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Beneficiaries of transmission expansion projects of an expansion plan: an Aumann-Shapley approach

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Abstract— The objective of this paper is to propose a novel methodology to compute the benefit obtained by the individual transmission network users from each of the transmission expansion projects within an expansion plan. The benefits computed should be coherent with the technical and economic principles that underlie the development of the expansion plan. Thus, this methodology is based on the idea that the benefits produced by each project of a plan should be determined considering all projects jointly, instead of individually. Some benefits obtained by users from projects evolve continuously with the deployment of the expansion plan, while others are discrete, since they occur at certain points of the deployment of this plan. A separate Aumann-Shapley game is solved to allocate continuous benefits, and each discrete one. In the second case, the standard Aumann-Shapley algorithm for the allocation of benefits is modified to cope with the fact that the function of each user's benefits is not continuous with the size of projects deployed. Two case studies are used to compare the methodology proposed with existing ones and demonstrate its applicability to real-life decision making processes. The results show that the methodology proposed is able to overcome problems detected in other methodologies, providing more accurate and sound results. The good properties of the methodology proposed make it applicable to problems related to network expansion regulation, such as the cost allocation of new investments. Although the methodology proposed is particularized to electric power systems, its concept and fundamentals can also be applied in other energy sectors, such as gas.

Index Terms— Aumann-Shapley; Cooperative game theory; Transmission; Network expansion planning; Net market benefit

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