**Project Drawdown Buildings Integration Procedure**

This document explains the step by step procedures for integrating the buildings 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 “Project Drawdown - Buildings Integration Model.xlsx” – does the solution result integration
2. The “Integrated TAM Model” refers to “BuildingSector\_TAM\_v1\_May2019.xlsm” – calculates the total addressable markets (TAMs) (which are copied to the Integration Model).
3. 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 (“PDS[x]-[y]p2050-[short name]” where [x] is the number of the scenario, [y] is the percent adoption in 2050, and [short name] is a brief descriptive name).
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.

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

1. The Buildings Integration Model has several raw and summarized interpolations of end use energy demand for each cluster. They are organized by end use type (e.g. space heating) or building metric (e.g. roof area), by ambition (e.g. Conservative) and by region (e.g. Middle East and Africa). These should align with what all the models have. So If a new TAM source is used, this changes the TAM numbers and should be replicated across all solutions using that TAM and the Integration Model file.
2. Note that the Integration Model is separate to the Integrated TAM Model. The Integration model has static copies of the TAM’s calculated in the Integrated TAM model. The Integrated TAM model combines average building metric data (floor area, roof area etc.) with average energy factors (space heating, lighting demand etc.) to estimate total demand. So TAM changes should only come from this file, and since the REF scenarios of the solutions are affected by the TAMs (many are fixed proportions of the TAM), then the model results are affected by TAM changes.

**Phase 3**: Sequentially adjust models

Sequentially copy each solution adoption and unintegrated efficiency factors (electricity and fuel) *to the Integration Model File* (on tabs PDS 1, PDS 2, and PDS 3) and copy adjusted efficiency factors *back to the solution models*. This updates the model results (so new *“- Integrated*” scenarios should be saved where change happens). Finally, copy annual electricity and fuel savings *to the Integrated Model File* (for each sequence chain: Space Heating/Cooling, Lighting, Water Heating, Cooking). **Be sure to note the color scheme when copying data, and follow the sequence of the cells from left to right and top to bottom.** *E.g. several of the Solution templates on the Integration Model (PDS 1 etc.) call for annual adoption data (so enter this first from Solution Model), then an Electricity Efficiency (consumption) value (enter second), then they show an updated Electricity Efficiency value (which should be put back into the Solution Model to adjust the results), and then the updated Electricity (or fuel) savings from the Solution Model should be copied to the Integration model*. This is expanded below.

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). The key elements of the integration are adjusting solution efficiencies to account for other (higher priority) solutions, and ensuring that there is no double counting in each cluster. Each scenario is copied to its relevant Integration Scenario sheet: PDS 1, PDS 2, and PDS 3, so it makes sense to do all three scenarios at the same time for each solution. Each of these Integration Scenario sheets has all buildings solutions laid out in order Left to Right and Top to Bottom. The top left of each sheet has the Table of Contents with links to each solution.
2. Solution energy (fuel and electricity) unit consumption and efficiencies are also copied to the Integration Model (from Advanced Controls when the relevant scenario is loaded). For some solutions, this includes fuel, electricity, fuel efficiency and electricity efficiency (that is, savings from switching conventional🡪 solution). Due to the overlapping solution adoptions, and assumed efficiency reductions on overlapping areas, the efficiencies are adjusted automatically for each solution, and this should be used to recalculate the solution model as it’s considered more accurate an input to the relevant scenario.
3. Copy the adjusted energy and efficiency inputs back to the solution models for each scenario and resave the scenario as “PDS[x]-[y]p2050-[short name]-Integrated”. Feel free to add a line in the scenario description to explain the integration changes.
4. Copy the new (integrated) scenario annual energy savings (electricity and/or fuel) from the solution model into the Integration Model: Unit Adoption Calculations B307+, Q307+ and/or AD307+. Note that the tables at B307 and Q307 should **not** both have data since they simply each show the electricity changes (in TWh) depending on the inputs used on Advanced Controls (B307 has data if ‘Advanced Controls’!C144 is used, and Q307 has data if ‘Advanced Controls’!D144 is used, so those two inputs should never both be used in the same model).
5. Some solutions interact with multiple Sequence Chains (e.g. BAS is in the Commercial Lighting and the Space Heating/Cooling chains). This means that its results must be integrated with those two chains **simultaneously**. This mean you should copy **all** of the following to the Integration Model before taking any of its output back to the Solution Models:
   1. The Share of Commercial Building Energy used for Space Heating
   2. The Share of Commercial Building Energy used for lighting
   3. Dynamic (Smart) Glass Adoption
   4. Dynamic Glass electricity efficiency data (Conventional and Solution consumption)
   5. Dynamic Glass fuel efficiency data (Conventional and Solution consumption)
   6. Commercial LED Lighting Adoption
   7. Building Automation (BAS) Adoption
   8. BAS electricity efficiency
   9. BAS fuel efficiency
6. Some solutions do not have any changes to be made since they don’t interact with other solutions (e.g. LED Lighting – Residential) or they don’t directly affect the impacts of other solutions (e.g. Heat Pumps or District Heating, which replace emissions prior to building integration). In those cases, the adoptions and energy savings are still copied to the Integration Model for record keeping (and to show results on the results sheets – Grid Impacts). Total adoption of Heat Pumps and District Heating must not exceed ***delivered heating*** demand.
7. When in doubt, read the yellow box at top left of each Solution area of the Integration Model sheets which explains the assumptions.

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

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

1. For each of the 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 Buildings Integrated Model that’s: Emissions reduction -> Emissions Redux and Financials -> Financials&Adoptions).