Implementing renewable energy targets in OSeMOSYS

KTH Royal Institute of Technology, division of Energy Systems Analysis

Need to represent RE targets in models

Commonly policies formulate targets as share that need to be achieved by a certain time. E.g.:

- EU: 2020 climate & energy package
  - 20% cut in greenhouse gas emissions (from 1990 levels)
  - 20% of EU energy from renewables
  - 20% improvement in energy efficiency

Source: EC, https://ec.europa.eu/clima/policies/strategies/2020_en. Accessed: 2019-01-20

Representing RE targets in OSeMOSYS

REMinProductionTarget: Share of a fuel that needs to be produced by renewable energy technologies

RETagFuel: Fuel that shall be (partly) produced by RE technologies

RETagTechnology: RE technologies that can produce fuel

Exercise

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Implementing a capacity reserve

Since the FUEL **FEL2** shall be partly produced by selected RE technologies we need to mark it.

- *RETagFuel:* Insert the following values

Fuel	2014	2015	2016	2017	2018	2019	2020	2021	2022
FEL2	1	1	1	1	1	1	1	1	1
	2023	2024	2025	2026	2027	2028	2029	2030	2031
FEL2	1	1	1	1	1	1	1	1	1
	2032	2033	2034	2035	2036	2037	2038	2039	2040
FEL2	1	1	1	1	1	1	1	1	1

Implementing a capacity reserve

Since the only locally available renewable TECHNOLOGIES are SOLPV1 and SOLPV2 these need to be tagged.

- *RETagTechnology:* Insert the following values

Technology	2014-2040
SOLPV1	1
SOLPV2	1

Implementing a capacity reserve

Since the only locally available renewable TECHNOLOGIES are SOLPV1 and SOLPV2 these need to be tagged.

- *REMinProductionTarget:* Insert the following values

Region	2014	2015	2016	2017	2018	2019	2020	2021	2022
Simplicity	0		0	0	0	0	0	0	0
	2023	2024	2025	2026	2027	2028	2029	2030	2031
Simplicity	0	0	0.15	0.15	0.15	0.15	0.15	0.15	0.15
	2032	2033	2034	2035	2036	2037	2038	2039	2040
Simplicity	0.15	0.15	0.15	0.15	0.2	0.2	0.2	0.2	0.2

Implementing capacity reserve in OSeMOSYS

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Content

- Defining the Reserve Margin

Reserve Margin

Reserve Margin is planned **excess of supply capacity** that is installed in comparison to the peak load (i.e. in MW).

It avoids shortages in power supply due to unforeseen demand peaks or due to sudden lack of renewable supply.

Reserve Margin

In mathematical terms, it is defined as **difference between the total generation capacity and expected peak demand of the year**:

$$\text{Available Reserve Margin (MW)} = A - B$$

$$\text{Available Reserve Margin (\%)} = (A - B) \times 100 / B$$

Where: A = Total Generation Capacity (MW)

B = Expected Peak Demand (MW)

Importance of Reserve Margin

Reserve Margin is a way of ensuring reliability by avoiding shortages in power supply – aim for a higher supply than what may be expected. However this cannot always be ensured:

- Projecting future electricity demand is difficult
- Commissioning of new power plants may take several years

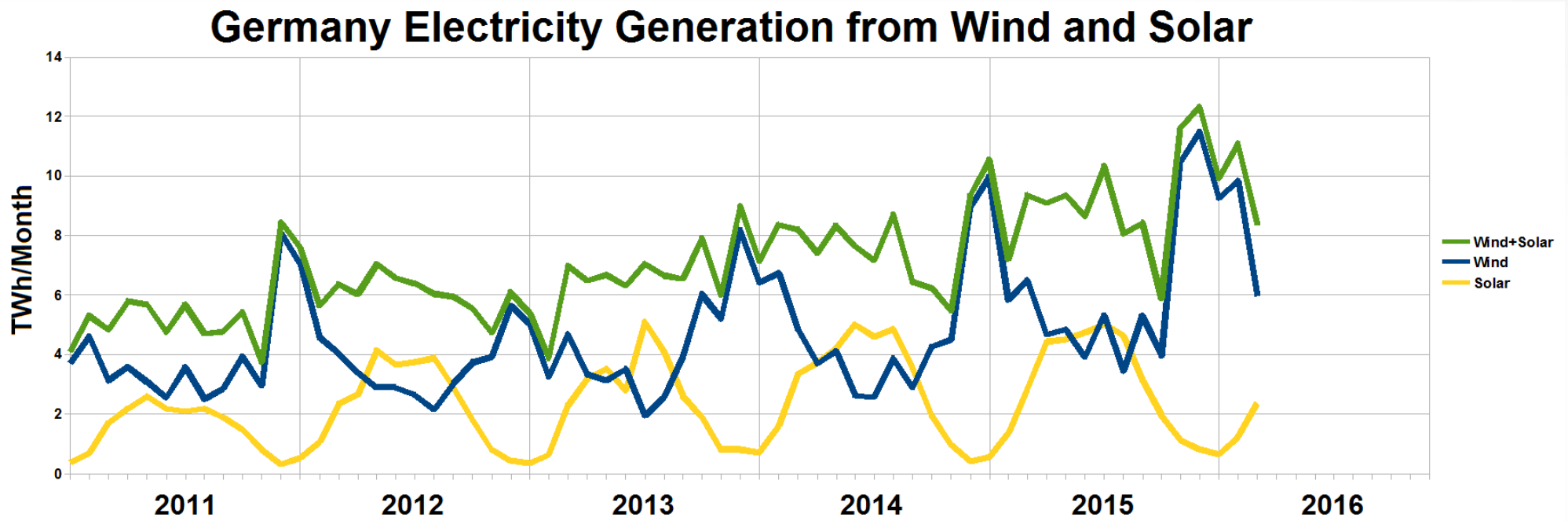
Capacity Credits

Not all technologies can contribute to the Reserve Margin to the same degree.

- *Dispatchable* technologies (e.g. gas turbines, coal power plants, storage options etc) typically can contribute up to 100% of their capacity.
- *Non-dispatchable* technologies (e.g. Solar PV, wind turbine etc) contribute to a significantly lower degree in the absence of storage; this varies according to the respective resource availability.

Capacity Credits: measure to what extent each technology can contribute to the Reserve Margin

Yearly Wind and Solar Generation Variability (e.g. Germany)



Source: https://commons.wikimedia.org/wiki/File:Germany_Monthly_Electricity_Generation_from_Wind_and_Solar.png

Capacity Credits for Wind

	Area	Wind Capacity Credit	Justification
	000 km²	%	
Angola	1,250	10%	resource is all along one coast
Botswana	600	5%	resource is concentrated and poor
DRC	2,345	5%	resource is concentrated in one area
Lesotho	30	0%	country is small
Malawi	118.5	5%	country is small and resource is concentrated
Mozambique	800	10%	resource is all along one coast
Namibia	820	10%	resource is all along one coast
South Africa	1,225	20%	resource is spread around country - along long coastline and inland - there is also a study
Swaziland	17	0%	country is small
Tanzania	950	10%	resource is concentrated in two areas that are relatively close
Zambia	750	5%	resource is poor
Zimbabwe	390	5%	resource is poor

Source: IRENA, 2014

Exercise

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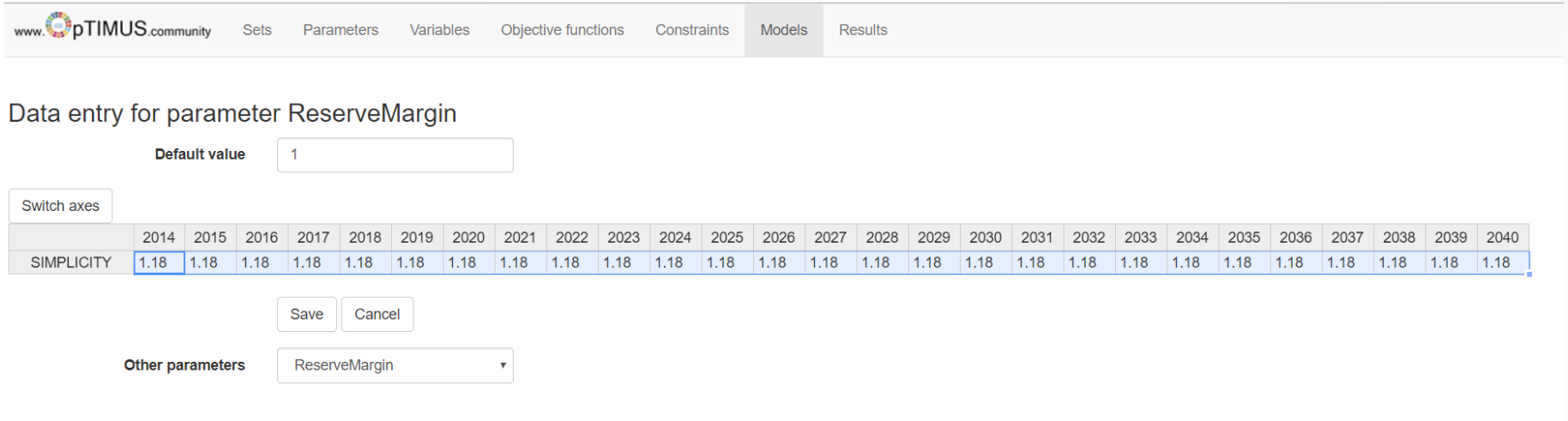
Exercise - Learning Objectives

By the end of this exercise you will be able to:

- Define a requirement for capacity reserve
- Define the fuel for which capacity reserve is needed
- Define capacity credits for each technology type

Defining reserve margin requirements

The first step is to decide to what level the reserve margin should be set.



	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
SIMPLICITY	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18

Input a *ReserveMargin* of **1.18** for all years, indicating that there should be enough capacity reserve to satisfy a theoretical demand level at least 18% above the annual peak demand.

Implementing a capacity reserve

The following parameters should be taken into account

- *ReserveMarginTagFuel:* defines the fuel for which we would like to have adequate capacity reserve.
- *ReserveMarginTagTechnology*: defines the level at which each technology can contribute to the capacity reserve. A value of 1 indicates 100% contribution of a technology's capacity, while 0 indicates a 0% contribution. Typically, dispatchable thermal power plants and storage options have a contribution of 100%, while non-dispatchable technologies (e.g. Wind and Solar PV) contribute based on their respective availability.

Implementing a capacity reserve

Since the FUEL **SEC_EL** represents electricity being generated by the power plants, we can indicate that the reserve margin needed is at this level.

- *ReserveMarginTagFuel:* Insert the following values

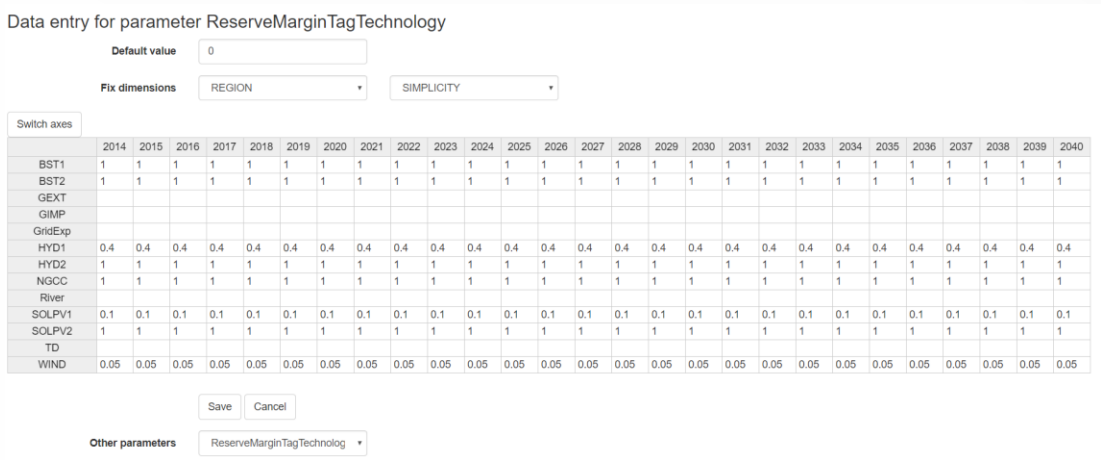
Fuel	2014	2015	2016	2017	2018	2019	2020	2021	2022
SEC_EL	1	1	1	1	1	1	1	1	1
	2023	2024	2025	2026	2027	2028	2029	2030	2031
SEC_EL	1	1	1	1	1	1	1	1	1
	2032	2033	2034	2035	2036	2037	2038	2039	2040
SEC_EL	1	1	1	1	1	1	1	1	1

Implementing a capacity reserve

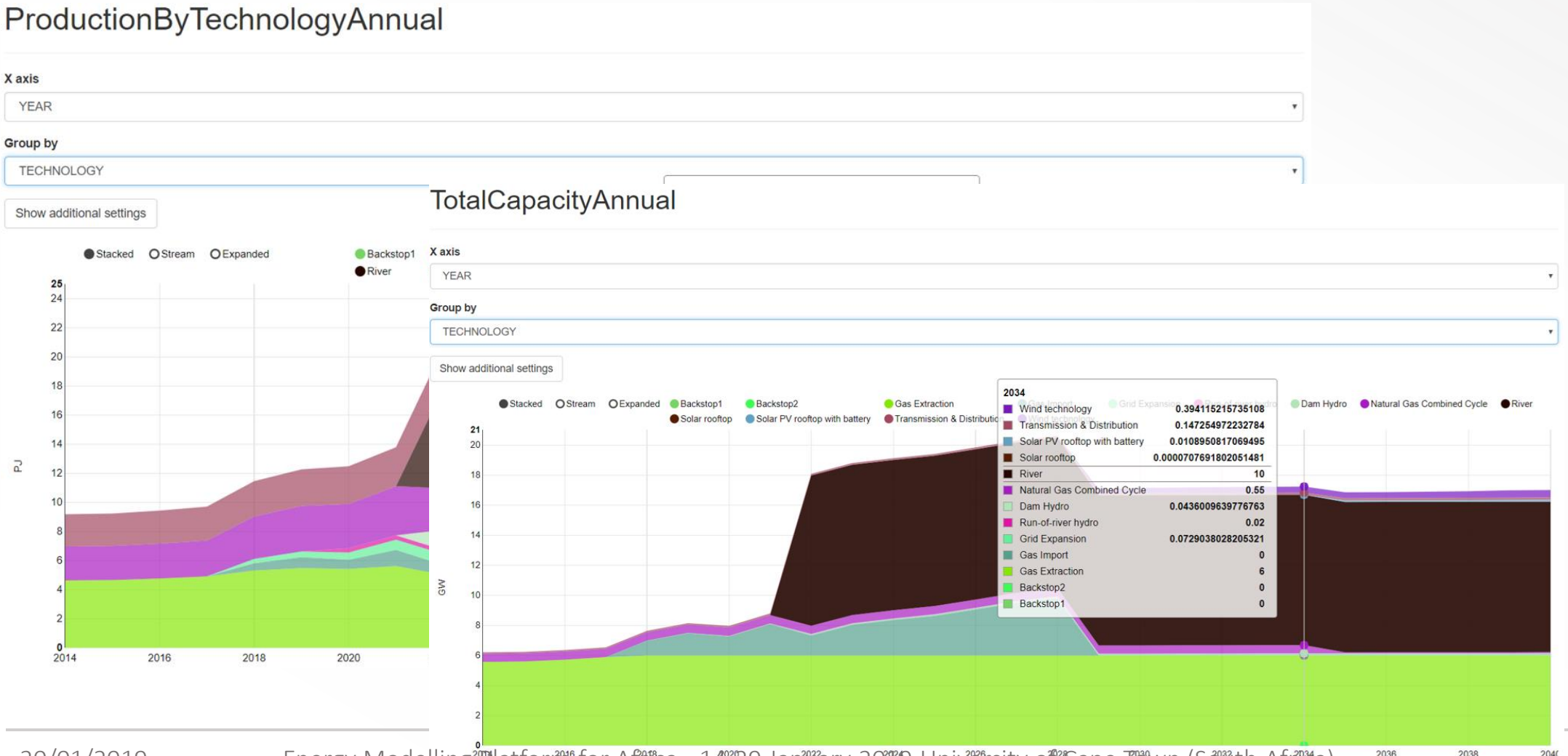
The final step is to define the contribution of each technology (i.e. capacity credit) to satisfying the reserve margin.

- *ReserveMarginTagTechnology:* Insert the following for 2014-2040.

Technology	2014-2040
NGCC	1
SOLPV1	0.1
SOLPV2	1
WIND	0.05
HYD1	0.4
HYD2	1
BACKSTOP1	1
BACKSTOP2	1



Run the model and check the results!



Changelog and Attribution

Date	Author	Reviewer	Reviser
2019-02-25	Taliotis, C., Gardumi, F., Shivakumar, A., Sridharan, V., Ramos, E., Beltramo, A., Rogner, H., Howells, M.	Howells, M., Beltramo, A.	Beltramo, A.

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