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 (in this slide set)

- Guide for BIM models and model uses in Retrofit (see separate slide set)
Preliminary concept design activities

- **Preliminary concept design activities** may happen in the beginning of concept design. The origin of these activities is in re-engineering of processes to enable all BIM modelling and process benefits. The phase is one of RIBA phases and is included in BIM guidelines.

- Many possible very rough alternatives are analysed in order to find most promising ones
  - Alternatives LOD is based on massing volume geometry and very rough information about orientation - openings - main windows

- D4E project explains a concept where energy parameters are used to find most promising volumes for further studies.

=> If there has not been a feasibility study during the programing phase, it is wise to include preliminary concept design activities to the early design stages
<table>
<thead>
<tr>
<th>Early design stages</th>
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<tr>
<td>Stage 1: Brief</td>
<td>Stage 2: Concept</td>
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<tr>
<td>Need identification</td>
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<td>Requirement and</td>
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Procurement: Design brief with KPIs
Guide for BIM models and model uses in Concept design

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

- Need identification
- Requirements and feasibility study

Concept design/energy simulation

Assessment

- Concept design/energy matching

Stage 0 Strategy
Stage 1 Brief
Stage 2 Concept
Stage 3 Definition
Stage 4 Design
Stage 5 Build
Stage 6 Commission
Stage 7 Operation
Concept design and simulation

Phase consists of

- Design and simulation consist of exploring technology options (using D4E library databases), producing initial design alternatives and running energy simulations for each design alternative (energy + energy matching). Finally, the alternatives and their analysis result are reviewed and best concept design solution is decided.

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

Concept design (Design alternatives and energy simulation)

From many alternatives (ARCH) to few Concept Design Solution (LOD2), building level EE

Energy simulations and what-if analysis (changing variables)

Model checking and filtering

Requirement model

Feasibility results (used models)

Feasibility study

Requirements model

Soft gate
Concept design (Design alternatives and energy simulation)

Chief designer: Review brief and feasibility results in order to communicate clients need to the design group.

Access architectural models (feasibility study models) on D4E project information platform
**Concept design (Design alternatives and energy simulation)**

**Chief designer + team**: Pre-design architectural alternatives considering client’s targets and end-user needs (= requirements model). Use D4E Component library.

See checklist for arch. design

From many alternatives (ARCH) to few Concept Design Solution (LOD2), building level EE

**Model checking and filtering**

Energy simulations and what-if analysis (changing variables)

**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**
**Concept design (Design alternatives and energy simulation)**

**End-user Client**
- Feasibility study

**Project management**

**Facility management**
- Requirement model

**Authorities**

**Design group management**
- Feasibility results (used models)

**Holistic EE – design**
- Supported by Design Components
- Model checking
- Analyses
- Collaboration
- Visualisation
- Data management

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

**Constructor**
- Chief designer/BIM coordinator: Generate Analytical models from each Alternatives (eeBIM filtering service in D4E platform)

**Feasibility study**
- Requirements model

**From many alternatives (ARCH) to few Concept Design Solution (LOD2), building level EE**

**Model checking and filtering**

**Energy simulations and what-if analysis (changing variables)**

**Soft gate**
Concept design (Design alternatives and energy simulation)

**Chief designer/Energy expert:** Prepare for simulations in composing a set of boundary conditions for future scenarios (e.g. for climate and cost changes).

**Energy expert/Chief designer:** Perform the energy analyses for each alternative keeping target values in mind. Change variables according to design team's brief.

Generate simulation reports. See checklist for energy designer.

Energy simulations and what-if analysis (changing variables)
Chief designer/ Design team: Compile the KPIs from the simulation results for each alternative according to the client’s preferences. Review (design group internal) simulation results of the alternatives and agree with the proposed solution to the client. Prepare the presentation to client.
Concept design (Design alternatives and energy simulation)

**Chief designer**: Presentation to client and client’s approval on the selected alternatives. Prepare the EE report of the selected alternatives for building authorities.

**Client/Project manager**: Decisions and guidance for the next phase.
Concept design and energy matching

Phase consists of

- Energy matching analyses, which explore the potential technology options according to the set target values set (requirements), based on EE-simulated architectural alternatives and the potentialities of a neighborhood level energy grid.
Concept design (Design alternatives and energy matching)

From many alternatives (ARCH) to few Concept Design Solution (LOD2), building level EE with energy matching

Same alternatives and analyses model are used as in previous activity (EE-simulation)

Energy matching analyses and what-if analysis (changing variables)
**Concept design (Design alternatives and energy matching)**

**Chief designer:** Review EE (energy simulation result in order to communicate clients need to the design group. Create shared understanding among design disciplines.

**Design group:**
Study each building level concept solutions and alternatives. Access architectural models and simulation results on D4E project information platform.

From many alternatives (ARCH) to few Concept Design Solution (LOD2), building level EE with energy matching.

**Same alternatives and analyses model are used as in previous activity (EE-simulation)**

**Energy matching analyses and what-if analysis (changing variables)**
<table>
<thead>
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<th>Facility management</th>
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<th>Design group management</th>
<th>Holistic EE –design Supported by Design Components</th>
<th>D4E portal: Model checking Analyses Collaboration Visualisation Data management</th>
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**Chief designer/Energy expert:** Prepare for energy matching analyses in composing a set of boundary conditions (e.g. for climate (solar/ wind potentials) as well as local gas, district heating, district cooling and electricity networks properties).

From many alternatives (ARCH) to few Concept Design Solution (LOD2), building level EE with energy matching

Same alternatives and analyses model are used as in previous activity (EE-simulation)

Energy matching analyses and what-if analysis (changing variables)
**Concept design (Design alternatives and energy matching)**

From many alternatives (ARCH) to few Concept Design Solution (LOD2), building level EE with energy matching.

**Requirements model**

**Energy expert/Chief designer:** Perform the energy matching analyses for each architectural alternative keeping target values in mind. Generate energy matching reports.
Chief designer + design team: Compile the KPIs from the energy matching analyses results for each architectural alternative according to the client’s preferences and select the best energy matching solution. Review (design group internal) the energy matching results of the alternatives and agree with the proposed solution to the client. Prepare the presentation to client, including results (reports) from analyses and KPI assessment.
Chief designer: Presentation to client and client’s approval on the selected alternative (including architectural solution with low energy demand and holistic neighbourhood level energy matching).

Prepare the energy matching report of the selected alternative for building authorities.

From many alternatives (ARCH) to few Concept Design Solution (LOD2), building level EE with energy matching.

Same alternatives and analyses model are used as in previous activity (EE-simulation).

Energy matching analyses and what-if analysis (changing variables).
Check list for design reviews.
ARCHITECT
Energy efficient building design ("passive mode"): 

Location and Site selection:
- Appropriate use of passive solar energy in winter Orientation of the building
- Passive cooling, e.g. natural shading for reduced summer time cooling demand
- Consider shadow effects (buildings around and tall trees)
- Consider general climate parameters

Building volume
- Consider efficient form (Volume factor <1)
- Look for usable lay-outs/considering functionality
- Efficient massing and lay out considering low energy demand.
- Avoid unnecessary corners/ windows/ bay window in the principal massing, as they increase thermal losses of the envelope.
- Use rectangular volumes as principal massing concept.
- Use entry locks.

Openings
- Primary function is focusing on natural lighting and views out through openings.
- Secondary Passive solar utilisation during heating season.
- Optimize with appropriate shadings for good summer thermal comfort (avoid overheating).

Micro climate
- Check that reflecting sun of neighbouring buildings and its impact to the indoor climate.
- Check that local winds are supporting usability
- Consider vegetation as shading to support comfort
- Orientation of building block to best directions considering use of renewable energy sources

Massive walls
- Use for sun harvesting with internal massive structural elements between heating and cooling season (spring and autumn). Be careful with overheating.
- Use for balancing heat gains to minimize cooling peak during summer time.

Shadings against sun (external and internal)
- Use shading elements to block the sun (heat load). Do not spoil your design concept of natural lighting and views out.
- Use supplementary building parts and elements of the facade to create sufficient shading.

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 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.
### Check list for design reviews.

**ENERGY EXPERT**

#### Use of renewable energy sources
- Identify local available renewable energy sources (solar, wind, geoenery, 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.
Guide for BIM models and model uses in Detailed and final design

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)
Detailed design

Phase consists of

• Holistic energy design during the detailed design phase with using advanced simulation tools and modelling techniques. Multi-disciplinary design teams explore various energy design solutions (including local RES) collectively and individually, in an interactive virtual workspace to achieve optimum energy efficiency at building level.
From Concept design (LOD2) to Detailed design (LOD4)
**Project management**: organize a kick of meeting to explain the brief and targets/values

**Chief designer**: Review output from concept design: the selected alternative

From Concept design (LOD2) to Detailed design (LOD4)
Design group: Develop further the architectural, HVAC, structural and electricity design models using D4E component library and information from the collaborative workspace. Share all preliminary domain models to D4E portal.
**Design group**: Access all domain model on D4E project information platform. Individually: Analyse of performance
Each designer may address different aspects of the defined criteria. In particular, the architect will address CO2 emissions and energy performance of building envelope (and aesthetics), while engineers (mechanical and electrical) will address light and thermal comfort, as well as energy efficiency of the systems and their impacts (cost, environmental, neighbourhood). Communicate with shared situational awareness.

See checklist for each designers’
Chief designer/ BIM coordinator:
Prepare all design models for coordination.
Facilitate the design review for clash detection and combined analysis using function of the collaborative workspace and assess the preferred indicators of each design discipline. Use checklists. Prepare the Review meeting report. Outcome: technically solid models
Chief designer: Facilitate the design review of maintainability and lifespan analysis in order to check the resilience.

Use checklists.

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

BIM coordinator + Experts: Prepare all design models for cost calculation and CO2 analyses (LCC and LCA). Prepare analytical model for energy analyses and for energy matching. Perform the analyses. Generate reports from analyses results.
Chief designer + team
Compile the KPIs from the design reviews and analyses results according to the client’s preferences. Review (design group internal) the KPIs. Use the checklists to facilitate the review.
Prepare the presentation to client, including results (reports) from analyses and KPI assessment.

From Concept design (LOD2) to Detailed design (LOD4)
**Detailed design (LOD2 -> LOD4)**

**End-user**
- Client

**Project management**
- Concept design (LOD2)
- Design brief for detailed design

**Facility management**
- Holistic EE - design
- Supported by Design Components

**Authorities**
- Design group management

**Constructor**
- As-designed (LOD4)
- Requirements model

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

**From Concept design (LOD2) to Detailed design (LOD4)**

**Chief designer**
- Presentation to client and client’s approval on design draft in detailed design (including architectural, structural, HVAC and electrical design solution with low energy demand and holistic neighbourhood level energy matching).
- Upload detailed design model to D4E portal

**Hard gate**
Integrated Design Review

Phase consists of

- This review is part of UC 3.0. (EE design in detailed design stage), step 15: (a) planning and preparations for an integrated design review, (b) facilitating review, (c) preparing the outcome of the review to be presented to the client.
Integrated design review

Design group management

Holistic EE – design
Supported by Design Components

Agenda

See checklist for design review

D4E portal: Model checking
Analyses
Collaboration
Visualisation
Data management

Fasilitation plan of the design review

eFuture changes

Dashboard & KPI Scoreboard

Soft gate
**Chief designer:** Invite the participant to the face-to-face or virtual review meeting with detailed agenda, give instructions for uploading domain models. Prepare needed tools and templates in virtual workspace.

**Chief designer:** Advice the LOD needed for each domain models. Plan the course of design review, decide the order of merging models, prepare agenda.
Chief designer/ BIM –coordinator:
Prepare needed tools and templates in virtual workspace. Check the design models. Upload and prepare all design models for coordination. Prepare tools to be used in coordination.

D4E portal: Model checking Analyses Collaboration Visualisation Data management
Chief designer: Facilitate the design review (use checklists if available).

Subjects may vary:
- Geometrical clash detection between design domains
- Analyse/calculation in relation to single KPI

Chief designer:

Facilitate the design review (use checklists if available).

Subjects may vary:
- Geometrical clash detection between design domains
- Analyse/calculation in relation to single KPI

Chief designer:

Facilitate the design review (use checklists if available).

Subjects may vary:
- Geometrical clash detection between design domains
- Analyse/calculation in relation to single KPI
Integrated design review


design group management

Holistic EE – design Supported by Design Components

D4E portal: Model checking Analyses Collaboration Visualisation Data management

Agenda

Fasilitation plan of the design review

See checklist for design review

eFuture changes

Dashboard & KPI Scoreboard

Subjects may vary:
- analyzing a specific quality performance (maintainability, usability, safety...)
- holistic assessment of the KPI framework
- evolutionary analyses of the solutions
- boundary elements and neighbourough impact

Design Advisory for evolutionary analyses
Integrated design review

Design group management

Holistic EE – design
Supported by Design Components

D4E portal:
Model checking
Analyses
Collaboration
Visualisation
Data management

Agenda

See checklist for design review

Facilitation plan of the design review

Chief designer:
Document discussion and pin point issues to the models if possible. Sent report to the team for comments. Prepare review meeting report. Make presentation for a client review

Dashboard & KPI Scoreboard
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.
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?
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 behaviour: 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.
- 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?
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.
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.
Final design

Phase consists of

- Collaborative design processes procuring design solutions based on component catalogue building objects and equipment (with their performance metric) and performance analyses based on EE simulations (detailed energy simulation with energy matching analyses).
End-user Client

Project management

Final design (LOD4)

Concept design (LOD2)

Design brief for final design

Authorities

Design group management

Holistic EE – design
Supported by Design Components

D4E portal: Model checking Analyses Collaboration Visualisation Data management

Constructor

From Detailed design (LOD4) to Final design (LOD4)

Requirements model

As-designed (LOD4)

From Detailed design (LOD4) to Final design (LOD4)

Design4Energy FACILITATOR

As-designed (LOD4)
Chief designer:
Access as designed (LOD4) models(detailed design) on D4E project information platform. Check comments or brief from previous design phase.

Facilitate design group kick off-meeting for the final design (face-to-face or virtual).
**Architect:** Further development of the architectural design using D4E component library. Add attribute level information.

**Designers/Experts:** Further Develop HVAC, Structural and electricity model (and other design models) using D4E component library. Add attribute level information.
Final design (LOD4)

Chief designer /BIM coordinator:
Prepare the BIM models for coordination. Use eeBIM service of the D4E portal.
Facilitate clash checking review using preferred indicators of each design discipline.

From Detailed design (LOD4) to Final design (LOD4)
**Designers /BIM coordinator:**

Prepare all design models for a quantity take off and detailed cost calculation and CO2 analyses.

Upload all design models to D4E platform and control analytical model preparation for energy analyses and for energy matching.

Control D4E tools (energy simulation and energy matching) to perform the analyses.

Generate reports from analyses results.

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**Final design (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

**From Detailed design (LOD4) to Final design (LOD4)**

**Requirements model**

**As-designed (LOD4)**

**Design4Energy FACILITATOR**
End-user
Client
Project
management
Final design (LOD4)

Facility
management

Authorities

Concept design
(LOD2)

Design brief for
final design

From Detailed design (LOD4)

Holistic
EE – design
Supported by
Design
Components

Chief designer:
Compile the KPIs from the analyses results according to the client's preferences and compare.
Review (design group internal) the KPIs agreed with the final 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.

D4E portal:
Model checking
Analyses
Collaboration
Visualisation
Data management

Constructor

Requirements model

As-designed
(LOD4)
Final design (LOD4)

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

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

From Detailed design (LOD4) to Final design (LOD4)
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 your 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.
Check list for internal design group review for ee-design

Overal 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.
Check list for design reviews.
ARCHITECT
Energy efficient building design (“passive mode”):

Location and Site selection:
- Appropriate use of passive solar energy in winter Orientation of the building
- Passive cooling, e.g. natural shading for reduced summer time cooling demand
- Consider shadow effects (buildings around and tall trees)
- Consider general climate parameters

Building volume:
- Consider efficient form (Volume factor <1)
- Look for usable lay-outs/ considering functionality
- Efficient massing and lay out considering low energy demand.
- Avoid unnecessary corners/ windows/ bay window in the principal massing, as they increase thermal losses of the envelope.
- Use rectangular volumes as principal massing concept.
- Use entry locks.

Openings:
- Primary function is focusing on natural lighting and views out through openings.
- Secondary Passive solar utilisation during heating season.
- Optimize with appropriate shadings for good summer thermal comfort (avoid overheating).

Micro climate:
- Check that reflecting sun of neighbouring buildings and its impact to the indoor climate.
- Check that local winds are supporting usability.
- Consider vegetation as shading to support comfort.
- Orientation of building block to best directions considering use of renewable energy sources.

Massive walls:
- Use for sun harvesting with internal massive structural elements between heating and cooling season (spring and autumn). Be careful with overheating.
- Use for balancing heat gains to minimize cooling peak during summer time.

Shadings against sun (external and internal):
- Use shading elements to block the sun (heat load). Do not spoil your design concept of natural lighting and views out.
- Use supplementary building parts and elements of the facade to create sufficient shading.

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 design reviews. ENERGY EXPERT

#### Use of renewable energy sources
- Identify local available renewable energy sources (solar, wind, geoenergy, biofuels) 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 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.

STRUCTURAL DESIGN

Spatial needs
• Consider space requirements for HVAC installations

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

Energy concept
• Massive walls
  ○ Use for sun harvesting with internal massive structural elements between heating and cooling season (spring and autumn). Be careful with overheating.
  ○ 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.
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

- 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
Explanation of the symbols used in Facilitator

SYMBOLS

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

Target setting  Architectural  Analytical  Design options

Construction  As-built  Renovation  Neighbourhood

Structural  HVAC  Electrical  Integrated

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
- Spaces
- LCA
- Lighting
- 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