Co-Simulation of Dynamic Energy System Simulation and COMSOL Multiphysics®

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INTRODUCTION:

- COMSOL Multiphysics® is used to develop a numerical model for a large-scale thermal energy storage (TES) in a renewable-district heating (R-DH) system.
- R-DH system was implemented in a dynamic system simulation tool (Modelica/Dymola).
- Thus, co-simulation approaches arise as a promising technique to couple both simulation tools.

Examples of Co-Simulation in Energy Systems:

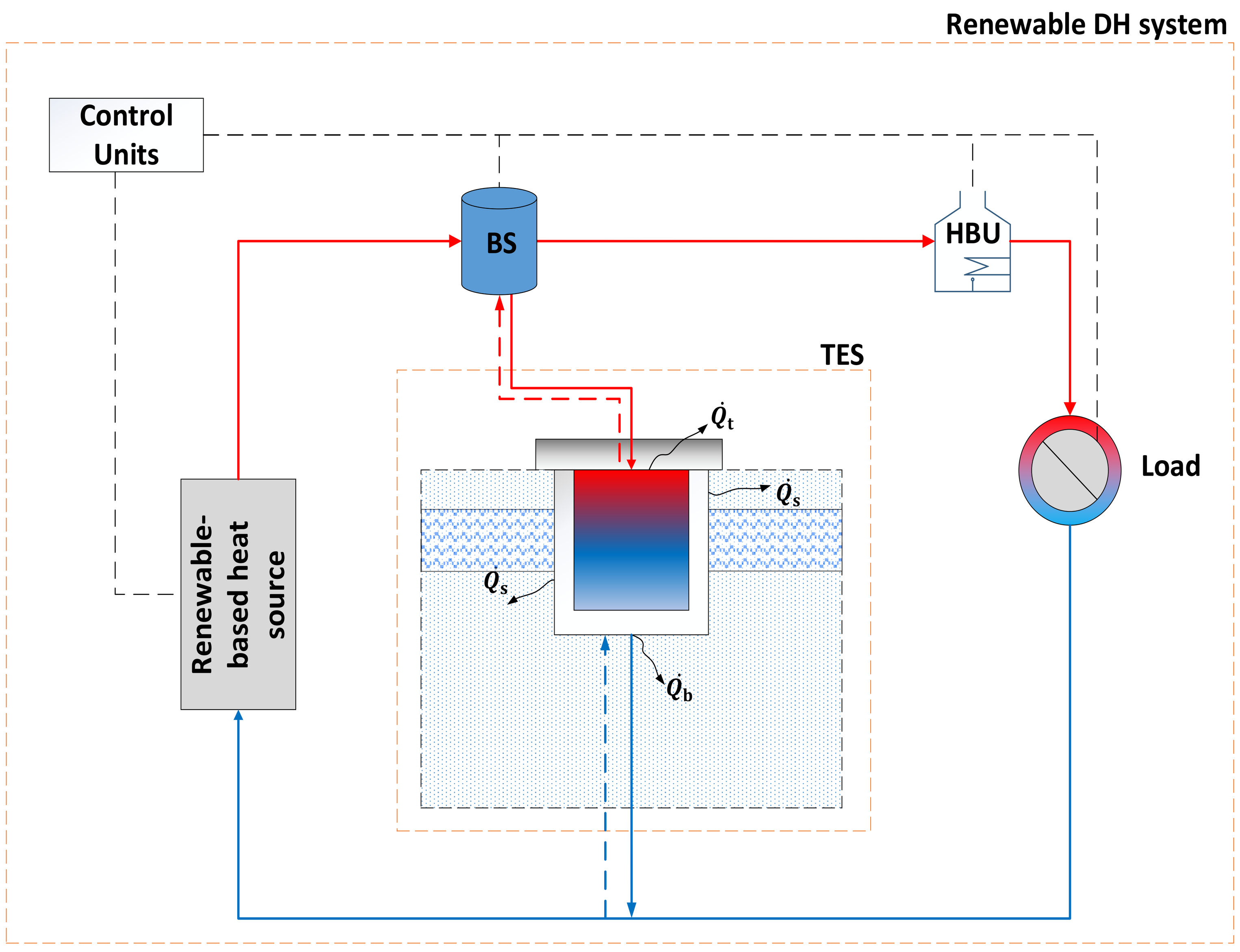

Figure 1. A possible co-simulation whereby R-DH system involving the generation (heat sources, buffer storage and heating back-up unit) and demand (load) with the control unit developed in Modelica/Dymola, whilst TES and surroundings developed in COMSOL Multiphysics.

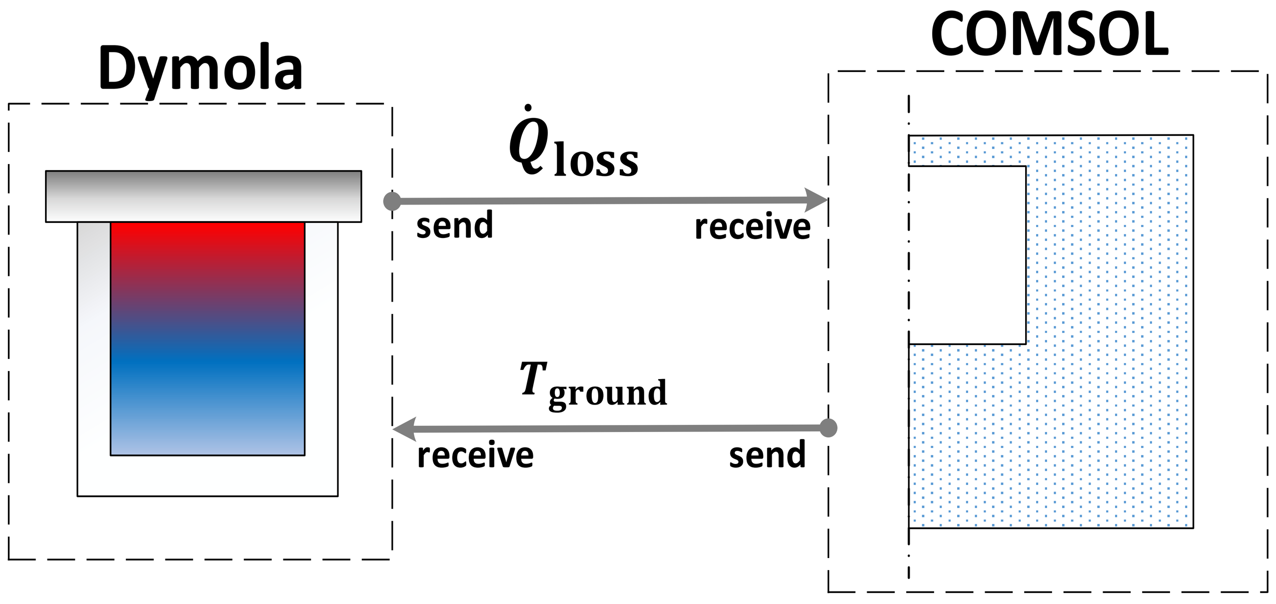

Figure 2. A possible co-simulation scenario between TES model in Dymola and ground model in COMSOL.

Co-Simulation of COMSOL Multiphysics:

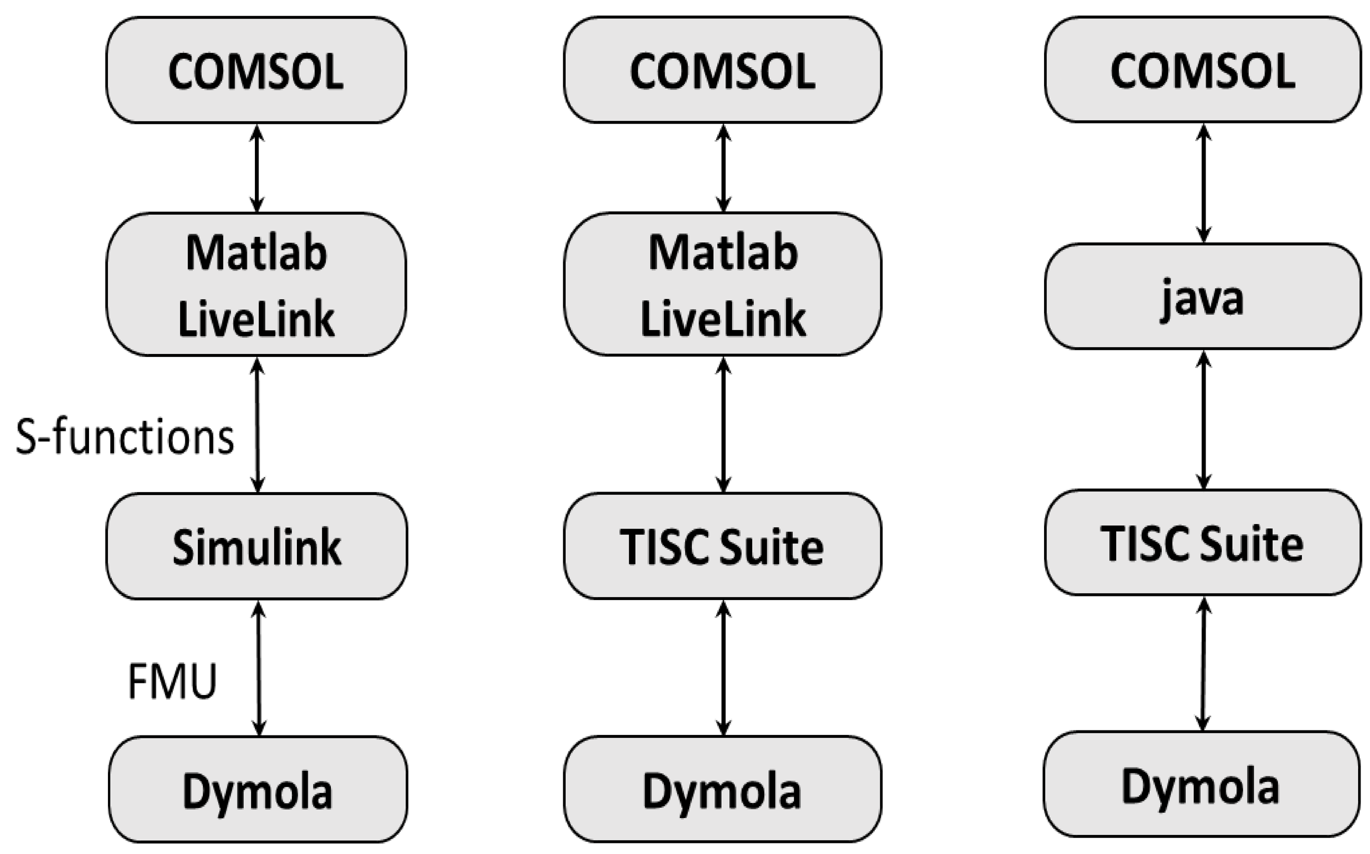

Figure 3. Co-simulation options for COMSOL Multiphysics and Modelica/Dymola.

Experimental Co-Simulation Setup and Results:

- Model: 2-D stainless-steel rectangle with 2x1 m^2.
- Physics: Heat Transfer in Solids.
- Boundary conditions:

$$T_H = 500.15 + 150 * sin(2\pi x/(10)) \text{ [K]}$$

$$T_C = 293.15 \text{ [K]}$$

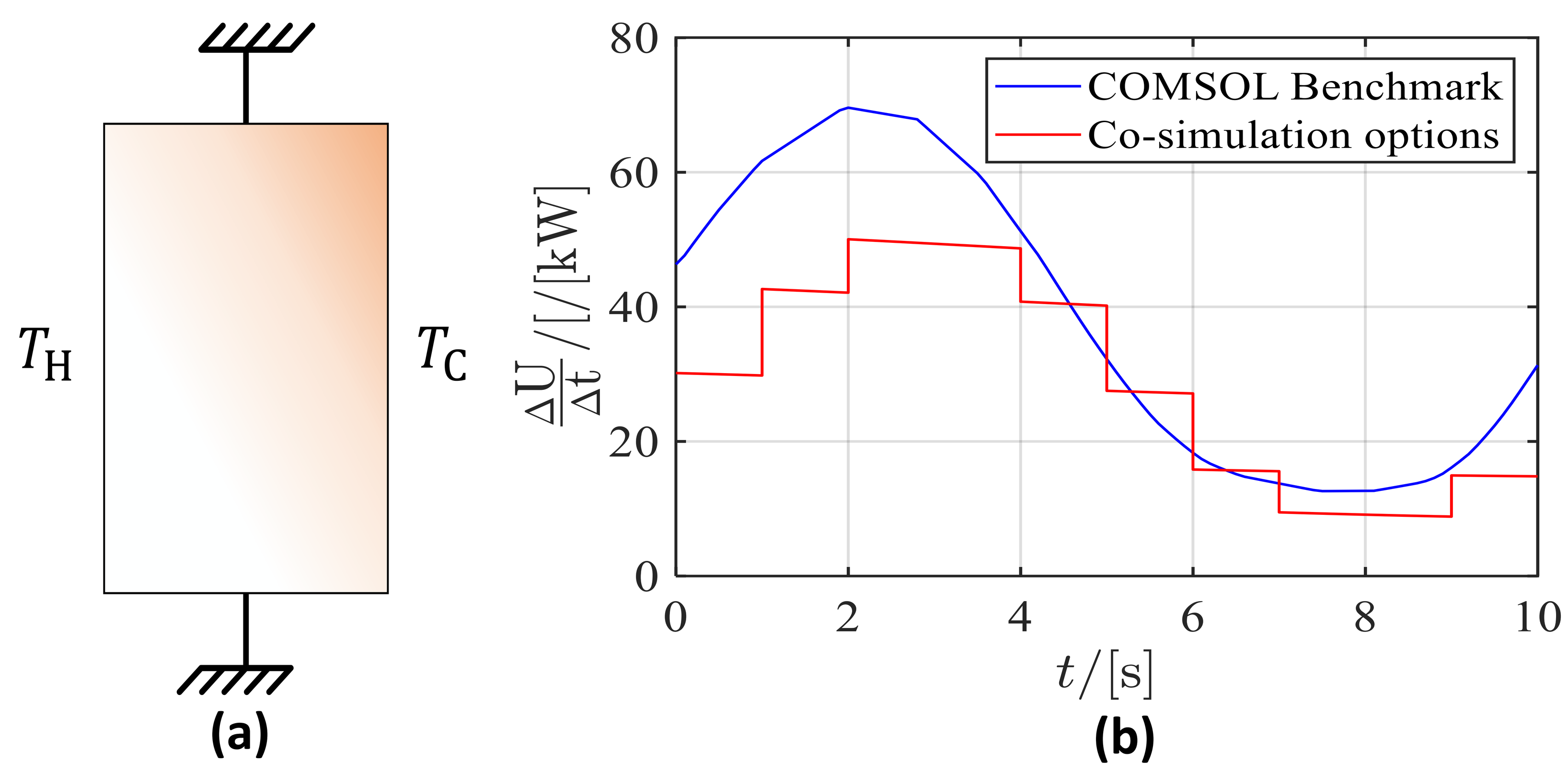

Figure 4. (a) Representation of the investigated case with the assigned boundary conditions, and **(b)** Sheet's internal energy change over time where the blue line represents the co-simulation and the red line represents COMSOL benchmark.

Table 1. Computational performance comparison.

Case	Simulation time [sec]
COMSOL Benchmark	2
Option Matlab LiveLink	38
Option java	54

Discussion and Conclusions:

- The co-simulation results show the pattern of the so-called "ping-pong" approach.

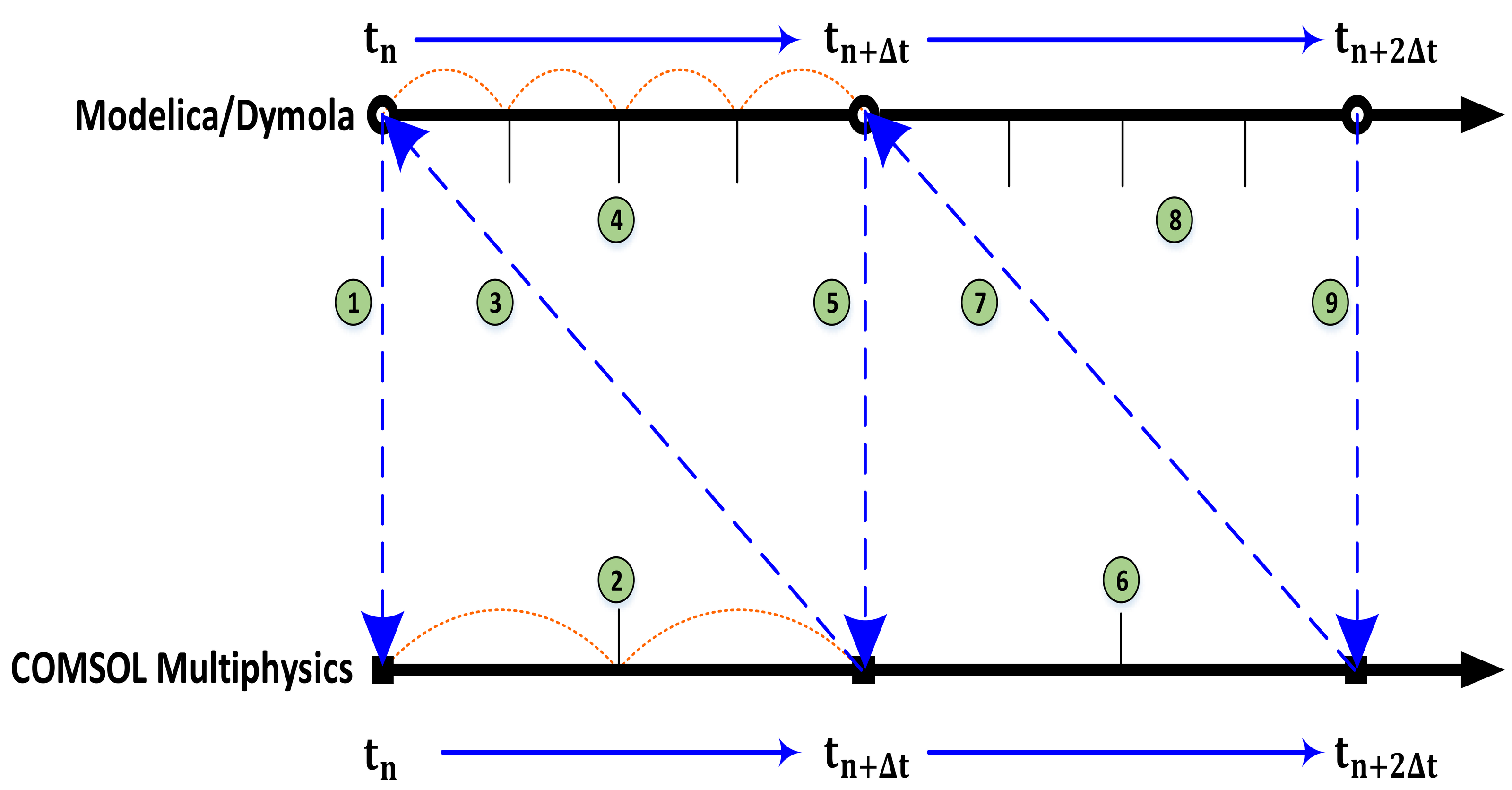

Figure 5. Schematic representation of ping-pong co-simulation.

- Both options with TISC Suite work and deliver results.
- Matlab LiveLink option outperforms java option.
- Yet, both suffer from the long execution time.
- Both are infeasible in terms of computation efforts.

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