Assessment of ecological sustainability and feasibility

Assessment criteria of the competition included:

1. Ecological sustainability including energy performance and material efficiency
2. Urban and architectural quality
3. Usability (functionality/quality of working environment)
4. Feasibility (economic efficiency and quality of technical solutions)

- These categories had to sum up with sound overall solution and it's development potential
- Referring to sustainable use of energy and material resources as well as cost efficiency, criteria 1. and 4. had transparent assessment framework:
  - quantitative criteria, described with performance based values
  - measured with kWh, tCO₂ and M€ units

Quantitative performance based target values

- Ecological sustainability was measured with energy performance and material efficiency target values
  - Energy performance followed the target of EPBD recast for 2019-2021, nearly zero energy buildings, which is the basis for energy performance target value of 80 kWh/(m² a) primary energy without tenant's electricity (all other energy flows included)
  - 80 kWh/(m² a) per program area corresponds to significantly lower value per net area

- Material efficiency was measured in kgCO₂/m² and teams competed to achieve possibly low value without compromising with other criteria

- Primary energy factors to calculate the target of 80 kWh/(m² a) were:
  - Electricity 2.0
  - District heat 0.7
Technical solutions used in competition entries (1/2)

Structural solutions:
- **Valaistus** and **Pastorale** were steel-framed, while the rest timber-framed.
- Of the steel-framed entries, wooden floor and facade elements have been used in **Valaistus**, while steel-concrete composite slab intermediate floor construction and steel cassette facade elements have been used in **Pastorale**.
- The use of timber and steel construction achieved advantages in materials efficiencies.
- Concrete was used however commonly for the laboratory facilities.

Energy supply:
- District heating in **Solaris** and **Valaistus**, as well as to a significant extent (40%) in **Pastorale**.
- In other entries’ heat pumps/boreholes were used with the peak power from the district heating, except in **191910** from electricity.
- Free cooling from boreholes was utilized in all entries.
- Waste heat of continuously cooled rooms caused some confusion and was not utilized in all entries.

Technical solutions used in competition entries (2/2)

Solar heat and electricity
- Solar cells were commonly placed on the roofs (where the generation of electrical power is more efficient), but in a few entries also on facades, facilitating also as solar protection screens.
- In **Solaris**, the positioning of the solar collectors was seen exceptionally difficult for maintenance.
- Similarly in **Valaistus**, the solar cells have been placed in a difficultly maintained location, but the solution had better development potential.
- In the other competition works, the placement of solar cells, either on the roof or facades, were fairly successful.

Natural light and solar protection
- In all competition entries, natural light had been utilized more or less in an exemplary fashion, and solar protection had been solved with effective external solar protection solutions.
Assessment of ecological sustainability

• Energy performance/primary energy as specified in the competition programme:
  - E-value for a reference building solution complying with currently valid minimum code requirements
  - E-value for the design solution with conventional energy supply solutions
  - E-value for the actual design solution

• Material efficiency:
  - with the main structure's carbon footprint that is derived from the carbon dioxide emissions resulting from the building materials' manufacture and the materials' possible carbon dioxide storage
  - Solaris has functioned as a carbon sink because its carbon dioxide storage has been larger than the emission caused by the manufacture of its building materials

Results of energy performance and material efficiency and construction cost estimates

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Results of ecological sustainability assessment

- The best energy performance was shown by Apila and material efficiency by Solaris
- Energy performance results were fairly even, only Pastorale was somewhat behind the others
- In terms of material efficiency, 191910 and Pastorale were clearly weaker than the other entries.

- When assessing the 30-year carbon footprint (energy and materials):
  - Apila's 6,500-tonne emissions were the lowest
  - Solaris and Valaistus followed with 7,100 and 7,300 tonnes
  - Pikkukampus were midway on the scale at 8,500 tonnes, and the two remaining competition entries 191910 and Pastorale were clearly weaker than the others, exceeding the 10,000-tonne limit

Energy performance + material efficiency = life cycle CO₂

- Energy performance and material efficiency were summed in kgCO₂/m² units in the assessment process
- Specific emission factor of 150 kgCO₂/MWh was used both for electricity and district heat as an estimate for next 30 years
- Such assessment resulted in life cycle CO₂ emissions, as well as LCC in the economic efficiency assessment, including construction and energy cost, therefore the proposals were compared in the life cycle carbon (tons of CO₂) and cost (M€) scale
- (maintenance, repairs and demolition were not taken into account)
Assessment of feasibility

- Ecological and economic efficiency map does not cover all aspects of assessment criteria:
  - three different E-values and carbon footprint of materials cover almost all in ecological sustainability criterion
  - feasibility criterion included the quality of technical solutions which is not covered by the map

- Quality of technical solutions and possible risks in the implementation (i.e. maintenance/durability issues, challenging technical solutions) were assessed
Results of feasibility assessment

- For the three best in ecological sustainability (Apila, Solaris and Valaistus), a cost estimates demonstrated virtually identical construction costs (the cost difference within a range of 1.5%)
- Construction cost estimates for Pastorale, Pikkukampus and 191910 were significantly larger (+7-13% compared to the most economic one)
- Thus the best in terms of energy performance, Apila, was also the best in terms of life cycle costs, with Valaistus and Solaris following closely behind
  - this was not completely expected because compared to Apila, slightly less work had been done in the compact entries (Solaris and Valaistus) to achieve good energy performance
  - in Valaistus, the waste heat of continuously cooled spaces was not utilized, and if utilized, that would lead to best energy performance, thus demonstrating the principle advantage of compactness
  - the advantages of a compact shape were not apparent in Valaistus's because the additional expenses of the complex facade and roof structure accounted for as much as 8% of the construction costs
  - likewise, significant additional costs were created in Solaris due to its complicated solar collector construction and weekly storage system for solar heat

Results of feasibility assessment

Apila was best-rated at the same construction cost level:
- because it had no significant implementation-related risks
- Apila was designed as a pure timber building, with economical spans suiting wood construction, as well as an advantageous building's height

Solaris:
- the complicated solar solution with the curved detached solar collector structure extending from the roof to the facades was considered as major risk factor
- possible changes in the system would be critical because the building’s exterior appearance has been specifically built around this system whose servicing is difficult

Valaistus:
- main risk factors were related to facades and roof
- possible changes to the shape and materials of the fabric-surfaced facades would significantly alter the building’s external appearance
- roof structures were studied in sketch level and may include technical challenges regarding the shape of the roof, the placement of solar cells, and structural design
- all these factors can be solved in further design, but could alter the building’s exterior and even interior character

Pikkukampus: facades implemented with hinged facade panels difficult in maintenance
Ecological and economic efficiency results (CO$_2$ of materials + energy use of 30 years vs. construction + energy cost)

- Solaris
- Valaistus
- Pikkukampus
- Pastorale
- Apila
- 191910