**Project Drawdown Transportation Integration Procedure**

This document explains the step by step procedures for integrating the 13 transport models with each other and with those outside the sector. No theoretical background or detailed explanations are provided since the Sector White paper explains all the methodology.

Notes:

1. The “Integration Model” refers to “TAM Solution Integration File.xlsx”
2. The Color scheme is rigorously used throughout the solution and integration models.

**Steps to Integration**

**Phase 1**: Verify Model Data and Scenarios

1. In each solution model, you should double check that the final scenarios are saved on the ScenarioRecord tab and that they each have clear descriptions and proper titles on that sheet (“PDSx-yp2050-short name” where x is the number of the scenario, and y is the percent adoption in 2050).
2. The recorder may store several scenarios, but they usually refer to TAM and variables that sometimes get changed. In some cases, older scenarios cannot be loaded correctly since they may not be able to reproduce the correct inputs. There is the possibility of loading the values instead of any scenario formulas. You can consider this if needed, but in general delete any old unusable scenarios. Test each one and look at stored results versus what’s calculated when loaded. This highlights the importance of storing copies of important models that need to be “frozen”
3. On loading each final scenario, check that they get progressively more aggressive for higher scenarios, that all results are calculated properly, and that correct adoption inputs (including adoption scenario names) are used
4. Do this check for all solutions before moving to next Phase.
5. EV and Hybrids have a special integration issue: the PDS scenarios possibly have to be limited (reduced) since they are the lower priority solutions in urban and nonurban passenger transport clusters. The limitation is done by copying the “available” TAM in pkm from the Integration Model to the models after the higher priority solution results are copied to the Integration model file). This is discussed in the Phase 3 onwards below.

**Phase 2**: Verify Integration Model TAM Data

1. The Transportation Integration Model has several raw and summarized interpolations of mobility demand for each cluster. They are organized by cluster (e.g. Freight), by sub-cluster (e.g. Air Freight), by ambition (e.g. Conservative) and these should align with what all the models have. So If a single model uses a new TAM source, this changes the TAM numbers and should be replicated across all solutions using that TAM and the Integration Model file.

Phase 3: Copy Non-Car Adoption data to the Transport Integration Model File and Adjust any Overallocations.

1. Solution Adoptions in functional units should be copied to the relevant portions of the Integration File (best to copy from the bottom of the Advanced Controls sheet – around column B and also copy the scenario name from ScenarioRecord). The key elements of the integration are ensuring that there is no double counting of mobility in each realm or cluster (Urban Passenger, Nonurban Passenger or Freight). The areas where each solution results (PDS1, PDS2, and PDS3 adoption *in billion passenger-km or million tonne-km* ***only***[[1]](#footnote-1)) are to be copied are:
   1. Urban Passenger Cluster (Non Car): Urban Pass Adoption
   2. Nonurban Passenger Cluster (Non Car): Nonurban Pass Adoption
   3. Freight: Freight Adoption
   4. Car Solutions (Carpooling, EV, Hybrids): Private Car Analysis & Split (see next Phase)
2. Each of these sheets has the PDS1, PDS2, and PDS3 scenarios stacked as you scroll down the sheets
3. Solutions should only be copied in sequence to allow for adjustment of adoptions for lower priority solutions.
4. Lower priority solutions may need to be adjusted in adoptions if the Adoption sheets show any overallocation (bright red cells in column C of the Adoption Sheets). Once there are no overallocations for any particular cluster, the integration of that cluster is complete. This is not likely a problem for the Freight solutions. The Nonurban cluster may exceed the TAM only by the car solutions, however note that the Efficient Aviation solution adoption may exceed the total historical Aviation share which is not a major problem since total aviation share will grow according to IEA data (the Aviation solution TAM), and this will be shown on the sheet.
5. Car solutions are part of the Urban and Nonurban passenger clusters, and may need adjustment. All adjusted adoptions should be copied back to the Solution model.
6. Most likely only the Car solution adoptions need to be adjusted to avoid double count, so all others can be copied to the model in order and those Car solutions follow a different procedure as below.

**Phase 4**: Integrate and Copy ***Adoptions*** of Car Solutions (Carpooling, EV, Hybrids)

Carpooling

1. For each PDS Scenario ***convert to Pkm*** and copy “Total URBAN -Estimated Car TAM” from Column E of Private Car Analysis & Split to the appropriate integrated TAM section (row 103) of the TAM Data tab of the Carpooling model. This limits the adoptions of the Carpooling model.
2. Load, and resave all Carpooling scenarios.
3. Copy Carpooling PDS adoptions to the Private Car Analysis & Split
4. Set all non-car PDS adoptions on both the Urban Pass Adoption and Nonurban Pass Adoption tabs to **Include** (4 solutions x 3 scenarios on urban, and 3 solutions x 3 solutions on nonurban).
5. From Private Car Analysis & Split set EV and Hybrids to **Exclude** (2 solutions x 3 scenarios for Urban and Nonurban).
6. From Private Car Analysis & Split set Carpooling to **Include** (1 solution x 3 scenarios for urban only). This enables you to see the TAMs after all but the EV and Hybrid solutions have been adopted in columns H and I of Private Car Analysis & Split.
7. If any cells in columns H and I are red then overallocation[[2]](#footnote-2) exists only from included solutions and the adoption of Carpooling should be adjusted downwards (if 0 Carpooling adoption results in red cells, then check adoptions of higher priority solutions). If any changes are made, be sure to copy the new adoption back to the Carpooling model. Ensure no overallocation exists before continuing.

Electric Cars

1. Copy “Total URBAN -Estimated Car TAM” and “Total NON URBAN -Estimated Car TAM” from Columns E and F of Private Car Analysis & Split (for each scenario) to the TAM Integration tab of the EV model. These should feed the appropriate Integrated TAM section (row 103) of the TAM Data tab of the EV model. This limits the adoptions of the EV model, and may change the results.
2. Load, and resave all EV scenarios.
3. Copy the EV adoptions from each new PDS scenario to the Private Car Analysis & Split tab of the Integration model.
4. From Private Car Analysis & Split set Electric Cars/EVs to **Include** (1 solution x 3 scenarios for urban and nonurban). This enables you to see the TAMs after all but the Hybrid solution have been adopted in columns H to L of Private Car Analysis & Split.
5. If any cells in columns H to L are red then overallocation[[3]](#footnote-3) exists only from included solutions and the adoption of EV’s should be adjusted downwards. Oftentimes, the overallocation exists only in urban or nonurban suggesting that the balance of the Urban driving fraction should probably be adjusted. Since there is much uncertainty in how much of the driving will happen within and outside cities, feel free to adjust this each year to reduce the overallocation. If any changes are made to the overall EV adoption, be sure to copy the new adoption back to the EV model. Ensure no overallocation exists before continuing, though small amounts after 2050 are easily ignored.

Hybrids

1. Copy “URBAN Remainder (After Solutions)” and “NONURBAN Remainder (After Solutions)” from Columns ***H*** and ***K*** of Private Car Analysis & Split (for each scenario) to the TAM Integration tab of the Hybrids model. These should feed the appropriate Integrated TAM section (row 103) of the TAM Data tab of the Hybrids model. This limits the adoptions of the Hybrids model, and may change the results.
2. Load, and resave all Hybrids scenarios.
3. Copy the Hybrids adoptions from each new PDS scenario to the Private Car Analysis & Split tab of the Integration model.
4. From Private Car Analysis & Split set Hybrids to **Include** (1 solution x 3 scenarios for urban and nonurban). This enables you to see the TAMs after all solutions have been adopted in columns H to L of Private Car Analysis & Split.
5. If any cells in columns H to L are red then overallocation[[4]](#footnote-4) exists only from included solutions and the adoption of Hybrids should be adjusted downwards. Oftentimes, the overallocation exists only in urban or nonurban suggesting that the balance of the Urban driving fraction should probably be adjusted. Since there is much uncertainty in how much of the driving will happen within and outside cities, feel free to adjust this each year to reduce the overallocation. If any changes are made to the overall Hybrids adoption, be sure to copy the new adoption back to the Hybrids model. Ensure no overallocation exists before continuing, though small amounts after 2050 are easily ignored.

**Phase 5**: Integrate and Copy ***Variables*** of Car Solutions (Carpooling, EV, Hybrids)

Carpooling has an impact on EVs and Hybrids (car occupancy) and EVs and Hybrids have an impact on Carpooling (fuel and electricity use). This section integrates the results by re-estimating the variable inputs given the integrated PDS adoptions.

1. From the Carpooling model, copy the reference and 2050 (Solution) car Occupancy for each scenario into the green cells of column S of the Private Car Variable Adjust sheet of the Integration Model.
2. From the Hybrid and EV models, copy the fuel consumption, fuel saved and electricity consumption (for hybrids, EV,s and ICE/Conventional cars) and paste special values in the appropriate areas of the Private Car Variable Adjust sheet of the Integration Model for each scenario. Note that the Hybrid fuel % saved doesn’t change for each scenario as the Hybrid is the same relative to the ICE, however the EV saves more fuel and uses more electricity in higher scenarios since the ratio of BEV to PHEV increases.
3. The integrated/output variables are shown in pale yellow. These should be copied to the Carpooling, EV, and hybrid models and the scenarios resaved to get accurate results (scenario titles should include “-Integrated” for clarity.

**Phase 6**: Copy Emissions, Financial, and Grid Results to Integration Model File

This final section allows us to get results out of the model for various purposes including pasting in the Transportation Integrated Model File, pasting results into a Core results tracker or pasting them into a Technical report.

1. For each of the 13 solution models, Download and open the Results extractor excel file, follow the instructions to copy the extractor into the model file.
2. Load each scenario using the ScenarioRecord and use the Result Extractor tab (AutoResults) to take the results of interest easily out of the model. For the Transportation Integrated Model that’s: Emissions reduction -> Emissions Redux and Financials -> Financials&Adoptions. Electricity demand changes (Electricity demand changes -> Grid Impacts tab) have to be copied from the Units Adoption Calculations Tab either from the table at B307 or that at Q307 (dependent on model inputs, one shows electricity saved, and the other additional electricity used, so the multipliers in row 9 of Grid Impacts must account for the two options (“-1” for Net Grid Electricity Used, and “1” for Net Grid Electricity Saved).

1. Note that for any solution that does not use either of these two units (like Public Transit that uses passenger-km), they need to be converted. [↑](#footnote-ref-1)
2. “Overallocation” here means that for an overallocated year, all the solutions are providing more mobility than total estimated demand. For instance, we could be saying that the world would need 1 million passenger-km according to the TAM but our models sum to more than 1 million. [↑](#footnote-ref-2)
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