WP1

BIM Implementation in NORFAC

WP5 description and definitions

Uses of BIM in NORFAC

Potential BIM outcomes and target groups

Implementation of BIM in NORFAC

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Nordic Built

CONTENTS

SCOPE

With the aim of clarifying the requirements and helping further decision- making in relation to the implementation of Building Information Modeling (BIM) in NORFAC, this report will cover 5 main topics:

- WP5 Description
- Glossary
- The Uses of BIM in NORFAC
- Potential BIM outcomes and target groups
- Recommendation for implementation of BIM in NORFAC

The last topic – "Recommendation for implementation of BIM in NORFAC" - will cover summary of the challenges related to the adoption of BIM and methodologies for overcoming these challenges; research on the different BIM applications and platforms used among the project partners and in the Nordic countries; mapping of BIM Uses, design processes and design themes; mapping of BIM technologies and interoperability issues.

WP5 Description

Objectives

To develop a general description of the modularized façade system with universal interfaces to each building element and installation unit that are not company specific but open to several Nordic SMEs to be part of the supply chain of product suppliers to the system.

Description of work

This WP contains the development of the **generic 3D Building Information Modeling platform**. The development of this virtual system is informed by the actual façade elements created in WP3. It is thus suggested that **the work on the actual façade elements is created alongside the BIM model** in order to secure **use and reuse of the information as a cross fertilization between the WPs**. The generic platform of the conceptual façade must be made **configurable to suit various applications of a real façade system**. This means that the BIM model must contain the **conceptual parametric framework for an actual adaptation of the façade elements in a real building**.

The balance in the parametric BIM model between how much can be configured and **how complex the model becomes**, must be addressed early after the studies and **conclusions obtained in WP2**. The complexity of the model is highly dependent on the constraints that the actual physical components used in the real façade elements, i.e. materials' dimensions and tolerances.

It is suggested to select **one responsible BIM manager**, who will be in charge of the model and the information sharing between different platforms. The **development of the 3D building information model** should be undertaken in **close collaboration with WP3** where the prototype is created. It is strongly suggested to work on the BIM model at the same time as on the real prototype and **share digital model information across platforms between the WPs using the same software format**, if it is possible. Otherwise, an independent exchange format, such as IFC, is suggested to facilitate this collaboration.

The idea of an Open BIM platform requires a sufficiently **high degree of flexibility that new partners can eventually use the system to "plug-in" their systems**, as a part of a façade element. The thought of the system delivery is that **every partner holds responsibility for the successful application of his or her delivery into the system**. That is only possible, if the system allows an easy access to its configuration.

Start

01.02.2016

End

01.09.2017

Involved

VIA Horsens, DTI, Passivhuscentrum, Mesterhus

Responsible

VIA Horsens

Result

A generic platform description transformed into a digital BIM model, as a knowledge bank of information to be used in refurbishment projects for designing, constructing and operating the façade system.

Glossary

BIM (Building Information Modeling)

Building Information Modeling is a BUSINESS PROCESS for generating and leveraging building data to design, construct and operate the building during its lifecycle. BIM allows all stakeholders to have access to the same information at the same time through interoperability between technology platforms.

BIM (Building Information Model)

Building Information Model is the output of the business process resulting in a DIGITAL PROTOTYPE, a virtual computer model of a project, which holds selected structured data about the asset (design, quantity, time, cost, as built, etc.).

BIM (Building Information Management)

Building Information Management is the ORGANISATION & CONTROL of the business process by utilizing the information in the digital prototype to effect the sharing of information over the entire lifecycle of an asset. The benefits include centralized and visual communication, early exploration of options, sustainability, efficient design, integration of disciplines, site control, as built documentation, etc. – effectively developing an asset lifecycle process and model from conception to final retirement.

BIM Use

BIM Use can be defined as "a method of applying Building Information Modeling during a facility's lifecycle to achieve one or more specific objectives".

BIM communication methods: Bespoke, Closed BIM, Open BIM

Bespoke is a method of implementing BIM where everyone needs to learn everyone else's language (applications/platforms) in order to establish good communication and sharing of information.

Closed BIM is a method of implementing BIM where everybody has to change their language (applications/platforms) in order to communicate successfully. Even though in some cases this method requires additional effort, it has multiple benefits as no loss of data occurs due to change of formats.

Open BIM is a universal approach to the collaborative design, realization and operation of buildings based on open standards and workflows. It supports a transparent, open workflow, allowing project members to participate regardless of the software tools they use. It, moreover, creates a common language for widely referenced processes, allowing industry and government to procure projects in transparent commercial engagement, comparable service evaluation and assured data quality.

BIM tool

BIM tool is a task-specific application that produces a specific outcome. Example tools are those for model generation, drawing production, specification writing, cost estimation, clash and error detection, energy analysis, rendering, scheduling, and visualization. Tool output is often standalone, as reports, drawings, and so forth. In some cases, however, tool output is exported to other tool applications, such as quantity take-offs to cost estimation, and structural reactions fed to a connection-detailing application.

BIM platform

BIM platform is an application, usually for design, that generates data for multiple uses. It provides a primary data model that hosts the information on the platform. Most BIM platforms have also internally incorporate tool functionality such as drawing production and clash detection. They typically incorporate interfaces to multiple other tools with varied levels of integration. Some platforms share the user interface and style of interaction.

BIM environment

BIM environment is the data management of one or more information pipelines that integrate the applications and platforms within an organization. It supports policies and practices of information within the organization. Often the BIM environment is not conceptualized and grows in an ad hoc manner by the needs within the firm. Automatic generation and management of multiple BIM tool datasets is their obvious use. Also, when multiple platforms are used, and thus multiple data models, another level of data management and coordination is required. These address tracking and coordinating communication between people as well as multiple platforms. BIM environments provide the opportunity to carry wider forms of information than model data alone, such as video, images, audio records, emails, object and assembly libraries for reuse, interfaces to the applications the organization supports, and links to corporate management and accounting systems, etc. BIM servers are the products targeted to support BIM environments.

The Uses of BIM in NORFAC

BIM as a "tool" for interdisciplinary development and sharing knowledge among project partners

BIM facilitates sharing of knowledge by providing 3D digital representation and detailed information about a product. Thus, it can greatly support interdisciplinary development and contribute to cross border cooperation and exchange of labor between the participating Nordic countries.

BIM as a basis for decision-making

Through sharing of knowledge and information among the project partners, simulation and analysis, BIM will enhance the proportion of value work, help decision-making throughout the design and production stages and reduce potential faults and defects early in the design process.

The use of BIM in NORFAC will, moreover, help capture learning and project findings and enable innovation by optimization in a transparent 3D driven environment. This again ensures understanding of complex concepts and product issues that can be analyzed and solved in a more holistic way and earlier in the design process.

BIM will greatly help achieving the goals of the project in terms of sustainability, too. By applying complete façade solutions to case study projects in a digital environment and performing energy simulations, BIM will provide qualified information and inspiration that can strengthen further development of the products in innovative contexts.

…

"The developed concept will be built according to the following critical success factors:

1. Cost effectiveness (based on 4 year ROI)
2. Easy to assembly/disassembly
3. Improved indoor climate in different climate zones, also in high polluted areas
4. Modularized concept with high flexibility in usage
5. High aesthetic expression
6. High export potential

The benefit of using BIM technology is the creation of a project specific visual knowledge database for common understanding and enhanced coordination. The project aims to create a best practice example on integrated façade solution using open Building Information Modeling (BIM) as the interaction for better design and collaboration in the integrated development process. The Open BIM platform will give the opportunity to make cross Border collaboration in Nordic countries and fast exchange of knowledge and experience between Nordic countries. This is important because on the international market, the Nordic countries are on the top score in terms of sustainability and by using experiences across countries, this will boost the market opportunity for the Nordic countries."

"The façade concept implements BSP (Building Simulation Process) based on predefined workflows that will enable the ability to perform iterative analysis, using advanced and predefined workflows for sustainable design factors, constructability, facility management and demolishing phases based on the "Open BIM platform". The "Open BIM platform" will enable all project participants in understanding and collaborating around the same visual platform."

"This project will also support the sustainability scheme like DGNB, BREEAM and LEED as part of the open BIM delivery platform."

BIM as an opportunity to open the market to SME companies

"An "Open BIM platform" will also give the opportunity to open the market to the SME firms who want to be a part of the supply chain of companies for the façade concept in specific markets. The BIM platform will allow these companies to get exact specifications early in the design stage, and builders to calculate costs for the refurbishment project early on a very precise basis."

"The platform is open so that Nordic SMEs can be part of the open business platform if they can fulfill the needed functionalities and costs in the platform. In the digital platform, there is an open part where all can get access to information and a closed part belonging to the supply chain of companies that deliver solutions to the platform and the modularized facade system."

BIM used as a marketing "tool"

"In the project, constructors and developers are part of the partners' group. They are interested in using the results of the project in commercial refurbishment projects on the Nordic market and internationally. There is a big market for cost effective, energy efficient and sustainable refurbishment projects that are user driven."

The development of an "Open BIM platform" will focus especially on building up an easy to navigate user interface with photo realistic objects of each building element/system. The end users will be able to make their adjustments on the solution and see the results of their choices in terms of total life cycle cost, energy efficiency and carbon footprint. …

Potential BIM Outcomes & Target Groups

DETAILED 3D OBJECTS

Design Teams (Architects, Engineers)

- Ready to use 3D objects for building models
- Earlier and more accurate visualizations of a refurbishment design
- Generation of accurate and consistent 2D drawings from the 3D objects at any stage of the project
- Better understanding of the façade systems' design
- Easy verification of consistency to the design intent
- Accurate quantity take off and cost estimates during the design stage
- Improvement of energy efficiency and sustainability
- Etc.

Production Teams

- Use of 3D objects for production drawings and documentation
- Quick reaction to design changes
- Discovery of design errors and omissions before production and construction
- Synchronization of design and production planning
- Better implementation of Lean Construction techniques
- Etc.

Construction Teams

- Use of 3D models for construction planning
- Quick reaction to design changes
- Discovery of design errors and omissions before construction
- Synchronization of design and construction planning
- Better implementation of Lean Construction techniques
- Synchronization of procurement with design and construction
- Etc.

Owners & Facility Managers Team

- Improved commissioning and handover of facility information
- Better management and operation of facility
- Integration with facility operation and management systems
- Etc.

USER INTERFACE WITH REALISTIC VISUALIZATIONS, ANIMATIONS & ACCURATE PRODUCT SPECIFICATIONS

Design Teams (Architects, Engineers) and Owners

- Possibility to choose the products that best suit their projects
- Possibility to get accurate information about the façade solutions' performance and thus meet the project requirements
- Possibility to accurately calculate quantities and costs in advance
- Etc.

Implementation of BIM in NORFAC

1. Challenges in the implementation of BIM in NORFAC
2. BIM implementation methodology
3. Elements for success
4. Project Level – BIM coordination, exchange and collaboration in NORFAC
5. Concept Level – Project phases
6. Project partners' BIM competencies
7. Questionnaires
8. Design themes/roles overview
9. Questionnaire
10. BIM applications/platforms used in the Nordic countries
11. Choice of BIM applications/platforms for NORFAC
12. Defining project phases and BIM Uses
13. Mapping BIM tools to design themes and roles
14. Tools and interoperability map
15. Understanding and mapping input data
16. Key activities

Challenges in the Implementation of BIM in NORFAC

In order to implement BIM successfully in NORFAC, all the challenges should first be listed out, and then an approach to the solutions should be found.

STRATEGIC CHALLENGES

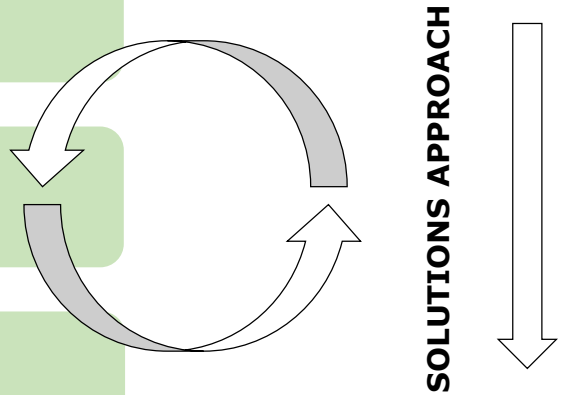
- Assigning roles and responsibilities
- Establishing collaboration and coordination
- Establishing rules for exchange of information

TACTICAL CHALLENGES

- Developing BIM process
- Defining goals/desired outcomes

OPERATIONAL CHALLENGES

- Choosing Applications and Platforms
- Defining workflows



BIM Implementation and Methodology

PROJECT LEVEL

Coordination | Exchange | Collaboration

CONCEPT LEVEL

Project Phases

Design > Production > Construction > (Operation)

COMPANY LEVEL

Strategy | Methodology | Technology

Normally, the implementation of BIM is observed in three levels – Concept Level (coordination, exchange of information, collaboration), Project Level (project phases) and Company Level (strategy, methodology, technology). As we are currently trying to find out the best solution for implementing BIM in NORFAC, focus should only be placed in the adoption of BIM at Concept and Project Level. However, all the issues concerning adoption of BIM at company level should also be taken into consideration.

Elements for Success

STRATEGY

- Clear project goals
- BIM management
- Collaboration and coordination
- Development of strategy

INFRASTRUCTURE

- Applications/platforms
- Templates
- Phase-based workflows
- Materials' and products' data inputs

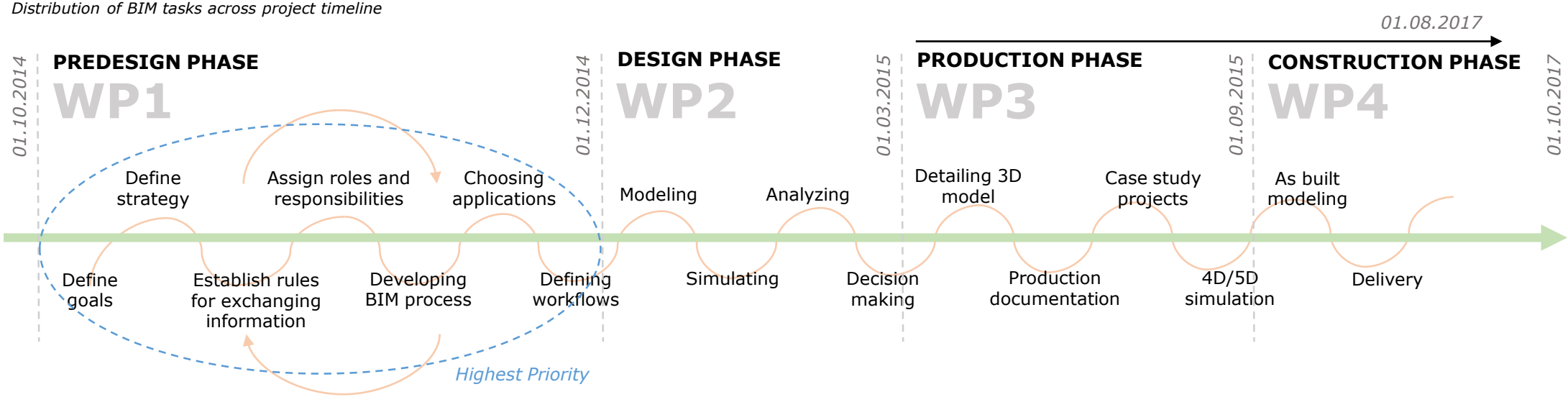
OUTCOME

- Visualizations
- Energy simulations
- Demonstration projects
- Etc.

IMPLEMENTATION

- Strategy-based implementation
- Phase-based implementation
- BIM methodology developed from best practice

Distribution of BIM tasks across project timeline



Project Level
BIM Coordination, Exchange & Collaboration in NORFAC

PROJECT LEVEL (Coordination | Exchange | Collaboration)								
PARTNER	**WP1**	**WP2**	**WP3**	**WP4**	**WP5**	**WP6**	**WP7**	**WP8**
DTI								
BA								
VUC					BIM Management			
BNT								
CWT								
CT								
MTH								
RT								
GS								
BSI								
MH								
PHC								
CGN								

Passively involved in WP5

At the project level, coordination, methods for exchanging information and collaboration need to be established by the leader of WP5 (VUC).

As BIM in its essence is an integrated part of the building DCO (Design, Construction and Operation) process, all companies involved in WP1, WP2 and WP4 (those marked with dark grey) need to give their input to those involved in WP5 (those marked with orange).

However, due the complexity of the project and the number of project participants, it is a good idea to limit the responsibilities in WP5 to as few partners as possible. The rest of the partners with competence in the field should only have a commenting role.

The roles can be distributed as follows:

- **WP5/BIM Leader – VUC** – establishing BIM implementation methods; responsible for collaboration, exchange of information and coordination; elaborating templates for exchange of information between the active and passive participants in WP5; establishing Best Practice BIM methods for the project; performing modeling and simulations of façade solutions and demonstration projects in WP3 and WP4; etc.
- **BIM Team – DTI, BA, MTH** – helping the BIM Leader with his responsibilities by giving input; BA – performing modeling and simulations in WP2; MTH - performing modeling and simulations in WP4;
- **Passively involved in WP5** - responsible for delivering their input in the format required by the BIM Leader;

NB:

As the distribution of roles and tasks in this report is only a recommendation based on the primary questionnaire done for WP1, a more in depth research concerning all partners' BIM competences should be performed, and then roles and tasks should be assigned.

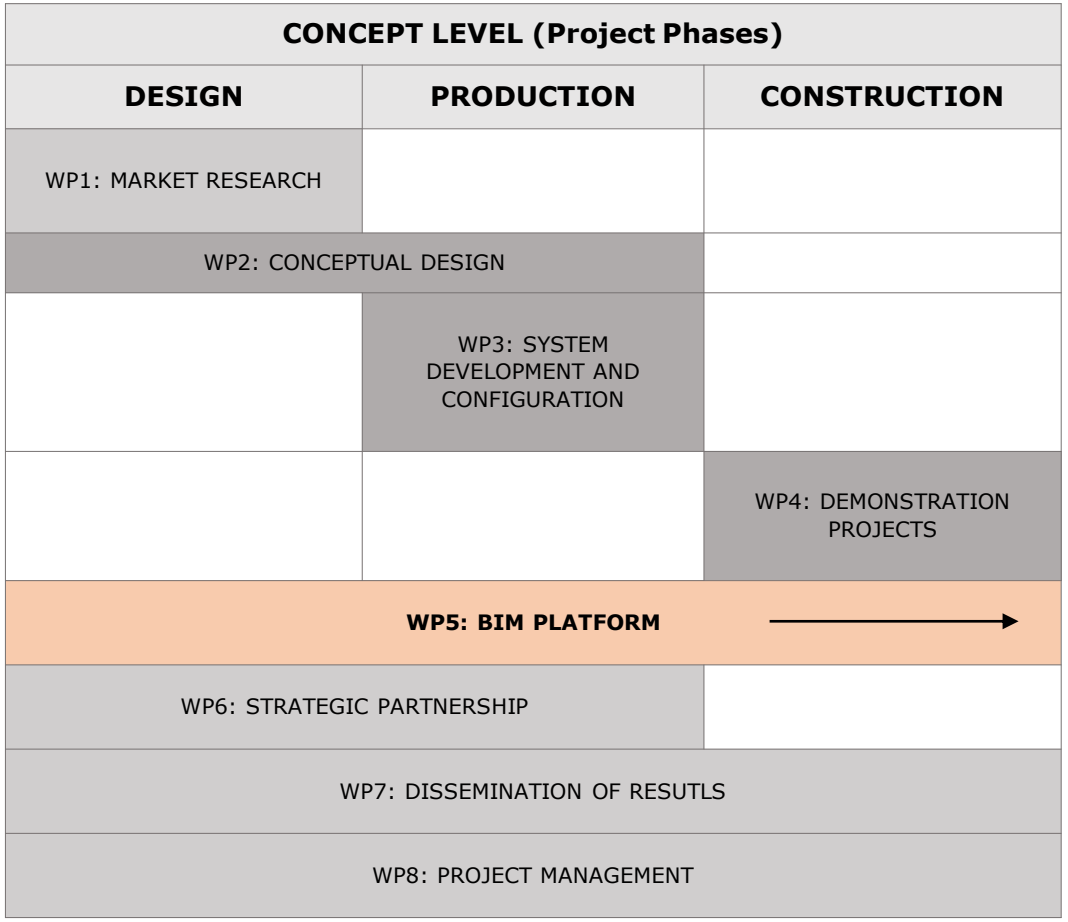
Not relevant for WP5

Should be involved in WP5

Passively involved in WP5

Involved in WP5

Concept Level Project Phases



A BIM implementation plan at Concept Level needs to be elaborated by the BIM Leader. The use of BIM should spread through all project phases – from conceptual design to demonstration projects and even further – to operation.

The main tasks in each project phase can be as follows:

WP2 - Conceptual design:

- To model and visualize the façade system solutions
- To insert data related to the façade systems' materials and products in the model
- To simulate and analyze the façade system solutions' performance

WP3 - System development and configuration:

- To create fully detailed digital prototypes of the façade system solutions along with the real-life façade solutions prototypes
- To perform simulations of façade system solutions' performance along with the real-life tests

WP4 - Demonstration Projects:

- To prepare/model case study projects
- To apply façade systems solutions to case study projects
- To perform simulations and analysis of the refurbishment project performance
- To visualize refurbishment projects' solutions

WP5 - Developing a Generic Platform in BIM:

- To finalize façade systems solutions
- To complete case study projects demonstrating Best Practice BIM implementation methods in refurbishment projects, incl. registration, modeling, design/refurbishment, manufacturing, energy performance simulation, cost calculation, construction time scheduling, construction, operation, etc.

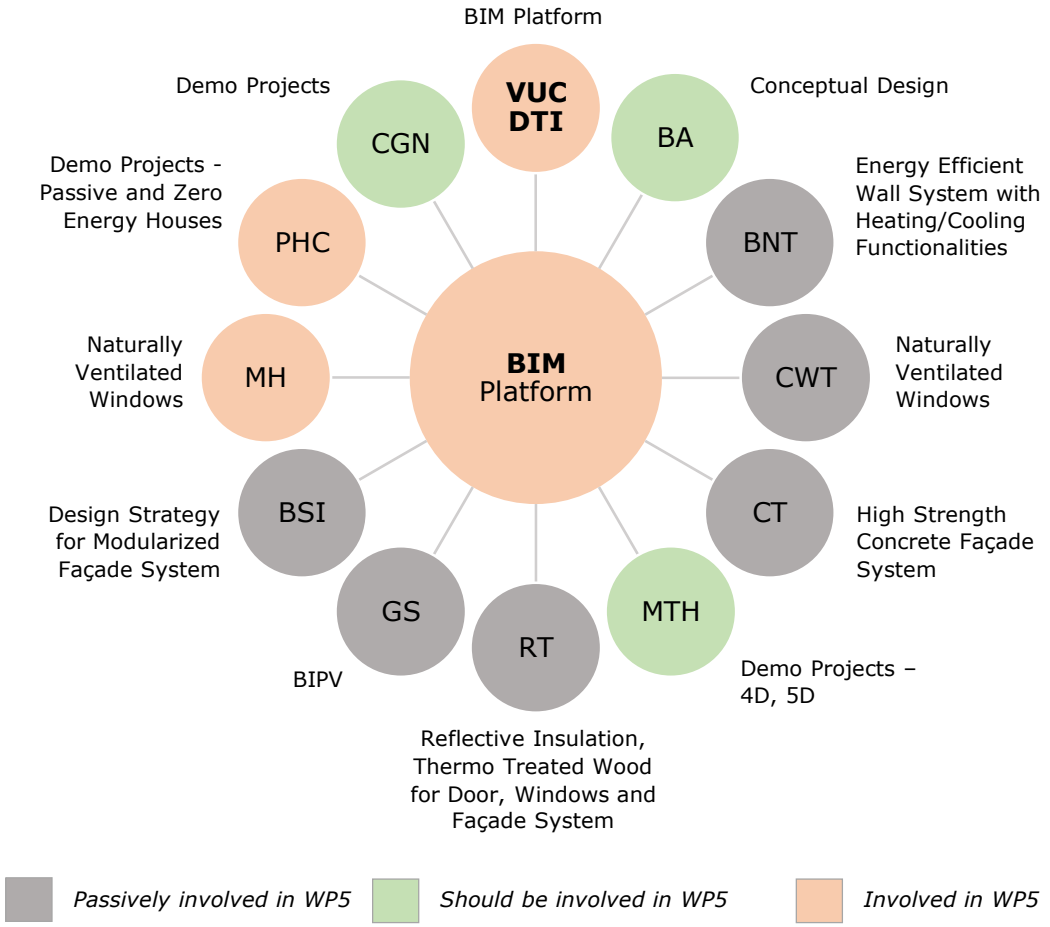
Not relevant for WP5 *Passively involved in WP5* *Involved in WP5*

Project Partners' BIM Competencies

In order to implement BIM successfully in NORFAC there is a need for common language and a platform to communicate the common language. Therefore, it is important to first observe which are the most commonly used BIM applications and platforms among the project partners. As a result from the survey that was sent to all project partners the following BIM platforms have been indicated as the mostly used once in their companies.

PARTNER	C.	BIM PLATFORMS
DTI	DK	**Revit**, Velux DV, Rockwool Energy, etc.
BA	DK	**Revit**, Velux DV, Simien, PHPP (p. 13)
VUC	DK	**Revit**, Sigma, MS Project, Vico, Solibri (p.12)
BNT	DK	Haven't answered
CWT	DK	Haven't answered
CT	DK	Haven't answered
MTH	DK	**Revit**, 3ds Max, Tekla, Navisworks, Autodesk QTO, Vico, SimpleBIM, Solibri (p. 14)
RT	DK	Not using BIM
GS	DK	**Revit** (p. 15)
BSI	DK	Not using BIM
~~**MH**~~	NO	**Revit**
PHC	NO	Not using BIM
CGN	SE	Not using BIM

Design Themes/Roles Overview



Questionnaire | VIA University College

Which BIM applications/platforms do you work with in your company? In which stage of the design/building process do you use them?

Design phase – SketchUp, Revit, Revit MEP, Be10, Sigma, MSProject

Construction phase – Revit, Sigma, MS Project, (Vico, Solibri – not fully implemented yet)

Do you have any established BIM workflows in your company? If so, please describe them briefly.

Revit – Used for conceptual modelling and visualization, detail drawings, production drawings

Revit – Used for collaboration between different disciplines' models (landscape, architect, engineer)

Sigma – use of quantities from Revit

What is the understanding/competence of using BIM processes/methodologies and applications/platforms among the employees of your company?

Revit – medium (few experts)

Sigma – low (few experts)

MS Project – medium (few experts)

Vico – low (few experts)

Solibri – low (few experts)

According to your experience, which are the most commonly used BIM applications/platforms in your country and in the rest of the Nordic countries? (please, answer separately for each country and possibly for each discipline; start with the highest priority).

Denmark:

Architectural companies – AutoCAD, Revit

Engineering companies – Revit, MagiCAD

Construction companies – StruSoft, Robot

Questionnaire | bjerg arkitektur a/s

Which BIM applications/platforms do you work with in your company? In which stage of the design/building process do you use them?

Concept phase – Vasari, Revit
Design phase – Revit
Detailed Design Phase - Revit

"Revit is by far our main tool for working with BIM. The tool is implemented from sketch to presentation, to "as built" drawings."

Nikolaj Folden Skole

Do you have any established BIM workflows in your company? If so, please describe them briefly.

Concept phase:

Modeling – Vasari, Revit
Simulation – Vasari, Velux Daylight Visualizer, Simien, PHPP
Visualization – Revit

Detailed Design Phase – Revit

What is the understanding/competence of using BIM processes/methodologies and applications/platforms among the employees of your company?

Revit – High (all)
Vasari, Velux Daylight Visualizer, PHPP – Medium (some experts)
Simien – Low (few experts)

According to your experience, which are the most commonly used BIM applications/platforms in your country and in the rest of the Nordic countries? (please, answer separately for each country and possibly for each discipline; start with the highest priority).

Denmark:

Architectural companies – Revit, ArchiCAD, etc.
Engineering companies – (AutoCAD), Revit
Construction companies – (AutoCAD)

Norway:

Architectural companies – ArchiCAD
Engineering companies – Revit

Questionnaire | MT Højgaard A/S

Which BIM applications/platforms do you work with in your company? In which stage of the design/building process do you use them?

Concept phase – SketchUp Make, Revit, 3ds Max, Infraworks, Autodesk Dynamo, Vasari

Design phase – Revit, Tekla, Civil3D, ArchiCAD, Bentley, Vico Office, Vico Schedule Planner

Detailed Design Phase – Solibri, SimpleBIM, Navisworks, Design Review, BIM Anywhere, MagiCAD, Autodesk QTO, Tekla BIM Sight

Do you have any established BIM workflows in your company? If so, please describe them briefly.

Concept phase: Infrworks / SketchUp / Revit / 3ds Max

Modeling – Vasari, Revit, Tekla, Bentley, ArchiCAD

Simulation – Vasari, Ecotect, Vico Scheduler, RIB iTWO, Synchro

Visualization – 3ds Max, Navisworks, Rhino, SketchUp

What is the understanding/competence of using BIM processes/methodologies and applications/platforms among the employees of your company?

ArchiCAD – Medium

Revit – High

Navisworks – High

Bentley – Medium

Vico – High

Solibri – High

3ds Max – Medium

According to your experience, which are the most commonly used BIM applications/platforms in your country and in the rest of the Nordic countries? (please, answer separately for each country and possibly for each discipline; start with the highest priority).

Denmark:

Architectural companies – Revit, AutoCAD, ArchiCAD, Rhino, AECOsim

Engineering companies – Tekla, Revit MEP, Revit Structure, Civil 3D

Construction companies – Vico, Solibri, Navisworks, RIB iTWO

Norway: ArchiCAD

Finland: ArchiCAD

Questionnaire | GAIA SOLAR

Which BIM applications/platforms do you work with in your company? In which stage of the design/building process do you use them?

Detailed Design Phase – Revit

Do you have any established BIM workflows in your company? If so, please describe them briefly.

There is no established workflow in Gaia. Gaia has experimented with BIM models towards architects and engineers, but still needs to measure the effort.

What is the understanding/competence of using BIM processes/methodologies and applications/platforms among the employees of your company?

Revit – Medium

Other – Knowledge of…

According to your experience, which are the most commonly used BIM applications/platforms in your country and in the rest of the Nordic countries? (please, answer separately for each country and possibly for each discipline; start with the highest priority).

Denmark:

All companies - Revit

BIM Applications/Platforms Used in the Nordic Countries

	DK	NO	SE	FI
ARCHITECTURE	Revit, (AutoCAD), ArchiCAD, Rhino, AECOsim, Bentley	Revit, ArchiCAD, (AutoCAD), Bentley	Revit, ArchiCAD, (AutoCAD),	Revit, ArchiCAD, (AutoCAD), Bentley
STRUCTURE	Revit, Tekla, Civil 3D, (AutoCAD)	Revit		
BUILDING SERVICES	(AutoCAD), Revit	Revit		
CONSTRUCTION	Navisworks, Solibri, Vico, RIB iTWO	Solibri		Solibri
Signed the IFC Statement	Yes	Yes	No	Yes

Choice of BIM Applications/ Platforms for NORFAC

As previously discussed in this report, there are two primary approaches for BIM integration: to stay within one software vendor's products (Closed BIM) or to use software from various vendors that can exchange data using industry supported standards (Open BIM).

The first approach may allow for tighter and easier integration among products in multiple directions. This requires, however, that all members of a design team use software provided from the same vendor.

The second approach uses either proprietary or open-source (publicly available and supported standards) to define building objects (Industry Foundation Classes, or IFCs). These standards may provide a mechanism for interoperability among applications with different internal formats. This approach provides more flexibility at the expense of possibly reduced interoperability, especially if the various software programs in use for a given project do not support, or only partially support with some data loss, the same exchange standards.

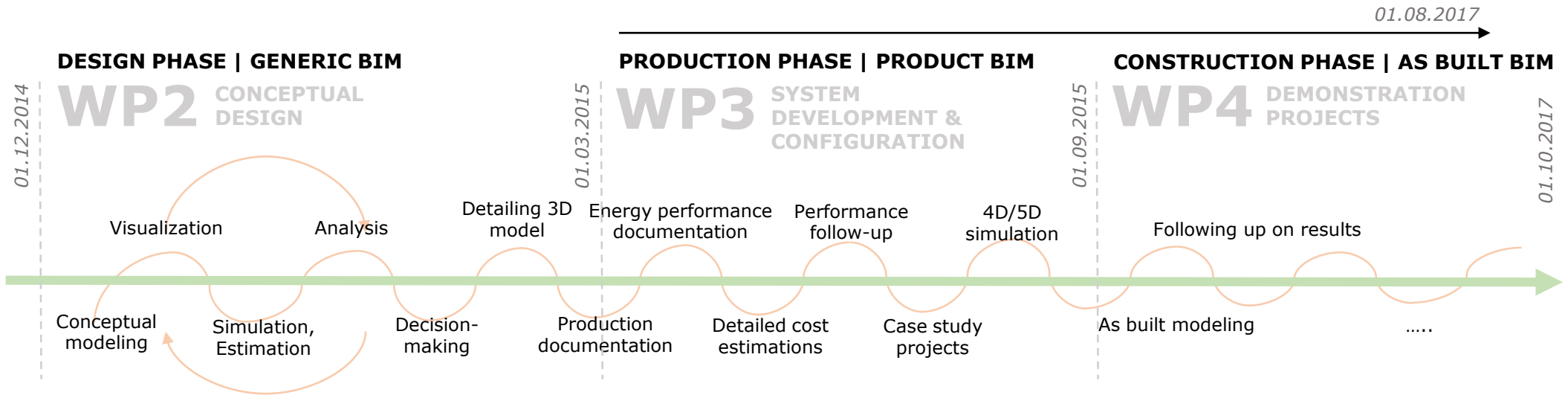
In order to use the full potential of BIM in NORFAC – to support interdisciplinary development and sharing of knowledge, to serve as a basis for decision-making, to help achieve the goals in terms of sustainability and enhance a holistic design approach – the best solution would be to use the Closed BIM approach throughout the façade system's design and production stage, no matter if the chosen software will correspond to the software used in all the Nordic countries. During the Demonstration Projects' stage, it will be most beneficial to again stay within the same software. However, an Open BIM approach can be considered for collaboration with external parties, if such is needed.

As most of the partners of NORFAC have indicated Revit as the most commonly used platform in their companies, it is recommendable that they agree on performing the design of the intelligent façade system in Revit. This will ensure better and easier exchange of information and more effective work sharing by the use of a central file.

Opposed to the traditional energy refurbishment strategies where focus is mainly on improving the thermal insulation of the existing building envelope, the goal of NORFAC is to provide a holistic solution, where ventilation and cabling are also integrated into the refurbishment façade. Revit is a family of integrated products that currently includes Revit Architecture, Revit Structure, and Revit MEP. Thus, detailed façade solutions comprising all disciplines can be modeled in a single file. Furthermore, Revit has a large set of associated applications. Thus, fully detailed 3D models can be achieved by the use of additional applications or Add Ins, such as Autodesk Advance Concrete, Autodesk Advance Steel, Timber Framing 2015, etc.

In the future, when the project has been completed successfully, 3D objects of the façade system's solutions can be created in various formats to meet different companies needs in both the Nordic countries and in the rest of the world.

Defining Project Phases and BIM Uses



Generic Modeling

- *3D models of facade proposals and solutions*
- *Data input on materials' and products' properties*
- *Visualizing different solutions*
- *Etc.*

Simulations, estimations

- *Energy performance calculation*
- *Daylight studies*
- *Cost estimations*
- *Etc.*

Decision-making

- *Decisions based on results analysis*

Detailed Modeling

- *Detailed 3D models of facade solutions*
- *Quantities take-off*
- *Production documentation and drawings*
- *Final solutions visualizations*
- *Etc.*

Simulations, estimations

- *Energy performance documentation*
- *Detailed cost estimations*
- *Etc.*

Performance control

- *Comparison between performance calculations and actual performance*

Demonstration Projects Modeling

- *Facade solutions applied to building models*
- *Quantities take-off*
- *Production documentation and drawings*
- *Refurbishment project visualizations*
- *Etc.*

Simulations, estimations

- *Energy performance documentation*
- *Detailed cost estimations*
- *Etc.*

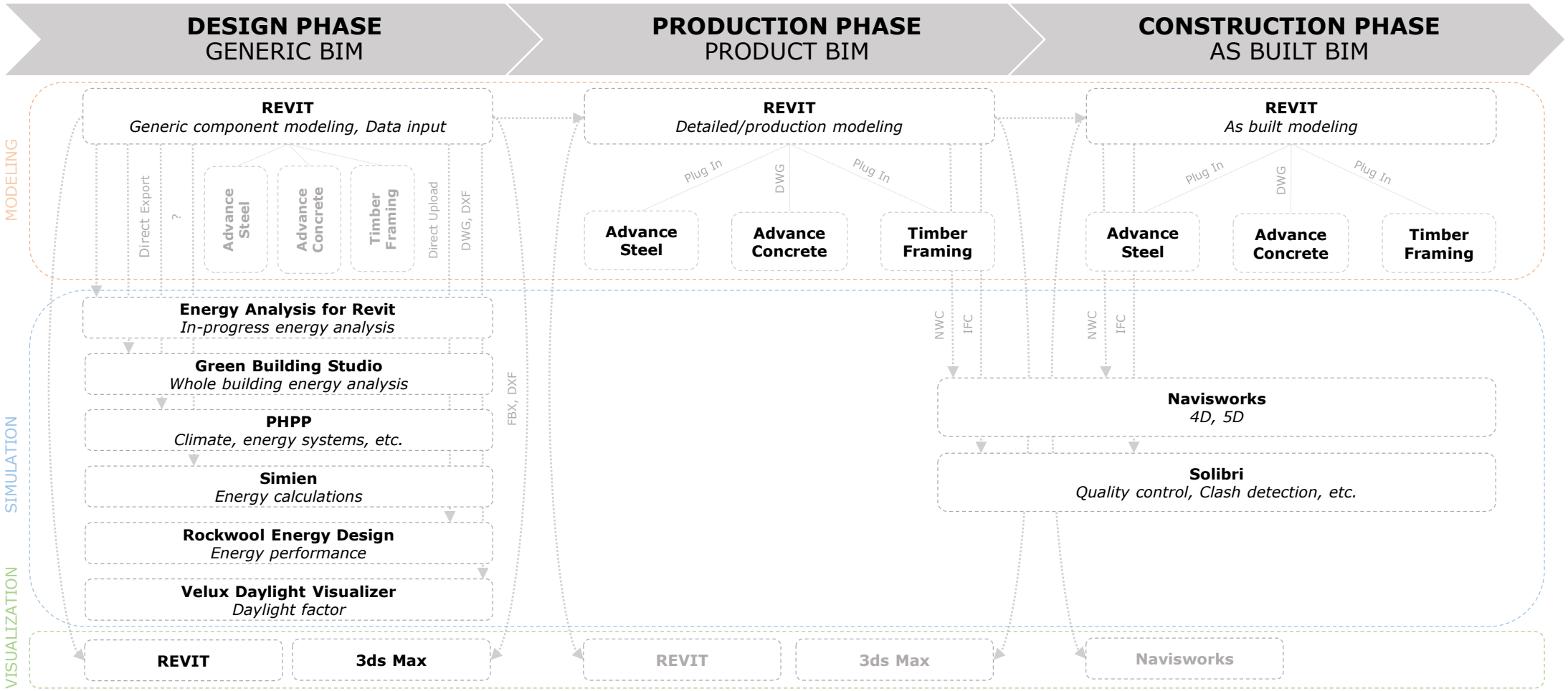
Performance control

- *Comparison between performance calculations and actual performance*

Mapping BIM Tools to Design Themes and Roles

Program & function	Site and climate	Air flow & quality	Visual comfort	Thermal comfort	Acoustic comfort	Materials & surfaces	Energy systems	Construction cost/planning	Operation & Energy
BA, CGN	**BA, CGN**	**CWT, MH**	**CWT, MH**	**BNT, RT**	**BNT, CWT, CT, RT, MH**	**CT, RT**	**GS**	**MTH, PHC, CGN**	**BA, PHC**
TASK	**TASK**	**TASK**	**TASK**	**TASK**	**TASK**	**TASK**	**TASK**	**TASK**	**TASK**
Energy demands Comfort demands Building Operation schedules	Climate analysis Site elements Site qualities	Turbulence Infiltration Indoor airflow Thermal distribution Natural ventilation	Daylight levels Glare Visibility Reflections	Heating hours Overheating Outdoor spaces Passive solar heat Solar radiation	Reverberation time Sound rays distribution Quality of room acoustic	Embodied energy Thermal properties Glazing properties Reflection values	Renewable energy systems Effect of sun power Mechanical systems	Overall production and construction cost Material cost Components cost	Energy use Energy cost Energy saving Operation cost
TOOLS	**TOOLS**	**TOOLS**	**TOOLS**	**TOOLS**	**TOOLS**	**TOOLS**	**TOOLS**	**TOOLS**	**TOOLS**
Excel PHPP SIMIEN	PHPP	Ecotect PHPP	Ecotect VELUX DV 3ds Max	PHPP Ecotect Revit, GBS	Ecotect	Ecotect Tally	PHPP GBS	Revit, QTO, Vico, Sigma	Revit, GBS PHPP Ecotect Excel
TARGET	**TARGET**	**TARGET**	**TARGET**	**TARGET**	**TARGET**	**TARGET**	**TARGET**	**TARGET**	**TARGET**
Framing refurbishment issues	Better understanding of climate and site	Comfortable air flows	Better visual and spatial comfort Comfortable contrasts	Better thermal comfort Less overheating and cold drags	Better acoustic and spatial comfort	Use of green materials Choice of materials with the right properties	Use of renewable energy concepts Choice of most effective system	Dynamic cost modeling Monitoring of economic process	Follow up on energy use

Tools & Interoperability Map



Understanding and Mapping Input Data

1. The BIM Management team in collaboration with the rest of the project partners should first define the materials'/products' properties/parameters that need to be inserted in the BIM models.
2. They can afterwards elaborate a template where the design teams will fill in the needed data.
3. The BIM team will then be responsible for filling in the data in the BIM models.

Example templates:

	THERMAL PROPERTIES					
Opaque Materials	U-values	Specific admittance	Thermal Lag	Thermal Decrement	Solar Absorption	Color Reflection
	(W/m2K)	(Y:W/m2K)	(Lag: hrs)	(Decr:0-1)	(abs:0-1)	
…						
…						

	THERMAL PROPERTIES			
Windows Materials	Shading Coefficient	Alternating Solar Gains	Refractive Indexes	Trans-parency
	(SC: 0-1)	(SG: 0-1)	(RI)	(Trans:0-1)
…				
…				

	SURFACE PROPERTIES		
Surfaces	Emissivity	Secularity	Roughness
	(SC: 0-1)	(SG: 0-1)	(RI)
…			
…			

SOUND ABSORPTION	
Sound Absorption Coefficients	Noise Ratings

Necessary values for thermal simulation

Necessary values for solar simulation

Necessary values for visualizations

Key Activities

1. Perform further research on project partners' BIM competencies
2. Agree on usage of BIM software
3. Assign roles and responsibilities
4. Define strategy and goals
5. Establish collaboration methods
6. Establish methods for exchanging information and coordination
7. Establish methods for quality control
8. Elaborate templates for data input
9. Develop BIM process and goals for each project stage
10. Define BIM workflows for each project stage to achieve the desired goals
11. …
12. …
13. …
14. …
15. Distribute WP5 budget along project phases
16. Hands on…

Conclusion

The use of BIM in NORFAC will greatly support and facilitate the project partners in finding the best flexible façade system solutions by serving as a "tool" for interdisciplinary development and sharing of knowledge between project participants and basis for decision-making. It will, furthermore, serve as a "marketing tool" and give an opportunity to open the market to SME companies.

Even though it pays off very well on the long term, the adoption of BIM is a very complex and time consuming task. It requires a holistic approach and is normally split into different levels – Project Level, Concept Level and Company Level – in order to facilitate the understanding of the actual adoption. Multiple issues - implementation strategy and methodology, choice of technology, education of employees, coordination and collaboration methods, methods for exchanging information, BIM technology, processes and workflows, etc. - need to be taken into consideration and solved simultaneously.

Even though just a single project, the implementation of BIM in NORFAC will also require careful planning and consideration of almost all the above mentioned tasks due to the number of project participants, the goals and complexity of the project. However, aspects such as educating project partners in BIM processes and technologies (which is normally an essential part of the BIM adoption) should be omitted due to the time and budget limits of the project (and probably the lack of need for such education for some of the partners). Tasks and responsibilities should be distributed among the project partners who already have experience in the field. The rest, who have interest in learning about BIM, will be able to benefit and learn as the project evolves.

As the project is already complex enough, simple solutions and clear strategy for the implementation of BIM in NORFAC need to be chosen. Many of the partners already have a lot of valuable experience concerning BIM. Therefore, the project should take advantage of their knowledge, and familiar processes and technologies should be applied.

A BIM team with a BIM leader has to be formed. They will define clear strategy, goals, roles and responsibilities, processes and use of technology together with predefined workflows and interoperability methods.

It should be in first place the project partners who will benefit from the use of BIM in NORFAC. Thus, the best choice for primary software tool would be Revit, due to the fact that all the partners using BIM are experienced in this platform. Additionally, other well known BIM applications will be used and will contribute in achieving the project goals in terms of sustainability. Closed BIM implementation method should be used as long as the project allows for that. If needed throughout the demonstration projects stage, an Open BIM methodology can be applied as well.

As the most important letter in BIM is "I" which stands for Information, an effective method for exchanging information should be established by means of central files, templates for data deliveries from non-BIM-involved project partners, etc. While the non-BIM-involved partners will be responsible for the correct delivery of their inputs, the BIM-involved partners will be responsible for inserting the data correctly in the models.

As Revit is widely used in the Nordic countries and in many other places of the world, 3D Revit objects will reach a great amount of the target groups in first place. As soon as the development project is completed, 3D objects in other formats can easily be modeled as well to reach other software users.

The elaboration of "a user interface with photo realistic objects of each building element/system where the end users will be able to make their adjustments on the solution and see the results of their choices in terms of total life cycle cost, energy efficiency and carbon footprint", will require the involvement of an IT team in the project and it is, thus, a topic for further discussion in the project management team.

BIM needs to be an integrated part of the project and should spread through all project phases.

If applied correctly, BIM will greatly contribute to the success of NORFAC!

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