zero year to an integer and then rejects duration ≤ 10 (source lines 750-757), so an exactly ten-year interval fails,



- 145 and it contains no > 50 test. Release v1.3.1 replaces the fixed lower threshold with a user-selected gap whose released default is five years (lines 1083-1084); it also has no upper bound. Direct boundary tests of v1.3 reject 9 and 10 years and accept 11, 50 and 51 years. Their Table 5 reports 9, 52, 53, 76, 77 and 108-year intervals as feasible. For the sensitivity runs reported here, the 50-year case changes the released rejection test from duration ≤ 10 to duration ≤ 10 or duration > 50 ; the five-year case changes only the lower threshold from ≤ 10 to ≤ 5 .
- 150 No-solution status has two relevant causes in the released calculation. A country can reach the selected peak after its allocation is exhausted, or it can retain a positive allocation and fail the timing screen. At 1.5 °C, 19 of 21 SEA-1 G1-G2 failures retain a positive budget and fail the screen. In SEA-2, 34 of 41 G4-G5 failures have exhausted their allocation by the selected peak; in SEA-3 the corresponding figure is 33 of 39. Changing the SEA-1 lower threshold from ten to five years reduces G1-G2 no-solution cases from 21 to 11.
- 155 The paper attributes the SEA-2 G4-G5 result to later peaks combined with the ten-year minimum. Emissions accumulated before the peak reduce the remaining allocation. For the 34 budget-exhausted cases, lowering the timing floor at the same peak makes no difference.

Supplementary Table S2 | Effect of adding only the published 50-year maximum while retaining released-v1.3 lower-bound behaviour. Values use the published Supplementary Table S3 grouping and released-source missing-value handling.

Scenario / target	No-solution released	No-solution with 50-year cap	Newly rejected	2050 reduction among countries with solutions
SEA-1, 1.5 °C	40	75	35	85.0% to 90.2%
SEA-1, 1.7 °C	8	86	78	79.6% to 86.9%
SEA-1, 2 °C	4	123	119	65.4% to 87.0%
SEA-2, 2 °C	35	121	86	53.8% to 55.9%
SEA-3, 2 °C	28	114	86	57.6% to 62.6%

160 **Supplementary Note 4 | Published solution sets and country-table provenance**

- Their Figure 7 reports 99/103/110 no-solution countries for SEA-1/2/3 at 1.5 °C/50%. Released v1.3 gives 40/65/64 using the published Supplementary Table S3 grouping. With the grouping stored in the bundled results archive it gives 40/65/60. The bundled archive itself contains 41/65/60; at 1.5 °C/50%, the source/archive difference is Kiribati, whose 2019 LULUCF input is missing. Across the three temperature targets, all source/archive differences are confined to Kiribati, Maldives and
- 165 Seychelles, whose missing 2019 LULUCF inputs are zero-filled by v1.3. Release v1.3.1 at its five-year default gives 18/56/54. None reproduces the published 99/103/110 pattern.

- Their Equation (8) gives $NZY = 2 \times CES / E_{\text{peak}} + BY$, with $BY = 2020$ and CES defined from the budget remaining after emissions from 2020 to the peak are deducted. Both released versions add the drawdown duration to the peak year instead, consistent with the straight-line post-peak construction. Released v1.3 reproduces 1 of 28 numeric net-zero years in their
- 170 Tables 5 and 6; v1.3.1's manual peak controls at both tested lower thresholds, and the bundled archive, also match only 1 of 28. Using the published Supplementary Table S3 grouping, the released peak-year anchor and an additional deduction of each country's 2019 net CO₂ reproduces 27 of 28 after rounding. The remaining case is India, SEA-3 at 1.7 °C/50% with immediate peaking: 2049 in the reconstruction and 2048 in their Table 5.

- Germany's peak is 2020 in all nine cells of their Table 6, so the year anchors in the printed Equation (8) and released code coincide in these cases. The released net-zero years are two years later than published. The accompanying model documentation defines the remaining budget as running “from 2020 to the time of global net-zero” but describes emissions deducted “from 2019 till the year of peak emissions”. This discrepancy prompted the additional 2019 deduction: it reproduces all nine German entries, although neither released code version implements it. For India under SEA-1 at 1.5 °C with a 2035 peak, v1.3 calculates 2045 but classifies the case as no solution because the interval is exactly ten years. Their
- 180 Table 5 reports 2044 as feasible, although the interval is only nine years. Under v1.3.1's manual peak-year setting, the same Indian case returns no solution at a ten-year threshold and 2045 at the released five-year setting.