HSLU Hochschule Luzern

Technik & Architektur

Master Thesis MSE Engineering Energy & Environment

Leveraging Demand-Side Management and Deregulated Market System

for Enhanced Energy Efficiency and Sustainability: Insights from a Comparative Analysis

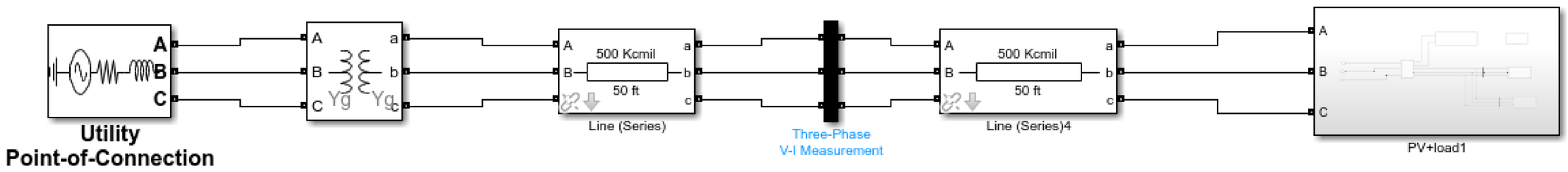

Figure 1: Simulink Model Implementation

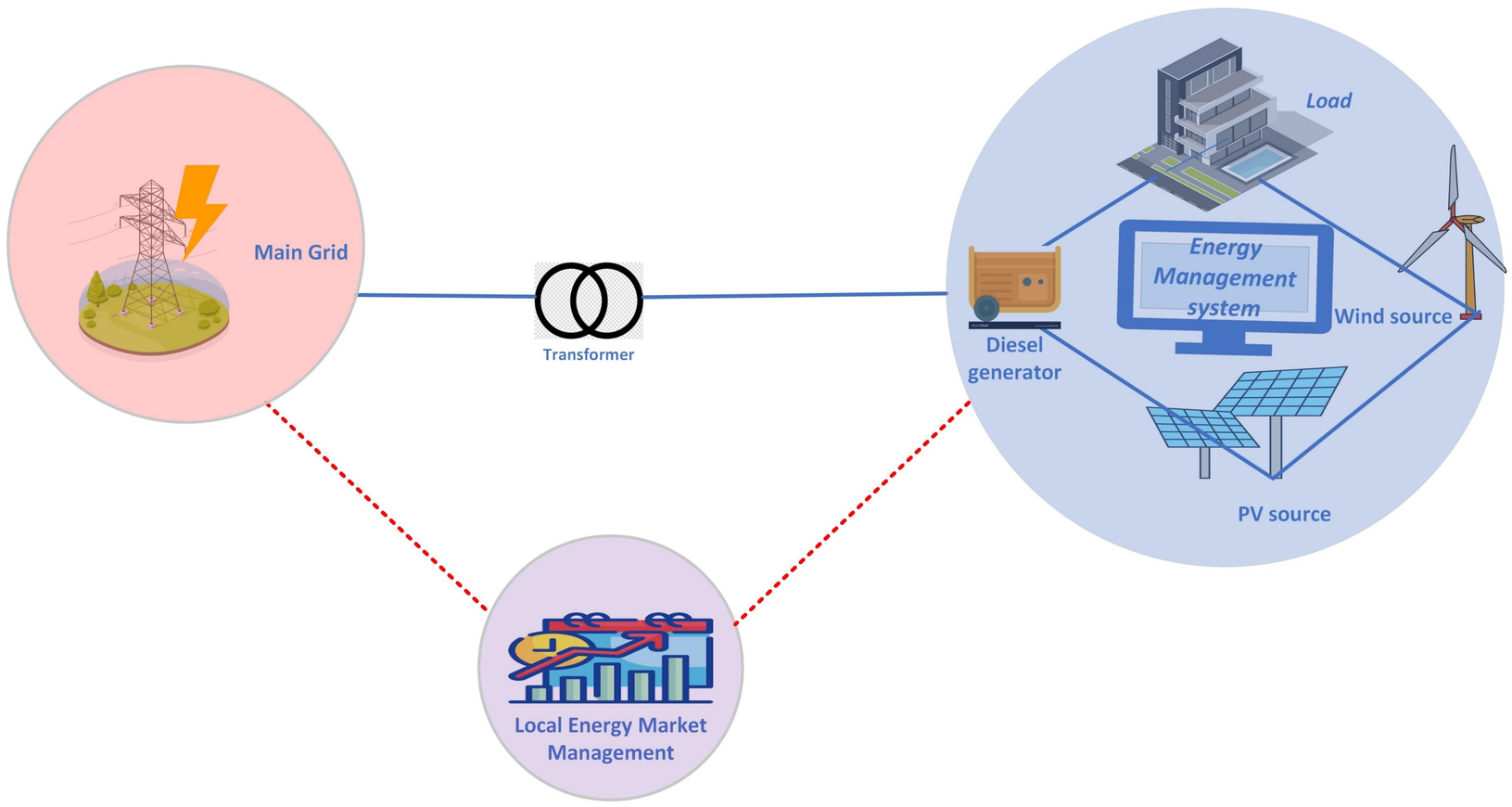

Figure 2: Design Structure in Real-World Application

Problem Definition

The challenge of efficiently managing peak loads remains significant, with uncontrolled ripple effects leading to grid instability and inefficiencies in energy distribution. This issue is worsened by the prevalent use of fixed-rate tariff systems by many electricity providers.

These systems lack the flexibility to incentivize consumers to adjust their energy usage according to real-time market conditions.

The lack of effective demand-side management (DSM) solutions leaves utilities insufficiently prepared to handle variable demand patterns and achieve energy-saving goals.

Furthermore, the electrical industry has historically been dominated by monopolistic institutions, which have restricted competition, slow down innovations and limited customer choice, resulting in suboptimal outcomes for several stakeholders.

Solution Concept

The Simulink model developed in this study provides a crucial framework for investigating dynamic tariff models that adjust supply and demand based on real-time pricing, promoting efficient energy use and enhancing grid stability. By implementing comprehensive DSM frameworks, the model empowers consumers to actively participate in load management initiatives. This approach demonstrates the potential benefits of a deregulated market system, improving market access and ensuring grid stability. The Simulink model serves as a foundational tool for exploring these concepts, enabling detailed analysis and refinement of dynamic tariff strategies and DSM practices

Results

In the base case scenario, the energy consumption pattern rely entirely on the main grid, leading to high energy bill expenses. The demand-side management implementation in Case 1 significantly reduces the stress from the grid by lowering non-essential load during peak demand periods.

In the case 2 scenario, DSM integration with deregulated market system achieve additional reductions in total energy consumption bills, by applying photovoltaic (PV) power sources. These findings underscore the effectiveness of combining demand-side management with renewable energy integration and market deregulation in optimizing energy usage and reducing costs.

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