FlexPlan

Web consultation – Technology: flexibility resources

The increasing integration of variable wind and solar generation in the power system requires getting flexibility from other resources, such as storage and demand. Storage, other than pumped-storage hydropower, and demand response have not been considered in traditional network planning procedures and it is the aim of FlexPlan project to revert this situation, where flexibility resources are presented as candidates for network planning, competing with new line construction.

To help the planning tool in the candidate selection process, a pre-processor tool methodology has been defined and the first version of this software has been produced. The pre-processor software receives as input:

- the results from an Optimal Power Flow (OPF) run on the non-expanded network model;
- the network model and scenario;
- a characterization for network nodes (useful to decide which technologies can be hosted in each place);
- a set of pre-defined network candidates provided by the user (especially useful for new grid expansion corridors).

With these inputs, the pre-processor tool is able to locate congestions in the network and select a preferred bus for the installation of flexible resources. For each of the identified locations, it proposes a set of candidate technologies, such as storage and demand response, but also conventional grid expansion solutions, such as lines and Phase Shifting Transformers (PST). As last step, for each of the proposed technologies, a size and cost is provided.

The network model and scenario inputs need to be present in all power system analysis tasks, including planning. However, the characterization of network nodes has been introduced in the present methodology with the aim to optimize the candidate pre-selection process. It permits to discard those technologies that are not suitable for a certain location.

In the current version of the candidate pre-processor tool, the work to adapt the candidates to the location where the congestion is identified is carried out through basic rules. The objective is to perform an automatic assessment, which does not involve the participation of the user (planner) once the planning optimization simulation has been launched. For every selected location, the set of candidate technologies is confronted, one by one, to the restrictions identified at the location and to the characteristics of the congestion.

The following table shows an example of the type of restrictions that can affect the candidate technologies considered in FlexPlan project.

Technology		Bus related characteristics and constraints															
		Type of bus				Resources		Location of bus					Restriction (1)	Congestion duration (6)			
		Substation		Load	Power Plant	no water	no cavern	urban	industrial area	semi-rural	Rural			<2 hours	2-6 hours	>6 hours	Yearly
		air	under								Plain	Mountain					>4380 h
Batteries	Li-ion			(2)	(2)												
	NaS			(2)	(2)												
	Flow			(2)	(2)												
Demand Response	Total (aggregated per zones)	(3)	(3)	(4)				(3)	(3)	(3)	(3)	(3)					
	Industrial (per facility)	(3)	(3)	(4)				(3)	(3)	(3)	(3)	(3)					
Hydrogen				(2)	(2)												
Pumped hydro				(2)	(5)												
Compressed air storage																	
Liquid-Air Electricity Storage systems																	
PST																	
Lines	AC overhead																
	AC underground (cable)																
	HVDC																
Transformer, converter																	

(1) Restriction to build new facilities. It could be total or partial for certain technology (such as batteries, hydrogen, lines or substation)
(2) When the bus is specific of loads and/or generators, the decision to install storage should be of the owners of the plant and not of the regulator. SOs set connection conditions and third parties decide how to meet them.
(3) Loads connected to substations can be of different types: mostly residential, mostly commercial, mostly industrial, big industrial (specific big facilities), mixed
(4) Industrial loads can be of different types, e.g.: metal, paper, textile, cement, water treatment, gas industry, mining, shipyard, high speed train, automotive, chemical, hydrogen, other.
(5) When it is already a hydro plant it could be "suitable" to upgrade (build a reservoir, increase capacity)
(6) Congestion duration could be considered as: average duration in hours of congestion, maximum duration of congestion, % of hours of congestion in a day…

To be able to perform this task (and others), the grid model input files have some fields that permit to provide some information on the bus characteristics, including:

- Type of bus: substation (air, air-compact, underground); Industrial load (including type); power plant (type); commercial load (type).
- Availability of natural resources (for substation type buses): water; wind; sun; cavern; biomass.
- Loads supplied (for substation type buses): residential; commercial; industrial; mixed; big industrial.
- Location of bus: urban; industrial area; semi-rural; rural.
- Geographic characteristics (for rural buses): mountainous; hilly; plain.
- Restricted area (not allowed to build new installations): for certain type or for all types.
- Geographic coordinates of buses: this information is currently not used for this purpose but is available for transmission nodes.

Since including this information for all network nodes would be too demanding, in the planning process a two-step approach is proposed: first, identify where congestions are; second, characterise the buses affected by that congestion.
Considering all this, we would be glad to have a feedback on the following issues:

1. Which conditions could be set to match technologies with nodes and establish limitations on the availability of a given node for a given technology, considering an automatic planning process?
2. Would you propose a very different approach to the one presented here?
3. Do you think that we could use the available characterization information for other tasks within the planning process, not considered in the presented methodology?
4. How could be assessed the impact of landscape factors on new infrastructures costs?