

## MILESTONE 1.1

### 1. GENERAL INFORMATION

**PROJECT:** BRANDENGEN SCHOOL

**CONTEXT:** DRAMMEN, NORWAY

**ORIGINAL USE:** SCHOOL 1914

**USE:** MULTI-FAMILY HOUSING

**DESIGNER(S):** ARNSTEIN ARNEBERG (ORIGINAL)

**COMPLETION DATE:** 2003



**Keywords:** Internal insulation, Moisture, Space heating control, Ventilation control, Lighting control, Building energy management system (BEMS), Buildings' aesthetics, Affordable operational and maintenance costs



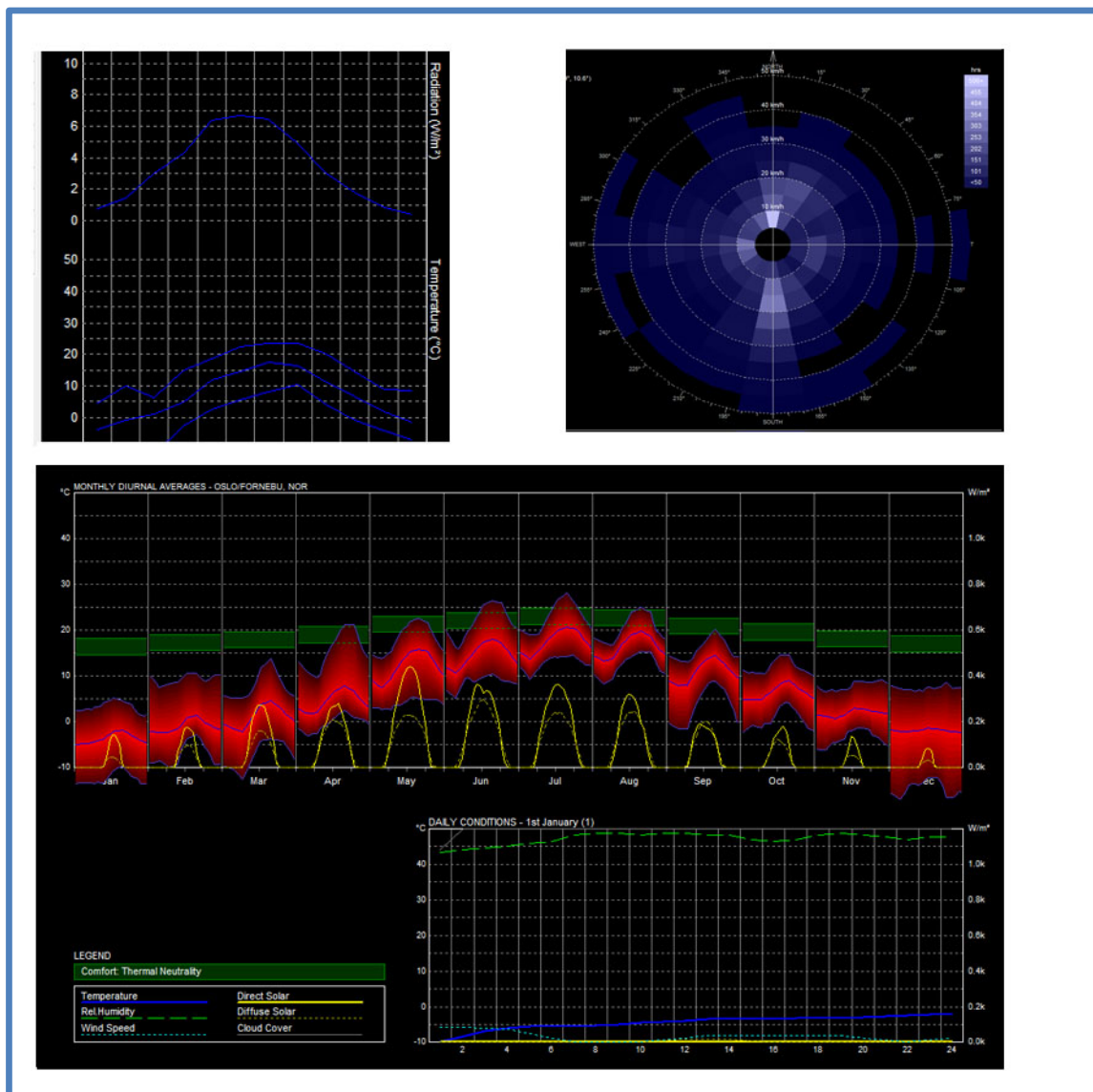
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## 2. CLIMATIC FEATURES

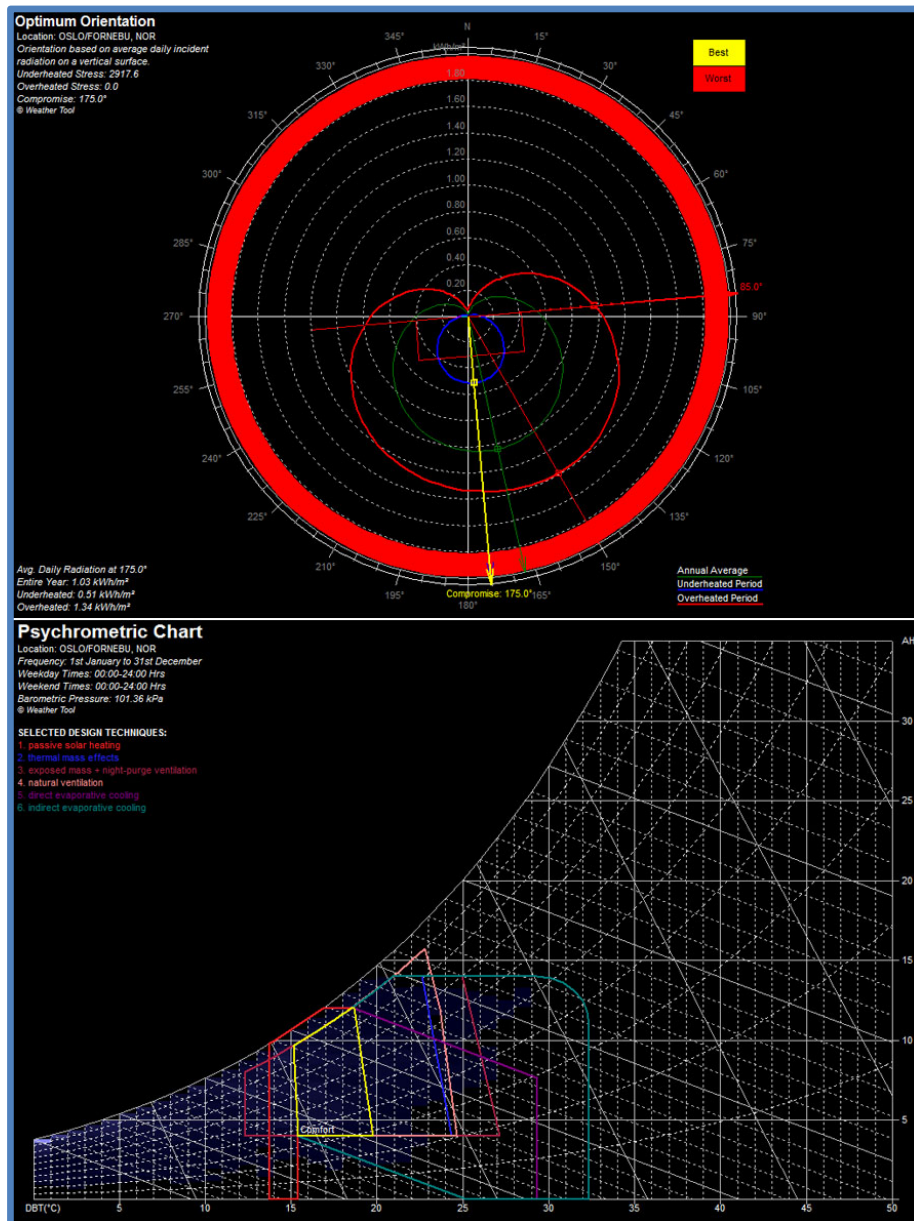
### CLIMATE SUMMARY:

- MONTHLY DATA: RADIATION (W/mq); MAX, MID, MIN TEMPERATURE °C
- PREVALLING WIND (WIND FREQUENCY – Hrs)
- HOURLY DATA – MONTHLY DIURNAL AVERAGES
- DAILY CONDITION (1<sup>ST</sup> JAN



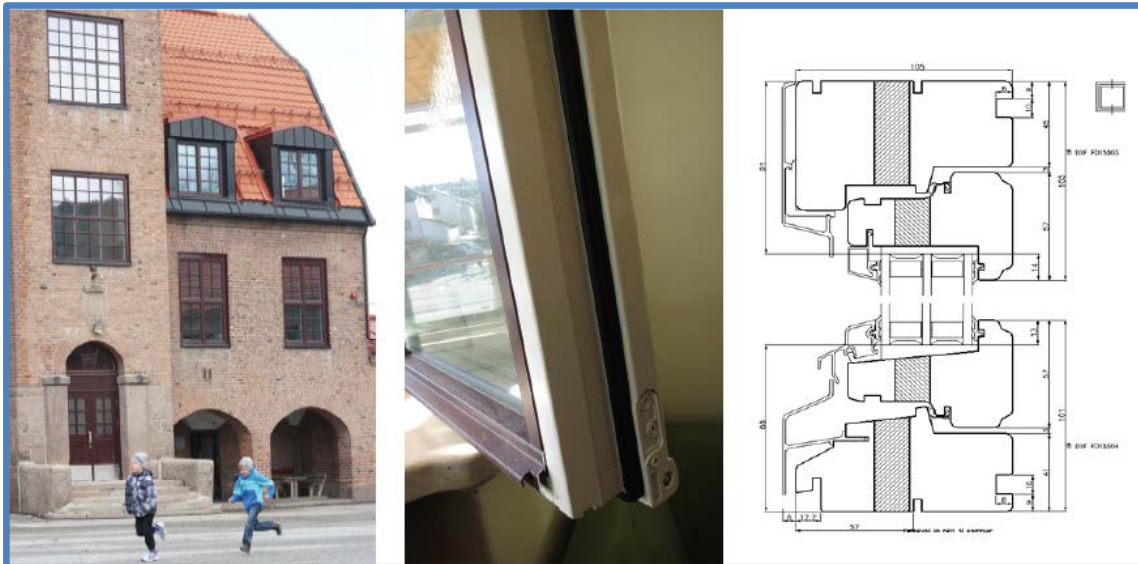
### 3.BIOCLIMATIC FEATURES

- OPTIMUM ORIENTATION
- COMBINATION OF PASSIVE ENERGY STRATEGIES



#### 4. URBAN AND/OR BUILDING FEATURES

The windows have been replaced at different times since 1965. As the windows have caused high heating costs and haven't contributed to an optimal indoor climate, the municipality decided to replace all windows installed after 1965, aiming for new high performance windows, which also pay respect to the historic aspects of the buildings' aesthetics. Existing original windows are being refurbished. Most of the original windows are located along corridors, where the indoor temperature requirements are not as strict as in classrooms. Design criteria for new windows were elaborated in co-operation between the architect N. Herland, a+form, the window manufacturer NorDan, and S. Tangen from the School of the Future Advisory and Evaluation Group. Searching for modern high performance windows the following criteria were required: Looking similar to the original windows from 1914, Long life expectation,  $U\text{-value} \leq 0.8 \text{ W/m}^2\text{K}$  (at affordable price), Affordable operational and maintenance costs.



Façade detail showing new passive house windows from NorDan (left); close up photo of new window (middle) - Photos: S. Røgeberg. Mai 2012; vertical section with the insulated frames (right).

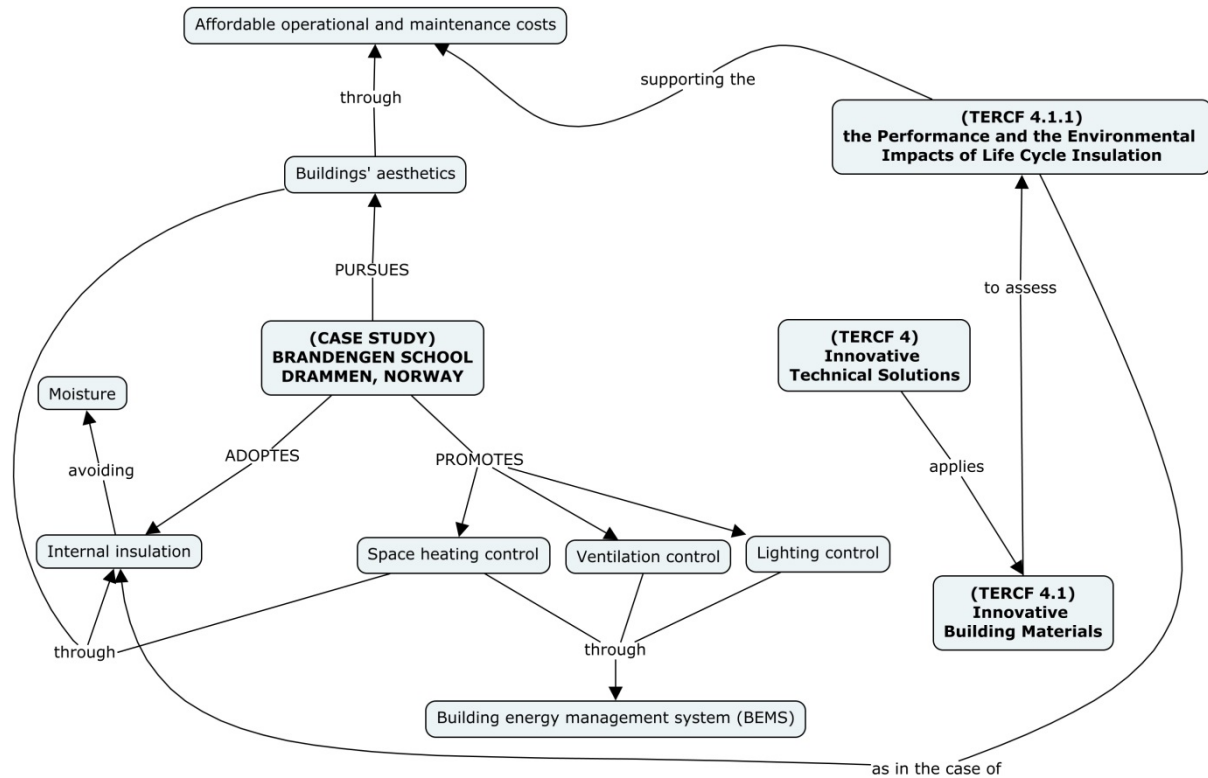
Glazing specifications	U-value [W/m <sup>2</sup> K]	Light transmission [%]	g-value [%]
Ground floor with exterior security glazing: Lam m/energi 2s VKS/Ar 6,38ES+16G+4+16G+ES6	0,53	56	35
Solar glazing on south and west façades: SKN165 m/Energi VKS/Ar 6"-14G+4+16G+ES4	0,58	48	27
Other windows have standard glazing: Energi 2s VKS/Ar 4ES+16G+4+16G+ES4	0,53	58	37

Characteristics of the windows of Brandengen School after the retrofit.



**5. FOCUS QUESTION AND MAP**

**How to improve the performance of the building envelope?**





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### 6. REFERENCES

HeikeErhorn-KluttigHansErhorn, School of the Future – Towards Zero Emission with High Performance Indoor Environment, Energy Procedia, Volume 48, 2014, Pages 1468-1473

M. Zinziet al, School of the Future Towards Zero Emission with High Performance Indoor Environment, Report Deliverable D6.1Design Phase Report, 2013,  
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