Homework 4

June 16, 2025

Please provide short answers! Bullet points are also accepted as answer. You can submit one Julia file which contains all the tasks, as well as only one set of csv files containing all the tasks.

Hand in until Monday, June 30 (16:00)

Task 1: Residual capacities

In real life, energy systems are seldomly created "from scratch" and instead are already existing systems that need to undergo a transformation. Therefore, we usually have to consider that there are already existing capacities of technologies that are installed. So for this task, you should include this into your model.

1. Read in the file *residualcapacity.csv* (which includes our data on existing infrastructure) and create the new parameter *ResidualCapacity* with it, using the correct dimensions. The default value should be 0.

2. Add the *ResidualCapacity* to the appropriate equation.

3. Run the model and investigate the result. What happens to the objective value?

Hint: The objective value should be: 477004.51 (rounded)

Task 2: Operational life & salvage value

Now, we also want to consider that technologies might not be able to run indefinitely (aka. they have a maximum technical lifetime). Also, the model only considers the time until 2050 and then abruptly ends, making any investments in later years less "valuable" for the model, since the added capacity is just lost. To combat this, a so-called *Salvage value* can be added to a model, which represents the remaining value of our technology investment.

We want to calculate the *Salvage value* using a linear depreciation - meaning that if a technology has a lifetime of 20 years, but the model ends 10 years after construction, the model should get $10/20 = 1/2$ of the costs refunded.

Task 2.1: Operational life

1. Read in the file *technologylifetime.csv* and create the new parameter *TechnologyLifetime* with it, using the correct dimensions. The parameter contains the operational life of all the technologies. Set the default value to 10 years.
2. Now, make sure that only technologies that are still within their *TechnologyLifetime* are considered in the calculation of the annual *TotalCapacity*.
   Hint: We assume that "within their lifetime" means until the very end of the year, so you should use <= as the condition.
3. Run the model and investigate the results. What happens to the distribution of your *NewCapacity* values?

Hint: The objective value should be: 477041.92 (rounded)

Task 2.2: Salvage value

1. Add a new variable called $SalvageValue_{y,r,t}$ which should be non-negative.
2. Add a a new equation that is only valid (e.g. only gets created) if the capacity is beyond its *TechnologyLifetime*. In this case, the *SalvageValue* should be equal to 0 (since the technology has met or exceeded its technical lifespan).
3. Add a second new equation that only is calculated if the technology is still within its technical lifetime. In this case, the *SalvageValue* should be equal to the original investment, divided by the time between construction of the *NewCapacity* and the end year and the *TechnologyLifetime*. [1] You also have to consider that the original investment is properly discounted.
   Hint: Mathematically, the equation should look like this:
   $SalvageValue_{y,r,t} = InvestmentCost_{y,t} * NewCapacity_{y,r,t} / (1 + DiscountRate)^{y-min(y)} * (1 - ((max(y) - y)/TechnologyLifetime_t))$ *Be careful about the brackets!*
4. Add the $SalvageValue_{y,r,t}$ to the objective function. Since this is a refund to your total costs, you should subtract it from the other values.
5. Run your updated model. What effects does this have on your objective function? Do you notice different investment choices by the model?

Hint: The objective value should be: 476475.21 (rounded)

[1] This means that if a technology has a lifetime of 30 years and has been constructed in 2040, it should have 66.6% of its value when the model ends in 2050. We can calculate this by subtracting the "used lifetime" from 100%, so 100%-(10/30)=2/3 or roughly 66.6%.