As can be noticed from Fig. 2, the centrality of node *0* decreased from 6 to 5, and the centrality of node *6* increases from zero up to 2. With regard to node *0* the decrease of the degree centrality confirms the reduction of GHG emissions, in fact the electrical demand referred to the power plant is lower. Instead, concerning node *6* the increase of the degree centrality is a measure of the installation of cogeneration systems or of the exploitation of renewable sources, as recommend by the Plan 20 20 20. The other nodes do not present changes in the out-degree centrality.

4. CONCLUSION

In this paper the energy mapping of the urban energy flows is studied through the implementation of the network theory in order to permit a scenarios analysis for the elaboration of energy strategies for the promotion and installation of cogeneration systems and in favor of renewable sources.

A flexible tool was developed in order to characterize the energy profile of an urban area and the validity of the proposed model was tested within the municipality of Catania. The developed model is able to define the interactions between nodes and allows the formulation of the urban energy trajectory relatively to the energy demand of each district. Moreover, the obtained network has been characterized from the structural point of view, by emphasizing the degree centrality for each node.

Further in-depth analysis are necessary in order to involve the heat demand of each district and to determine a criterion according to which nodes choose their connections, as for example a cost and environmental criterion. Further direction of the research could refer to the description of how networks may change over time or to analyze scenarios when node or arcs are added or deleted.

REFERENCES

1. Fifth Assessment Report, AR5, available at http://www.ipcc.ch/report/ar5/index.shtml
2. Lindseth G., "The cities for climate protection campaign (CCPC) and the framing of local climate policy," *Local Environment*, Vol. 9, No. 4, 325 – 336, August 2004.
3. European Commission act COM (2014) 689.
4. European Parliament Resolution OJ 2010/C349E/16.
5. Directive 2009/29/EC.
6. Eskin N., Türkmen H., "Analysis of annual heating and cooling energy requirements for office buildings in different climates in Turkey," *Energy and Buildings*, 40 (2008), 763 – 773. DOI: 10.1016/j.enbuild.2007.05.008.
7. Hutchinson E. et al., "Can we improve the identification of cold homes for targeted home energy-efficiency improvements?" *Applied Energy*, 83 (2006), 1198–1209. DOI: 10.1016/j.apenergy.2006.01.007.
8. Rylatt M. et al., "Using GIS to estimate the replacement potential of solar energy for urban dwellings," *Environment and Planning B: Planning and Design*, 30 (2003), 51–68. DOI: 10.1068/b12931.
9. Batty M., "Building a science of cities," *Cities*, 29 (2912) S9–S16. DOI: 10.1016/j.cities.2011.11.008.
10. Newman M.E.J., *Networks an Introduction*, Oxford University Press 2010.
11. Batty M., "Cities as flows, cities of flows," *Environmental and Planning B: Planning and Design*, 2011, volume 38, pp. 195–196. DOI: 10.1068/b3802ed.
12. Boccaletti S. et al., "Complex networks: structure and dynamics," *Physics Reports*, 424 (2006), 175–308. DOI: 10.1016/j.physrep.2005.10.009.
13. Trial version available at https://it.mathworks.com
14. Data available at www.comune.catania.it
15. Data available at www.autorita.energia.it