Survey on “Empirical research on flexibility options in open energy models”

The aim of this survey is to investigate the characteristics of energy system models. This includes the current status of implementation as well as future planned implementations. The focus lies on flexibility options, how they are implemented in the model and which technologies or parameters might be underrepresented in the modelling landscape.

The results of the survey will be evaluated and summarized in a review paper. The review paper is intended to help modelers select a suitable model for their respective research question. Furthermore it is planned to publish the collected information on the open energy platform to make it permanently accessible.

Your response will be treated confidentially and the results are used for academic reasons only.

You may reserve your right to anonymity if you wish to do so. In case you provide us with your details, only Anya Heider and Ricardo Reibsch (researchers at the RLS_Graduate_School on energy system transition of the Reiner-Lemoine-Stiftung) will see your response.

The completion of the survey takes about 30 min.

We know that not all the questions might be relevant for your specific model as we evaluate a variety of models with different focuses. If you are not sure about the answers or think they might need further explanation, please feel free to comment on the respective question. It will help us to better understand the models.

Thank you very much for your participation!

Part 0: Basic Information

Name:
Contact details (email):
Model / framework name:
Version:
Last updated:
Date:

Part 1: Model

This section raises information on the model itself and does not specifically focus on flexibility.

1.1 Which **spatial scope** is ***possible*** to be mapped with the model? What scopes it the model ***usually used*** for? *Multiple selections possible,* *NUTS = Nomenclature of Territorial Units for Statistics*		
Possible	*Usually used*	
☐	☐	local (NUTS3)
☐	☐	regional (NUTS1 - NUTS2)
☐	☐	national
☐	☐	international
☐	☐	other:

1.2 Which **temporal scope** can be mapped with the model? *Multiple selections possible*		
Possible	*Usually used*	
☐	☐	very short duration (<sec)
☐	☐	short duration (sec – 15 min)
☐	☐	intermediate duration (15 min - days)
☐	☐	long duration (days - years)
☐	☐	other:

1.3 Which **temporal resolution** can be mapped with the model? *Multiple selections possible*		
Possible	*Usually used*	
☐	☐	<hourly
☐	☐	hourly
☐	☐	intermediate
☐	☐	annual
☐	☐	other:

1.4 How is the **decision making process** implemented? *Multiple selections possible*	
☐	perfect foresight
☐	myopic foresight (rolling horizon)
☐	decision-/agent-based
☐	other:
☐	none

1.5 How is the **heat sector** represented? *Multiple selections possible*
☐ excluded
☐ exogenous aggregated heat demand
☐ endogenous disaggregated choices regarding demand
☐ endogenous disaggregated choices regarding technology
☐ other:

1.6 How is the **transport sector** represented? *Multiple selections possible*
☐ excluded
☐ exogenous aggregated transport demand
☐ endogenous disaggregated choices regarding demand
☐ endogenous disaggregated choices regarding mode, technology
☐ other:

1.7 Is a representation of **probabilistic behavior** implemented?	
☐ Yes	☐ No
Explanation *(optional)*:	

1.8 Is a representation of **social factors** or **behavioral aspects** implemented? *e.g. consideration of social justice, sufficiency, behavior of different actors etc.*	
☐ Yes	☐ No
Explanation *(optional)*:	

1.9 How are **grid ancillary services** represented? *Multiple selections possible*	
frequency measures ☐ spinning reserve ☐ balancing energy ☐ sheddable loads	voltage compensation ☐ power factor correction ☐ curtailment
Operational management ☐ feed-in management ☐ redispatch	☐ Reconstruction of supply / black start
Explanation *(optional)*:	

1.10 Are **new features** planned for the near future?	
☐ Yes	☐ No
If yes, which ones and when:	

1.11 Is it possible for the user to **implement new features**?	
☐ Yes	☐ No
Explanation *(optional)*:	

Part 2: Technologies

This section covers technical parameters that are applicable to several flexibility options.

All flexibility options (supply, demand, storage)

2.1 How is the **efficiency** of a flexibility option implemented? *e.g. efficiency dependent on power output or temperature*	
☐ by a fixed value	☐ by a function
☐ other:	
Explanation *(optional)*:	

2.2 Is the **ramping** of flexibility options implemented? *e.g. conventional power plants (short term to intermediate), demand (short term), storage (very short term)*	
☐ Yes	☐ No
Explanation *(optional)*:	

2.3 Is the **response time** of a flexibility option implemented? *e.g. conventional power plants, storages, demand, power electronics*	
☐ Yes	☐ No
Explanation *(optional)*:	

2.4 Is a **recovery time after activation** implemented? *e.g. conventional power plants, demand*	
☐ Yes	☐ No
Explanation *(optional)*:	

2.5 If **operational constraints** (ramping, response time) are implemented, when were they introduced?	
Year:	

Network

2.6 Is a **grid representation** implemented? *Multiple selections possible*	
☐ none	☐ transfer capacity
☐ AC power flow	☐ DC power flow
☐ interconnectors	
Explanation *(optional)*:	

2.7 Are **import and export** modelled?	
☐ simplified	☐ flow based
☐ none	☐ other:
Explanation *(optional)*:	

Part 3: Further specifications on flexibility options

This section evaluates technology specific parameters influencing the available flexibility.

Conventional power plants

3.1 Is a **minimum load** in conventional power plants implemented?	
☐ Yes	☐ No
Explanation *(optional)*:	

3.2 Is a **discrete power plant capacity expansion** in conventional power plants implemented?	
☐ Yes	☐ No
Explanation *(optional)*:	

Demand

3.3 How is the **maximum deferrable load** implemented? *Multiple selections possible*
☐ fixed value
☐ time-dependent
☐ type-dependent
☐ time- and type-dependent
☐ none
☐ other:

3.4 Is a **shifting time** implemented?	
☐ Yes	☐ No
Explanation *(optional)*:	

3.5 Is a **price elasticity** implemented?	
☐ Yes	☐ No
Explanation *(optional)*:	

Storage

3.6 How are **storages** implemented?	
☐ fixed (simplified static model)	☐ dynamic (e.g. efficiency dependent on temperature, seasonally varying storage capacity etc.)
☐ none	
Explanation *(optional)*:	

3.7 How is **aging** implemented? *Multiple selections possible*	
☐ cycle aging	☐ calendrical aging
☐ none	
Explanation *(optional)*:	

3.8 Is a **discharge over time / self-discharge** implemented?	
☐ Yes	☐ No
Explanation *(optional)*:	

Variable renewable energies

3.9 Is a **curtailed operation** in order to serve grid ancillary services implemented?	
☐ Yes	☐ No
Explanation *(optional)*:	

Part 4: Technology representation

This section focuses on the representation of specific technologies, if it is possible to represent them or a own representation already exists in the model.

4.1 Is it ***possible*** to represent the following **supply side technologies**? If yes, are they ***predefined*** within the model (e.g. as own class or template)? *Multiple selections possible*					
Fossil thermal generation					
possible	*predefined*		*possible*	*predefined*	
☐	☐	Hard coal	☐	☐	CCGT
☐	☐	Lignite	☐	☐	OCGT
☐	☐	Oil	☐	☐	CHP
☐	☐	Natural gas	☐	☐	other:
Dispatchable renewable generation					
possible	*predefined*		*possible*	*predefined*	
☐	☐	Bioenergy	☐	☐	Geothermal energy
☐	☐	Hydropower with reservoir	☐	☐	Concentrated solar power
☐	☐	other:			
Variable renewable generation					
possible	*predefined*		*possible*	*predefined*	
☐	☐	Photovoltaic	☐	☐	Run-of-River hydro
☐	☐	Wind onshore	☐	☐	Wave power
☐	☐	Wind offshore	☐	☐	Tidal power
☐	☐	other:			
Other generation					
possible	*predefined*		*possible*	*predefined*	
☐	☐	PEM-FC	☐	☐	Nuclear
☐	☐	SOFC	☐	☐	other:
Comments *(optional)*:					

4.2 Is it ***possible*** to represent the following **demand side technologies**? If yes, are they ***predefined*** within the model (e.g. as own class or template)? *Multiple selections possible*					
Demand response					
possible	*predefined*		*possible*	*predefined*	
☐	☐	Households	☐	☐	Industrial Loads
☐	☐	Service Sector	☐	☐	other:
Sector coupling					
possible	*predefined*		*possible*	*predefined*	
☐	☐	Power-to-Gas	☐	☐	Heat pumps
☐	☐	Power-to-Hydrogen	☐	☐	Electric vehicles
☐	☐	other:			
Comments *(optional)*:					

4.3 Is it ***possible*** to represent the following **storage technologies**? If yes, are they ***predefined*** within the model (e.g. as own class or template)? *Multiple selections possible*					
Electricity-to-Electricity					
possible	*predefined*		*possible*	*predefined*	
☐	☐	Pumped hydro storage (PHS)	☐	☐	Batteries
☐	☐	Compressed air energy storage (CAES)	☐	☐	(Super-) Capacitors
☐	☐	Flywheels	☐	☐	other:
Energy system integration					
possible	*predefined*		*possible*	*predefined*	
☐	☐	Fuels (e.g. Hydrogen)	☐	☐	Heat storages
☐	☐	Vehicle-to-grid	☐	☐	others:
Comments *(optional)*:					

4.4 Is it ***possible*** to represent the following **network related technologies**? If yes, are they ***predefined*** within the model (e.g. as own class or template)? *Multiple selections possible*					
Grid type					
possible	*predefined*		*possible*	*predefined*	
☐	☐	Distribution grids	☐	☐	Transmission grids
Grid operation					
possible	*predefined*		*possible*	*predefined*	
☐	☐	Smart grids	☐	☐	Microgrids
☐	☐	other:			
Grid topology					
possible	*predefined*		*possible*	*predefined*	
☐	☐	Interconnectors	☐	☐	Network extension
☐	☐	Switches	☐	☐	other:
Comments *(optional)*:					