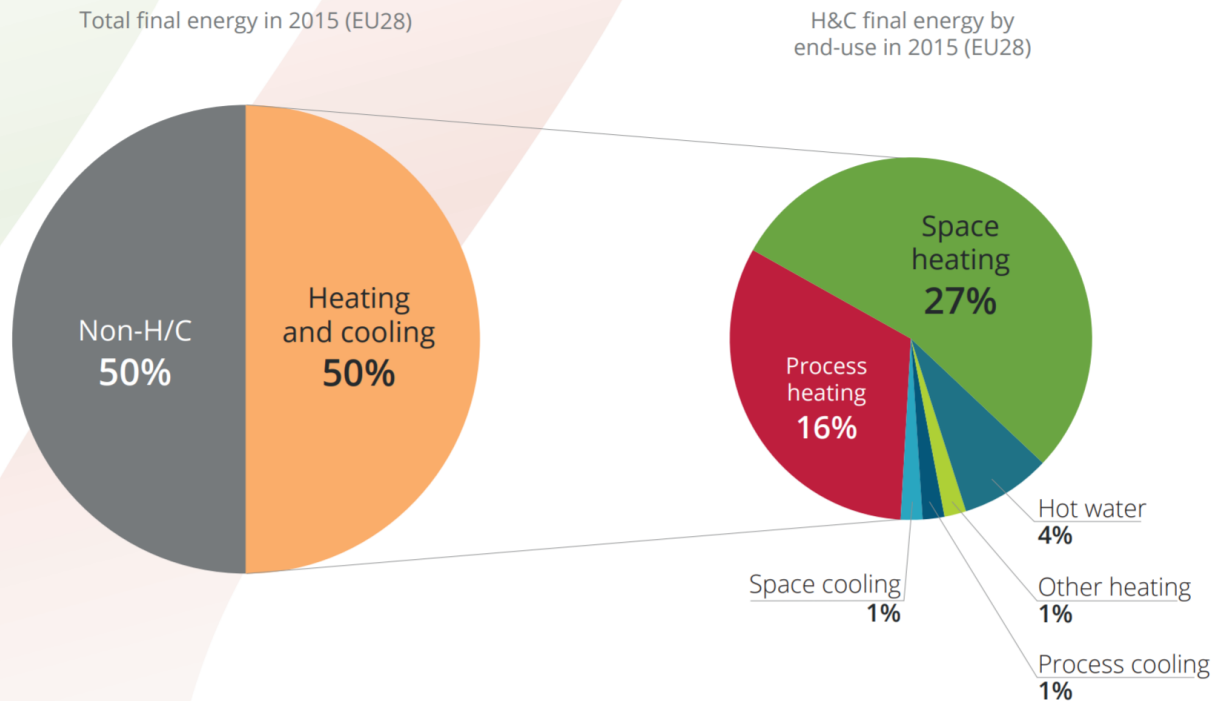


Combined Heat and Energy Storage

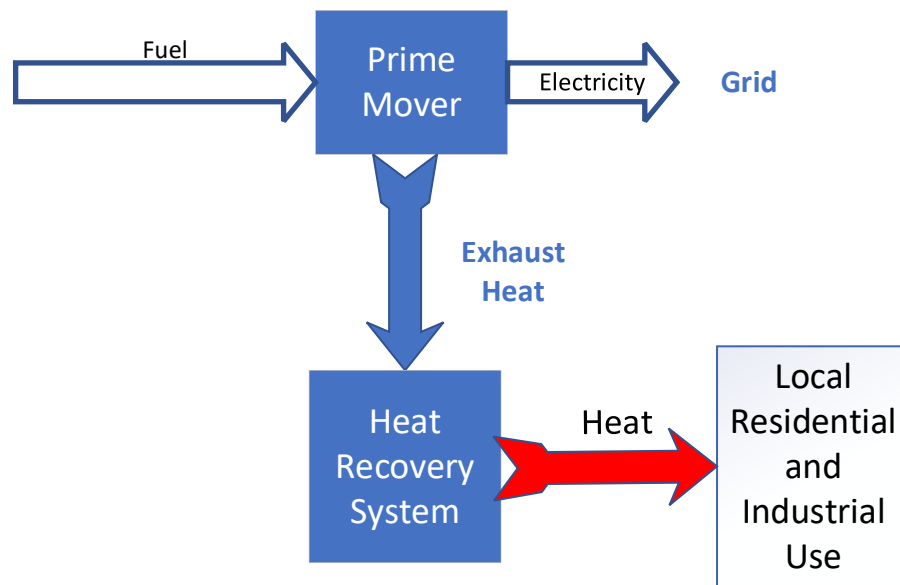
We use a lot of energy to heat things...



Source: Heat Roadmap Europe

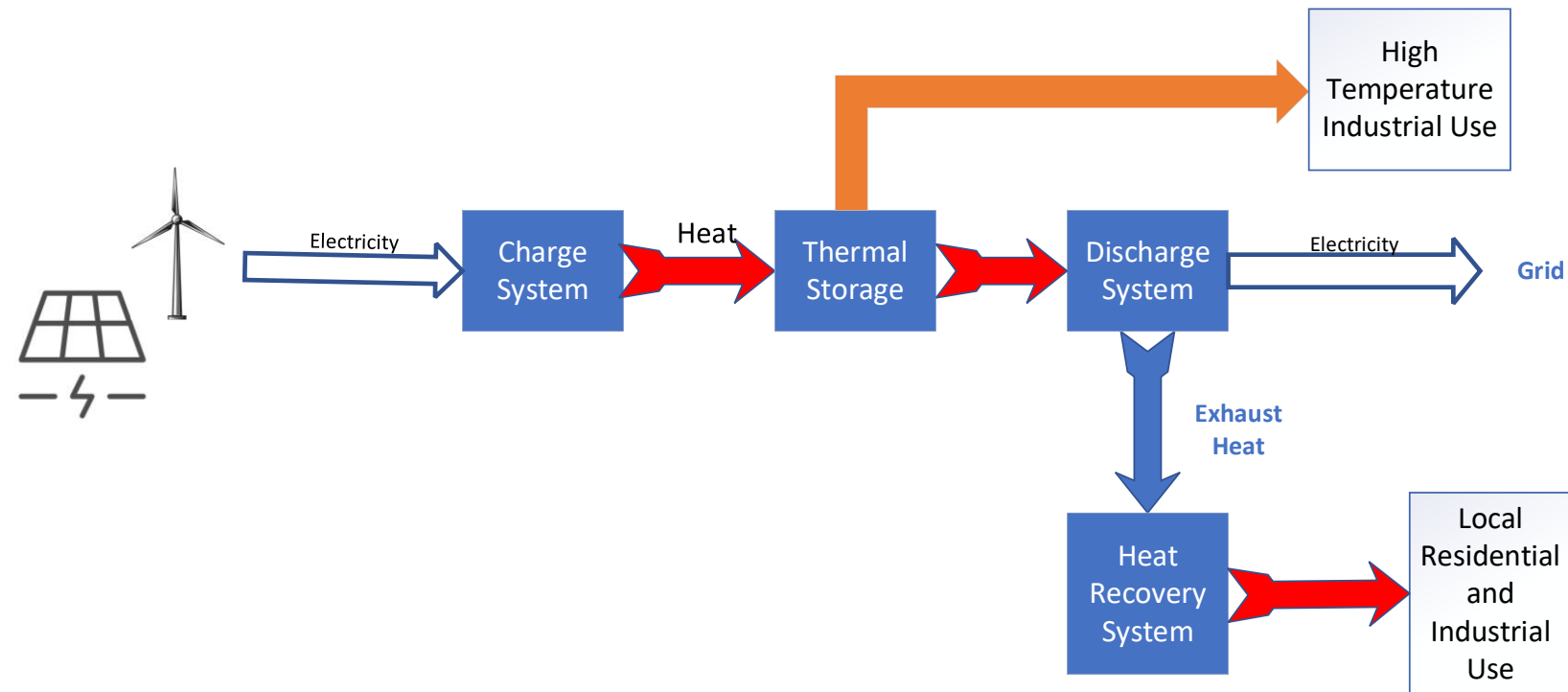
- Globally, residential and industrial heating uses energy levels comparable to electricity generation (more in most cases).
- Today, most of the heat is generated from fossil fuel sources with a trend towards electrification – heat pumps.
- Decarbonization requires that we utilize all tools available to us including combined heat and power as well as digitalization.

Fuel-Based Combined Heat and Power



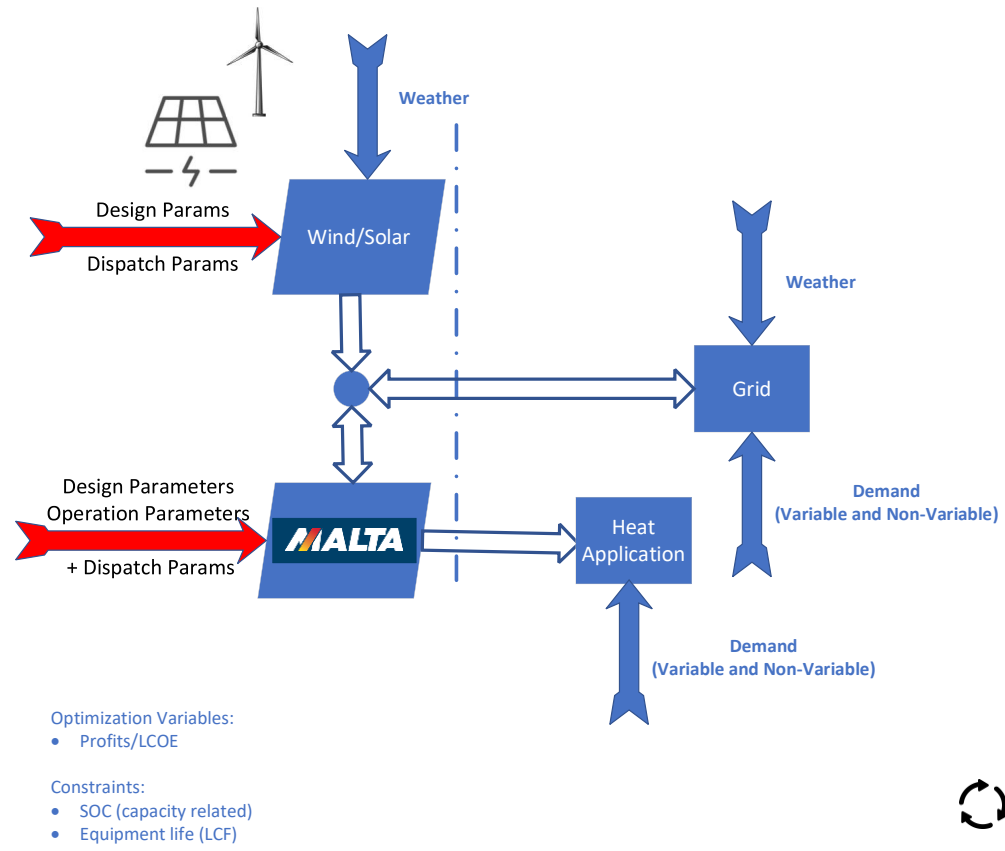
- Heat engines require the removal of the inefficiency of the system to complete the thermodynamic cycle.
- In thermal electricity generation, combined heat and power provides an excellent path to improved efficiency through the use the “waste heat” of a heat engine for heating applications.
- Use of combined heat and power is wide-spread, but still a small fraction of overall electricity generation or heating.

A Combined Heat and Energy Storage System



- In a thermal energy storage system, the same opportunity exists: the inefficiency of the cycle can be used for heating applications.
- In an energy storage application, there is also the opportunity to use the main stored heat high-temperature applications.
- If the charge system is heat-pump based (such as Malta's system), there is additional opportunity for "CHESS efficiencies" approaching or even exceeding 100%.

The Dispatch Optimization Problem



- The co-dispatch of heat and power is a challenge and an opportunity.
- The energy storage system by design an intermittent system: has to charge in order to dispatch and sometimes the system doesn't need to operate at all – e.g., hold the stored energy.
- The heat dispatch and electricity dispatch are closely tied.
- The time-scale is at least of the order of the duration capability of the energy storage system.
- Additional (low-temperature) thermal energy storage can help decouple the problem.
- Malta's Digital team is working on sophisticated methods for the dispatch of electricity and heat