

Extended matching indices and dynamic matching analysis of simulated buildings with hybrid on-site energy systems

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□ The concept introduced in this presentation is based on a published journal paper: Sunliang Cao, Ala Hasan, Kai Sirén, "On-site energy matching indices for buildings with energy conversion, storage and hybrid grid connections", *Energy and Buildings*, 2013. [Online] available: <http://www.sciencedirect.com/science/article/pii/S0378778813003150>

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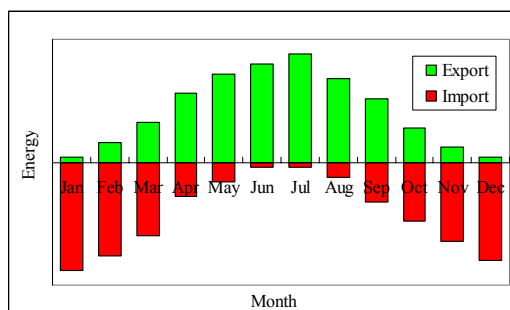
The importance of matching analysis

□ On-site renewable energy system should be significantly enhanced

□ European Parliament regulates that all new buildings built from 2021 should be nearly zero-energy buildings (nZEB)



□ Mismatch problem is an inevitable side-effect (Renewable fraction in electrical and thermal grids is not likely to reach 100% in EU by the year of 2021)

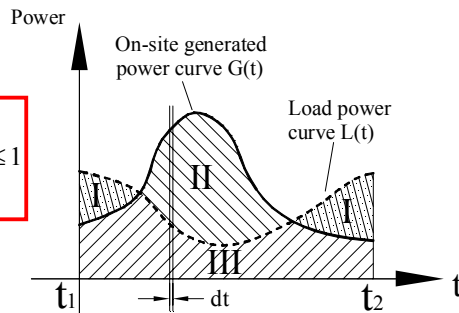


The monthly imported and exported energy for an all electric-based nZEB equipped with on-site PV

Two basic matching indices

- On-site energy fraction (OEF)
Section III/ Sections I and III

$$OEF = \frac{\int_{t_1}^{t_2} \text{Min}[G(t); L(t)]dt}{\int_{t_1}^{t_2} L(t)dt} ; 0 \leq OEF \leq 1$$



- On-site energy matching (OEM)
Section III/Sections II and III

$$OEM = \frac{\int_{t_1}^{t_2} \text{Min}[G(t); L(t)]dt}{\int_{t_1}^{t_2} G(t)dt} ; 0 \leq OEM \leq 1$$

Extended matching indices

- Extension based on OEF: OEF_e, OEF_h, and OEF_c
- Extension based on OEM: OEM_e, OEM_h, and OEM_c

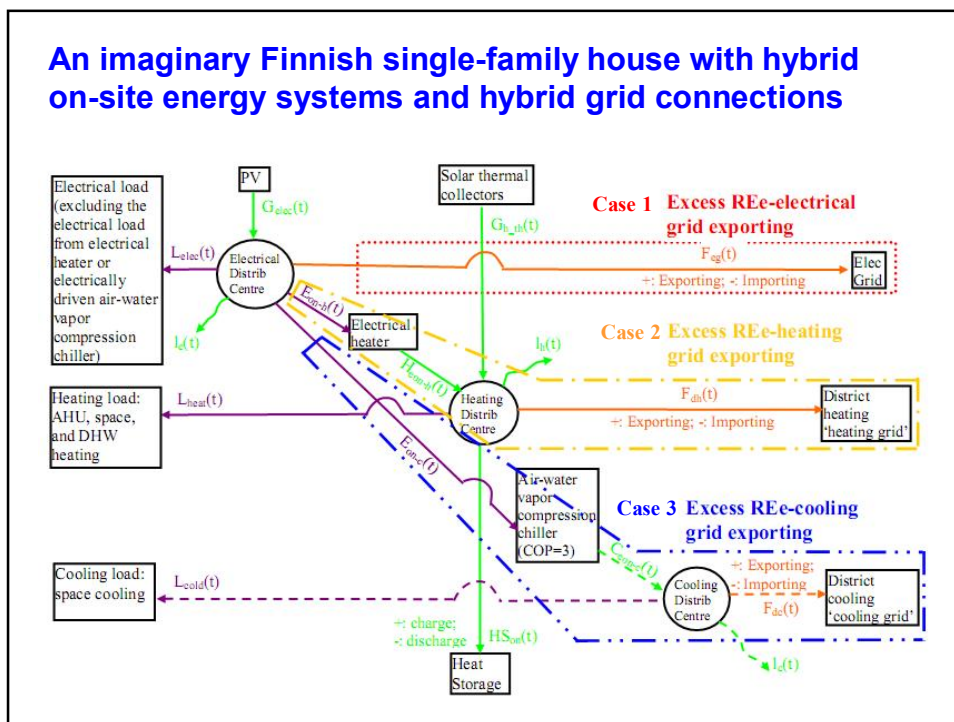
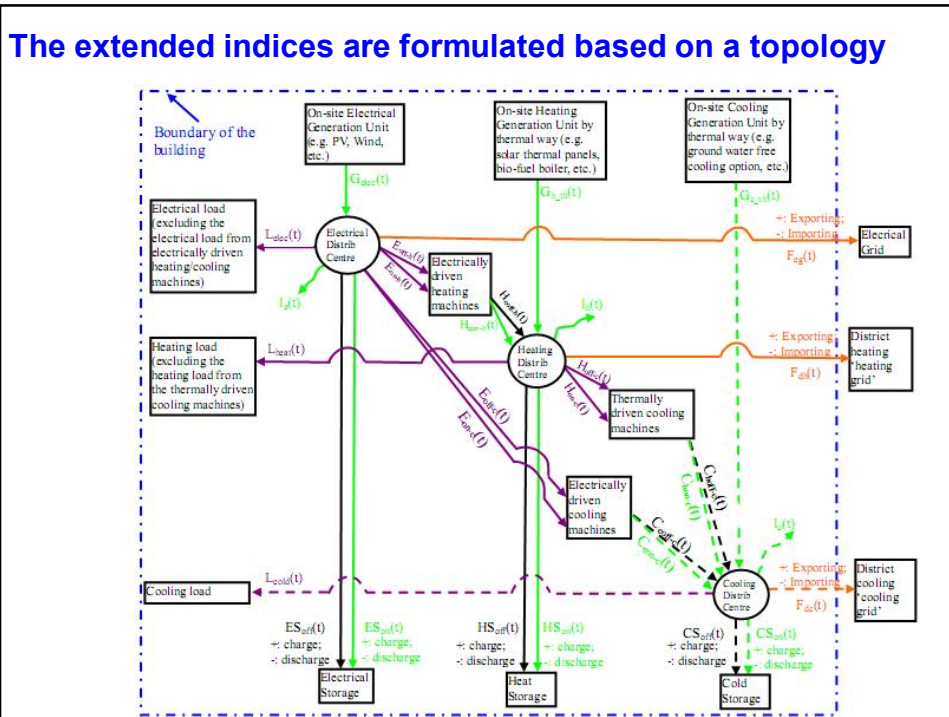
The postfixes of e, h, and c represent the electrical, heating, and cooling aspects, respectively.

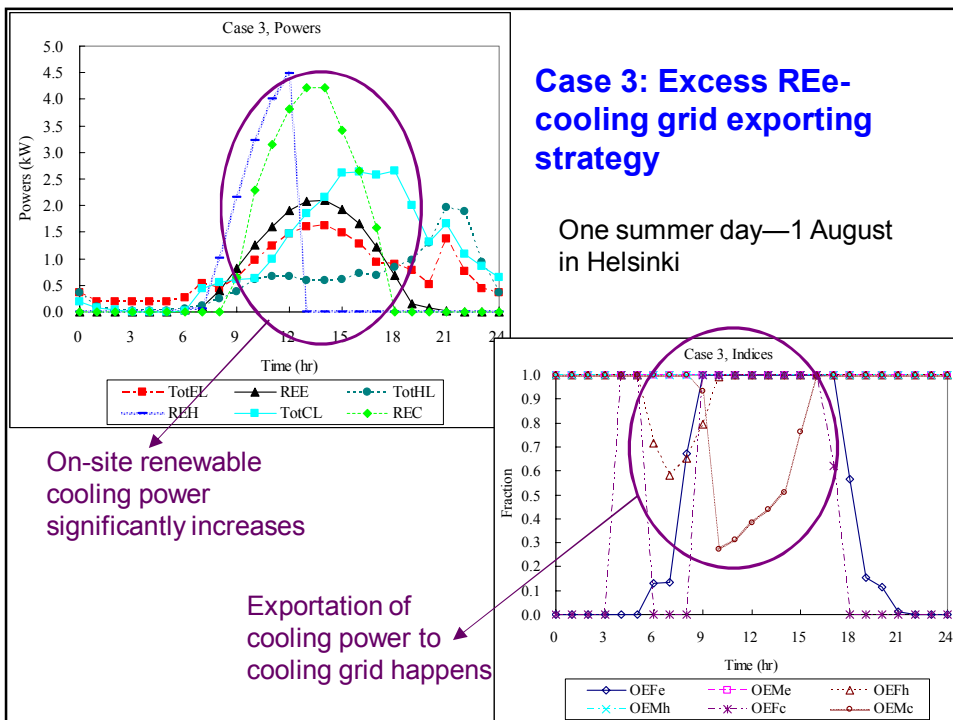
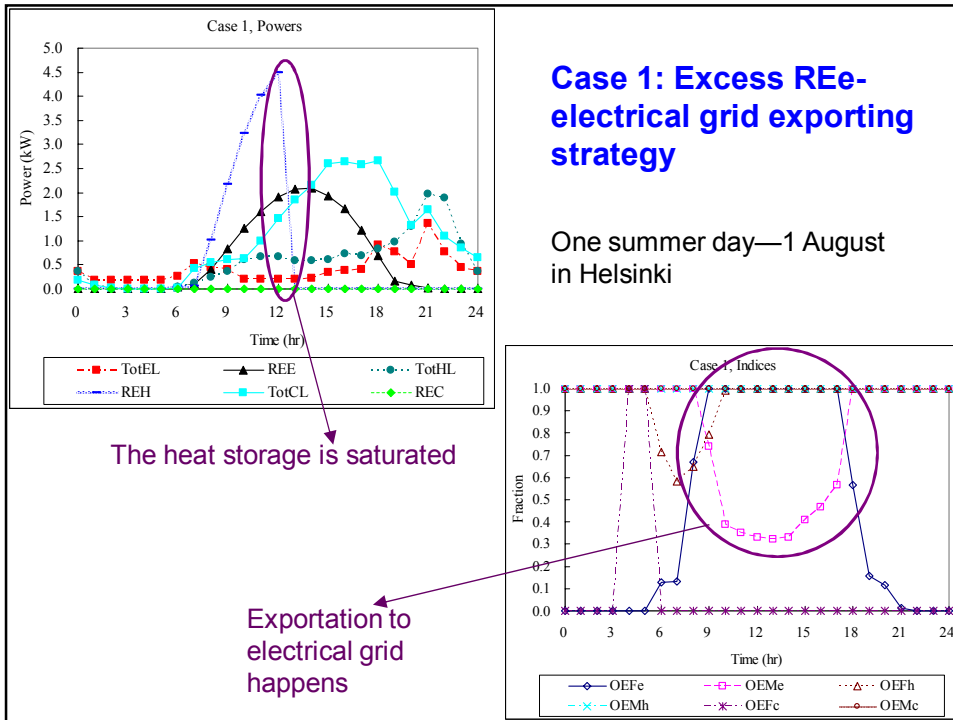
Examples:

adjust the studied time period and time-step flexibly

$$OEF_h = \frac{\int_{t_1}^{t_2} \text{Min}[G_{h_th}(t) + H_{con-h}(t) - HS_{on}(t) - l_h(t); L_{heat}(t) + H_{off-c}(t) + H_{on-c}(t)]dt}{\int_{t_1}^{t_2} [L_{heat}(t) + H_{off-c}(t) + H_{on-c}(t)]dt}$$

$$OEM_h = \frac{\int_{t_1}^{t_2} \text{Min}[G_{h_th}(t) + H_{con-h}(t); L_{heat}(t) + H_{on-c}(t) + HS_{on}(t) + l_h(t)]dt}{\int_{t_1}^{t_2} [G_{h_th}(t) + H_{con-h}(t)]dt}$$





Conclusions

- Six detailed matching indices are defined based on the extension of two basic matching indices.
- These indices can be used to assess the increasingly complicated hybrid on-site renewable energy systems involving various energy forms, energy conversions, diversified storage types, and hybrid grid connections.
- The matching caused by certain excess RE-grid exporting strategy can be evaluated by the extended indices and the topology.
- By adjusting t_1 , t_2 , and dt , both the long term and short term matching situations can be assessed.

