D4E- Facilitator - Guides for model uses

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3 sets of Facilitators

- Guide for BIM models and model uses in **Needs Identification and Requirements & Feasibility study** *(see separate slide set)*

- Guide for BIM models and model uses in **Concept design**
  - **Detailed design and Final design**
    - Including integrated design review *(see separate slide set)*

- Guide for BIM models and model uses in **Retrofit** *(in this slide set)*
Guide for BIM models and model uses in Retrofit

Run the slides in video presentation mode.
Click areas in the process map for To-Do’s and extra information.

DM-TOOL: BIM PROCESS EXECUTION FACILITATOR (D4E-FACILITATOR)
Defining the need for maintenance/retrofit

Phase consists of

- Collecting initial data of the building consisting of monitored EE performance data.
- Analyses of retrofit concept and making a decision between
  - (1) retrofit,
  - (2) extra maintenance or
  - (3) change of behavior/change of purpose of use supported by an analysis tool.
- Designing retrofit alternative based on client’s needs and performance target set with help of conducted analyses.
Retrofit and maintenance modelling

Decision support tool

Monitored data

Defining the need for maintenance /retrofit

Preliminary concept design

Operation
Design4Energy

Project management

Facility management

Authorities

End-user

Client

Operation

Defining the need for maintenance/retrofit

Decision making support

Initial data model

Design group management

Holistic EE – design

Supported by Design Components

D4E portal: Model checking Analyses Collaboration Visualisation Data management

Constructors
**Facility management**: Collect monitored data about the building operation. Study Benchmark data.
Facility management: Run Preliminary data analyses. Prepare the specification of requirement for FM.
Set project objectives (level of energy savings etc.) and performance targets.
Create and describe potential retrofit alternatives from maintainability perspective.
Run analyses of retrofit concept: retrofit, extra maintenance, change of behavior (change of purpose of use).
Prepare the report, present the results.
Client: Review the report from FM. Set Specification of requirements (KPIs and their target levels). Check legal requirements. Present the brief for architect and other designers.

Design group and architect: Review the design brief and report from facility manager. Review FM model (as monitored and inventory model (as inspected) and other information. Compose all information to initial data model.

Update the BIM model (as-designed). Create and describe retrofit alternatives based on usability of spaces and technical improvements for the building.
Design group and architect:
Analyse maintainability together with facility manager. Create potential EE solutions for each alternatives.

Design check list

Energy expert:
Review reports of Architects and Facility manager. Check neighbourhood implications and potentialities for each drafted retrofit alternatives and EE solution (building level). Analyse holistic energy matching for each alternatives.
Defining the need for maintenance/retrofit

Operation

- End-user
- Client
- Project management
- Facility management
- Authorities
- Design group management
- Holistic EE – design
  Supported by Design Components
- D4E portal: Model checking Analyses Collaboration Visualisation Data management
- Constructor

Chief designer/architect:
Assess KPIs for each alternative.
Perform the alternative selection (matching KPI levels with target values).
Prepare the selected alternative for further design or actions.
Phase consists of

- Design with developing BIM model from LOD2 to LOD4 with help of analyses and collaborative reviews
  - From Selected Alternative to Concept design solution (1/2)
  - From Concept design (LOD2) to Final Design solution (LOD 4)
- Final performance assessment to support client’s decision making.

When using or showing any of the slides please refer to the source: VTT, 2017
Retrofit & maintenance modelling/ Studying the alternatives (LOD1-2)

- End-user
  - Client
- Project management
- Facility management
- Authorities
- Design group management
- Holistic EE –design
  - Supported by Design Components
- D4E portal:
  - Model checking
  - Analyses
  - Collaboration
  - Visualisation
  - Data management
- Constructor

- Requirements model
- Design brief
- Project starts
- Up-dated Requirements model
- Selected Retrofit concept alternative
- Selected Alternatives (ARCH, LOD 1-2)
- eFuture changes

Design4Energy FACILITATOR
**Client:** Produce retrofit or maintenance brief. Define KPIs. Upload the brief to D4E portal.

**Design group management**

- **Holistic EE – design**
  - Supported by Design Components

- **Selected Alternatives**
  - (ARCH, LOD 1-2)

**D4E portal: Model checking Analyses**

- Collaboration
- Visualisation
- Data management

**Constructor**

**End-user**

- Client

**Project management**

**Facility management**

**Authorities**

**Up-dated Requirements model**

**Selected Retrofit alternative**

**Soft gate**

**Retrofit & maintenance modelling/ Studying the alternatives (LOD 1-2)**
**Chief designer /Architect:** Access as designed (LOD2) concept models from previous phase. Search from D4E project information platform.

Develop the architectural design using D4E component library and using performance indicators as search criteria (Option generator service).

**GUIDELINE**

**Architect:**
Follow modeling guidelines: Handover for EE - simulation

**D4E portal:**
Model checking Analyses Collaboration Visualisation Data management

**Soft gate**
Retrofit & maintenance modelling/ Studying the alternatives (LOD1-2)

End-user
Client

Project
management

Facility
management

Authorities

Design group
management

Holistic
EE –design
Supported by
Design
Components

D4E portal:
Model checking
Analyses
Collaboration
Visualisation
Data management

Constructor

Design brief

Requirements model

Project starts

Selected Alternatives
(ARCH, LOD 1-2)

D4E portal:
Model checking
Analyses
Collaboration
Visualisation
Data management

Chief designer /expert
designers Run EE-
simulations and energy
matching for each
alternative

Design group:
Review neighbourhood
implications.
Review adaptability
(evolutionary aspect)

Up-dated
Requirements
model

Selected Retrofit
alternative

See checklist for
design review
Retrofit & maintenance modelling/ Studying the alternatives (LOD1-2)

End-user
Client

Project management

Facility management

Authorities

Design group management

Holistic EE –design
Supported by Design Components

D4E portal:
Model checking Analyses
Collaboration Visualisation
Data management

Constructor

Design brief

Requirements model

Project starts

Selected Alternatives (ARCH, LOD 1-2)

eFuture changes

Selected Retrofit alternative

Up-dated Requirements model

Design group: Review the KPIs. Agreed with the proposed solution to the client. Use the checklists to facilitate the review. Prepare the presentation to client, including results (reports) from analyses and final KPI assessment.

Design4Energy FACILITATOR
Design4Energy

Project
management

End-user
Client

Facility
management

Authorities

Design group
management

Holistic
EE – design
Supported by
Design
Components

D4E portal:
Model checking
Analyses
Collaboration
Visualisation
Data
management

Constructor

Retrofit & maintenance modelling/ Studying the alternatives (LOD 1-2)

**Design brief**

**Project starts**

**Client:** Studying assessment results of the concept alternatives and choosing one alternative for detailed design.

**Selected Retrofit alternative**

**eFuture changes**

**Up-dated Requirements model**

**Selected Alternatives (ARCH, LOD 1-2)**

**Requirements model**

**Requirements model**

**Client:** Studying assessment results of the concept alternatives and choosing one alternative for detailed design.

**Up-dated Requirements model**

**Selected Retrofit alternative**

**eFuture changes**

**Selected Alternatives (ARCH, LOD 1-2)**

**Requirements model**

**Client:** Studying assessment results of the concept alternatives and choosing one alternative for detailed design.
The design team identify what could be the potential future changes and their possible outcomes and effects to the building energy design. If there are many possible solutions to adapt to change situations, their performance should be assessed and the best alternative selected.
Design Advisory

The design team should together identify what could be the potential future changes and their possible outcomes and effects to the building energy design. If there are many possible solutions to adapt to change situations, their performance should be assessed and the best alternative selected. The checklists for some typical future changes that could be considered in the design process in the scope of D4E are the following:

1. Consider changes of energy pricing:
   - Price of energy increases or decreases: is the overall energy solution still profitable and costs on an acceptable level? For example, if the energy price is 20% higher, how does the energy system reflect to the changed circumstances?
   - Flexibility in energy demand: consider e.g.:
     What energy loads could be adapted according to the price of energy?
     Would it be possible to shift energy loads to other times if profitable?
   - Can the Building Energy Management System adapt the energy demand in a flexible manner? How easy/difficult it would be, can it be automatized?
   - How easily the electrical equipment can be automatically managed?
   - Would it be possible to add energy storage? It could be one future strategy to cope with increasingly fluctuating real-time energy prices (avoiding of expensive peak hours). More fluctuation in electricity pricing (among others due to increasing the share of RES), which can cause significant fluctuation in the real time electricity pricing and cause more often expensive electricity price tariffs at some times.
   - Long term future changes (over 50 years) in the energy markets and business can affect radically to the needed technical building services and building structure changes.

2. Consider demographical changes in community:
   - Changes in the family sizes, e.g. increasing demand for smaller apartments.
   - Changes in the population, which can be forecasted with:
     urban planning tools and service network analysis, forecasting of district energy system changes, forecasting the need for public service spaces (e.g. schools, day care centres), system dynamic method.
   - What if: the neighbourhood is under development within the next 20 years – what would be optimal layout and size of apartments in a building in order to maximise the profit?
Design Advisory

The design team should together identify what could be the potential future changes and their possible outcomes and effects to the building energy design. If there are many possible solutions to adapt to change situations, their performance should be assessed and the best alternative selected. The checklists for some typical future changes that could be considered in the design process in the scope of D4E are the following:

3. Consider changes in the people behaviour:
   - Changes in the people behavior:
     e.g. ownership of cars: how many people need private car parking facilities. Transportation and use of private cars influences the need of parking facilities, which are often expensive.
     Effects to the space demand of the bicycle storages.
   - What if cars are increasingly used as energy storage in the future? Already now e.g. electricity plug-ins are available often in Nordic private car parking places.
   - How to increase the flexibility of energy demand?
   - Could demand response in peak load shifting be used in the building?
   - Increasing demand for individual control of users to adjust the building performance, e.g. temperature, ventilation, and cooling.

4. Consider changes in the usage profiles of spaces: possibilities to adapt the space usage e.g. from office to residential building:
   - Adaptability is achieved by design strategies, such as flexible routes of HVAC systems, spatial buffers and/or space allocation.
   - Changes in cultural behavior: e.g. in Finland one common sauna in an apartment building instead of private saunas in each apartment.
   - Different user preferences concerning flexibility: e.g. early adapters.
   - Awareness of energy usage among residents can increase the efficiency of energy use, e.g. through the comparison of individual residents’ consumption to the average energy consumption in the same or similar building, district and city; and showing of real-time energy usage. This could reduce the energy demand.
   - What space usage mix could provide the best energy matching option (especially in large building complexes and in relation to the neighbourhood)?
   - How building space use efficiency could be improved?
Design Advisory

The design team should together identify what could be the potential future changes and their possible outcomes and effects to the building energy design. If there are many possible solutions to adapt to change situations, their performance should be assessed and the best alternative selected. The checklists for some typical future changes that could be considered in the design process in the scope of D4E are the following:

5. Consider changes in the local energy production
   - Changes in the surplus production amount.
   - Changes in preference limits for local energy generation. Energy tariff strategies can be either dynamic or fixed price level.
   - Critical changes in local RES technologies with significantly reduced costs can change the local energy markets and supply.

6. Consider changes in neighbourhood
   - Other building types in the neighbourhood: how could they affect?
   - What if there will be new buildings (or other shading), which reduces on-site solar production in the existing building?
   - Shading or mirroring effects from neighbouring buildings, e.g. mirroring effect from the nearby building can increase the need for cooling in an office building.
   - If new ground heat pump boreholes will be put nearby existing heat pumps’ boreholes, potential temperature changes to the existing system, and hence, the co-efficiency of the performance of the heat pumps can reduce.
Design Advisory

The design team should together identify what could be the potential future changes and their possible outcomes and effects to the building energy design. If there are many possible solutions to adapt to change situations, their performance should be assessed and the best alternative selected. The checklists for some typical future changes that could be considered in the design process in the scope of D4E are the following:

7. Climate change
   - What kind of effects could be caused from changes there could be on the local weather and climate? What are the risks?
   - How can the building to be designed, or its site, protect local environment to suffer risks of climate change?
   - How can the building to be designed adapt or be highly resilient for the changes caused by the climate?
   Extreme climate events: rains, floods, winds, variation of cold and warm temperature, drought.

8. Regulatory changes
   - Potential new requirements for the energy performance of the building.
   - We know the EU-strategy for nearly zero energy buildings.
   This means that the target should be set there’re, as the new regulations are already on place when the next renovation cycle occurs (30 years cycle).
   There is also a need for using local renewable energy sources because the target level is not reachable otherwise, at least in Nordic countries.

9. Changes in technologies
   - What if cars are increasingly used as energy storage in the future? Already now e.g. electricity plug-ins are available often in Nordic private car parking places.
   - Would it be possible to add energy storage? It could be one future strategy to cope with increasingly fluctuating real-time energy prices (avoiding of expensive peak hours). More fluctuation in electricity pricing (among others due to increasing the share of RES), which can cause significant fluctuation in the real time electricity pricing and cause more often expensive electricity price tariffs at some times.
   - What kind of improvements could be coming to smarter and more efficient, more automatized building energy management systems? Solutions for improved energy matching of demand and production on site, optimisation of energy costs, etc.
Phase consists of

• Design with developing BIM model from LOD2 to LOD4 with help of analyses and collaborative reviews
  – From Selected Alternative to Concept design solution (2/2)
  – From Concept design (LOD2) to Final Design solution (LOD 4)
• Final performance assessment to support client’s decision making.
Retrofit & maintenance modelling/ Concept design (LOD2)

End-user
Client

Project
management

Facility
management

Authorities

Design group
management

Holistic
EE –design
Supported by
Design
Components

D4E portal:
Model checking
Analyses
Collaboration
Visualisation
Data
management

 MEP and HVAC spatial
requirements

From Selected alternative (LOD1-2)
to Concept Design Solution (LOD2)

As-designed (LOD2)

Requirements
model

Updated
Requirements model

Analysis
reports from
previous
phase

Selected Alternative
ARCH, LOD 1-2)

Design4Energy
FACILITATOR
Retrofit & maintenance modelling/ Concept design (LOD2)

**Client:** Studying assessment results of the previous phase and choosing one alternative for concept design.

**End-user Client**
- Analysis reports from previous phase
- Updated Requirements model

**Project management**

**Facility management**

**Authorities**

**Design group management**

**Holistic EE – design**
- Supported by Design Components
- Selected Alternative ARCH, LOD 1-2)

**D4E portal:**
- Model checking
- Analyses
- Collaboration
- Visualisation
- Data management

**Constructor**

**From Selected alternative (LOD1-2) to Concept Design Solution (LOD2)**

**As-designed (LOD2)**

**MEP and HVAC spatial requirements**

**Client:** Studying assessment results of the previous phase and choosing one alternative for concept design.
**Design group**

- **Design group**: Studying clients requirements for concept design.
- **Design Kick-off meeting**

**D4E portal:** Model checking analyses, collaboration, visualisation, data management

**Holistic EE –design**

- Supported by Design Components

**Requirements model**

- Analysis reports from previous phase
- Updated Requirements model

**Retrofit & maintenance modelling/ Concept design (LOD2)**

- **From Selected alternative (LOD 1-2) to Concept Design Solution (LOD2)**
- **As-designed (LOD2)**

**MEP and HVAC spatial requirements**

**End-user**

- **Client**

**Project management**

**Facility management**

**Authorities**

**Design group management**

**Selected Alternative ARCH, LOD 1-2**

**Updated Requirements model**
Retrofit & maintenance modelling/ Concept design (LOD2)

End-user
Client

Project management

Facility management

Authorities

Design group management

Holistic EE –design
Supported by Design Components

D4E portal:
Model checking
Analyses
Collaboration
Visualisation
Data management

Constructor

Analysis reports from previous phase

Updated Requirements model

Requirements model

Improve concept design.

**Architect and structural engineer:**
Modelling to LOD 2 level using project catalogue.

**HVAC and electrical engineer:**
Defining spatial requirements and communicating them to chief designer.

Selected Alternative (ARCH, LOD 1-2)

From Selected alternative (LOD1-2) to Concept Design Solution (LOD2)

As-designed (LOD2)

GUIDELINE

MEP and HVAC spatial requirements

Updated Requirements model

Analysis reports from previous phase
**Retrofit & maintenance modelling/ Concept design (LOD2)**

- **End-user Client**
  - Analysis reports from previous phase

- **Project management**
  - Updated Requirements model

- **Facility management**
  - Holistic EE –design Supported by Design Components
  - Selected Alternative ARCH, LOD 1-2)

- **Authorities**
  - MEP and HVAC spatial requirements

- **Design group management**
  - From Selected alternative (LOD1-2) to Concept Design Solution (LOD2)

- **D4E portal: Model checking Analyses Collaboration Visualisation Data management**

- **Constructor**
  - BIM coordinator/ chief designer and design group:
    - Prepare models and designs for early quantity take off and cost calculation (ROI and LCC).
  - Experts: Run the cost analyses and share results in common working environment
  - BIM service. Run the simulations

**Requirements model**
Chief designer: Review (design group internal) the KPIs agree with the proposed solution to the client. Use the checklists to facilitate the review.

Prepare the presentation to client, including results (reports) from analyses and final KPI assessment.
**Chief designer:**
Presentation to client, LOD 2 alternative(s) with main solutions.

**Client:** Study assessment results of the concept alternatives and choose one alternative for detailed. Use requirement model to compare indicator values.

**Design group management**
- Updated Requirements model
- Selected Alternative ARCH, LOD 1-2)

**Holistic EE –design Supported by Design Components**
- MEP and HVAC spatial requirements

**D4E portal: Model checking Analyses Collaboration Visualisation Data management**

**End-user Client**

**Project management**

**Facility management**

**Authorities**

**Constructor**
Phase consists of

- Design with developing BIM model from LOD2 to LOD4 with help of analyses and collaborative reviews
  - From Selected Alternative to Concept design solution
  - From Concept design (LOD2) to Final Design solution (LOD 4)
- Final performance assessment to support client’s decision making.
Retrofit & maintenance modelling/ Detailed and final design (LOD2 -> LOD4)

End-user Client

Project management

Facility management

Authorities

Design group management

Holistic EE –design
Supported by Design Components

D4E portal: Model checking Analyses Collaboration Visualisation Data management

Constructor

Design brief for detailed and final design

Concept design (LOD2)

From Concept design (LOD2) to Final design (LOD4)

Requirements model

As-designed (LOD4)
**Client:** Produce retrofit design brief for detailed and final design. Define KPIs in more detailed level if necessary.
Retrofit & maintenance modelling/ Detailed and final design (LOD2 -> LOD4)

End-user Client

Project management

Facility management

Authorities

Design group management

Holistic EE – design
Supported by Design Components

D4E portal:
Model checking Analyses Collaboration Visualisation Data management

Constructor

Design brief for detailed and final design

Chief designer: Organize a design kick-off meeting to review clients brief.

All designers: Improve design models. Use product catalogue, add attributes.

From Concept design (LOD2) to Final design (LOD4)
Design4Energy

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End-user
Client

Project
management

Facility
management

Authorities

Design group
management

Holistic
EE –design
Supported by
Design
Components

D4E portal: Model checking
Analyses
Collaboration
Visualisation
Data management

Constructor

Retrofit & maintenance modelling/ Detailed and final design (LOD2 -> LOD4)

Design brief for detailed and final design

Concept design (LOD2)

From Concept design (LOD2) to Final design (LOD4)

As-designed (LOD4)

Requirements model

BIM coordinator and Chief designer:
Prepare the BIM models for coordination.

Design check list

FACILITATOR
Chief designer: Organize model clash detection meetings with all design disciplines. Share reports for problem solving (design solutions). Facilitate clash checking review using preferred indicators of each design discipline. Iterate meetings as many times as needed, in particular LOD phase.
Design4Energy

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Project
management

End-user
Client

Retrofit & maintenance modelling/ Detailed and final design (LOD2 -> LOD4)

Chief designer: Organize meetings with maintenance and facility operational experts to check appropriate maintainability level. Seek for holistic solutions. Review neighbourhood implications Review adaptability (evolutionary aspect)

Design brief for detailed and final design

Concept design (LOD2)

Facility
management

Authorities

Chief designer

Chief designer

Design group
management

Holistic
EE –design
Supported by Design Components

D4E portal:
Model checking Analyses Collaboration Visualisation Data management

Constructors

Requirements model

As-designed (LOD4)

From Concept design (LOD2) to Final design (LOD4)
Chief designer/ BIM coordinator /designers: Prepare all design models for a quantity take off and detailed cost calculation and CO2 analyses. Prepare analytical model for energy analyses and for energy matching. Perform the analyses and generate reports from analyses results.
Retrofit & maintenance modelling/ Detailed and final design (LOD2 -> LOD4)

Chief designer with design group: Review the KPIs agreed with the proposed solution to the client. Use the checklists to facilitate the review.

Design check list

Prepare the presentation to client, including results (reports) from analyses and final KPI assessment.

From Concept design (LOD2) to Final design (LOD4)
Retrofit & maintenance modelling/ Detailed and final design (LOD2 -> LOD4)

End-user
Client
Project management
Facility management
Authorities
Design group management
Holistic EE – design
Supported by Design Components
D4E portal: Model checking Analyses Collaboration Visualisation Data management
Constructor

Chief designer:
Presentation to client and client’s approval on final design models to be used for procurement
Prepare detailed design documentations and the integrated model for call for tenders.

Design brief for detailed and final design

From Concept design (LOD2) to Final design (LOD4)
**Handover from architectural design model to analytical model for EE simulation.**

**Modelling guideline for architect (using Revit software)**

<table>
<thead>
<tr>
<th>Number</th>
<th>Guideline</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Turn on the 'Areas and Volumes' option in Architecture &gt; Room and Area (panel)</td>
</tr>
<tr>
<td>2</td>
<td>Go to coarse view and press TL for thin lines. This ensures that multiple layers can be identified more easily. Resolve multiple layers (e.g. ceilings and slabs)</td>
</tr>
<tr>
<td>3</td>
<td>Make columns non-room-bounding</td>
</tr>
<tr>
<td>4</td>
<td>Run interference checks (in the Collaborate tab) and resolve any warnings about overlapping building elements when possible</td>
</tr>
<tr>
<td>5</td>
<td>Change function of external walls and ground floors to 'exterior'</td>
</tr>
<tr>
<td>6</td>
<td>Make half-height internal walls non room bounding</td>
</tr>
<tr>
<td>7</td>
<td>Replace bay windows with windows directly on the main wall</td>
</tr>
<tr>
<td>8</td>
<td>Use the 'Automatically Embed' option to place curtain glazing within walls instead of making holes in the wall's profile</td>
</tr>
<tr>
<td>9</td>
<td>Assign spaces to all areas, including lifts, risers, and voids</td>
</tr>
<tr>
<td>10</td>
<td>Assign space to roof so that it can be extracted from Revit, otherwise it is ignored</td>
</tr>
<tr>
<td>11</td>
<td>Ensure space limits are sufficient for each space to have a bounding element or another space at the top and bottom</td>
</tr>
<tr>
<td>12</td>
<td>Ensure spaces are set to Unoccupied by unticking the Occupiable selection and Unconditioned where/when required</td>
</tr>
<tr>
<td>13</td>
<td>Add zones and assign spaces</td>
</tr>
<tr>
<td>14</td>
<td>Add separate zone to unoccupied spaces</td>
</tr>
<tr>
<td>15</td>
<td>In Analyze &gt; Energy Settings &gt; Energy Model – Building Services set appropriate settings</td>
</tr>
<tr>
<td>16</td>
<td>Occupancy, lighting and equipment settings can be addressed in each space individually. The relevant schedules are linked to the Building Type option during gbXML export and can be viewed in Manage &gt; MEP Settings &gt; Building/Space Type Settings</td>
</tr>
<tr>
<td>17</td>
<td>Infiltration can be set by selecting the Zone and managing the Energy Analysis options or by following point 16 above.</td>
</tr>
<tr>
<td>18</td>
<td>Heating system can be set following point 16 above but is not transferred in gbXML. Only the designHeatT and designCoolT are exported in gbXML.</td>
</tr>
<tr>
<td>19</td>
<td>In the gbXML export options ensure that appropriate settings are defined for the building. The Export Category needs to be set to Spaces. The export Complexity needs to be set to Simple or Simple with shading. The Building Construction needs to be selected and the None should be clicked to ensure that the actual constructions and thermal properties of the elements are not overridden by defaults.</td>
</tr>
<tr>
<td>20</td>
<td>Export gbXML and check on a viewer (e.g. SketchUp's OpenStudio Plugin)</td>
</tr>
</tbody>
</table>
**Check list for internal design group review for ee-design**

**Overall Design Advisory**

- The overall energy efficiency and sustainability of a building composes of various design decisions related to energy efficiency and used energy sources. Accordingly, holistic energy solutions are required when targeting to the best possible buildings’ energy design.

- The holistic energy design of buildings should primarily target to minimise the energy demand without compromising the good quality of using the building. In addition, holistic energy design should include the optimal use of renewable energy sources, as well as minimising the CO2 emissions and optimising the energy costs.

- In the target setting phase, the target values are set for the energy demand, renewable energy sources use, CO2 emissions and energy costs. As continuation in the concept design phase, potential and available energy design options are identified and the main concept for the building energy solution is drafted according to the targets. In practise, this can mean e.g. minimising the energy demand with passive design solutions, giving priority to local and on-site renewable energy sources (solar energy, biomass based heat production, heat pumps etc.). At the same time, energy costs should be considered against set targets and planning how to manage the energy demand and selling of excess energy (if available). In many cases, the focus is to minimise the costs of heating, cooling and electricity demands and production among others through energy matching with the entire neighbourhood. In the detailed design, the detailed design decisions are done, while the overall energy system should be still kept in mind.

| See checklist for architectural design (EE passive design) | See checklist for energy designer |
| See checklist for design group review (arch, HVAC, structural) | See checklist for structural designer |
| See checklist for HVAC designer |
## Check list for design reviews.

**ARCHITECT**

### Energy efficient building design ("passive mode"): 

<table>
<thead>
<tr>
<th>Location and Site selection:</th>
<th>Micro climate</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Appropriate use of passive solar energy in winter Orientation of the building</td>
<td>• Check that reflecting sun of neighbouring buildings and its impact to the indoor climate.</td>
</tr>
<tr>
<td>• Passive cooling, e.g. natural shading for reduced summer time cooling demand</td>
<td>• Check that local winds are supporting usability</td>
</tr>
<tr>
<td>• Consider shadow effects (buildings around and tall trees)</td>
<td>• Consider vegetation as shading to support comfort</td>
</tr>
<tr>
<td>• Consider general climate parameters</td>
<td>• Orientation of building block to best directions considering use of renewable energy sources</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Building volume</th>
<th>Massive walls</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Consider efficient form (Volume factor &lt;1)</td>
<td>• Use for sun harvesting with internal massive structural elements between heating and cooling season (spring and autumn). Be careful with overheating.</td>
</tr>
<tr>
<td>• Look for usable lay-outs/ considering functionality</td>
<td>• Use for balancing heat gains to minimize cooling peak during summer time.</td>
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<tr>
<td>• Efficient massing and lay out considering low energy demand.</td>
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<tr>
<td>• Avoid unnecessary corners/ windows/ bay window in the principal massing, as they increase thermal losses of the envelope.</td>
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<tr>
<td>• Use rectangular volumes as principal massing concept.</td>
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<tr>
<td>• Use entry locks.</td>
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<table>
<thead>
<tr>
<th>Openings</th>
<th>Shadings against sun (external and internal)</th>
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<tbody>
<tr>
<td>• Primary function is focusing on natural lighting and views out through openings.</td>
<td>• Use shading elements to block the sun (heat load). Do not spoil your design concept of natural lighting and views out.</td>
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<tr>
<td>• Secondary Passive solar utilisation during heating season.</td>
<td>• Use supplementary building parts and elements of the facade to create sufficient shading.</td>
</tr>
<tr>
<td>• Optimize with appropriate shadings for good summer thermal comfort (avoid overheating).</td>
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</tbody>
</table>

### Co-design with energy expert and HVAC for technical spaces  
- Locations and size of energy production and storage equipment  
- Spatial needs for systems and equipment  

### Efficient renewable energy production on-site:  
- Preliminary identification of possible placing of renewable energy production equipment (e.g. solar panels and heat collectors on roof surfaces, heat pump (pumping station at the building and location of bore holes in the yard).  
- Efficient use of roof for active solar systems by adequate roof pitch
Check list for internal design group review

ARCHITECT together with STRUCTURAL and HVAC DESIGNERS

Aim for as simple as possible solutions to increase the reliability of the solutions.

- Compactness of the house for reduced heat losses.
  - In detailed design: use HVAC and building components from D4E library
- Window design for passive solar energy utilisation.

- Spatial needs and lay-outs
  - Routing needs and technical room in dwelling unit design.
  - Placing of kitchen appliances, heating equipment, water heaters etc. for utilization of internal heat loads.

- Thermal and moisture technical design and analyses
  - Thermal insulation of building surfaces.
  - Minimize thermal bridging or use exterior insulation systems to reduce thermal losses.
  - Consider the need of all structural components; they may influence on thermal properties and cost efficiency.
  - Use modular dimensions, e.g., 600 mm for frame walls and windows.
  - Consider moisture dry-out from thick structures; avoid double vapour barriers in wet rooms.

Indoor climate
  - Design for air barrier. Installations inside air barrier for air tightness.
  - Design for wind barrier.
  - Consider ways and means to seal all components leading through a structure.

- Ventilation
  - Space allocation for routing of ventilation duct work.
  - Terminal inlets and directness of ventilations duct work in spatial planning.

- Quality
  - Consider the order of site work already in design.
Check list for design reviews.  
ENERGY EXPERT

Use of renewable energy sources
- Identify local available renewable energy sources (solar, wind, geoenergy, bio fuels) and their maximum potential for utilisation.
- Check the availability of the space and the preliminary plans for on-site renewable energy production from architect and from structural designer (e.g. space for a mounting of solar panels, heat collectors or a wind mill).

Energy concept
- Preliminary design of energy production needed for the energy demand (district heating, cooling, gas, boiling, etc.) and inform HVAC planner about this energy concept.
- Respond to energy demand with dimensioning of energy mix using as much renewable energy sources as possible
  - Geothermal
  - Sun power
  - Wind
  - Biofuels

Analyses and collaboration
- Analysing of energy matching and neighbourhood impacts with the indicators from the target setting.
  - Decisions based on KPIs
- Sizing /dimensioning
  - Sizing of the local energy grid connection (for heating, cooling, gas, electricity)
- Co-design with architect and HVAC for technical spaces
  - Locations and size of energy production and storage equipment
  - Spatial needs for systems and equipment
- Preliminary and detailed design of energy storages if required.
Check list for design reviews.
STRUCTURAL DESIGN

Spatial needs
• Consider space requirements for HVAC installations

Indoor climate
• Minimize thermal bridging or use exterior insulation systems to reduce their effects.
  o Design for air barriers for through-holes of technical installations.
  o Design joints with air barriers. Consider ways and means to seal all components leading through a structure.
  o Design for wind barrier
  o Use modular dimensions, e.g., 600 mm for frame walls and windows, in order to minimise thermal bridges

Energy concept
• Massive walls
  o Use for sun harvesting with internal massive structural elements between heating and cooling season (spring and autumn). Be careful with overheating.
  o Use for balancing heat gains to minimize cooling peak during summer time.
• Consider the need of all structural components; they may influence on thermal properties and cost efficiency.

Quality
• Consider the order of site work already in design.
• Consider moisture dry-out from thick structures; avoid double vapour barriers in wet rooms.
Check list for design reviews.
HVAC DESIGNER

Design level KPIs are communicated these metrics as starting points for concept design phase:

- Thermal loss parameters of envelope components
  - U-value and G-value of windows
- Occupancy
- Hot water consumption, Hot water heat recovery
- Internal energy loads according to purpose use
- Lighting profiles according to purpose use

Management of EE key performance indicators

- Technical system selection and sizing: heating, cooling, ventilation, electricity and automation.
  - Choosing systems, equipment and building objects from component catalogue based on performance
  - Decisions based on KPIs

Consider space requirements for HVAC installations and renewable energy production.

- Check Routings together with architect and structural designer

<table>
<thead>
<tr>
<th>Facade</th>
<th>Control</th>
<th>Dimensioning</th>
<th>Indoor climate</th>
<th>Comfort</th>
<th>Energy calculation</th>
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</table>

- Facade
  - Draught control and window size
  - Solar control

- Control
  - Thermal mass assessment

- Dimensioning
  - Ventilation heat recovery
  - Ventilation air flow and schedules
  - Minimum ventilation rate and control

- Indoor climate
  - Ventilation Inlet terminal placing
    - place and mixing strategy
  - Draught control
  - Lighting levels
  - Overheating and simulations
  - Noise control

- Comfort
  - Wet room heating

- Energy calculation
Check list for review of integrated model (model checking).
Internal meeting of the design group

A short checklist to support the preparation for model integrations

Each designer individually:
- Check domain BIM model that it is technically solid and contains the right information content (level of development) in right details (level of details, also in attribute data)
- Publish and upload you model to the D4E portal

Chief designer:
• Prepare the agenda for model checking
  – Plan the proper order the domain models will be merged with each other (for example HVAC with STRUCT, then STRUCT with ARCH, then HVAC with ARCH)
  – List the key design issue to be discussed in the review
  – Invite experts if needed for design content evaluation (for instance: constructability and maintainability)
• Distribute agenda
• Facilitate the design review meeting and prepare report

BIM coordinator:
– Run testing round with merging of the domain models
– Communicate any technical issues with chief design and domain designers
Check list for internal design group review for running KPI assessment

A short checklist to support the preparation for main KPI assessment (before each hard gate).

- Calculate each strategic indicator with appropriate method (all results are based on energy simulation and energy matching analysis).
- Run multi-criteria calculation in the assessment tool.
- Assessment results are visualised in the virtual working space. Study each indicator.
- Compare design value and indicator specific scores to the target value levels.

- Seek for design solutions (with a component library), which reach the target values.
- Consider neighbourhood aspects through each design level (holistic design).
- Consider flexibility for future changes (evolutionary design).
- Collaborate with the design team to find most balanced design solution. Use integrated BIM to support discussion.
Explanation of the symbols used in Facilitator

SYMBOLS

When using or showing any of the slides please refer to the source: VTT, 2017
When using or showing any of the slides please refer to the source: VTT, 2017
Analysis 1/2

- Quantity
- Rent management
- Visualisation
- Fire
- Procurement
- Cost estimation
- LCC
- 4D scheduling
- Safety
- Lighting
- Spaces
- LCA
- Acoustics

When using or showing any of the slides please refer to the source: VTT, 2017
Analysis 2/2

Indoor environment  | Thermal flow  | Clash checking
Upkeep            | Maintenance   | Cleaning
Use               | Consumption   | Energy matching
Assessment        | Collaboration | Data sharing

Decision

When using or showing any of the slides please refer to the source: VTT, 2017
Model based on...

- Registers
- Component catalogue data
- Attribute level data

When using or showing any of the slides please refer to the source: VTT, 2017
For further information please contact tarja.makelainen@vtt.fi

Presentations (power point slides with hyperlinks) are shared on request.

Open source development efforts for any testing of the Facilitator (or part of it) is highly appreciated.

When using or showing any of the slides please refer to the source: VTT, 2017