



15.879 Advanced System Dynamics Modeling

Spring 2025

Exercise 3- Modeling Energy Efficiency Co-flows¹

Submit your model to the shared dropbox before the class on Friday 2/21/2025

Co-flows are versatile formulations that allow for tracking characteristics of stocks. For example, you can track experience of employee (primary stock) in a coflow (a separate stock tracking total experience). A stock may have multiple coflows to capture its various characteristics. In building coflow structures we assume elements inside each stock (and its coflow) are perfectly mixing, and thus are not distinguishable. This assumption usually requires that material exiting a stock have the average characteristic as those inside the stock, though there are advanced formulations that can bypass this assumption in special cases. You can learn more about coflow structures in chapter 12.1 of Business Dynamics.

This exercise focuses on building more complex coflow structures. Specifically, in studying energy demand, energy efficiency is an important feature of capital stocks such as residential buildings. A good model should be able to distinguish among three distinct determinants of energy efficiency:

- **Vintage effect:** Buildings built at different times have different technologies and insulation practices that change their energy efficiency. As a first order approximation, the vintage effect can be captured based on the year the building was built.
- **Retrofits:** Investments in retrofits can enhance the energy efficiency of buildings. However, depending on the original design and the technology used, retrofits can only go so far in enhancing efficiency. For example, the maximum enhancement in efficiency using insulation retrofits would be different between wooden and cement houses.
- **Efficiency technologies:** new technologies may change the extent to which retrofits can enhance energy efficiency. For example, the introduction of double-pane windows significantly enhanced the extent to which retrofits can improve energy efficiency.

Start with developing a model of buildings in a city and their energy efficiency. Your ultimate goal is to be able to track buildings and their total energy consumption consistently in light of changing efficiency levels due to retrofits and the introduction of new efficiency technologies. First, focus on capturing the basic building and energy efficiency coflow structure along with the vintage effect. Next, add retrofits, and finally incorporate the possibility of changes in efficiency technologies that may enhance the scope of efficiency gains available through retrofits. Your final model should track the different cohorts of buildings and their energy efficiency, should allow you to implement retrofits on those buildings, and should enable you to enhance the potential for retrofits based on introduction of new technologies. For simplicity, build your model with only 3 age (vintage) cohorts for buildings. Also, try to put your model in (analytical) equilibrium as you build it.

Bonus: If you can, implement the model using subscripts in Vensim (DSS) in a way that you can change the number of cohorts in your model with minimum editing. See the example model age.mdl that comes with Vensim DSS installation (usually it is located in: C:\Users\Public\Vensim\Models\Sample\EXTRA).

Submission Instructions

¹ Designed by Hazhir Rahmandad, Fall 2019. Updated and edited Spring 2025.

Put your Vensim model(s) in the shared dropbox folder under session 3. Please name your model submission(s) as: S03-<Last Name>-EnergyCoflow.mdl
for example, “S03-Rahmandad-EnergyCoflow.mdl”.

MIT OpenCourseWare
<https://ocw.mit.edu/>

15.879 Building Serious System Dynamics Models from Scratch
Spring 2025

For information about citing these materials or our Terms of Use, visit: <https://ocw.mit.edu/terms>.