

# Hands-on exercise 5: Adding a service demand by correlation

In the previous tutorial we added an exogenous service demand. That is, we explicitly specified what the demand would be per year. However, we may not know what the electricity demand may be per year. Instead, we may conclude that our electricity demand is a function of the GDP and population of a particular region. To accommodate such a scenario, MUSE enables us to choose a regression function that estimates service demands from GDP and population, which may be more certain in your case. In this section we will show how this can be done.

This tutorial will build off the default model that comes with MUSE. To copy the files for this model, run:

```
python -m muse --model default --copy PATH/T0/COPY/THE/MODEL/T0
```

## Additional files

Similarly to before, we must amend the `technodata/preset` folder. As we are no longer explicitly specifying demand, we can delete the `Residential2020Consumption.csv` and `Residential2050Consumption.csv` files. Instead, we must replace these files with the following:

- **A macrodrivers file:** This contains the drivers of the service demand that we want to model. For this example, these will include GDP based on purchasing power parity (GDP PPP) and the population that we expect from 2010 to 2110.
- **A regression parameters file:** This file will set the function type we would like to use to predict the service demand and the respective parameters of this regression file per region.
- **A timeslice share file:** This file sets how the demand is shared between timeslice.

The example files for each of those just mentioned can be found below, respectively:

- [Macrodrivers.csv](https://github.com/EnergySystemsModellingLab/MUSE_OS/blob/v1.3.3/docs/tutorial-code/6-add-correlation-demand/1-correlation/technodata/preset/Macrodrivers.csv) ([https://github.com/EnergySystemsModellingLab/MUSE\\_OS/blob/v1.3.3/docs/tutorial-code/6-add-correlation-demand/1-correlation/technodata/preset/Macrodrivers.csv](https://github.com/EnergySystemsModellingLab/MUSE_OS/blob/v1.3.3/docs/tutorial-code/6-add-correlation-demand/1-correlation/technodata/preset/Macrodrivers.csv))
- [regressionparameters.csv](https://github.com/EnergySystemsModellingLab/MUSE_OS/blob/v1.3.3/docs/tutorial-code/6-add-correlation-demand/1-correlation/technodata/preset/regressionparameters.csv) ([https://github.com/EnergySystemsModellingLab/MUSE\\_OS/blob/v1.3.3/docs/tutorial-code/6-add-correlation-demand/1-correlation/technodata/preset/regressionparameters.csv](https://github.com/EnergySystemsModellingLab/MUSE_OS/blob/v1.3.3/docs/tutorial-code/6-add-correlation-demand/1-correlation/technodata/preset/regressionparameters.csv))
- [TimesliceSharepreset.csv](https://github.com/EnergySystemsModellingLab/MUSE_OS/blob/v1.3.3/docs/tutorial-code/6-add-correlation-demand/1-correlation/technodata/preset/TimesliceSharepreset.csv) ([https://github.com/EnergySystemsModellingLab/MUSE\\_OS/blob/v1.3.3/docs/tutorial-code/6-add-correlation-demand/1-correlation/technodata/preset/TimesliceSharepreset.csv](https://github.com/EnergySystemsModellingLab/MUSE_OS/blob/v1.3.3/docs/tutorial-code/6-add-correlation-demand/1-correlation/technodata/preset/TimesliceSharepreset.csv))

For a full description of these files, see the link [here](https://muse-os.readthedocs.io/en/v1.3.3/user-guide/..inputs/correlation_files.html) ([https://muse-os.readthedocs.io/en/v1.3.3/user-guide/..inputs/correlation\\_files.html](https://muse-os.readthedocs.io/en/v1.3.3/user-guide/..inputs/correlation_files.html)).

Download these files and save them within the `preset` folder.

Next, we must amend our `toml` file to link to these files.

## TOML file

Towards the bottom of the `toml` file, you will see the following section:

```
[sectors.residential_presets]
type = 'presets'
priority = 0
consumption_path= "{path}/technodata/preset/*Consumption.csv"
```

This enables us to run the model in exogenous mode (i.e. explicitly specifying demand), but now we would like to run the model using the new regression files. This can be done by linking new variables to the new files, as follows:

```
[sectors.residential_presets]
type = 'presets'
priority = 0
timeslice_shares_path = '{path}/technodata/preset/TimesliceSharepreset.csv'
macrodrivers_path = '{path}/technodata/preset/Macrodrivers.csv'
regression_path = '{path}/technodata/preset/regressionparameters.csv'
```

## Running and visualising our new results

With those changes made, we are now able to run our modified model, with the `python -m muse settings.toml` command in the command line, as before.

As before, we will now visualise the output.

In [1]:

```
import matplotlib.pyplot as plt
import pandas as pd
```

In [2]:

```
mca_capacity = pd.read_csv(
    "../tutorial-code/add-correlation-demand/1-correlation/Results/MCACapacity.csv"
)
mca_capacity.head()
```

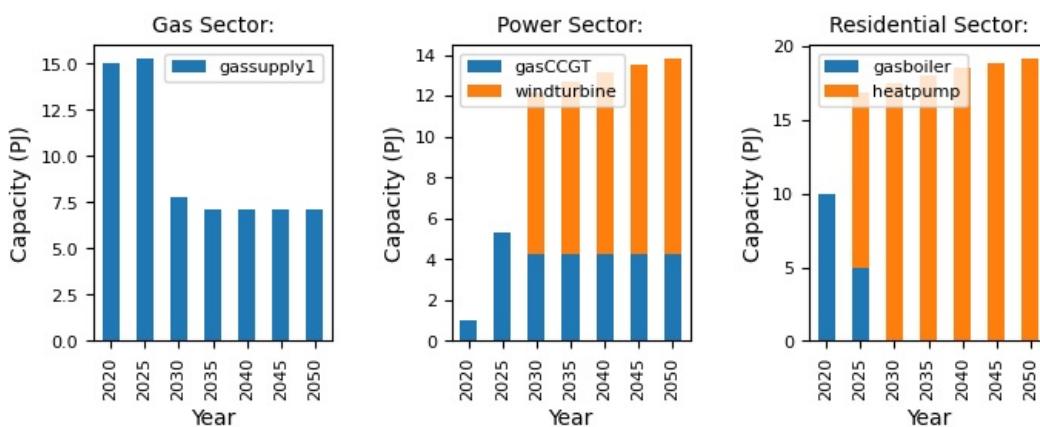
Out[2]:

agent	capacity	dst_region	installed	region	sector	technology	type	year	
0	A1	10.0000	R1	2020	R1	residential	gasboiler	newcapa	2020
1	A1	1.0000	R1	2020	R1	power	gasCCGT	newcapa	2020
2	A1	15.0000	R1	2020	R1	gas	gassupply1	newcapa	2020
3	A1	5.0000	R1	2020	R1	residential	gasboiler	newcapa	2025
4	A1	11.8632	R1	2025	R1	residential	heatpump	newcapa	2025

In [3]:

```
fig, axes = plt.subplots(1, 3)
all_years = mca_capacity["year"].unique()
for ax, (sector_name, sector_data) in zip(axes, mca_capacity.groupby("sector")):
    sector_capacity = sector_data.groupby(["year", "technology"]).sum().reset_index()
    sector_capacity.pivot(
        index="year", columns="technology", values="capacity"
    ).reindex(all_years).plot(kind="bar", stacked=True, ax=ax)
    ax.set_ylabel("Capacity (PJ)")
    ax.set_xlabel("Year")
    ax.set_title(f"{sector_name.capitalize()} Sector:", fontsize=10)
    ax.legend(title=None, prop={"size": 8})
    ax.tick_params(axis="both", labelsize=8)

fig.set_size_inches(8, 2.5)
fig.subplots_adjust(wspace=0.5)
```



As expected, we see a different scenario emerge. The demand does not increase linearly, with variations in the total demand in the residential sector, in line with the changing population data.