The impact of resolution on load matching in a Norwegian context

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Introduction

Generation of energy at building level receives increasing interest in Norway, as in the rest of Europe. Load matching is the correlation between the building's generation and load, which in most cases aims at optimizing the amount of self-consumption. When analyzing generation in relation to load, it is of interest to study the choice of resolution and what impact this has on load matching indicators. This study analyses the importance of choosing the right resolution, starting with daily measurements and going down to 15-minute resolution for two case studies.

Net Zero Energy Buildings and load matching

Sartori, Napolitano and Voss [1] propose a definition of the net ZEB-balance as a condition that is satisfied when weighted supply meets or exceeds weighted demand over a period of time, nominally a year. This is given by Eq. 1.

$$\textit{Net ZEB balance} = |\textit{weighted supply}| - |\textit{weighted demand}| \geq 0 \quad (1)$$

The term load matching (LM) refers to the degree of matching of the on-site generation with the building load profiles [2]. This can be analyzed by studying the degree of self-generation (load cover factor) and self-consumption (supply cover factor). Self-generation is the share of energy demand covered by on-site energy production. Self-consumption is the share of on-site generated energy used by the building. Equations 2 and 3 give the mathematical expression of these definitions [2].

$$\gamma_D = \frac{\int_{\tau_1}^{\tau_2} \min[P_D, P_S]\, dt}{\int_{\tau_1}^{\tau_2} P_D\, dt} \quad \text{(self-generation)} \quad (2)$$

$$\gamma_S = \frac{\int_{\tau_1}^{\tau_2} \min[P_D, P_S]\, dt}{\int_{\tau_1}^{\tau_2} P_S\, dt} \quad \text{(self-consumption)} \quad (3)$$

γ_D and γ_s represents share of self-generation and self-consumption, P_s is the onsite generation (supply) of energy in [W], P_D is the load (demand) in [W] and $\tau 1$, $\tau 2$ start and end the observation period.

When Eq. 1 is zero the net ZEB balance is reached, and there is a perfect annual balance between on-site generation and demand. This is a special case where self-generation (Eq. 2) is equal to self-consumption (Eq. 3).

Method

The dimensions of the PV systems and consumption patterns for the two case studies are very different, but common for both is a large mismatch between consumption and generation. For the purpose of this study the total generation data collected through 2016 for both cases have been scaled up to net ZEB level to analyze the effect of resolution on load match indicators, for a wide range of generation capacities. The results are presented by two graphs illustrating ZEB load matching for each of the two buildings.

Case studies

Økern
Type: Nursing home
Capacity: 130 kW_p
PV: REC 260PE, flat roof, tilt 10° and 20°, azimuth East and West.
Heat source: District heating

Skarpnes
Type: Dwellings
Capacity: 7.36 kW_p per dwelling
PV: SunPower 230NE-BLK-I, roof integrated, tilt 32°, azimuth South-West (+48°).
Heat source: Gr. well/heat pump

Results

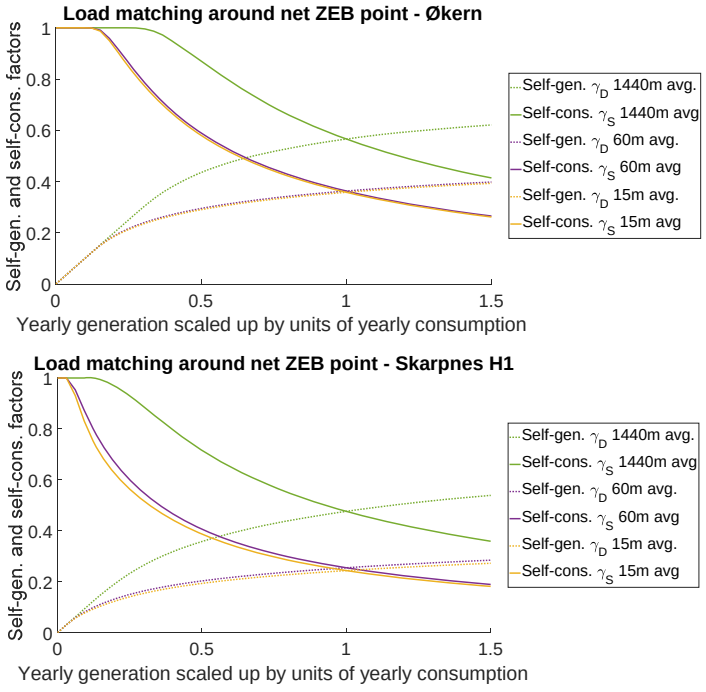

Figure: Effect of resolution on load matching factors at net ZEB point Økern (upper) and Skarpnes (lower)

Conclusions

The results show that collecting data on a daily basis (24 hr resolution) will give a wrong impression of self-consumption and self-generation by 20 % (Økern) and 23 % (Skarpnes) compared to hourly based data (at ZEB level). The difference between 15-minute and hourly based data resolution is very small (0 % Økern and 1 % Skarpnes).

References

[1] Sartori, I., A. Napolitano, and K. Voss, *Net zero energy buildings: A consistent definition framework.* Energy and Buildings, 2012, p. 220-232.

[2] IEA, *ANALYSIS OF LOAD MATCH AND GRID INTERACTION INDICATORS IN NET ZERO ENERGY BUILDINGS WITH HIGH-RESOLUTION DATA;* IEA Task 40/Annex 52 Towards Net Zero Energy Solar Buildings 2014, International Energy Agency.

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