

Modified Model-Based Systems Engineering Driven Approach for Defining Complex Energy Systems

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Abstract : The internal and the external interactions between the complex structural and behavioral characteristics of the complex energy system result in unpredictable emergent behaviors. These emergent behaviors are not well understood, especially when modeled using the traditional top-down systems engineering approach. The intrinsic nature of current complex energy systems has called for an elegant solution that provides an integrated framework in Model-Based Systems Engineering (MBSE). This paper mainly presents a MBSE driven approach to define and handle the complexity that arises due to emergent behaviors. The approach provides guidelines for developing system architecture that leverages in predicting the complexity index of the system at different levels of abstraction. A framework that integrates indefinite and definite modeling aspects is developed to determine the complexity that arises during the development phase of the system. This framework provides a workflow for modeling complex systems using Systems Modeling Language (SysML) that captures the system's requirements, behavior, structure, and analytical aspects at both problem definition and solution levels. A system architecture for a district cooling plant is presented, which demonstrates the ability to predict the complexity index. The result suggests that complex energy systems like district cooling plant can be defined in an elegant manner using the unconventional modified MBSE driven approach that helps in estimating development time and cost.

Keywords : district cooling plant, energy systems, framework, MBSE

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