Ⅳ-2 国外のインタビュー調査

インタビュー先の概要と選定理由

今回のフィンランド調査では、フィンランドの不動産、建設、行政、教育、研究機関、協会のぞれぞれの分野から、インタビュー対象を選定した。結果として、各分野から計 9 件のインタビューを実施することができた。以下に、インタビュー先となる各組織の概要と選定意図をまとめる。

不動産分野では、ARA と YLVA からインタビューへの協力が得られた。それぞれの組織概要と選定意図は以下の通りである。

ARA の概要：

ARA（フィンランド住宅金融開発センター）は、環境省の管轄下にある政府機関である。戦後のフィンランドの住宅不足を解消するために 1949 年に設立された。それ以来、フィンランド国内の新築住宅 100 万戸以上（全住宅生産量の約 1/3）を助成しており、近年木造集合住宅の建設に力を入れている。

YLVA の概要：

YLVA のオーナーはヘルシンキ大学の学生組合であり、YLVA の利益は学生の活動を促進するために使用することを意図している。、YLVA の事業活動は、不動産とレストラン部門に重点を置いていており、長期的な計画を前提として街や社会と一体化し続けられるような持続可能な意思決定をもった事業に取り組んでいる。

選定理由：

ARA は不動産分野において、木造建築の推進に力を入れている公的な組織である。一方で、YLVA は必ずしも木造に力を入れている訳ではない、一般的な組織と言える。今回のインタビューでは、不動産分野からみた木造に関するファイナンスや耐久性等についての意見を、木造を推進する立場及び一般的な立場（必ずしも木造を推進していない）から、ヒヤリングすることを意図したため、上記の 2 社をインタビュー先として選定した。

建設分野では、SRV からインタビューへの協力が得られた。組織概要と選定意図は以下の通りである。

SRV の概要：

SRV は、フィンランドを代表するプロジェクトマネジメントコントラクターである。SRV は、建設に関連するソリューションが、何年も何世代にもわたって、利用者、住民、環境の福利、経済的価値、利益を保証する、ライフサイクルを考慮した新しい事業の実現に取り組んでいる。また、商業施設、ビジネス施設、住宅、インフラストラクチャー、ロジスティクス関連施設などの開発・建設など幅広い用途の建物に精通している。

選定理由：

SRV は建設分野において、木造建築に特化している訳ではなく、少数ではあるが中大規模木造建築の建設を行った経験があり、将来的に木造の割合を増やしていこうとしている企業の一つである。よって、建設分野からの木造に関するファイナンスや耐久性等についての意見に加えて、木造建築の建設に関わる経験に基づく課題や問題点、将来的な木造の普及に関する意見についてヒヤリングできると考えたため、SRV をインタビュー先として選定した。

行政では、環境省とヘルシンキ市（都市環境課）からインタビューへの協力が得られた。それぞれの組織概要と選定意図は以下の通りである。

環境省の概要：

環境省は、フィンランド政府の環境・住宅政策を策定している。関連する政策は、環境保護、土地利用、自然保護、建設、住宅などの問題についてである。また、環境省は、行政区域内の戦略的な計画の立案と管理、新しい法律の起草、環境問題に関する国際協力の責任も担っている。全体的な目標として、魅力的で安全な生活環境を作り、生物多様性を守り、環境破壊を防止し、フィンランドの住宅事情を改善することを掲げている。

ヘルシンキ市（都市環境課）の概要：

ヘルシンキ市（都市環境課）は、ヘルシンキの都市環境に関する計画、建設、維持管理、建築規制、環境サービスなどを担当している部署である。都市環境事業部の各部門の業務は、都市環境委員会、建築物・公共物小委員会、環境・許認可分科

会、都市環境課の役職者によって運営されている。

選定理由：

環境省は木造建築の普及を進めていく上で、政府機関で中心となる存在であるため、木造建築の普及や耐久性に関わる現状、課題や問題点、LCAや木造建築関わる政策について網羅的に把握しているため、インタビュー先として選定した。また、ヘルシンキ市（都市環境課）は、必ずしも木造だけに特化している訳ではないが、カーボンニュートラル実現に向けて木造の活用に力を入れ始めている代表的な行政機関である。また、行政の立場からの木造に関する耐久性等についての意見に加えて、将来的な木造建築の普及に関する意見についてヒヤリングできると考えたため、インタビュー先として選定した。

教育分野では、アアルト大学（建築学科）とタンペレ大学（建築学科）からインタビューへの協力が得られた。それぞれの組織概要と選定意図は以下の通りである。

アアルト大学（建築学科）の概要：

アアルト大学は、フィンランド・エスポー市のオタニエミにメインキャンパスを構える学際的な大学である。6つの学部をもち、合計で約20,000人の学生と4,500人の職員（うち400人が教授）が在籍している。特に、建築学科はフィンランドを代表する研究機関としても、木造建築を含めた多くの研究に取り組んできている。

タンペレ大学（建築学科）の概要：

タンペレ大学は、2019年初めにタンペレ大学とタンペレ技術大学が合併し、タンペレ応用科学大学と緊密な連携を保つ財団型の新タンペレ大学として誕生した。世界トップレベルの研究とイノベーション活動を融合させ、産業、ビジネス、公共部門に利益をもたらすアプリケーションの開発に取り組んでいる。特に、建築学科はアアルト大学と並んで、木造建築に関する多くの研究に取り組んできている。

選定理由：

アアルト大（建築学科）とタンペレ大学（建築学科）は木造建築に関してフィンランドを代表する教育機関であり、木造建築の普及や耐久性に関わる現状、課題や問題点、研究内容について網羅的に把握しているため、インタビュー先として選定した。

研究機関では、VTTからインタビューへの協力が得られた。組織概要と選定意図は以下の通りである。

VTTの概要：

VTTは、フィンランド政府に属するヨーロッパを代表する研究機関です。社会における研究と技術の活用と商業化を推進し、科学技術の手段を通じて、地球規模の大きな課題を、企業や社会の持続的な成長につなげることを意図している。

選定理由：

VTT はフィンランドを代表する研究機関かつ木造建築の普及や耐久性に関わる現状、課題や問題点、ＬＣＡや既存ストックの活用を含めた研究内容について網羅的に把握しているため、インタビュー先として選定した。

協会機関では、グリーンビルディング協会からインタビューへの協力が得られた。組織概要と選定意図は以下の通りである。

グリーンビルディング協会の概要：

グリーンビルディング協会（FIGBC）は、建築環境が気候変動を解決する中心的な役割を果たすことを目指している。活動の効果は、包括的な協力と、専門家や国際的なネットワークの意見によって成り立っており、社会に対して環境的な方向性を示すことのできる活動に取り組んでいる。

選定理由：

グリーンビルディング協会は、環境認証機関として、木造建築の普及や耐久性に関わる現状、課題や問題点、ＬＣＡや既存ストックの活用を含めた研究内容について把握しているため、インタビュー先として選定した。

次項以降に各インタビュー結果をまとめる。

良質なストック形成等に向けた、木造建築物への融資における合理的な融資期間等に関する普及・広報			
会議名	**Interview meeting for wood construction in terms of finance and durability/木造のファイナンスと耐久性の観点からみたインタビュー会議**		
日時	4th January, 2023 10:00-12:00/2023年1月4日10:00-12:00		
場所	Ministry of Environment, meeting room/環境省会議室		
出席者	Sampo Vallius (SV), ARA・ Senior Specialist / ヴァリウス サンポ (ARA・ シニアスペシャリスト), Vesa Ijas, (VI) ARA・ Senior Architect /イヤス ヴェサ（ARA・ シニアアーキテクト）, Shin Murakami (SM), Sugiyama Uni・Professor/ 村上心（椙山大・教授）, Hiroki Ishiyama (HI), Osaka City Uni・Associate Professor /石山央樹（大阪公立大・准教授）, Daishi Sakaguchi(DS), Nihon Fukushi Uni・Associate Professor /坂口大史（日本福祉大学・准教授）		
作成日	2023年1月5日	**記入者**	坂口大史

■ 議事	
議題	(1) General condition of market for residential building/住宅用途の建物に関する一般的な状況とマーケットの状況 (2) Current situation of wood construction/木造建築の現状
内容	(1) General condition of market for residential building ・Could you explain about your organization?(DS) - ARAVA (Asuntorakennustuotannon Valtuuskunta) became ARA in 2008, under ministry of Environment. It is a little bit unique process of the development of the organization but probably the reason is that the ARA has been working concerning living environment. I will share the slides for our organization. Please refer to these slides for more information. (VI) ・What is the general lifecycle for building in Finland? (SM) - Life span depends on the structure type but generally between 50-100 years. Wood construction is same as concrete construction and it is 50 years. (SV) ・How much is the budget for the maintenance in general? (HI) - Maintenance budget: Included in the rent. Generally, 3-5 euro per floor square meter. (SV) - 15% of payment when the tenant start living in the apartment, and it will be paid back when the tenant will move out. (VI) - Precast concrete structure is commonly used in multi-story residential building because it will lead to shorter construction, and industrialization. (VI) ・ Is wood construction popular in the market of Finland? (SM) - Yes, it is getting popular. But ARA is neutral to different types of construction meaning

	not only prioritize wood construction. (VI) ・ When the shortage of housing will be solved? (SM) In 1960, people started moving big cities and ARA has been providing the dwellings but not solved yet. (VI) - Subsides for wood construction will be applied because about 10% more expensive than concrete building if it is same spec. (VI) ・ 40 years interest for 1.7% and if the market average interest is over 1.7%, it will be covered. Shorter loan interest 10 years is 2.5%, currently the market interest is over 3%. (SM) - In Finland, the land price is still relatively cheaper even in Helsinki. Subsides for land cost is 700euro per floor square meter. Construction cost is about 5,000euro per floor square meter. Normal market land price is 2,000 euro per floor square meter. (VI) - The construction cost is always based on the market competition. (SV) - The reason for the subside is to create social mix house in/out of the building. The extra cost for new construction is shared by all tenants in all other buildings. (VI) (2) Current situation of wood construction/木造建築の現状 ・ What kind of methods are used for wood construction in Finland? (HI) - General structural method used for wood construction is Timber flame, Platform/prefabricated method, frame elements and modular construction. I will also share 2nd reference for the details. Please refer to the slides. (VI) ・ How have the regulations of wood construction changed in Finland? (DS) - By 2010, only 4th floor was possible by wood construction. In 2011, first 5 floor apartment was built in wood construction (LVL element system) and the system was used in 120 dwellings apartment in Helsinki. Only one project was realized but no other project was realized. (VI) - During 2011-2012, post and beams wood construction is realized and during 2013-2015, CLT construction was realized. Different types of wood buildings have been realized. (VI) ・ When you conduct a project, how will the budget be compared? (DS) - Concrete construction will be compared by cost competition provided from different contractors, but wood construction does not need to be compared because not so many companies could do wood building. (SV) - Benefits for wood construction is in shorter construction work on the site but more time in the factory, in total duration almost same. (VI) ・ How much is the rough price of aprtment for the cost per square meter? (SM) - For example in the case of 14th floor in Joensuu 4,300 euro per floor square meter. In the case of Puukuokka in Jyvaskyla, 3800euro per floor square meter. Land price and construction price is much cheaper in countryside. (VI) ・ Is there any problem for building in terms of durability in Finland?

	- Problem of mold is more common in concrete building. Not is wood building. (VI) ・ Do you think wood construction will be more popular in Finland? (DS) - Traditionally log structure has been used and 1997 was the golden age for 2-3 story apartments in Finland. Between 2000-2010, only one multi-story wood apartment was realized. There was a big fire in Turku and that restricted fire regulations for wood construction and has been difficult to build higher building with wood construction by 2011. (VI) - In 2011, more that 4th floor by wood structure became possible, currently 8th floor is possible. The situation is getting better. (SV) - If we look at the case of Austria, Austria has different fire regulations for wood construction. For instance, there is no need of sprinkler even for 8th floor wood building. (VI) ・ What can we do to spread more wood construction? (HI) - Architects must know the construction system, dimension and to make 3D models of wood construction for engineers and contractor. (SV) - For wood construction, university should be included in the research and monitor the construction, especially important in the first 10 years of the project. ARA reserves 700,000 euros for the research and ARA is happy to collaborate internationally in the practical projects. (VI) （日本語訳） (1) 住宅用途の建物に関する一般的な状況とマーケットの状況 ・あなたの組織はどのような組織か（DS) - ARAVA (Asuntorakennustuotannon Valtuuskunta) は2008年に環境省の管轄でARAとなりました。組織の発展過程が少し特殊であるが、おそらくARAが生活環境に関する活動をしてきたことが理由である。組織については一つ目の資料を参照してほしい。(VI) ・フィンランドの建築物のライフサイクルはどの程度で設定されているか？ (SM) - 寿命は構造の種類によって異なるが、一般的には50～100年です。木造はコンクリート造と同じで50年である。(SV) ・一般的にメンテナンスの予算はどの程度か？(HI) - メンテナンスの予算は。家賃に含まれている。一般的に1フロア1平方メートルあたり3-5ユーロとなっている。(SV) - 入居時に15％を支払い、退去時に返金される。(VI) - プレキャストコンクリートによる建物は、建築期間の短縮と工業化につながるため、多層住宅によく使われる。(VI) ・フィンランドでは、木造建築は人気があるのか？ - はい、特に近年では人気が出てきている。しかし、ARAでは、木造建築だけを優先するのではなく、RC造やS造を含めて様々なタイプの建物に中立的な立場をとっている。(VI)

	・住宅不足はいつ解消されるのか？(SM) - 1960年に大都市への移住が始まり、ARAが住居を提供するようになったが、まだ解決していない。(VI) - 木造建築は、同じスペックならRC造の建物より10%程度高いので、補助金を適用されるケースが多い。(VI) - 40年金利は1.7%で、市場平均金利が1.7%を超えればカバーされる。短めのローン金利10年は2.5%、現在市場金利は3%以上である。(SM)。 - フィンランドでは、ヘルシンキでもまだ地価が比較的安い。土地代に対する補助金は床面積あたり700ユーロで、建設費は 1 平方メートルあたり 5,000 ユーロ程度です。通常の市場地価は1坪2,000ユーロとなっている。(VI) - 建設費は常に市場競争に基づいて決定されている。(SV) - 補助金を適用する理由は、建物内外の低所得者から高所得者まで分け隔てなく住む（social mix house）の状態をつくることを目的としている。新築を建てるための余分な費用は、他のすべてのビルのテナントが分担することになっている。(VI) (2) 木造建築の現状 ・フィンランドの木造建築にはどのような工法があるか。（HI） - 木造建築に用いられる一般的な構造方法は、ティンバーフレーム、プラットフォーム/プレハブ工法、フレームエレメント、モジュール工法である。これについても2つ目の資料を共有するので、詳しくはそちらを参照してほしい。(VI) ・フィンランドにおける木造建築の規制はどのように変化してきたか 。(DS) - 2010年までは、4階までしか木造建築を建てることが可能ではなかった。2011年に初めて5階建てのアパートが木造で建てられ（LVLエレメントシステム）、ヘルシンキの120戸のアパートでこのシステムが使用された。このシステムでは1件のみ実現したが、他のプロジェクトは実現しなかった。(VI) - 2011年から2012年にかけて、柱と梁の木造建築が実現し、2013年から2015年にかけて、CLT建築が実現した。その後も異なるタイプの木造建築が実現されてきた。(VI) ・プロジェクトを実施する場合、予算はどのように比較されるか。(DS) - RC造の建物は、業者間のコスト競争によって比較されるが、木造建築は、それほど多くの業者ができるわけではないので、比較する必要はない。(SV) - 木造のメリットは、現場での工期が短く、工場での工期が長く、トータルの工期はほぼ同じであることが挙げられる。(VI) ・マンションの一般的な坪単価の目安はいくらであるか？ - 例えば、ヨエンスーの14階の場合、1平方メートルあたり4,300ユーロであった。　ユヴァスキュラのPuukuokkaの場合、1平方メートルあたり3800ユーロであった。土地価格も建築価格も、都会に比べると田舎ではもっと安区なる。(VI) ・フィンランドでは、建築物の耐久性に問題はないのか？ - カビの問題は、RC造の建物に多いが、木造建築はそれほどでもない。(VI) ・フィンランドで木造建築は、今後もっと普及すると思うか？ (DS) - フィンランドでは、伝統的にログハウスが使われており、1997年はフィンランドで2-3階建てのアパートの黄金時代であった。2000年から2010年にかけて、木造の多層

	階アパートは1件しか実現しなかった。それは、トゥルクで大火事があり、木造建築の防火規制が厳しくなり、2011年まで木造で高い建物を建てることが難しくなっていたからである。(VI) - 2011年には4階以上が可能になり、現在では8階まで可能である。状況は良くなってきていると感じる。(SV) - オーストリアの事例を見ると、オーストリアは木造建築に対して異なる防火規制がある。例えば、8階建ての木造建築でもスプリンクラーは必要ないなどの特徴がある。(VI) ・木造建築を普及させるためにはどうしたらよいか？(HI) - 建築家は、木造建築の構造や寸法を知り、技術者や請負業者のために木造建築の3Dモデルを作る必要がある。(SV) - 木造建築の場合、特にプロジェクトの最初の10年間は、大学も研究に参加し、建築する工程をモニタリングすることが重要である。ARAは70万ユーロを研究費として確保しており、実用的なプロジェクトで国際的な協力できれば大変嬉しい。(VI)
備考	・特になし

■ 次回の予定	
日時	年　　月　　日（　　曜日）　　時　　分より
場所	

ara The Housing Finance and Development Centre of Finland

The Role of ARA in subsidizing Social and Affordable Housing in Finland

Vesa Ijäs/Sampo Vallius 4.1.2023/

14.6.2022 International Social Housing Festival, Director Jarmo Lindén
Housing Finance and Development Centre of Finland

Content

- *Finland in general*
- *Short housing history*
- *How Social and Affordable housing is financed?*
- *Co-operation between Government and municipalities - Case Helsinki*
- *Social Housing operators – Clients of ARA*
- *Cost-based rents and housing benefits*
- *Tenant selection*
- *What's good in Finnish systems - some shortcomings*

Independance Day: 6th December (1917)

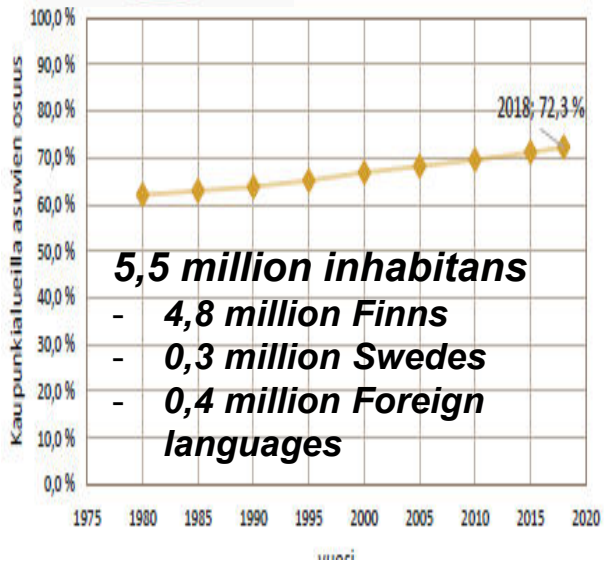
Finland = mostly forests, swamps and lakes…
Urbanization rate: 72,3% (2018)

338 465 km2

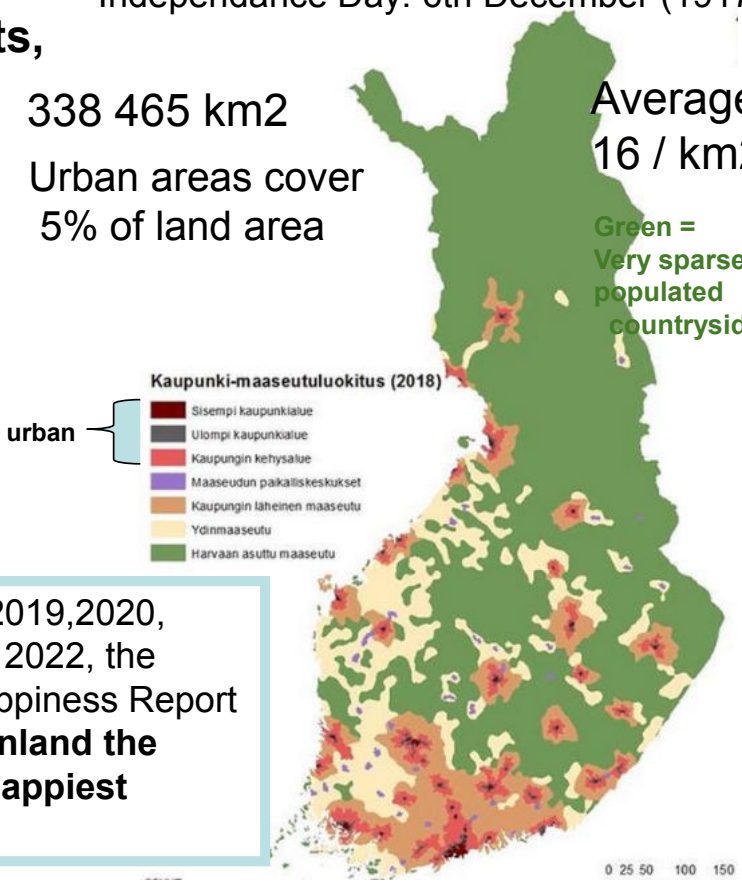
Urban areas cover 5% of land area

Average: 16 / km2

Green = Very sparsely populated countryside



5,5 million inhabitans
- ***4,8 million Finns***
- ***0,3 million Swedes***
- ***0,4 million Foreign languages***



In 2018, 2019,2020, 2021 and 2022, the World Happiness Report ranked **Finland the world's happiest country**

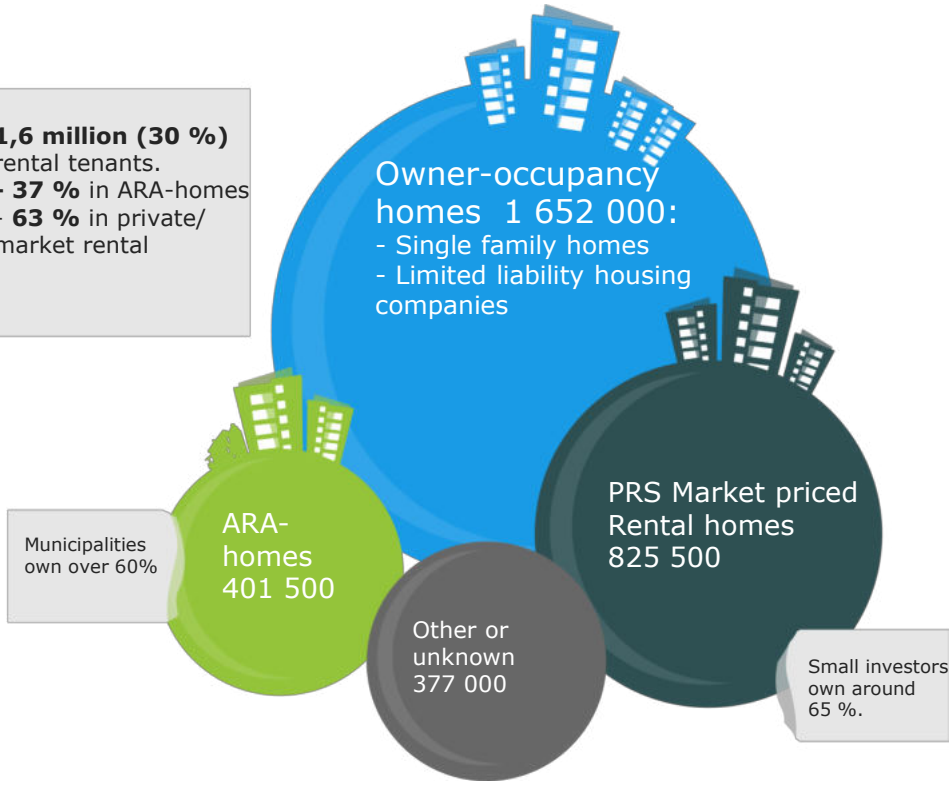
9.1.2023

ara

Housing Stock in Finland 31.12.2020: 3,25 Million homes

65% is owner-occupancy and
35% rental + right-of-occupancy

1,6 million (30 %) rental tenants.
- 37 % in ARA-homes
- **63 %** in private/ market rental



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ARA– housing stock under restrictions (following SGEI rules by EU)

- **Ordinary rental dwellings** **250 000**
  - Over 70 % owned by municipality-owned companies
- **Rental dwellings for special groups** **100 000**
  - Rental dwellings for elderly
  - Rental dwellings for students
  - Other different special groups
- **ARA- rental dwellings in total** **350 000**

+ 50 000 dwellings without restrictions

- **Right of occupancy dwellings** **50 000**
- **ARA –dwellings total** **400 000**
  - 13 % of all housing

Right-of-occupancy homes since 1990

- A right-of-occupancy home combines the security of owning your own home with the flexibility of renting
- **ARA grants a loan for 85%** of the approved construction and building site price
- The holder of the right-of-occupancy pays **15 % of the real construction price** of the right-of-occupancy home
- Resident pays **a monthly fee**, which is like rent including maintenance and amortization of loan - fee has to be below the market rent level in the same area
- Right-of-occupancy home can never be redeemed, it retains its right-of-occupancy status. In right-of-occupancy home residenti has the same security of tenure as in owner-occupied homes.

- For applying the right-of-occupancy homes the applicant must have a **queue number** from the municipal housing authority. THIS WILL BE REFORMED 2023: ARA will give national queue numbers
- After getting the queue number it is possible to fill in the apartment application to the registers of the companies offering right-of-occupancy homes
- there is **no income limit**, but the applicant cannot have too much of assets. For over 55 years old applicants there are no assets limit either
- The resident moving out will get back the money he invested (15%), adjusted with the building cost index.
- Existing stock over 50 000 homes – all ARA subsidised

ARA was established in 1949

1949 Housing production committee (ARAVA)

- The state housing loans programme - first for 5 years - was established ***to solve "temporary housing shortage"***
- The agency and the loans were named **ARAVA** (**A**suntor**a**kennustuotannon **va**ltuuskunta)

1966 National Housing board (AH)

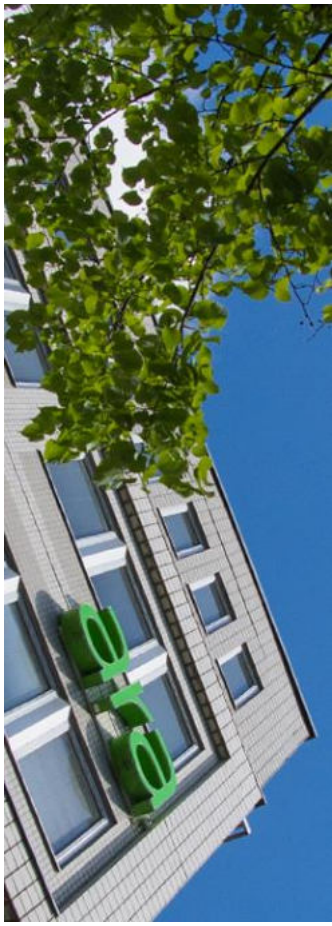
- 1983 Moved under the new *Ministry of Environment*

1993 The Housing Fund of Finland (ARA)

- Concentrating on Social Housing

2008 The Housing Finance and Development Centre of Finland (ARA)

- Regionalised from Helsinki to Lahti



Second World War – in which Finland lost 100 000 lives - caused housing shortage as well

120 000 homes were left in areas annexed by the Soviet Union = 400 000 evicted from those areas had to be rehoused rapidly

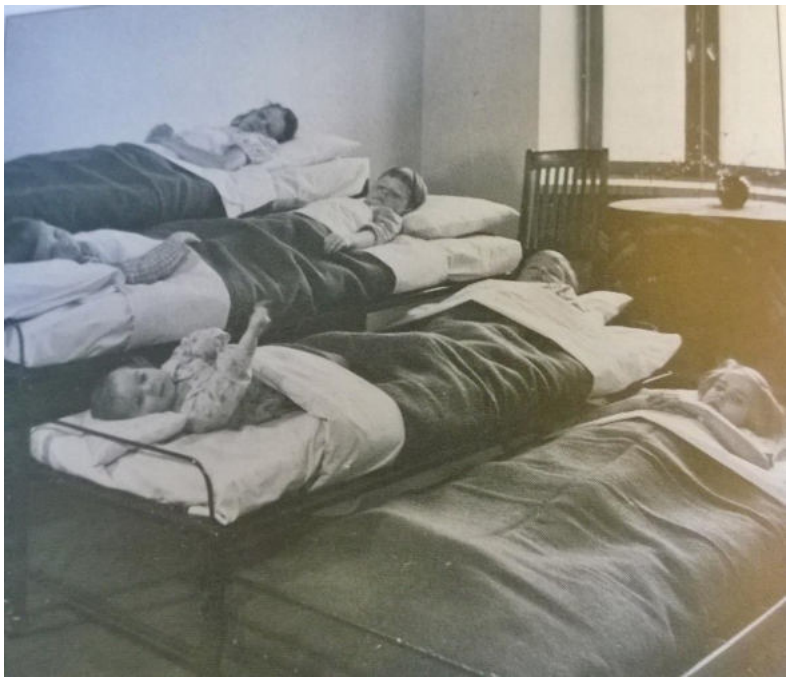
20 000 homes were ruined by Russian airstrikes to cities

15 000 homes were destroyd and burned by German army in Lapland 1944-1945

= together **over 10% housing stock was lost**

Baby Boomers were born after the WW II: 1946-1949 annually was born over 100 000 children

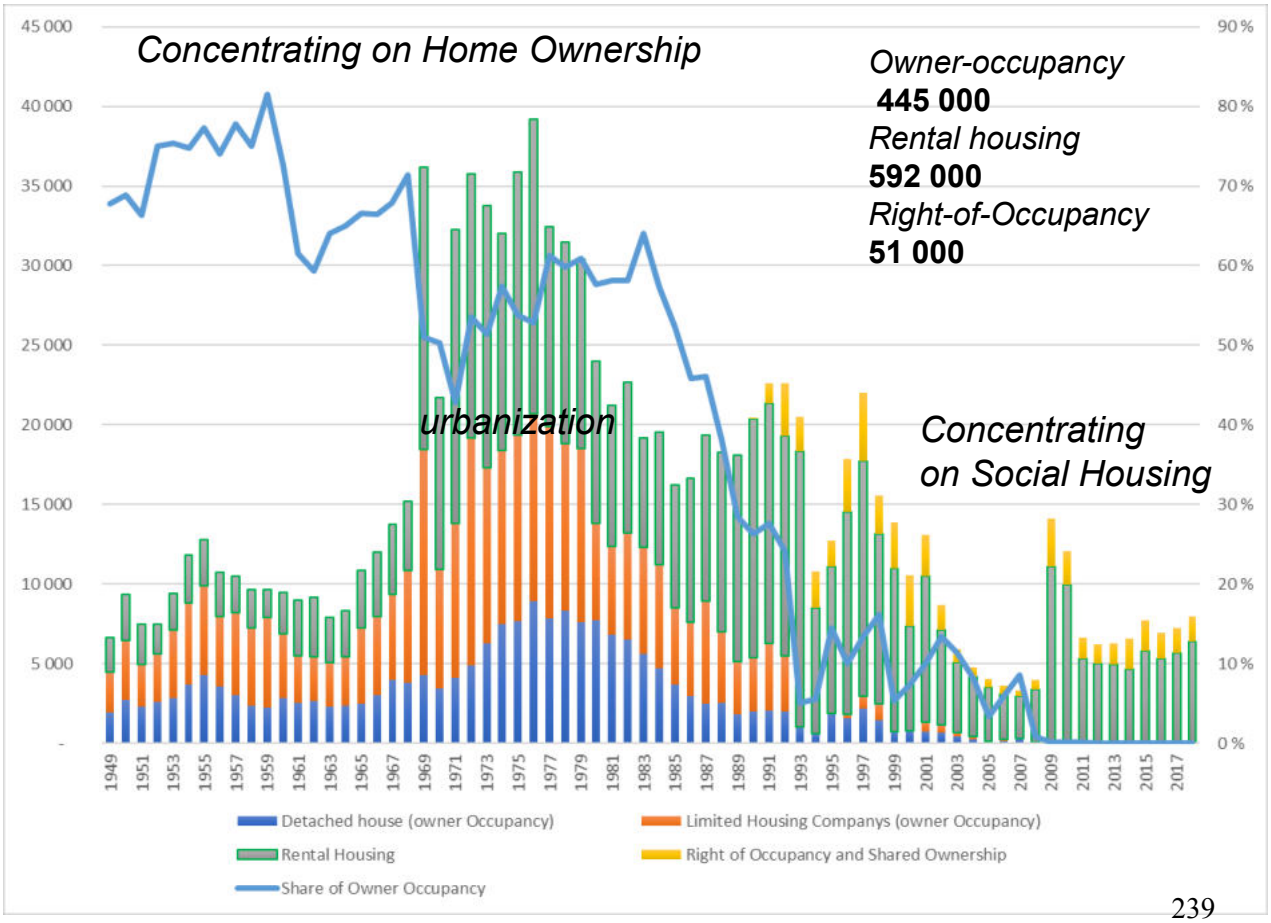
- ARAVA was helping to solve housing problems of families
- Great move to the cities started in Finland in the sixties
- Last year only 45 000 children were born…



ARA's History since 1949:

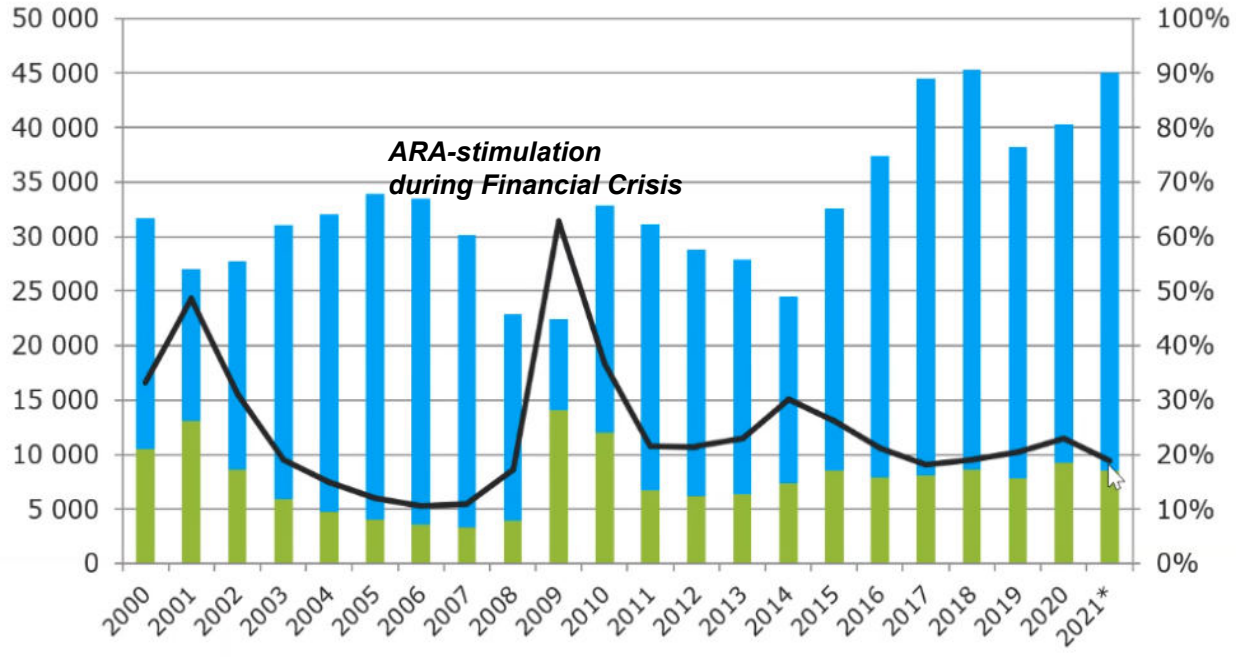
Government subsidised housing starts by tenure status 1949-2018 over 1,1 million dwellings = 1/3 of all

and share of owner occupancy



Housing production in Finland 2000 – 2021
Market and ARA and %-share of ARA

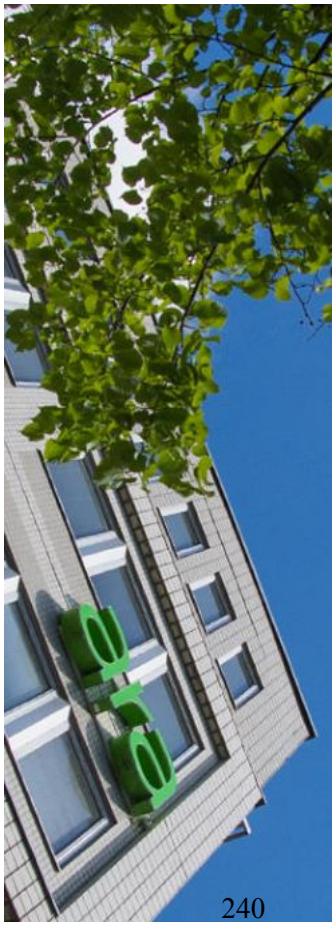
Private investments have been booming on PRS since 2015: housing Construction is historically high - but apartment size is smaller and smaller = Market ”solution” to Affordability crisis…



ARA Implements Government Housing Policy (supply side policies)

An expert partner and developer of housing

- ARA implements government housing policy, aiming for sustainable and affordable housing
- ARA is part of public administration and operates under the Ministry of the Environment
- delivers grants, subsidies, and guarantees related to housing and construction and renovation of housing
- guides and monitors the use of ARA housing stock
- is involved in housing development projects, like Homelessness and suburbs development
- manages expert tasks and information services related to housing and housing markets, and carries out related research
- oversees building energy performance certificates



Finnish Housing Support System is Mixed
= *Combination of Supply and Demand Side measures*

- **Demand linked subsidies**
  - promoting housing consumption
  - housing allowances (over 2 Billion)
  - tax-relief for interest on housing loans (will be abolished totally 2023)
  - Tax relief in selling (after 2 years)
  - First time buyer interest subsidy (ASP –scheme)
  - Partial guarantee for home loans
  - Over 90 % of all subsidies

- **Supply linked subsidies (ARA)**
  - encouraging social housing production and renovation
  - interest-subsidy loans with guarantee
  - investment grants
  - Renovation and other grants
  - Less than 10 % of subsidies

9.1.2023

ara

ARA provides funding and subsidies for social and affordable housing projects

- **LOANS = 2 335 Million Euros in 2022**
  - **Interest subsidy loans** for new construction, renovation, and acquisition
  - **guarantee loans** for rental housing construction and housing company renovations

- **GRANTS = 330 Million Euros in 2022**
  - investment subsidies for special groups, energy grants, repair grants, infrastructure grants, housing advice etc.

- The funds for grants and subsidies are provided mainly from **the Housing Fund of Finland** (operated by ARA) and partly from government budget – **all mandated by parliament**

Loans are mainly from Municipality Finance since 2008

Kuntarahoitus
MUNICIPALITY FINANCE

Government Budget 2022:
ARAs Grants for Housing 2019 => 2022 (Million Euros)

Most grants are mandates from ***The Housing Fund of Finland,*** *which is Off-budget fund with 5,8 Billion Euros, Operated by ARA*

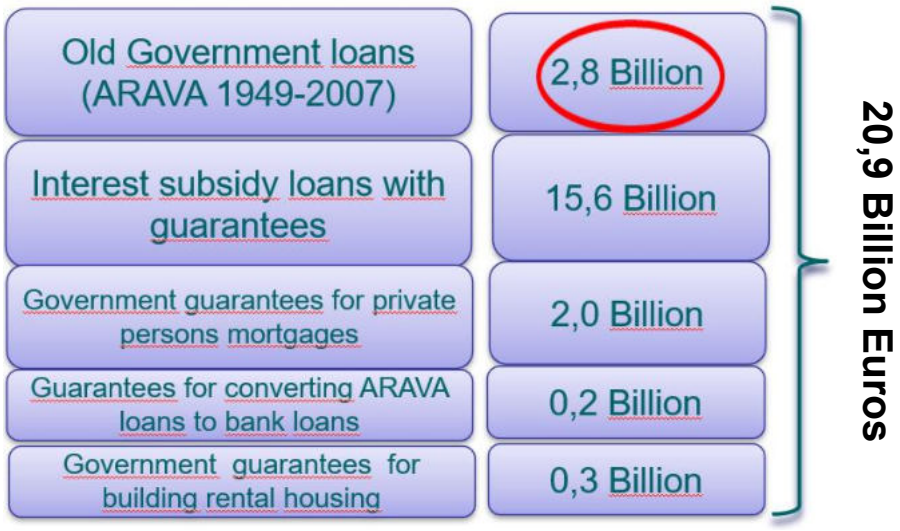
	2019	2022
• Investment grants for special groups	105 M€	90,0 M€
• Start-up grants (MAL)	20 M€	40,0 M€
• Infrastructure grants for municipalities (MAL)	15 M€	25,0 M€
• Repair grants	35,5 M€	33,85M€
• Demolition grants	5,0 M€	8,0 M€
• Housing advice grants	0,9 M€	3,9 M€
• Research & development	0,7 M€	0,7 M€
• Infrastructure for charging of electric cars grants	1,5 M€	30,0 M€
• Preventation of economic difficulties in rental housing	1,0 M€	-
• Promoting co-operative housing pilots	0,4 M€	-
• *Energy efficiency grants*	-	*70,0 M€*
• *Grants for municipalities to replace oil-heating*		*4,9 M€*
• *Promoting use of purpose change grant*	-	*1,0 M€*
• *Promoting housing accessiblity for elderly*	-	*10,0 M€*
• *Grants for suburbs renewal projects*	-	*8,0 M€*
• *Grants for remodelling services to eradicate homelessness (Ministry of Social and Health Affairs)*		*3,4 M€*
• **Together**	**185,0** M€	**330,4 M€** **+79%**

Housing Fund of Finland's (VAR) loans and obligations at the end of 2021

Interest subsidies and grants are paid from this Fund

Housing Fund of Finland was established in 1990

Government Programme 2019:
"When it comes to state-subsidised housing, the Housing Fund of Finland will retain its position as an extra-budgetary fund and we will seek new sources of income for the fund. We will ensure that the state support system promotes innovative, environmentally friendly housing solutions."



Own capital of the Fund is 5,8 Billion Euros

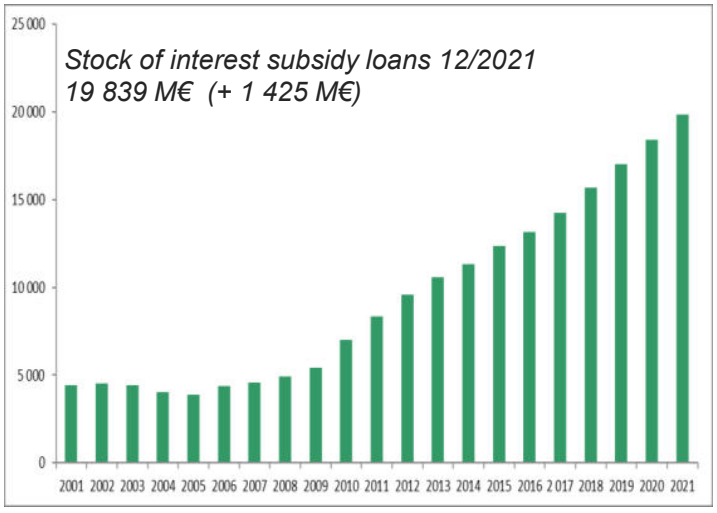
ARA Jarmo Lindén 5.11.2010

In Finland Social / Affordable Housing is achieved with combination of:

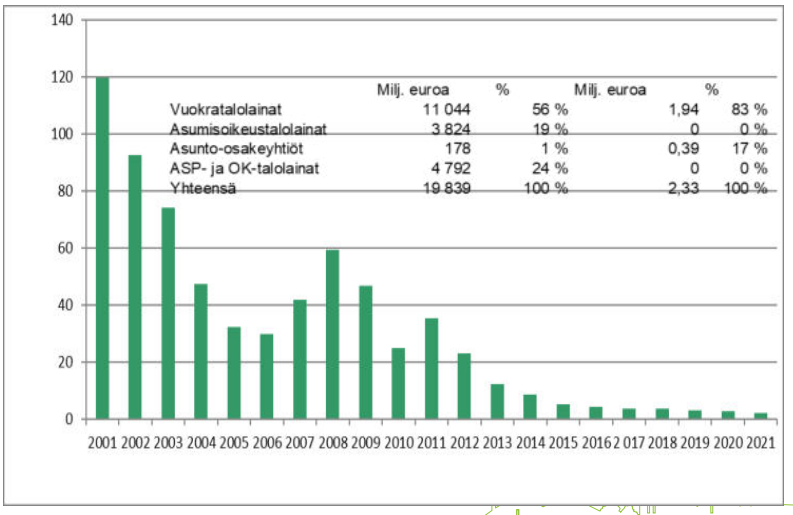
- **ARA interest subsidy loans (1950 Million Euros 2022 = 10 000 new dwellings)**
  - **ARA accepts plans and costs of every project (Design for all –principle, accessibility)**
  - **Bidding for construction,** economic cycle effects, social housing production counter-cyclical
  - **Long running time of loans,** usually **40 years**
  - **High LTV of ARA loans,** usually **95%** of acquisition costs
  - **Government guarantee** is included in ARA interest subsidy loans (free of charge)
  - **Direct grants are combined with ARA loans,** investment grants up to 50% and start-up grants
- **Affordable price/rent of building site** (Municipalities support Social Housing projects with cheaper plots than market price, EU/SGEI regulations)
- **Affordable rent** in ARA Housing = cost recovery principle: In Helsinki -60% vs PRS
- Owners of social rental housing= municipalities and non-profit private actors
- **Co-operation between Government and Municipalities** is necessary - Agreements on Land Use, Housing and Traffic - targets for social housing production
- Both supply (ARA) and demand (housing benefits) side subsidies are needed to achieve affordability with good quality housing for all

ARA's supply side support is very cheap measure for government – high impact with low cost!

Stock of interest subsidy loans 2001-2021



Paid interest subsidies 2001-2021



Interest subsidy loan with investment grants for special groups (2022: 90 M€)

- Special groups: *Homeless*, people with mental problems, disabled, elderly with dementia, students and youth

- **Grant Categories:**

  I Grant category maximum 15% (e.g. students and youth housing)

  II Grant category 20 - 25% (supported housing e.g for people with mental problems)

  III Grant category 35 - 40% (service housing for elderly 24/7)

  IV Grant category 50% (*long-term homelessness*, disabled people)

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Investment Grants for Social Rental Housing of Special Groups 2005- 2020: 1,4 Billion Euros grants + 4,5 Billion Euros interest subsidy loans for 54 000 dwellings

ARA has approved 6 Billion investments for 54 000 rental homes during 2005-2020 for Special Groups

This funding was used to renovate shelters to housing: 50% grant + 50% loan

Special Group	Rental dwellings		Grants		Average grant / dwelling (€)
	Number	Share	Million €	Share	
Elderly people (with dementia)	21 990	41 %	776,2	54 %	35 296
Students	19 793	37 %	152,9	11 %	7 725
Disabled persons	4 885	9 %	281,3	20 %	57 575
Homeless people	**2 265**	**4 %**	**88,8**	**6 %**	**39 184**
Persons with mental problems	1 391	3 %	43,2	3 %	31 052
Others (e.g youth with special needs)	3 294	6 %	99,2	7 %	30 131
2005 - 2020	**53 618**	**100 %**	**1 441,5**	**100 %**	**26 885**

Renovation and energy subsidies granted by ARA

Subsidies for housing companies and ARA-entities

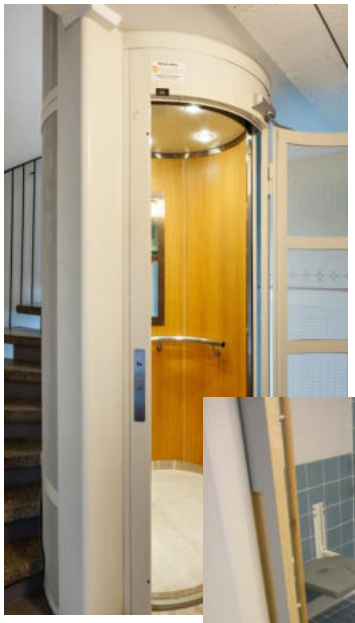
- Accessibility subsidy
- Elevator subsidy
- Subsidy for EV home charging infrastructure
- Subsidy for house condition examinations and renovations planning
- Subsidy for energy efficiency renovations

Subsidies for the households

- Subsidy for elderly
- Subsidy for disabled people
- Subsidy for energy efficiency renovations
- Subsidy for house condition examinations and renovations planning

9.1.2023

Renovation subsidies



- **Lift grant**
  - subsidies are granted for **installing new lifts in old blocks of flats** whose stairwells lack them
  - maximum grant **45 % of costs**
  - About 100 lifts annually (together over 4000)
- **Subsidies for the renovation of homes for elderly or disabled people (max 70 % of costs)**
  - to improve accessibility or safety and make possible to live in own home longer
  - for the renovation of homes which are in permanent residential use and at least one of the residents is over 65 years old or disabled, income and wealth limits (means-testing)
- **Accessbility grant**
  - making residential buildings accessible to people with impaired mobility
  - construction of ramps, widening of front doors and construction of railings
  - the goal is unimpeded accessibility to the building and its flats and common areas from outside
  - Maximum grant **45% of costs**

Agreements on Land use, Transport and Housing 2020-2023/2031(MAL) – between Government and Municipalities

Agreements since year 2000

- Agreements between Government and municipalities in the **Helsinki metropolitan area** and **Tampere**, **Turku** and **Oulu regions**
- Aims to promote of an adequate amount of dwellings and plots for the dwellings
- Includes ARA subsidies for housing production
  - Infrastructure grants for municipalities (70 M€)
  - Start-up grants (3000 -10 000 euros/dwelling in social rental production + wood extra)
  - Municipalities commit to take care of plot supply also to social housing (20-30 % of housing)
- Government investments in collective transport systems and other traffic arrangements
- Housing production target in **Helsinki region**: 66 000 new dwellings in 2020-2023, of which **ARA Social housing 18 200 dwellings = 27,6% of all** (4600 /year)
- Based on joint responsibility to develop urban regions in sustainable way
- Government target: Finland should be carbon neutral year 2035
- the goal of eradicating homelessness was integrated into the new MAL agreements

- **New MAL Agreements for 3 regions: Jyväskylä, Kuopio and Lahti regions**

ARA's Clients = Social Housing Providers

- Subsidising Social Housing projects requires the consent of the municipality in question
- Social housing is carried out by *municipality-owned companies* or *designated non-profit organisation*, which ARA approves and monitors
- ***Companies owned by Finnish municipalities***
  - Municipality-owned social housing companies (around 1000)
  - Biggest HEKA = Helsinki City Housing Company (over 50 000 homes)
- ***Designated borrowers*** (around 600)
  - Designated by ARA, borrowers have to commit rules and legal framework of owning social rental dwellings
  - Non-profit organisations: biggest Y *Foundation* (around 18 000 homes)
  - Special purpose associations:
    - E.g student housing foundations and elderly housing organisations

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Restrictions in ARA subsidised rental dwellings

- To ensure that subsidies are benefiting the tenants and dwellings are kept in intended use
- **Rental use** obligation for **40 years (**ARA can liberate if there is no need in region)
- **Cost recovery principle in rent setting** => rents under market rents
- Selling of dwellings is regulated and needs permission of ARA
- **Tenant selection principles:** priority for those who are in greatest need for housing and with smallest income should have the priority (no income cap)
- **Tenant democracy** (co-decision law)
- Finnish Social Housing subsidies are considered as Services of General Economic Interests (EU/SGEI)

9.1.2023

Tenant Selection Criterias in Social Rental Apartments

- Tenants are selected based on their need for housing and the search criteria, ***not a queueing system***
- The tenants selection principles are based in Finnish law. The selection criteria include ***need for housing, wealth and income***
- ***Priority is given to the homeless*** **and other applicants of limited means and low income who have the most urgent situation**.
- If more than one applicant is in equally urgent need for housing, the applicants' income and assets are compared. Priority will be given to the lowest income applicants
- When selecting tenants, attention is also paid to ***maintaining a varied resident structure in the building and a healthy social balance in the residential area***
- Selection and prioritization is done by landlord and monitored by the municipality
- ARA steers and guides the process in general

Urgency levels (Helsinki City):

https://www.hel.fi/kaupunkiymparisto/asunnonhaku-en/apply-for-an-apartment/apply-for-an-ara-apartment/selection-criteria/selection-criteria

- ***Extremely urgent (AT1), for example:***
- *Homeless individuals or people still living with relatives or friends*
- *Employees in the Helsinki Metropolitan Area with no home*
- *Renters with a fixed-term or terminated lease agreement*
- *Adults still living with their parents*
- *People subletting a home*
- ***Urgent (AT2), for example:***
- *Current apartment is too small (more than 1 person per room)*
- *Excessive housing costs (more than 40 per cent of a household's gross income is currently being spent on housing, as defined in EU statistics on income and living conditions)*
- ***In need of housing (AT3), for example:***
- *Desire to move is due to the current apartment's equipment level, location, etc.*
- At present, 80 % of those who have received a social housing apartment of City of Helsinki have had an extremely urgent need

The rent setting procedure in the social housing in Finland

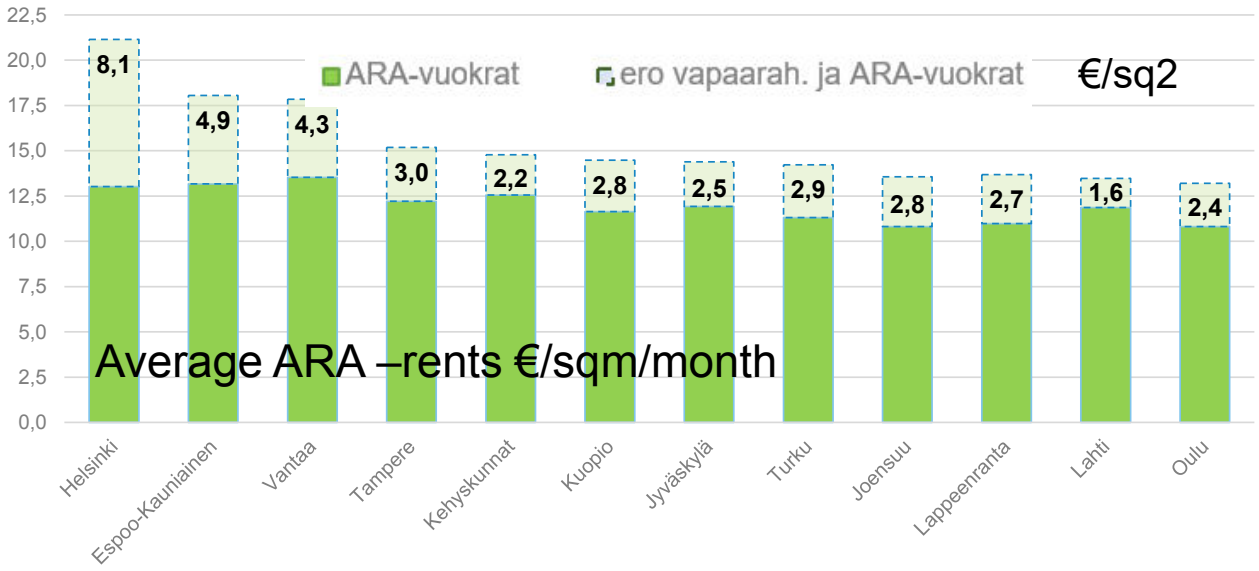
- The rent of ARA apartments covers the capital costs recurred from construction/renovation loans and the maintenance, heating and management costs of the building = **Cost recovery principle**
- However according to social housing laws the rents of all the state-subsidised social housing properties, owned by one owner can be leveled
- **Each housing company can use leveling procedures by its own choice**. Rent leveling is however forbidden between market financed housing and subsidised housing of the same owner (market rents can support social rents but not vice versa)

- *Helsinki City Housing Company (Heka)* owns approximately 50 000 subsidised social housing apartments (the biggest rental housing provider in Finland):
  - the yearly revenues are the same as the yearly, payment-based, costs that occur from constructing, repairing, maintaining, and managing all the apartments financed by interest-subsidised loans.
  - These costs are collected into total costs which are then leveled to rents for each apartment. In Heka the leveling of the total costs to rents is based on *the "use value" of the buildings*.
  - The use value-based rent leveling model is based on scoring the parameters of the buildings: the age of the building, performed renovations, location, quality of the building, and the type of the building
  - The goal of the rent leveling is to *assure that the yearly rent chances for all tenants are moderate* and that the rent reflects the use-value of the rental unit in relation to every rental unit of the owner

Cost recovery principle in practice: Difference of ARA-average rent and PRS rents in biggest cities 2020

PRS rent higher than ARA rent:

Helsinki	+62%
Espoo	+39%
Vantaa	+32%
Turku	+26%
Tampere	+24%



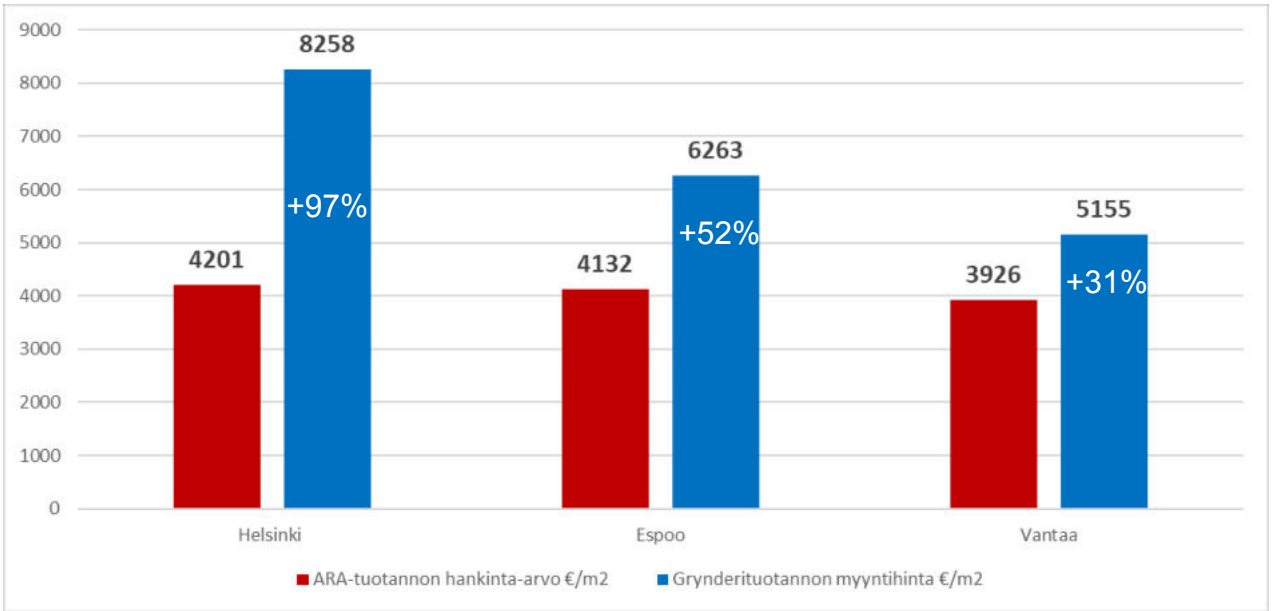
The average rent of the Helsinki City Housing Company (Heka) will be only 0.8% higher in 2022 than 2021. The average rent in Heka housing units in 2022 is EUR 12.10 per square metre per month. Heka is the largest landlord in Finland. More than 92,000 residents of Helsinki live in our **approximately 50,000 social rental apartments**.

Cost control and steering of plans

- Building projects are influenced by cost and quality monitored by ARA
- Aims to build high-quality dwellings at reasonable costs
- Rents are based on these costs accepted by ARA = Cost recovery principle
- In ARA-construction as a rule is **competition in tendering**
- Information on construction cost is gathered by ARA and it makes possible to ensure that building projects are based on reasonable construction costs and support is not channelled into input prices

- Steering of planning
  - Accessibility, energy-efficiency
  - Costs can be higher if - for example - energy-efficiency improvements are included

Difference between ARA Social housing new production (red) and private new production (blue) in Metropolitan cities, October 2020 (€/sq2)

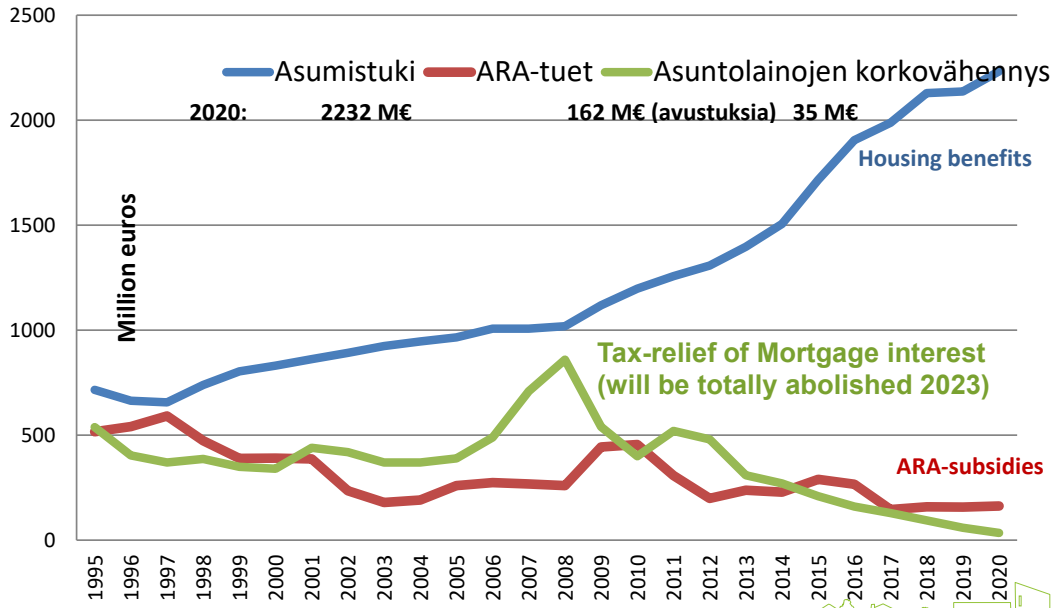


Lähteet ARA-tietokanta ja Rakennuslehden selvitys:
https://www.rakennuslehti.fi/2020/11/uusien-asuntojen-kauppa-kay-kovilla-kierroksilla-helsingissa-ja-espoossa-vantaalla-kaupat-romahtivat/

Housing Benefits and social assistance for housing was 2 591 Million Euros in 2020 (3,8 % Government Budget and 1,1% GDP)

In 2020, *Kela (the National Social Insurance Institution*) paid a total of **2 232** million EUR in housing benefits. The amount increased by 4.2% in real terms from the previous year. At the end of the year, **859 212** people lived in households that received housing benefits, which is **15.5%** of the Finnish population.

On top of that: in 2020 Kela paid **359** M€ of social assistance to compensate housing costs



Maximum housing cost for general housing benefit in 2021: Benefit covers 80% of housing costs (if no income)

Household size persons	Municipality in category 1, EUR per month	Municipality in category 2, EUR per month	Municipality in category 3, EUR per month	Municipality in category 4, EUR per month
1	521	504	400	353
2	754	723	584	514
3	960	912	741	657
4	1 122	1 064	878	783
+ each additional person,	140	133	120	115

- Municipalities in category 1: Helsinki
- Municipalities in category 2: Espoo, Kauniainen ja Vantaa
- Municipalities in category 3: Hyvinkää, Hämeenlinna, Joensuu, Jyväskylä, Järvenpää, Kajaani, Kerava, Kirkkonummi, Kouvola, Kuopio, Lahti, Lappeenranta, Lohja, Mikkeli, Nokia, Nurmijärvi, Oulu, Pori, Porvoo, Raisio, Riihimäki, Rovaniemi, Seinäjoki, Sipoo, Siuntio, Tampere, Turku, Tuusula, Vaasa and Vihti
- All other municipalities belong to category 4.

https://www.kela.fi/web/en/housing-costs-and-types-of-homes

KELA = The National Social Insurance Institution of Finland

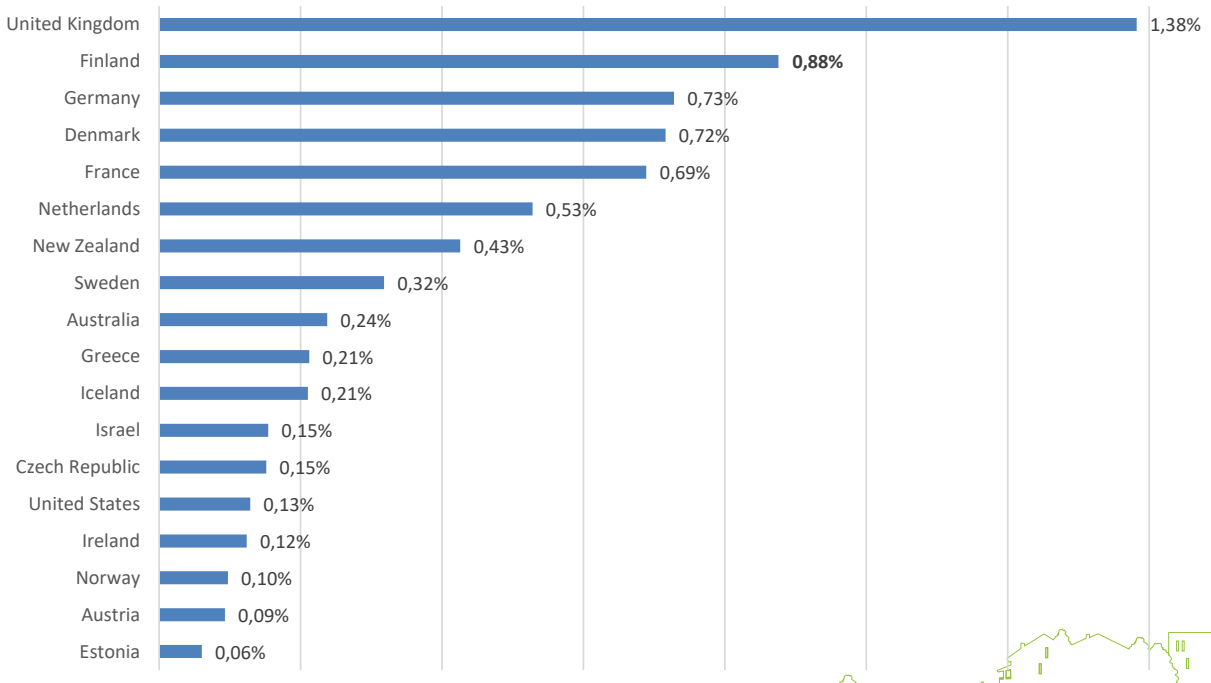
Basic social assistance, recognised housing costs by municipality 2021

In addition to the housing costs, water charges are recognised at an amount of €22.80 per person.

Municipality	Single-person household, EUR per month	Two persons, EUR per month	Three persons, EUR per month	Four persons, EUR per month	+ each additional person, EUR per month
Helsinki	694	844	964	1057	118
Espoo Vantaa					
Tampere	572	700	773	855	104
Turku	540	620	721	861	104
Oulu	496	608	705	771	107

Government Spending on Housing Allowances in OECD as % of GDP (2020 or last year available)

https://www.oecd.org/housing/data/affordable-housing-database/housing-policies.htm

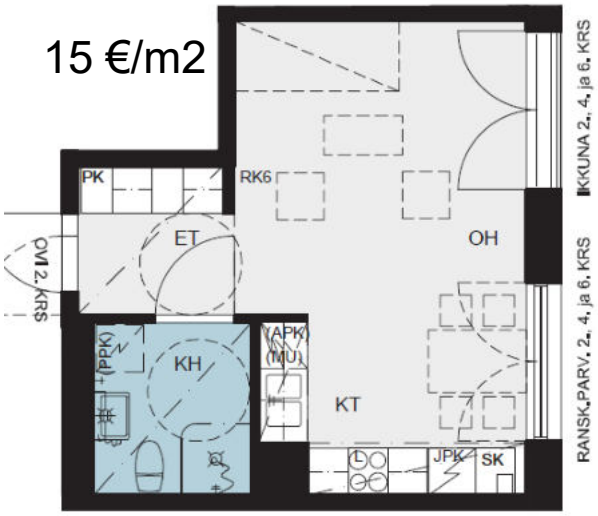


9.1.2023

Social (ARA) vs. market housing (PRS): two brand new dwellings in Jätkäsaari

HEKA/ ARA studio:
30 m2 Rent: 450 €/month

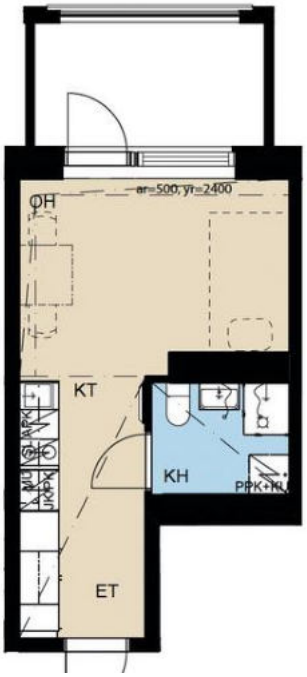
15 €/m2



Market priced studio:
23 m2 Rent: 889 €/month

38,6 €/m2

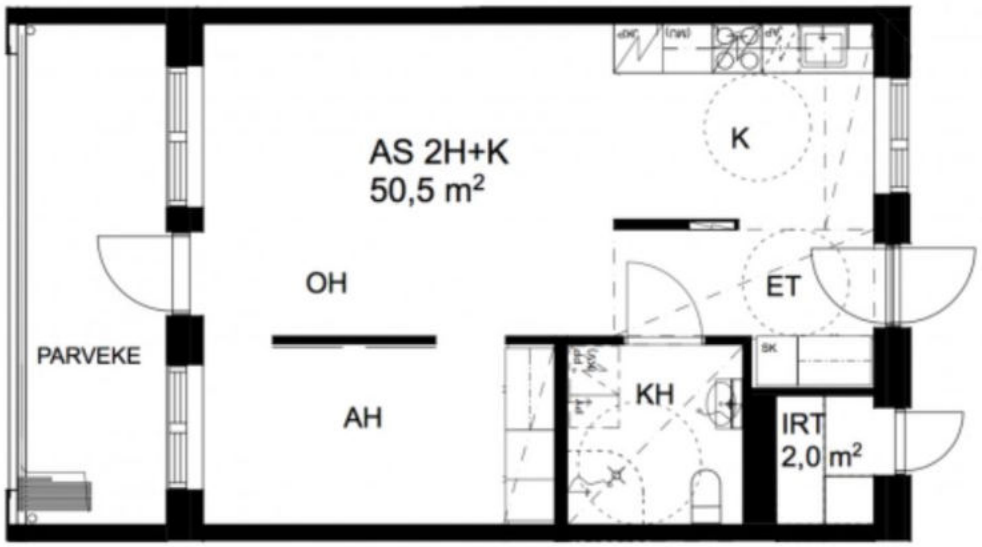
PRS has free rent setting since 1995



In 2021 average size of ARA studios was 39,9 m2

Social Housing has high quality standards: ARA is optimazing cost-quality -relationship

- Good quality + Affordable rents
- Heating is always part of rent
- Other services like Wifi,
- … and always sauna available!
- Not too small (average 50 m2)
- Design for all – accessibility!
- Social Mix in housing areas
- Good location and public transport nearby
- Facililities for community-buildning
- Promoting decarbonation of housing



Towards ecological living: ARA is developing and piloting new innovative housing solutions

Major development projects:

- Zero energy residential area: *Tuusulan Rykmentinpuisto*, Housing Fair 2020
- The first certified passive energy apartment building in Finland: Assisted living centre *Onnelanpolku*, 2014
- The first zero energy apartment building, *Järvenpää* and *Kuopio*, 2012
- *Käräjätörmä* multigeneration cooperative village, competition and implementation 2017–2019
- ARA design contest on an energy-efficient residential area, 2016
- ARA-EFL Accessible Housing design contest, 2015–2016
- ARA-home 2049 international contest, 2012

ARA-home 2049 contest for architectural students

ARA design contest on energy-efficient residential area

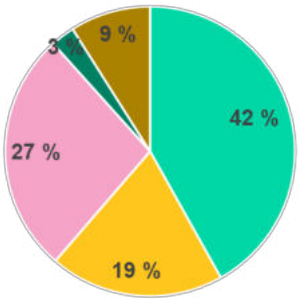
ARA and EFL student competition on accessible housing

A look at the participants of the Tampere Käräjätörmä multigenerational cooperative village design competition

Helsinki: SOCIAL MIX Housing Policy Objectives

Helsinki

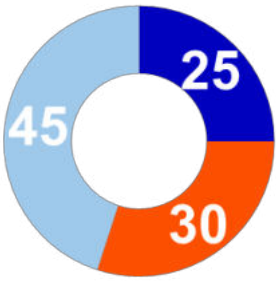
Existing housing stock = 22% ARA homes



- Owner-occupied housing units
- Government subsidised rental housing units
- Non-subsidised rental housing units
- Right-of-occupancy housing units
- Other/unknown

Helsinki

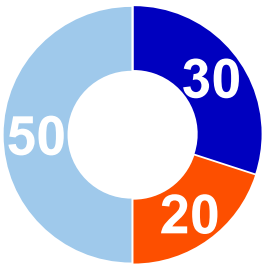
Objectives for forms of tenures in annual housing production:



=1750 %

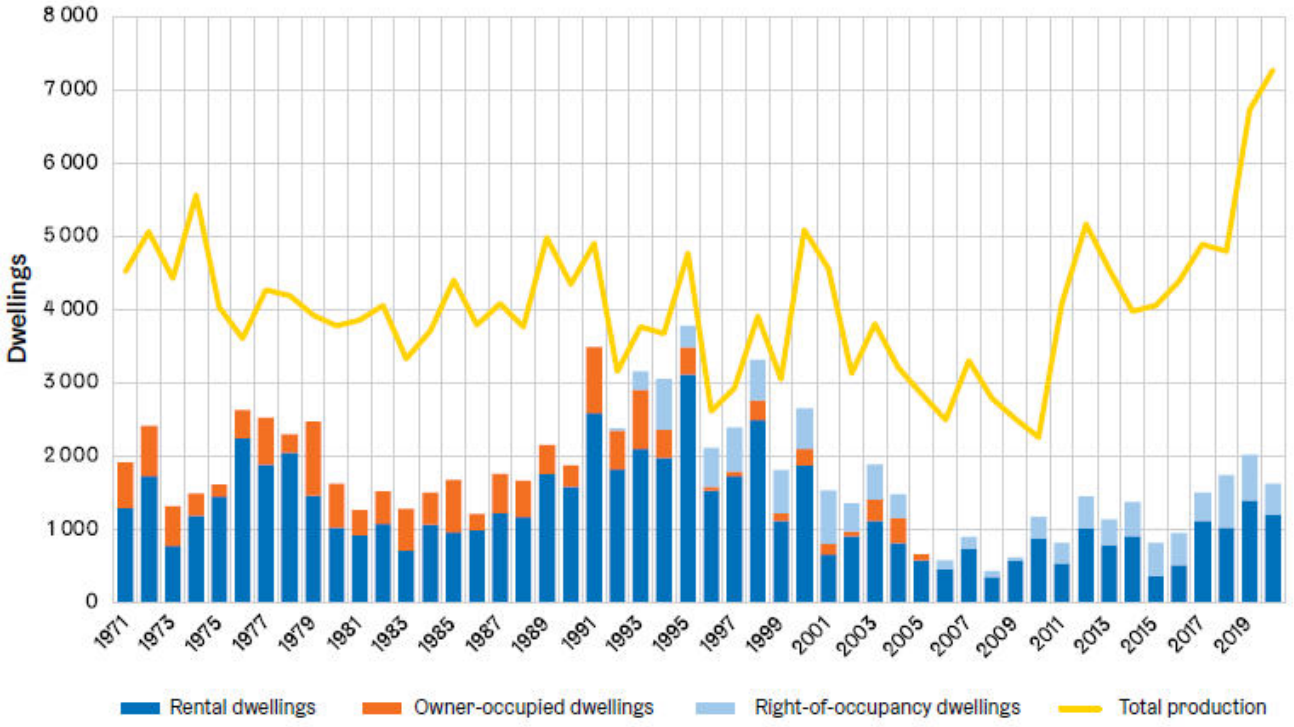
- ARA rental housing (including student and youth housing) 25 %
- Intermediate housing (e.g. Hitas and right-of-occupancy housing) 30 %
- Non-regulated owner occupied and rental housing 45 %

New targets 2023: 8000 new homes/year



= 2400

Arava/ ARA production by occupancy arrangement and total housing production in Helsinki in 1971–2020



Helsinki

Occupancy types of existing and planned residential buildings in the Jätkäsaari waterfront housing area (City of Helsinki, HSY)

Social Mix in practice

The City of Helsinki owns 70 % of its land area

The City's housing assets consist of 63 000 housing units, of which 50 000 are ARA-subsidised rented housing units and 5 000 ARA Right-of-occupancy housing.
The City also has its own housing developer

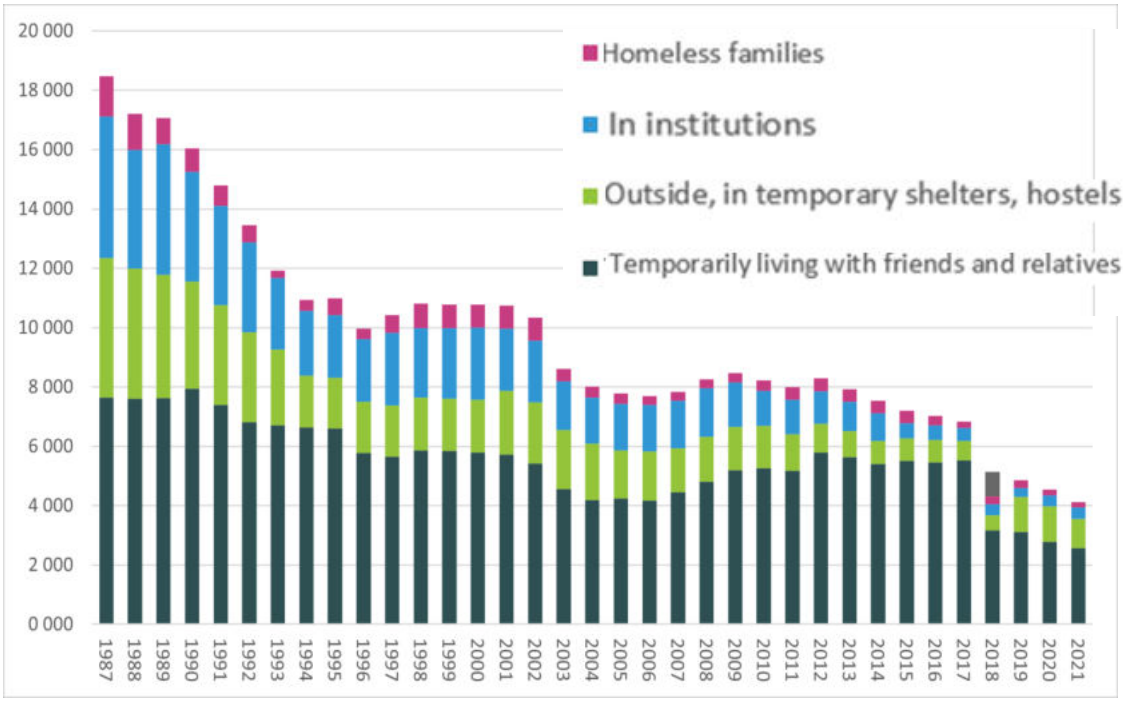
Helsinki

ARA is subsidizing Housing Advice services

- ARA has had mandate to promote and subsidize housing advice services in ARA-housing since 2009
- Year 2021 we had 0,9 M€ for grants
- Year 2022 we have **3,9 M€** for **agreements with municipalities** to enhance and develop housing advice
- Focus will be on making housing advice more readily available and on preventing homelessness, particularly among young people and migrants
- To improve access to housing advice, **Government will give an Act proposal for Parliament in next autumn to make it a statutory service 2023** and allocate resources for it
- In future Housing advice services must be available to all, irrespective of the form of housing

Homelessness Reports has been published since 1987 – 35nd Edition on 2021 is available in English

https://www.ara.fi/en-US/Materials/Homelessness_reports/Homelessness_in_Finland_2021(63305)



Alone living Homeless:
2008: 8260
2021: 3948
Change - 4312

= - 52% since Housing First was implemented 2008

Social Housing in Finland

- Pragmatic approach – path dependancy
- Based on wide co-operation between government and municipalities
- Government has not withdrawn from responsibility on supply side
- Use of EU SGEI-regulations (mofidied with Brussels laws)

- Some shortcomings:
  - Originally based on large scale productíon of new housing, not management of existing stock
  - Loan system based on back-weighted amortization (40 years, inflation expectation) – most of construction loan exists when need for renovation
  - Who are right and motivated owners of social housing stock besides municipalities?
  - Scattered housing difficult to organise

Summary: Essential in Finnish social housing policy

- Housing is a core element in ensuring welfare - markets do not provide affordable housing for all
- Constitution of Finland: "*The public authorities shall promote the right of everyone to housing and the opportunity to arrange their own*"
- *Combination of supply and demand side subsidies (mixed model)*

- Housing needs of low income households and shortage of rental housing in growth centres
  - High housing costs especially in Helsinki region
  - Housing markets are more balanced outside Helsinki metropolitan area
- Needs to promote housing for special groups
  - Ageing population, sheltered homes
  - Housing of the disabled persons, aim to abandon institutions
  - Housing for homeless persons
  - Housing for youth and students
- Integrated residential areas (social stability, no slums, no segregation)
  - Social and other housing situated side by side = Social Mix principle
  - Tenant selection criterias in social housing but also aim to avoid segregation in house level

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Housing is based on long-term commitment for affordability and high quality

Thank you!

Jarmo.linden@ara.fi

ara The Housing Finance and Development Centre of Finland

The Role of ARA in subsidizing Social and Affordable Housing in Finland

Vesa Ijäs/Sampo Vallius 4.1.2023/

14.6.2022 International Social Housing Festival, Director Jarmo Lindén
Housing Finance and Development Centre of Finland

Content

- *Finland in general*
- *Short housing history*
- *How Social and Affordable housing is financed?*
- *Co-operation between Government and municipalities - Case Helsinki*
- *Social Housing operators – Clients of ARA*
- *Cost-based rents and housing benefits*
- *Tenant selection*
- *What's good in Finnish systems - some shortcomings*

Independance Day: 6th December (1917)

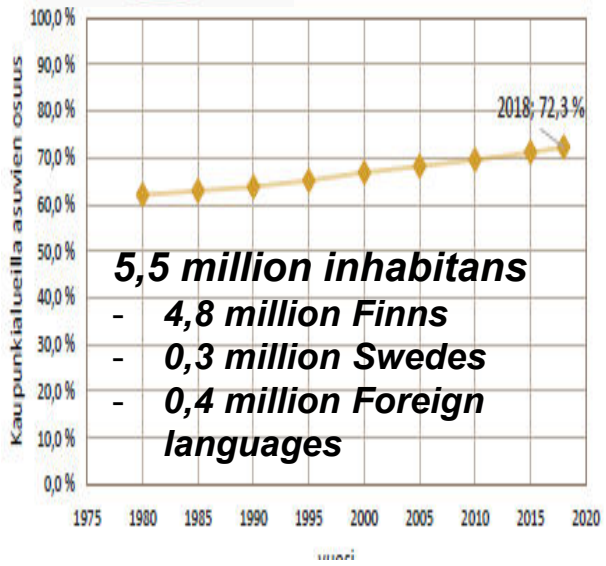
Finland = mostly forests, swamps and lakes…
Urbanization rate: 72,3% (2018)

338 465 km2

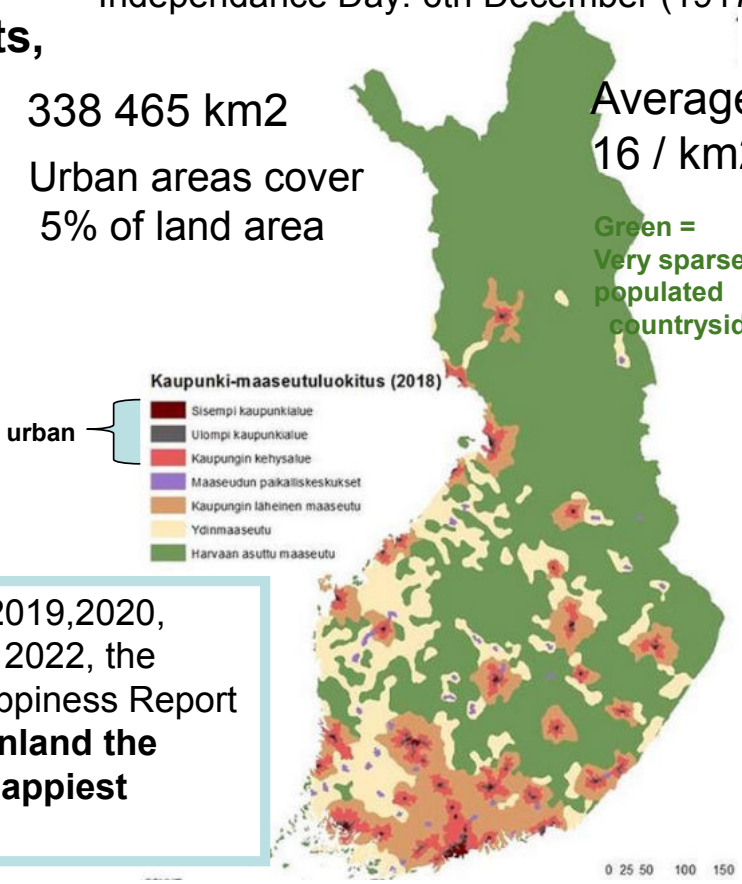
Urban areas cover 5% of land area

Average: 16 / km2

Green = Very sparsely populated countryside



5,5 million inhabitans
- ***4,8 million Finns***
- ***0,3 million Swedes***
- ***0,4 million Foreign languages***



In 2018, 2019,2020, 2021 and 2022, the World Happiness Report ranked **Finland the world's happiest country**

9.1.2023

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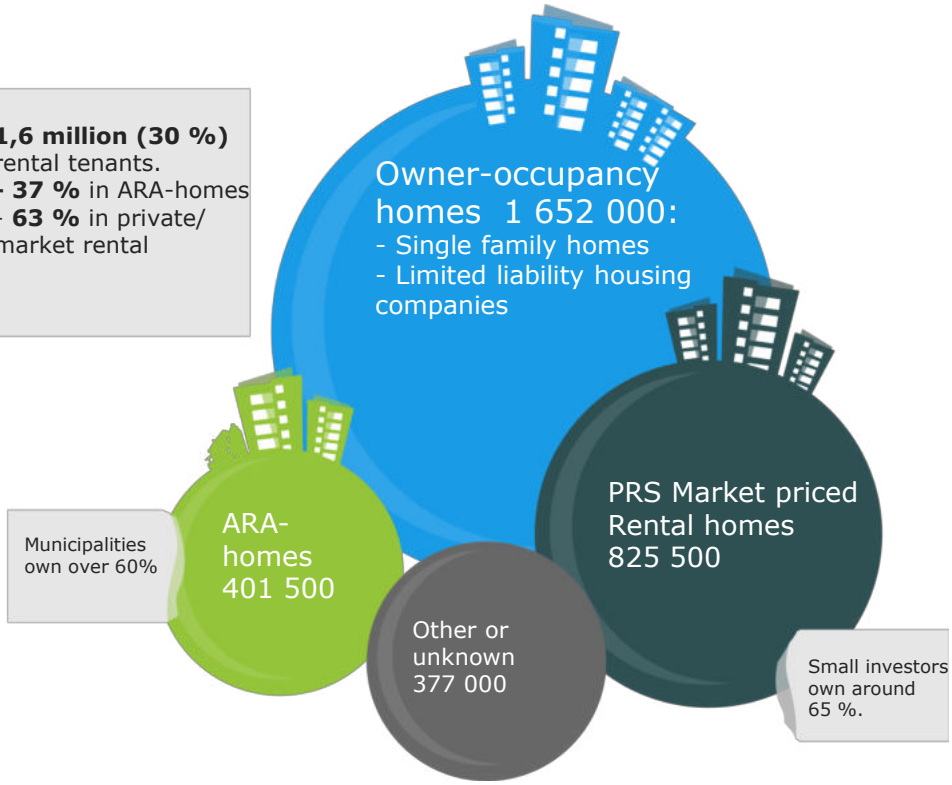
Housing Stock in Finland 31.12.2020: 3,25 Million homes

65% is owner-occupancy and
35% rental + right-of-occupancy

1,6 million (30 %) rental tenants.
- 37 % in ARA-homes
- **63 %** in private/ market rental



9.1.2023

ARA– housing stock under restrictions (following SGEI rules by EU)

- **Ordinary rental dwellings** **250 000**
  - Over 70 % owned by municipality-owned companies
- **Rental dwellings for special groups** **100 000**
  - Rental dwellings for elderly
  - Rental dwellings for students
  - Other different special groups
- **ARA- rental dwellings in total** **350 000**

+ 50 000 dwellings without restrictions

- **Right of occupancy dwellings** **50 000**
- **ARA –dwellings total** **400 000**
  - 13 % of all housing

Right-of-occupancy homes since 1990

- A right-of-occupancy home combines the security of owning your own home with the flexibility of renting
- **ARA grants a loan for 85%** of the approved construction and building site price
- The holder of the right-of-occupancy pays **15 % of the real construction price** of the right-of-occupancy home
- Resident pays **a monthly fee**, which is like rent including maintenance and amortization of loan - fee has to be below the market rent level in the same area
- Right-of-occupancy home can never be redeemed, it retains its right-of-occupancy status. In right-of-occupancy home residenti has the same security of tenure as in owner-occupied homes.

- For applying the right-of-occupancy homes the applicant must have a **queue number** from the municipal housing authority. THIS WILL BE REFORMED 2023: ARA will give national queue numbers
- After getting the queue number it is possible to fill in the apartment application to the registers of the companies offering right-of-occupancy homes
- there is **no income limit**, but the applicant cannot have too much of assets. For over 55 years old applicants there are no assets limit either
- The resident moving out will get back the money he invested (15%), adjusted with the building cost index.
- Existing stock over 50 000 homes – all ARA subsidised

ARA was established in 1949

1949 Housing production committee (ARAVA)

- The state housing loans programme - first for 5 years - was established ***to solve "temporary housing shortage"***
- The agency and the loans were named **ARAVA** (**A**sunto**ra**kennustuotannon **va**ltuuskunta)

1966 National Housing board (AH)

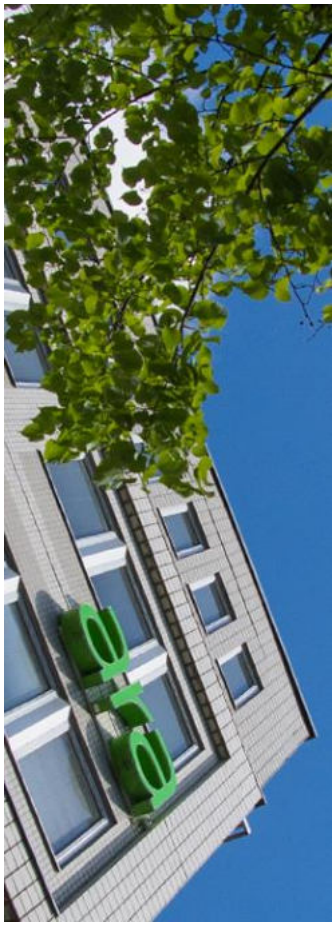
- 1983 Moved under the new *Ministry of Environment*

1993 The Housing Fund of Finland (ARA)

- Concentrating on Social Housing

2008 The Housing Finance and Development Centre of Finland (ARA)

- Regionalised from Helsinki to Lahti



Second World War – in which Finland lost 100 000 lives - caused housing shortage as well

120 000 homes were left in areas annexed by the Soviet Union = 400 000 evicted from those areas had to be rehoused rapidly

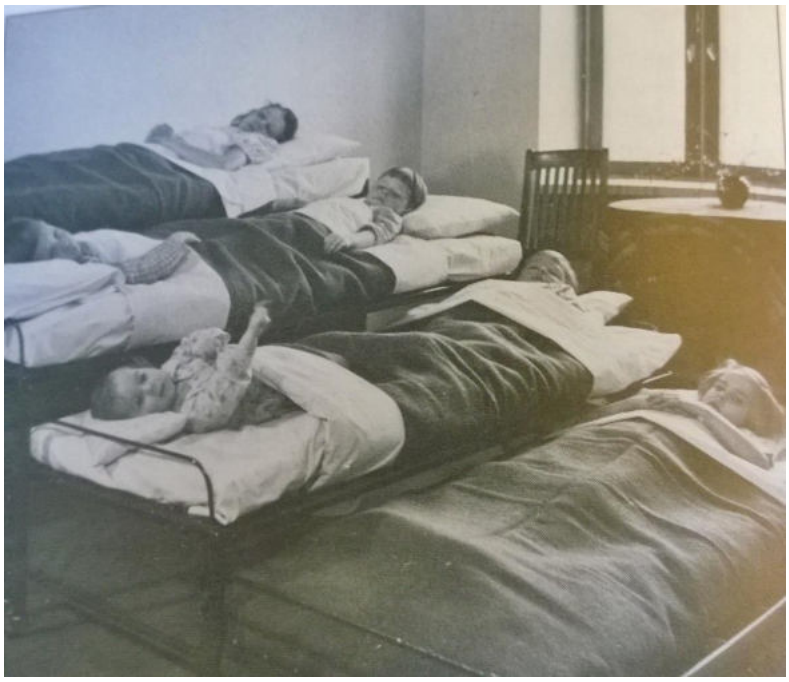
20 000 homes were ruined by Russian airstrikes to cities

15 000 homes were destroyd and burned by German army in Lapland 1944-1945

= together **over 10% housing stock was lost**

Baby Boomers were born after the WW II: 1946-1949 annually was born over 100 000 children

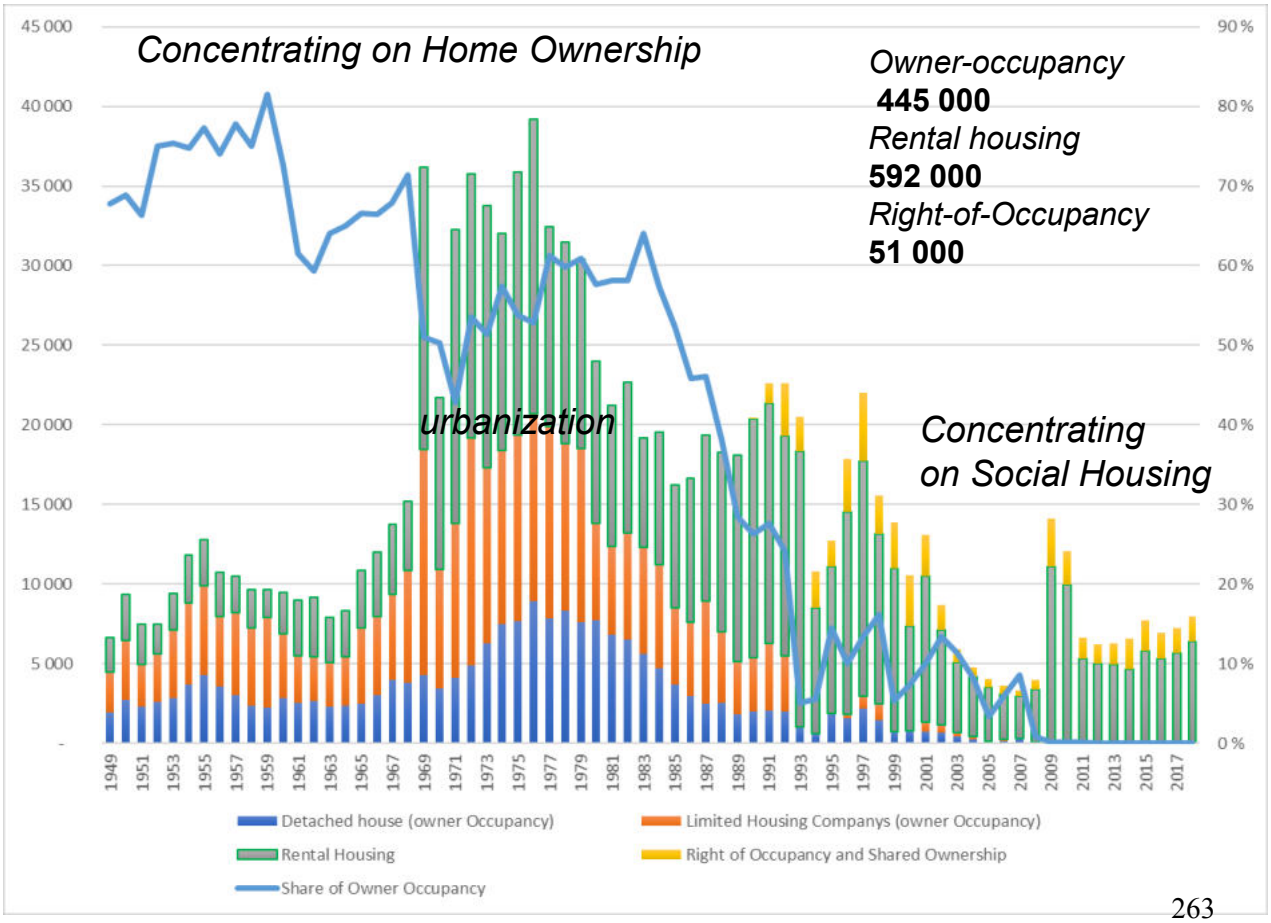
- ARAVA was helping to solve housing problems of families
- Great move to the cities started in Finland in the sixties
- Last year only 45 000 children were born…



ARA's History since 1949:

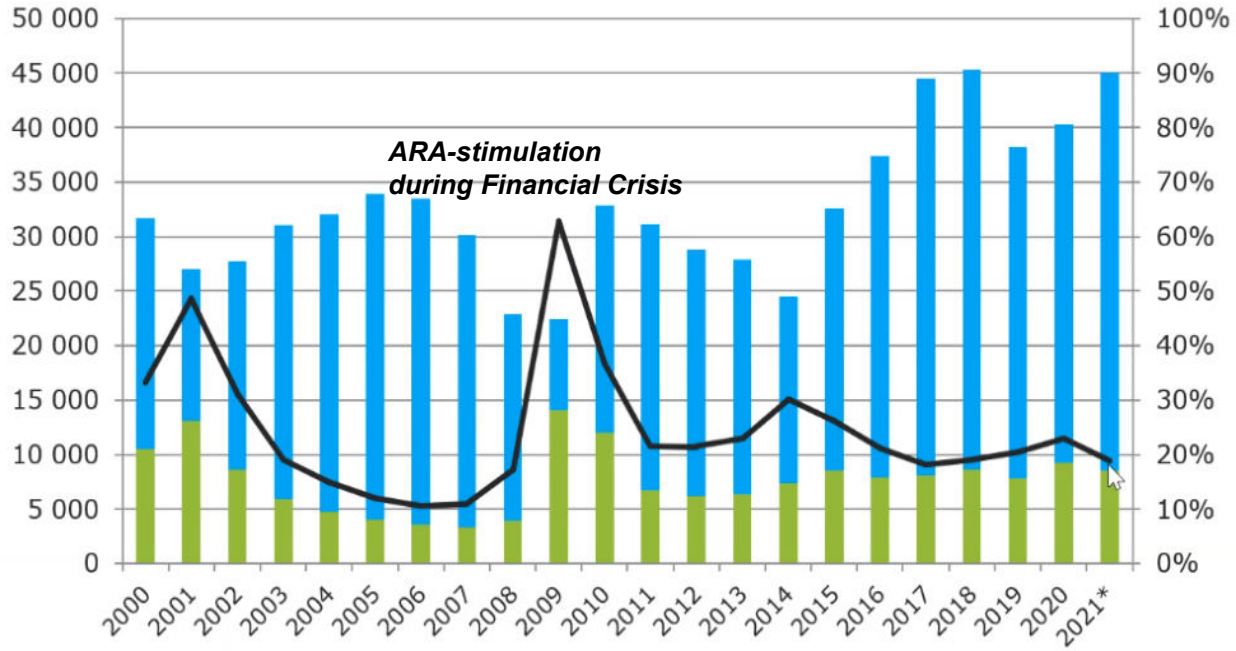
Government subsidised housing starts by tenure status 1949-2018 over 1,1 million dwellings = 1/3 of all

and share of owner occupancy



Housing production in Finland 2000 – 2021
Market and ARA and %-share of ARA

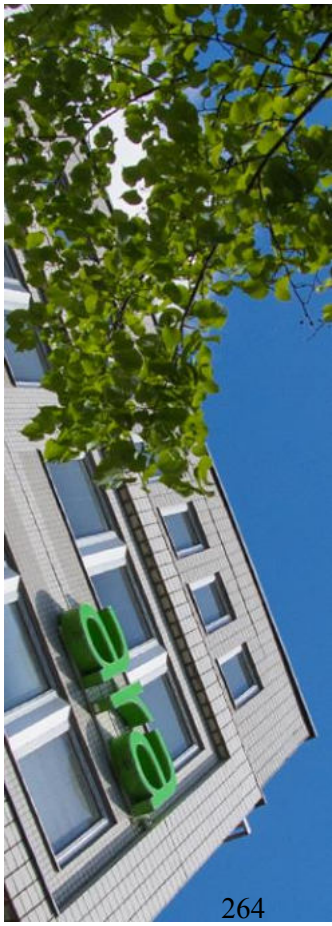
Private investments have been booming on PRS since 2015: housing Construction is historically high - but apartment size is smaller and smaller = Market ”solution” to Affordability crisis…



ARA Implements Government Housing Policy (supply side policies)

An expert partner and developer of housing

- ARA implements government housing policy, aiming for sustainable and affordable housing
- ARA is part of public administration and operates under the Ministry of the Environment
- delivers grants, subsidies, and guarantees related to housing and construction and renovation of housing
- guides and monitors the use of ARA housing stock
- is involved in housing development projects, like Homelessness and suburbs development
- manages expert tasks and information services related to housing and housing markets, and carries out related research
- oversees building energy performance certificates



Finnish Housing Support System is Mixed
= *Combination of Supply and Demand Side measures*

- **Demand linked subsidies**
  - promoting housing consumption
  - housing allowances (over 2 Billion)
  - tax-relief for interest on housing loans (will be abolished totally 2023)
  - Tax relief in selling (after 2 years)
  - First time buyer interest subsidy (ASP –scheme)
  - Partial guarantee for home loans
  - Over 90 % of all subsidies

- **Supply linked subsidies (ARA)**
  - encouraging social housing production and renovation
  - interest-subsidy loans with guarantee
  - investment grants
  - Renovation and other grants
  - Less than 10 % of subsidies

9.1.2023

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ARA provides funding and subsidies for social and affordable housing projects

- **LOANS = 2 335 Million Euros in 2022**
  - **Interest subsidy loans** for new construction, renovation, and acquisition
  - **guarantee loans** for rental housing construction and housing company renovations

- **GRANTS = 330 Million Euros in 2022**
  - investment subsidies for special groups, energy grants, repair grants, infrastructure grants, housing advice etc.

- The funds for grants and subsidies are provided mainly from **the Housing Fund of Finland** (operated by ARA) and partly from government budget – **all mandated by parliament**

Loans are mainly from Municipality Finance since 2008

Kuntarahoitus
MUNICIPALITY FINANCE

Government Budget 2022:
ARAs Grants for Housing 2019 => 2022 (Million Euros)

Most grants are mandates from ***The Housing Fund of Finland,*** *which is Off-budget fund with 5,8 Billion Euros, Operated by ARA*

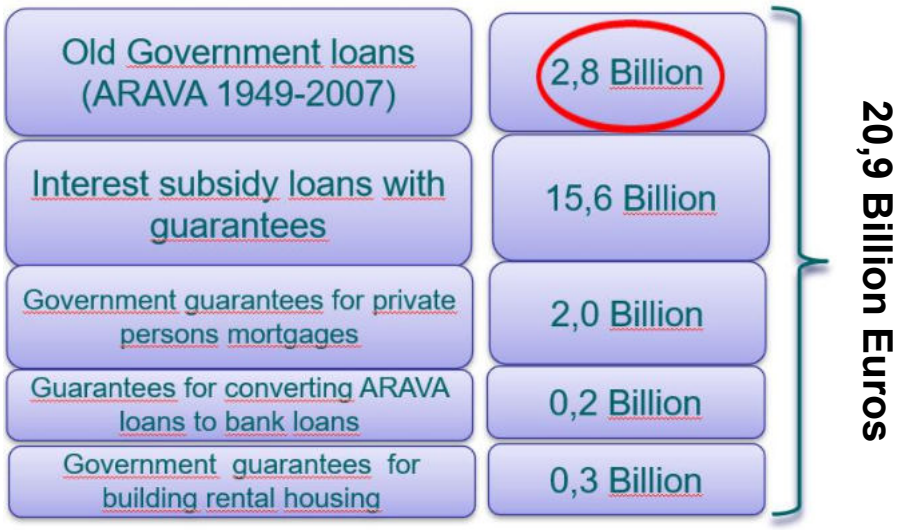
	2019	2022
• Investment grants for special groups	105 M€	90,0 M€
• Start-up grants (MAL)	20 M€	40,0 M€
• Infrastructure grants for municipalities (MAL)	15 M€	25,0 M€
• Repair grants	35,5 M€	33,85M€
• Demolition grants	5,0 M€	8,0 M€
• Housing advice grants	0,9 M€	3,9 M€
• Research & development	0,7 M€	0,7 M€
• Infrastructure for charging of electric cars grants	1,5 M€	30,0 M€
• Preventation of economic difficulties in rental housing	1,0 M€	-
• Promoting co-operative housing pilots	0,4 M€	-
• *Energy efficiency grants*	-	*70,0 M€*
• *Grants for municipalities to replace oil-heating*		*4,9 M€*
• *Promoting use of purpose change grant*	-	*1,0 M€*
• *Promoting housing accessiblity for elderly*	-	*10,0 M€*
• *Grants for suburbs renewal projects*	-	*8,0 M€*
• *Grants for remodelling services to eradicate homelessness (Ministry of Social and Health Affairs)*		*3,4 M€*
• **Together**	**185,0** M€	**330,4 M€** **+79%**

Housing Fund of Finland's (VAR) loans and obligations at the end of 2021

Interest subsidies and grants are paid from this Fund

Housing Fund of Finland was established in 1990

Government Programme 2019:
"When it comes to state-subsidised housing, the Housing Fund of Finland will retain its position as an extra-budgetary fund and we will seek new sources of income for the fund. We will ensure that the state support system promotes innovative, environmentally friendly housing solutions."



Own capital of the Fund is 5,8 Billion Euros

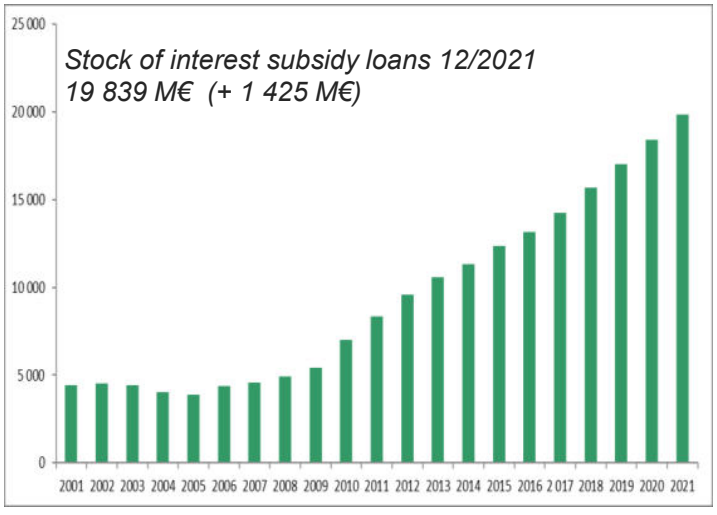
ARA Jarmo Lindén 5.11.2010

In Finland Social / Affordable Housing is achieved with combination of:

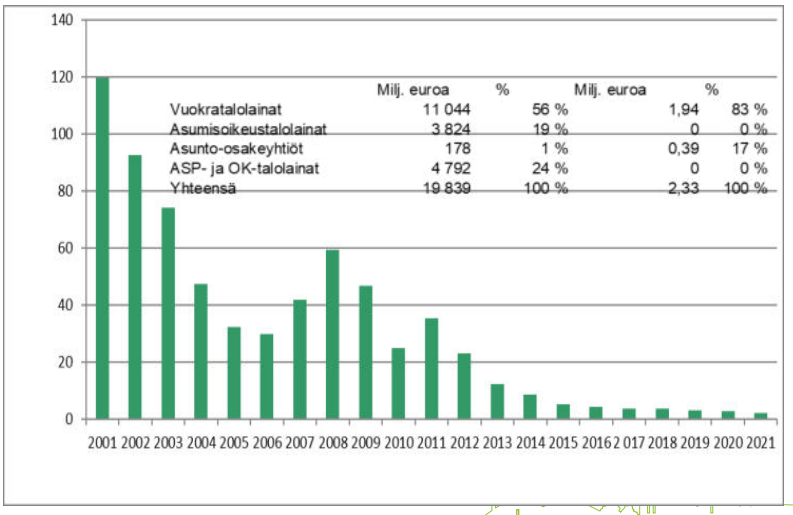
- **ARA interest subsidy loans (1950 Million Euros 2022 = 10 000 new dwellings)**
  - **ARA accepts plans and costs of every project (Design for all –principle, accessibility)**
  - **Bidding for construction,** economic cycle effects, social housing production counter-cyclical
  - **Long running time of loans,** usually **40 years**
  - **High LTV of ARA loans,** usually **95%** of acquisition costs
  - **Government guarantee** is included in ARA interest subsidy loans (free of charge)
  - **Direct grants are combined with ARA loans,** investment grants up to 50% and start-up grants
- **Affordable price/rent of building site** (Municipalities support Social Housing projects with cheaper plots than market price, EU/SGEI regulations)
- **Affordable rent** in ARA Housing = cost recovery principle: In Helsinki -60% vs PRS
- Owners of social rental housing= municipalities and non-profit private actors
- **Co-operation between Government and Municipalities** is necessary - Agreements on Land Use, Housing and Traffic - targets for social housing production
- Both supply (ARA) and demand (housing benefits) side subsidies are needed to achieve affordability with good quality housing for all

ARA's supply side support is very cheap measure for government – high impact with low cost!

Stock of interest subsidy loans 2001-2021



Paid interest subsidies 2001-2021



Interest subsidy loan with investment grants for special groups (2022: 90 M€)

- Special groups: *Homeless*, people with mental problems, disabled, elderly with dementia, students and youth

- **Grant Categories:**

  I Grant category maximum 15% (e.g. students and youth housing)

  II Grant category 20 - 25% (supported housing e.g for people with mental problems)

  III Grant category 35 - 40% (service housing for elderly 24/7)

  IV Grant category 50% (*long-term homelessness*, disabled people)

9.1.2023

Investment Grants for Social Rental Housing of Special Groups 2005- 2020: 1,4 Billion Euros grants + 4,5 Billion Euros interest subsidy loans for 54 000 dwellings

ARA has approved 6 Billion investments for 54 000 rental homes during 2005-2020 for Special Groups

This funding was used to renovate shelters to housing: 50% grant + 50% loan

Special Group	Rental dwellings		Grants		Average grant / dwelling (€)
	Number	Share	Million €	Share	
Elderly people (with dementia)	21 990	41 %	776,2	54 %	35 296
Students	19 793	37 %	152,9	11 %	7 725
Disabled persons	4 885	9 %	281,3	20 %	57 575
Homeless people	**2 265**	**4 %**	**88,8**	**6 %**	**39 184**
Persons with mental problems	1 391	3 %	43,2	3 %	31 052
Others (e.g youth with special needs)	3 294	6 %	99,2	7 %	30 131
2005 - 2020	**53 618**	**100 %**	**1 441,5**	**100 %**	**26 885**

Renovation and energy subsidies granted by ARA

Subsidies for housing companies and ARA-entities

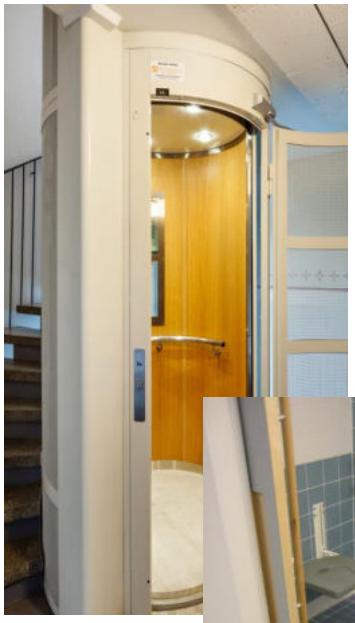
- Accessibility subsidy
- Elevator subsidy
- Subsidy for EV home charging infrastructure
- Subsidy for house condition examinations and renovations planning
- Subsidy for energy efficiency renovations

Subsidies for the households

- Subsidy for elderly
- Subsidy for disabled people
- Subsidy for energy efficiency renovations
- Subsidy for house condition examinations and renovations planning

9.1.2023

Renovation subsidies



- **Lift grant**
  - subsidies are granted for **installing new lifts in old blocks of flats** whose stairwells lack them
  - maximum grant **45 % of costs**
  - About 100 lifts annually (together over 4000)
- **Subsidies for the renovation of homes for elderly or disabled people (max 70 % of costs)**
  - to improve accessibility or safety and make possible to live in own home longer
  - for the renovation of homes which are in permanent residential use and at least one of the residents is over 65 years old or disabled, income and wealth limits (means-testing)
- **Accessbility grant**
  - making residential buildings accessible to people with impaired mobility
  - construction of ramps, widening of front doors and construction of railings
  - the goal is unimpeded accessibility to the building and its flats and common areas from outside
  - Maximum grant **45% of costs**

Agreements on Land use, Transport and Housing 2020-2023/2031(MAL) – between Government and Municipalities

Agreements since year 2000

- Agreements between Government and municipalities in the **Helsinki metropolitan area** and **Tampere**, **Turku** and **Oulu regions**
- Aims to promote of an adequate amount of dwellings and plots for the dwellings
- Includes ARA subsidies for housing production
  - Infrastructure grants for municipalities (70 M€)
  - Start-up grants (3000 -10 000 euros/dwelling in social rental production + wood extra)
  - Municipalities commit to take care of plot supply also to social housing (20-30 % of housing)
- Government investments in collective transport systems and other traffic arrangements
- Housing production target in **Helsinki region**: 66 000 new dwellings in 2020-2023, of which **ARA Social housing 18 200 dwellings = 27,6% of all** (4600 /year)
- Based on joint responsibility to develop urban regions in sustainable way
- Government target: Finland should be carbon neutral year 2035
- the goal of eradicating homelessness was integrated into the new MAL agreements

- **New MAL Agreements for 3 regions: Jyväskylä, Kuopio and Lahti regions**

ARA's Clients = Social Housing Providers

- Subsidising Social Housing projects requires the consent of the municipality in question
- Social housing is carried out by *municipality-owned companies* or *designated non-profit organisation*, which ARA approves and monitors
- ***Companies owned by Finnish municipalities***
  - Municipality-owned social housing companies (around 1000)
  - Biggest HEKA = Helsinki City Housing Company (over 50 000 homes)
- ***Designated borrowers*** (around 600)
  - Designated by ARA, borrowers have to commit rules and legal framework of owning social rental dwellings
  - Non-profit organisations: biggest Y *Foundation* (around 18 000 homes)
  - Special purpose associations:
    - E.g student housing foundations and elderly housing organisations

Restrictions in ARA subsidised rental dwellings

- To ensure that subsidies are benefiting the tenants and dwellings are kept in intended use
- **Rental use** obligation for **40 years (**ARA can liberate if there is no need in region)
- **Cost recovery principle in rent setting** => rents under market rents
- Selling of dwellings is regulated and needs permission of ARA
- **Tenant selection principles:** priority for those who are in greatest need for housing and with smallest income should have the priority (no income cap)
- **Tenant democracy** (co-decision law)
- Finnish Social Housing subsidies are considered as Services of General Economic Interests (EU/SGEI)

Tenant Selection Criterias in Social Rental Apartments

- Tenants are selected based on their need for housing and the search criteria, ***not a queueing system***
- The tenants selection principles are based in Finnish law. The selection criteria include ***need for housing, wealth and income***
- ***Priority is given to the homeless*** **and other applicants of limited means and low income who have the most urgent situation**.
- If more than one applicant is in equally urgent need for housing, the applicants' income and assets are compared. Priority will be given to the lowest income applicants
- When selecting tenants, attention is also paid to ***maintaining a varied resident structure in the building and a healthy social balance in the residential area***
- Selection and prioritization is done by landlord and monitored by the municipality
- ARA steers and guides the process in general

Urgency levels (Helsinki City):

https://www.hel.fi/kaupunkiymparisto/asunnonhaku-en/apply-for-an-apartment/apply-for-an-ara-apartment/selection-criteria/selection-criteria

- ***Extremely urgent (AT1), for example:***
- *Homeless individuals or people still living with relatives or friends*
- *Employees in the Helsinki Metropolitan Area with no home*
- *Renters with a fixed-term or terminated lease agreement*
- *Adults still living with their parents*
- *People subletting a home*
- ***Urgent (AT2), for example:***
- *Current apartment is too small (more than 1 person per room)*
- *Excessive housing costs (more than 40 per cent of a household's gross income is currently being spent on housing, as defined in EU statistics on income and living conditions)*
- ***In need of housing (AT3), for example:***
- *Desire to move is due to the current apartment's equipment level, location, etc.*
- At present, 80 % of those who have received a social housing apartment of City of Helsinki have had an extremely urgent need

The rent setting procedure in the social housing in Finland

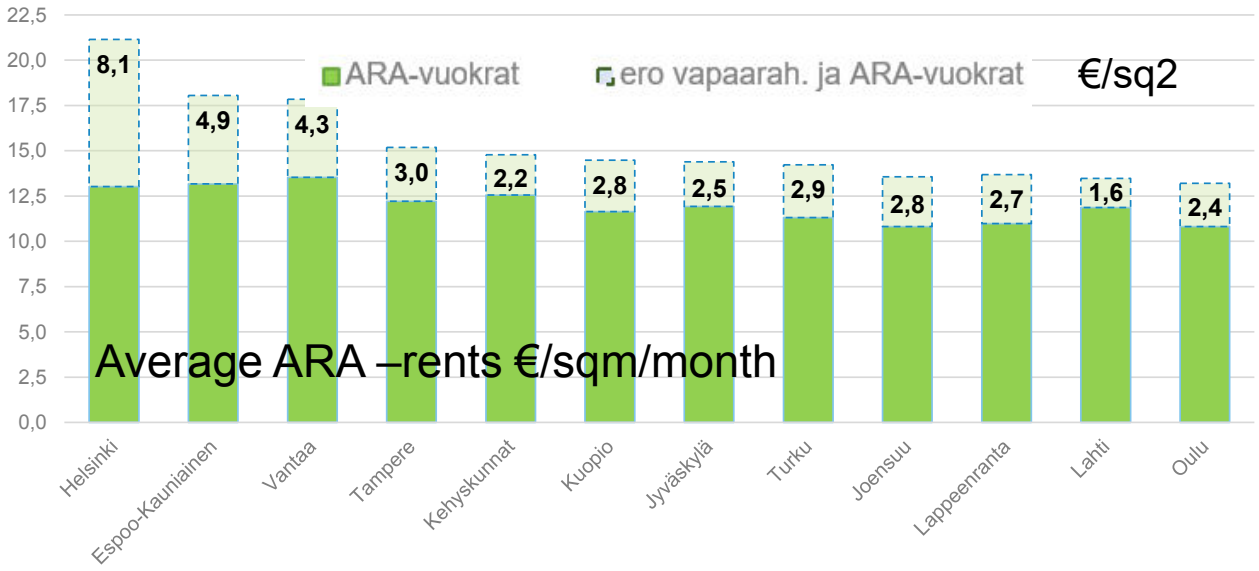
- The rent of ARA apartments covers the capital costs recurred from construction/renovation loans and the maintenance, heating and management costs of the building = **Cost recovery principle**
- However according to social housing laws the rents of all the state-subsidised social housing properties, owned by one owner can be leveled
- **Each housing company can use leveling procedures by its own choice**. Rent leveling is however forbidden between market financed housing and subsidised housing of the same owner (market rents can support social rents but not vice versa)

- *Helsinki City Housing Company (Heka)* owns approximately 50 000 subsidised social housing apartments (the biggest rental housing provider in Finland):
  - the yearly revenues are the same as the yearly, payment-based, costs that occur from constructing, repairing, maintaining, and managing all the apartments financed by interest-subsidised loans.
  - These costs are collected into total costs which are then leveled to rents for each apartment. In Heka the leveling of the total costs to rents is based on *the "use value" of the buildings*.
  - The use value-based rent leveling model is based on scoring the parameters of the buildings: the age of the building, performed renovations, location, quality of the building, and the type of the building
  - The goal of the rent leveling is to *assure that the yearly rent chances for all tenants are moderate* and that the rent reflects the use-value of the rental unit in relation to every rental unit of the owner

Cost recovery principle in practice: Difference of ARA-average rent and PRS rents in biggest cities 2020

PRS rent higher than ARA rent:

Helsinki	+62%
Espoo	+39%
Vantaa	+32%
Turku	+26%
Tampere	+24%



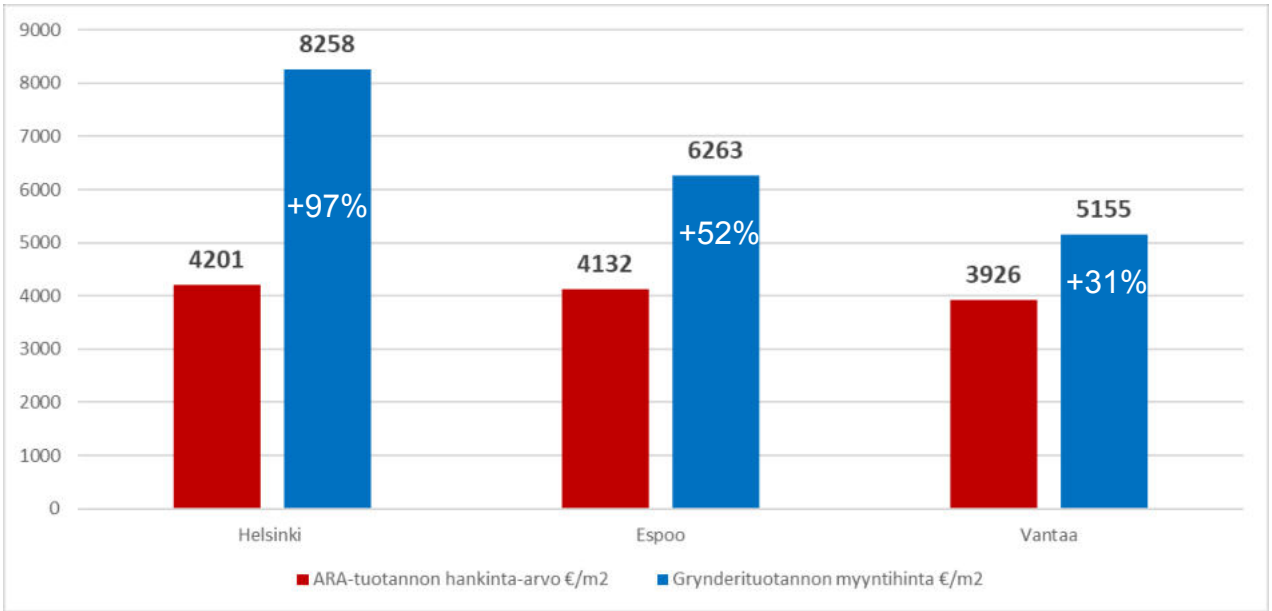
The average rent of the Helsinki City Housing Company (Heka) will be only 0.8% higher in 2022 than 2021. The average rent in Heka housing units in 2022 is EUR 12.10 per square metre per month. Heka is the largest landlord in Finland. More than 92,000 residents of Helsinki live in our **approximately 50,000 social rental apartments**.

Cost control and steering of plans

- Building projects are influenced by cost and quality monitored by ARA
- Aims to build high-quality dwellings at reasonable costs
- Rents are based on these costs accepted by ARA = Cost recovery principle
- In ARA-construction as a rule is **competition in tendering**
- Information on construction cost is gathered by ARA and it makes possible to ensure that building projects are based on reasonable construction costs and support is not channelled into input prices

- Steering of planning
  - Accessibility, energy-efficiency
  - Costs can be higher if - for example - energy-efficiency improvements are included

Difference between ARA Social housing new production (red) and private new production (blue) in Metropolitan cities, October 2020 (€/sq2)

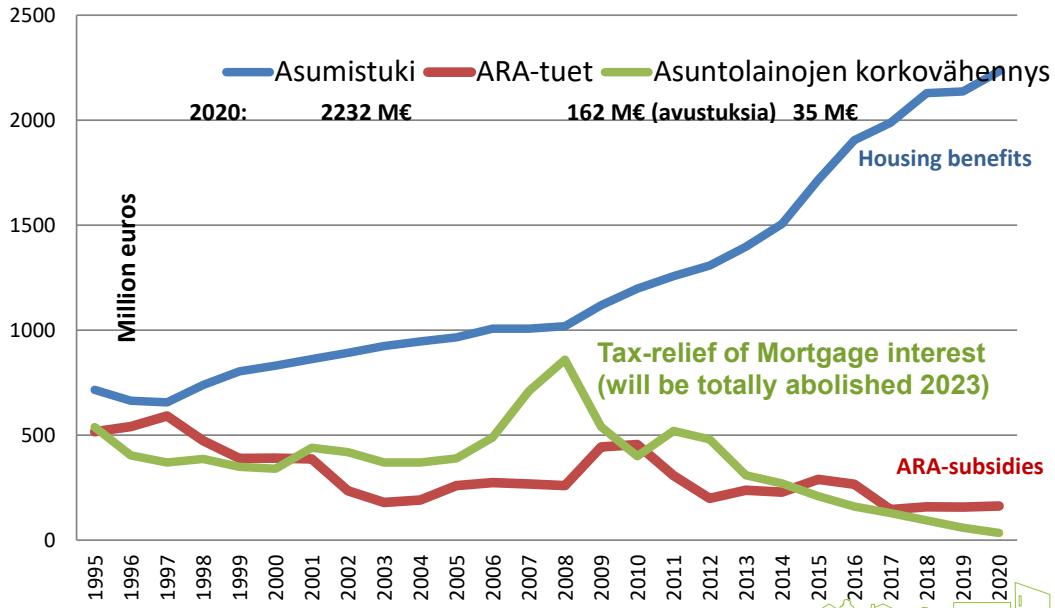


Lähteet ARA-tietokanta ja Rakennuslehden selvitys:
https://www.rakennuslehti.fi/2020/11/uusien-asuntojen-kauppa-kay-kovilla-kierroksilla-helsingissa-ja-espoossa-vantaalla-kaupat-romahtivat/

Housing Benefits and social assistance for housing was 2 591 Million Euros in 2020 (3,8 % Government Budget and 1,1% GDP)

In 2020, *Kela (the National Social Insurance Institution*) paid a total of **2 232** million EUR in housing benefits. The amount increased by 4.2% in real terms from the previous year. At the end of the year, **859 212** people lived in households that received housing benefits, which is **15.5%** of the Finnish population.

On top of that: in 2020 Kela paid **359** M€ of social assistance to compensate housing costs



Maximum housing cost for general housing benefit in 2021: Benefit covers 80% of housing costs (if no income)

Household size persons	Municipality in category 1, EUR per month	Municipality in category 2, EUR per month	Municipality in category 3, EUR per month	Municipality in category 4, EUR per month
1	521	504	400	353
2	754	723	584	514
3	960	912	741	657
4	1 122	1 064	878	783
+ each additional person,	140	133	120	115

- Municipalities in category 1: Helsinki
- Municipalities in category 2: Espoo, Kauniainen ja Vantaa
- Municipalities in category 3: Hyvinkää, Hämeenlinna, Joensuu, Jyväskylä, Järvenpää, Kajaani, Kerava, Kirkkonummi, Kouvola, Kuopio, Lahti, Lappeenranta, Lohja, Mikkeli, Nokia, Nurmijärvi, Oulu, Pori, Porvoo, Raisio, Riihimäki, Rovaniemi, Seinäjoki, Sipoo, Siuntio, Tampere, Turku, Tuusula, Vaasa and Vihti
- All other municipalities belong to category 4.

https://www.kela.fi/web/en/housing-costs-and-types-of-homes

KELA = The National Social Insurance Institution of Finland

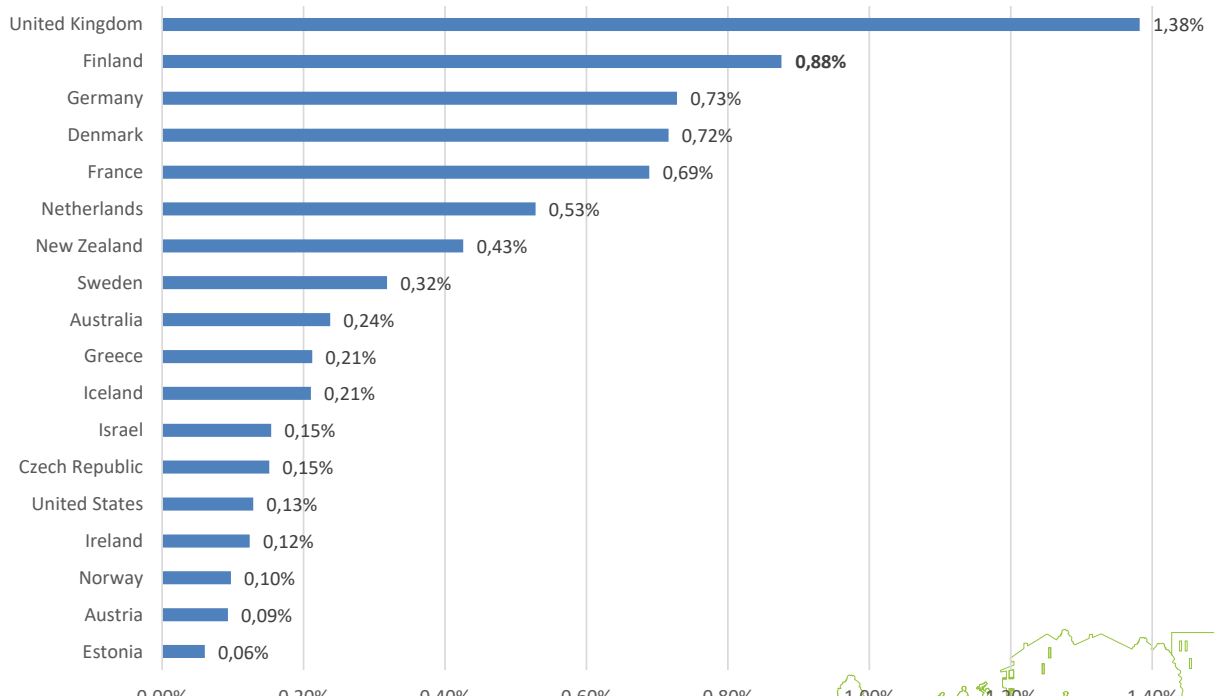
Basic social assistance, recognised housing costs by municipality 2021

In addition to the housing costs, water charges are recognised at an amount of €22.80 per person.

Municipality	Single-person household, EUR per month	Two persons, EUR per month	Three persons, EUR per month	Four persons, EUR per month	+ each additional person, EUR per month
Helsinki	694	844	964	1057	118
Espoo Vantaa					
Tampere	572	700	773	855	104
Turku	540	620	721	861	104
Oulu	496	608	705	771	107

Government Spending on Housing Allowances in OECD as % of GDP (2020 or last year available)

https://www.oecd.org/housing/data/affordable-housing-database/housing-policies.htm

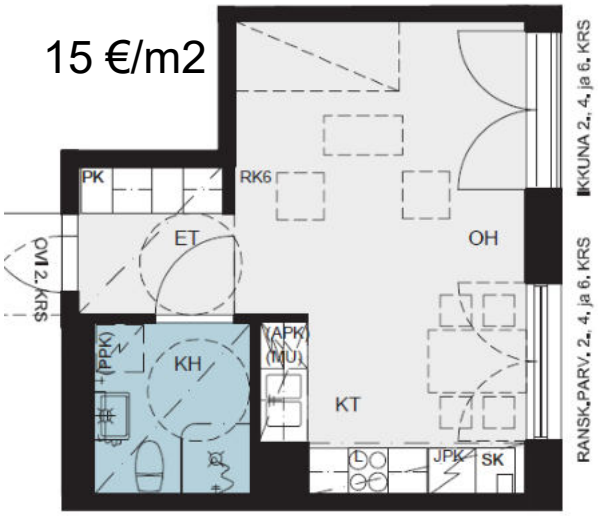


9.1.2023

Social (ARA) vs. market housing (PRS): two brand new dwellings in Jätkäsaari

HEKA/ ARA studio:
30 m2 Rent: 450 €/month

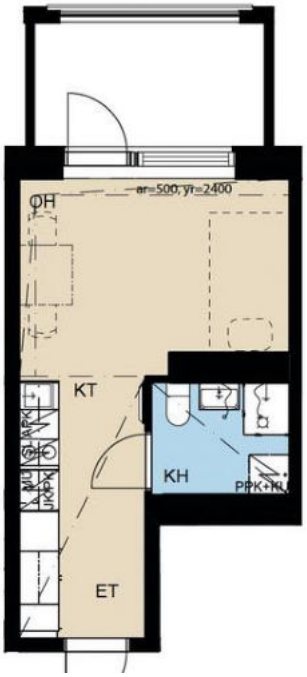
15 €/m2



Market priced studio:
23 m2 Rent: 889 €/month

38,6 €/m2

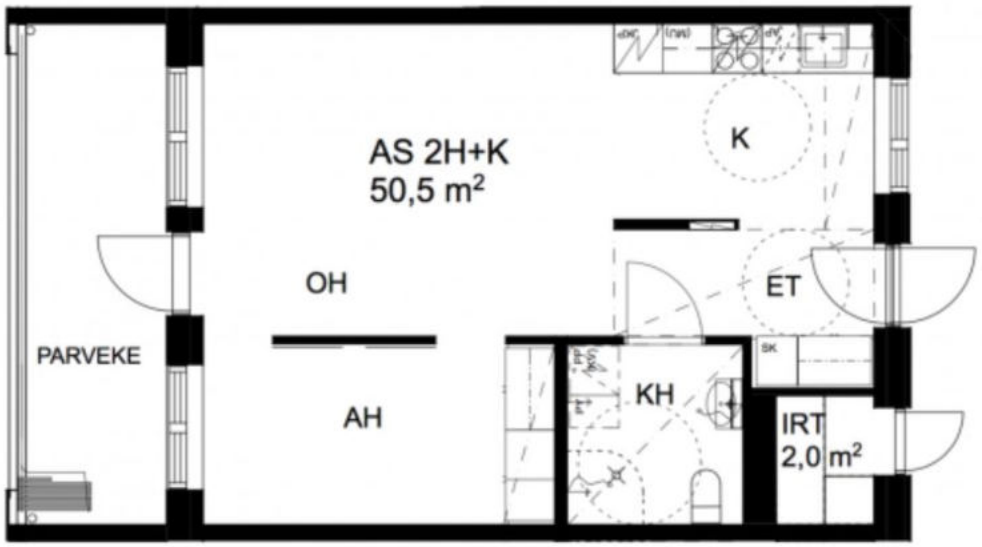
PRS has free rent setting since 1995



In 2021 average size of ARA studios was 39,9 m2

Social Housing has high quality standards: ARA is optimazing cost-quality -relationship

- Good quality + Affordable rents
- Heating is always part of rent
- Other services like Wifi,
- … and always sauna available!
- Not too small (average 50 m2)
- Design for all – accessibility!
- Social Mix in housing areas
- Good location and public transport nearby
- Facililities for community-buildning
- Promoting decarbonation of housing



Towards ecological living: ARA is developing and piloting new innovative housing solutions

Major development projects:

- Zero energy residential area: *Tuusulan Rykmentinpuisto*, Housing Fair 2020
- The first certified passive energy apartment building in Finland: Assisted living centre *Onnelanpolku*, 2014
- The first zero energy apartment building, *Järvenpää* and *Kuopio*, 2012
- *Käräjätörmä* multigeneration cooperative village, competition and implementation 2017–2019
- ARA design contest on an energy-efficient residential area, 2016
- ARA-EFL Accessible Housing design contest, 2015–2016
- ARA-home 2049 international contest, 2012

ARA-home 2049 contest for architectural students

ARA design contest on energy-efficient residential area

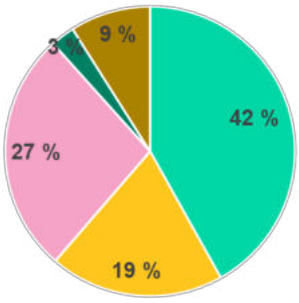
ARA and EFL student competition on accessible housing

A look at the participants of the Tampere Käräjätörmä multigenerational cooperative village design competition

Helsinki: SOCIAL MIX Housing Policy Objectives

Helsinki

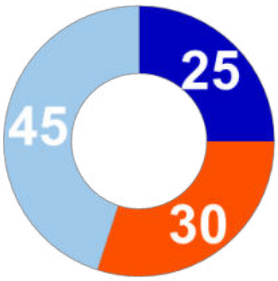
Existing housing stock = 22% ARA homes



- Owner-occupied housing units
- Government subsidised rental housing units
- Non-subsidised rental housing units
- Right-of-occupancy housing units
- Other/unknown

Helsinki

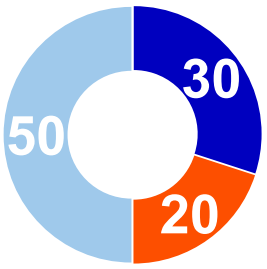
Objectives for forms of tenures in annual housing production:



=1750 %

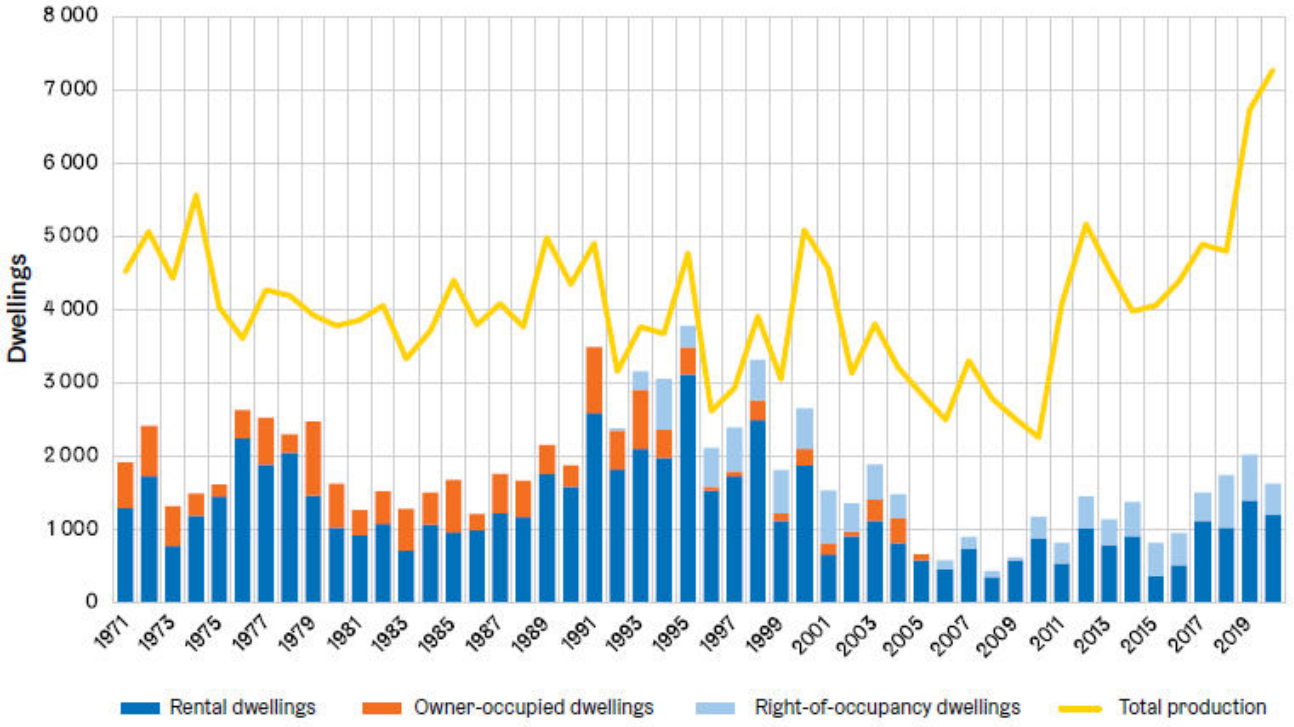
- ARA rental housing (including student and youth housing) 25 %
- Intermediate housing (e.g. Hitas and right-of-occupancy housing) 30 %
- Non-regulated owner occupied and rental housing 45 %

New targets 2023: 8000 new homes/year



= 2400

Arava/ ARA production by occupancy arrangement and total housing production in Helsinki in 1971–2020



Helsinki

Occupancy types of existing and planned residential buildings in the Jätkäsaari waterfront housing area (City of Helsinki, HSY)

Social Mix in practice

The City of Helsinki owns 70 % of its land area

The City's housing assets consist of 63 000 housing units, of which 50 000 are ARA-subsidised rented housing units and 5 000 ARA Right-of-occupancy housing.
The City also has its own housing developer

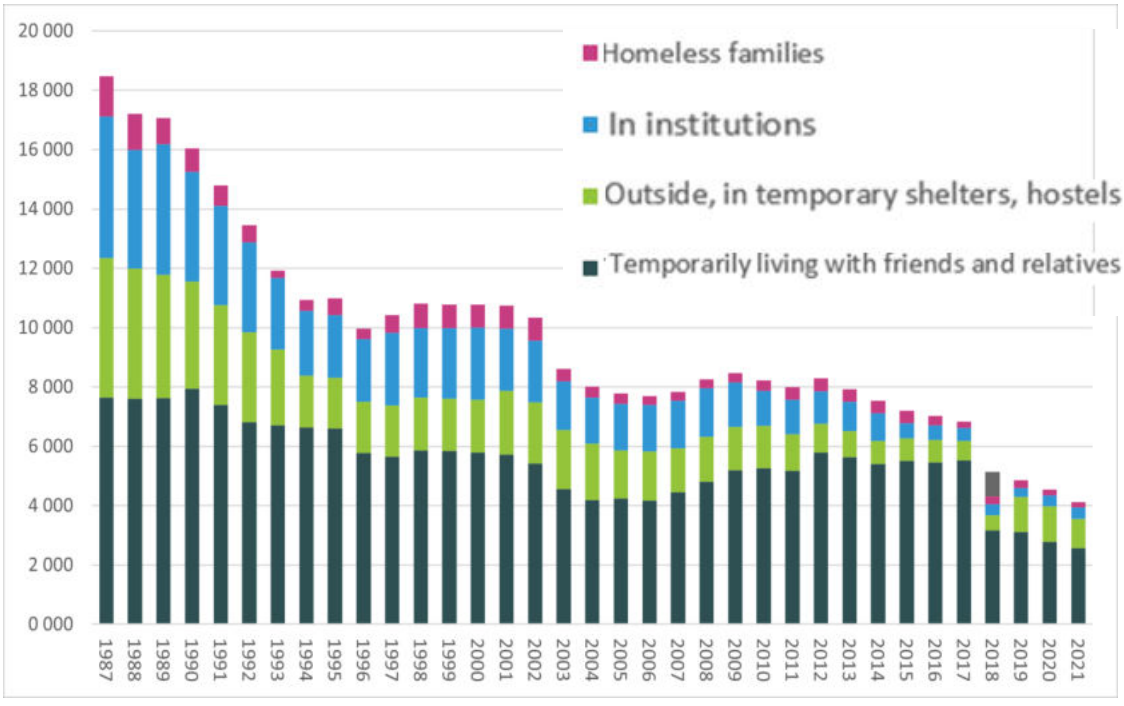
Helsinki

ARA is subsidizing Housing Advice services

- ARA has had mandate to promote and subsidize housing advice services in ARA-housing since 2009
- Year 2021 we had 0,9 M€ for grants
- Year 2022 we have **3,9 M€** for **agreements with municipalities** to enhance and develop housing advice
- Focus will be on making housing advice more readily available and on preventing homelessness, particularly among young people and migrants
- To improve access to housing advice, **Government will give an Act proposal for Parliament in next autumn to make it a statutory service 2023** and allocate resources for it
- In future Housing advice services must be available to all, irrespective of the form of housing

Homelessness Reports has been published since 1987 – 35nd Edition on 2021 is available in English

https://www.ara.fi/en-US/Materials/Homelessness_reports/Homelessness_in_Finland_2021(63305)



Alone living Homeless:
2008: 8260
2021: 3948
Change - 4312

= - 52% since Housing First was implemented 2008

Social Housing in Finland

- Pragmatic approach – path dependancy
- Based on wide co-operation between government and municipalities
- Government has not withdrawn from responsibility on supply side
- Use of EU SGEI-regulations (mofidied with Brussels laws)

- Some shortcomings:
  - Originally based on large scale productíon of new housing, not management of existing stock
  - Loan system based on back-weighted amortization (40 years, inflation expectation) – most of construction loan exists when need for renovation
  - Who are right and motivated owners of social housing stock besides municipalities?
  - Scattered housing difficult to organise

Summary: Essential in Finnish social housing policy

- Housing is a core element in ensuring welfare - markets do not provide affordable housing for all
- Constitution of Finland: "*The public authorities shall promote the right of everyone to housing and the opportunity to arrange their own*"
- *Combination of supply and demand side subsidies (mixed model)*

- Housing needs of low income households and shortage of rental housing in growth centres
  - High housing costs especially in Helsinki region
  - Housing markets are more balanced outside Helsinki metropolitan area
- Needs to promote housing for special groups
  - Ageing population, sheltered homes
  - Housing of the disabled persons, aim to abandon institutions
  - Housing for homeless persons
  - Housing for youth and students
- Integrated residential areas (social stability, no slums, no segregation)
  - Social and other housing situated side by side = Social Mix principle
  - Tenant selection criterias in social housing but also aim to avoid segregation in house level

ara

Housing is based on long-term commitment for affordability and high quality

Thank you!

Jarmo.linden@ara.fi

良質なストック形成等に向けた、木造建築物への融資における合理的な融資期間等に関する普及・広報			
会議名	**Interview meeting for wood construction in terms of finance and durability/木造のファイナンスと耐久性の観点からみたインタビュー会議**		
日時	4th January, 2023 14:00-15:30/2023年1月4日14:00-15:30		
場所	SRV head quarter, meeting room/ SRV本社会議室		
出席者	Miimu Airaksinen (MA), SRV・Senior Vice President/ アイラクシネン ミイム(SRV・シニア・バイス・プレジデント) , Shin Murakami (SM), Sugiyama Uni・Professor/ 村上心（椙山大・教授）, Hiroki Ishiyama (HI), Osaka City Uni・Associate Professor /石山央樹（大阪公立大・准教授）, Daishi Sakaguchi(DS), Nihon Fukushi Uni・Associate Professor /坂口大史（日本福祉大学・准教授）		
作成日	2023年1月5日	**記入者**	坂口大史

■ 議事	
議題	(1) General condition and maintenance for wood building/木造建築に関する一般的な状況とメンテナンスについて (2) Forecast of future of wood construction/木造建築の将来的な見通しについて
内容	(1) General condition of market for wood building ・ How do you see wood construction in general? (SM) - Wood apartment and residential building are popular due to less CO_2 emission and carbon footprint. (MA) - The users are more willing to have wood construction in terms of living comfort and the building owner is interested in the values like green certificate in the current market. The city is also pushing “Green city 2035” and they would like to reach carbon neutral through land use planning, which allows to build only wood buildings in some areas. (MA) ・ What kind of building type is popular for wood construction? (SM) - In case of school by wood construction, the building will be lower CO_2 emission so that as the incentive the city will pay for the reduction of CO_2, which will improve the cost competitive of wood construction. (MA) - The price for the apartments by wood construction was cheaper than concrete building in some cases. Nowadays, Finland has been cutting more forests, which will raise the price of wood.(MA) ・ How is the maintenance plan for wood construction? (HI) - Lifespan is set as long as concrete building. There is no difference in building types. However, wood façade must be carefully maintained at least once in 10 years. The maintenance cost for wood construction a little bit higher than concrete building because wood needs more regular maintenace. (MA)

	・ Do you have some kinds of maintenance plan for wood construction? (DS) - The load for the maintenance in wood construction and concrete is almost same as long as it is used inside or load-bearing components. (MA) - 50 years life expectancy is used for the simulation in general. Service handbook in each project will give the cost estimation and timing for the maintenance in 50 years scale. (MA) (2) Forecast of future of wood construction ・ How do you see the future of wood construction? - The key is how to reduce the cost. The risk of price rising for the future is always existing no matter what structure you will use for building. (MA) - The construction cost is higher in Helsinki than in North part or any other countryside area. The construction cost generally differs from 3,500-5,000 euro per floor square meter. (MA) ・ The cost for maintenance will be barrier to spread wood construction? (SM) ・ Not so much. The maintenance cost includes cleaning is 7-8euro per floor square meter. Cleaning is meaning daily cleaning. Repair work will be added on top of it. (MA) - There are two models for the operation of building: The one is just building and the second is including 10 years relationship for the maintenance of the building, monitoring the quality of wood and building condition. (MA) - The cost for the maintenance of wood building is a bit different from concrete building because of the wood façade is often used in wood construction, wood building could cost a bit more but not so big difference except the outside wood. (MA) ・ The methods of wood construction can be chosen in each project? (HI) - Currently, CLT is more popular because of the prefabricated method. CLT is generally more expensive, not knowing exactly how much percentage more expensive. The details of CLT is dependent on the producer even though the concrete is generally same. Wood construction should be more standardized. (MA) ・ Is there any special worker for wood construction? (SM) - Generally same worker with concrete building. But wood construction is not so common for the worker. Thus, there is special training of wood construction for worker before they start working in the construction site. (MA) ・ What do you think of the benefit to use wood construction in your project? (DS) - Wood structure has benefits in their light weight (easy construction), CO_2 emission and people prefer wood smell and feeling in interior. Disadvantages are noise, fire safety and moisture. (MA) - Concrete sector has been dominating the market, but wood construction has more potentials in terms of environmental reasons and better living environment. (MA) - In other European countries, Sweden is in similar condition but other country like Netherlands has difficulty to get good quality of wood. (MA)

	- In case of lager size of wood construction, the building has sprinkler and not so much risk of fire but on the contrary, there is a risk of water damage. Also, gypsum board will protect the building from the fire in case of wood building. (MA) ・ What kind of wood construction could be competitive in the market and what will be key topics? (HI) - ARA is taking more cost-effective way of construction. SRV is using wood construction for a bit higher income area or higher spec building so that the 5-10% price difference is not a big problem for the clients. (MA) - The maintenance duration for concrete building is less than wood. There is service book for each project for the maintenance and model cases for maintenance in each phase. (MA) ・ In larger scale building in Japan, we have a building circumstance, reach energy saving and try to control moisture content. (SM) - 10 years ago, the price difference between wood and concrete was not 5-10%. The reason to make a gap is that sprinkler will be needed for higher building anyway whether wood or concrete. (MA) - The main driver is CO_2 emission and people comfort for higher price. Comparing 10 years ago, the market tends to prefer wood construction. (MA) （日本語訳） (1) 木造建築に関する一般的な状況とメンテナンスについて ・ 木造建築を全般的にどのようにとらえているか？(SM) - 木造のアパートや住宅は、CO2排出量やカーボンフットプリントが少ないので人気がある。(MA) - 住み心地という点では、ユーザーの方が木造建築を希望している場合も多く、建物オーナーも現在の市場ではグリーン認証書などの価値に興味があるようである。また、市は「グリーンシティ2035」を推進しており、土地利用計画を通じてカーボンニュートラルを目指したいと考えており、一部の地域では木造建築物のみを建設とするなどの場合もある。(MA) ・木造建築はどのような建築タイプに人気があるのか？(SM) - 例えば、木造の学校の場合、CO2排出量が少ないので、CO2削減分をインセンティブとして市が負担することになり、木造のコスト競争力が向上する。(MA) - 木造アパートの価格は、RC造より安い場合があった。現在、フィンランドでは森林の伐採が進んでおり、木材の価格が上がっている。(MA) ・木造建築のメンテナンスに関する考え方は、どうなっているのか？(HI) - 木造建築の寿命はRC造の建物と同じに設定されている。フィンランドでは、建物の種類による差はないと思われる。ただし、木造のファサードは例外で、10年に一度は丁寧にメンテナンスをする必要がある。そういった点も含めると、一般的には、木造はRC造より定期的なメンテナンスが必要なため、メンテナンス費用は少し高くなる。(MA)

	・木造建築物について、何らかのメンテナンス計画は策定されているか？(DS) - 木造もRC造も、屋内や耐力部材であれば、メンテナンスの負荷はほとんど変わらないため、木造だからといって特別な計画はされていない。(MA) - 一般的に木造でもRC造でも50年が建物の寿命としてシミュレーションに使われている。また、プロジェクト毎にサービスハンドブックがあり、50年スケールでのメンテナンスの費用見積もりと時期が記載されているのが一般的である。(MA) (2) 木造建築の将来的な見通しについて ・木造建築の将来性をどのように考えていますか？ - 木造建築もそうであるが、鍵はどの様にコストを下げていけるかである。実際は、どのような構造で建物を建てるにしても、将来的に価格が上昇するリスクは常に存在している。(MA) - 特にヘルシンキでは、フィンランドの北部や他の地域よりも建築コストが高くなる。一般的には、床面積1平方メートルあたり3,500～5,000ユーロの差がある。(MA) ・木造建築を普及させるには、メンテナンスにかかる費用がネックになるのでは？(SM) - それほどでもない。清掃を含めたメンテナンス費用は、1㎡あたり7～8ユーロとなっている。この清掃とは日常清掃のことである。メンテナンスとしては、これに修繕費が加算される。(MA) - 実際の建物の運用には、2つのモデルが存在する。一つは、建物を建てるだけのパターンで、もう一つは、建物のメンテナンス、木材の品質や建物の状態をモニタリングするための10年間の関係を含むものである。(MA) - 木造建築のメンテナンス費用は、RC造の建物とは少し異なる。これは、木造建築では木をファサードに使うことがよくあるためで、その場合、木造建築は少し費用がかかるが、外で使用される木材を除けばそれほど大きな差はない。その理由は、木造建築の方が一般的に建物の品質自体が良いからである。(MA) ・木造建築の工法はプロジェクトごとに選べるのか？(HI) - CLTは一般的に高価であり、何％高いか正確には分からないが、現在では、プレハブ工法であるCLTの方が人気がある。コンクリートは生産者によらず品質が同じでも、CLTは生産者に依存する。木造建築はもっと標準化されるべきである。(MA) ・木造建築には特別な職人が必要なのか？(SM) - 一般的にRC造の建物と同じ作業員で建設を行っている。しかし、木造建築は、作業員にとってあまり一般的ではない。従って、建設現場で働き始める前に、木造建築に関する特別なトレーニングが行われる。(MA) ・木造建築を使用する利点はなんであるか？(DS) - 木造のメリットは、軽量（施工性）、CO2排出量、木の香りや質感が好まれること、などが挙げられる。一方で、デメリットは、騒音、防火、湿気などになる。(MA) - 市場では依然としてコンクリートが主流であるが、木造は環境面や住環境の面からも可能性があると感じている。(MA) - 他のヨーロッパ諸国では、スウェーデンは同じような状況であるが、オランダのような国は、良質な木材を入手するのが困難であるため状況が異なる。(MA) - 木造の規模が小さい場合、スプリンクラーもあり、火災の危険は少ないが、逆に水害の危険もある。また、木造の場合、石膏ボードが火災から建物を守ってくれるので逆

	に安心感がある。(MA) ・ 今後、どのような木造建築が市場で競争力をもちうるか、また、どのようなことが鍵となるトピックになるか？(HI) - 例えばARA は、より費用対効果の高い建築方法をとっている。一方で、SRVは、少し高所得の地域や高スペックの建物に木造を使っており、5-10%の価格差は顧客にとって大きな問題にはならないようにしている。(MA)
備考	・特になし

■ 次回の予定	
日時	年　　月　　日（　　曜日）　　時　　分より
場所	

良質なストック形成等に向けた、木造建築物への融資における合理的な融資期間等に関する普及・広報			
会議名	**Interview for wood construction in terms of LCA/木造に関するLCAの観点からみたインタビュー会議**		
日時	5th January 2023 13:00-14:30/2023年1月5日13:00-14:30		
場所	Green building council, meeting room/グリーンビィルディング協会会議室		
出席者	Miisa Tahkanen (MT), Green building council・ Leading Specialist /タフカネン ミイサ（グリーンビルディング協会・リーディングスペシャリスト）, Shin Murakami (SM), Sugiyama Uni・Professor/ 村上心（椙山大・教授）, Hiroki Ishiyama (HI), Osaka City Uni・Associate Professor /石山央樹（大阪公立大・准教授）, Daishi Sakaguchi(DS), Nihon Fukushi Uni・Associate Professor /坂口大史（日本福祉大学・准教授）		
作成日	2023年1月6日	**記入者**	坂口大史

■ 議事	
議題	(1) General condition and LCA for wood building/木造建築に関する一般的な状況とLCA (2) Forecast of future of wood construction/木造建築の将来的な見通し
内容	(1) General condition and LCA for wood building ・ Could you explain your organization? (SM) - FIGBC's gives the certificate and are organized by 300 companies of architecture firms and construction companies. FIGBC belongs to World Green Building Council by 70 national GBCs and FIGBC is part of Europe regional network. (MT) ・ How is the regulations for wood construction in Finland? (HI) - 8th stories are maximum for wood structure because of fire regulations. 2 hours for fireproof is required for 8 stories height. (MT) - Hybrid structure like concrete and wood are considered as the regulations of whole wood building in Finland, which will make wood structure more difficult to fit the regulations. (MT) ・ The public sector is positive for wood construction? (DS) - The government and city are tried to pushing wood structure because of the better performance in LCA in general. (MT) - FIGBC will try to contribute to the sector's sustainable development for industry and government. FIGBC also publish common metrics like guidebook and analysis report for green building and sustainability. (MT) ・The guidebook is commonly used in EU or in Finland? (SM) - The guidebook is used for Finland in general. The difference is for instance, Finland use only A1-A5, B6, C1-C4 in the criteria. B1-B5 is excluded because it is in use stage and uncertain future thing. (MT) ・ The criteria is used for new building or old building? (SM)

	- It is for new building and major renovation of old building. BREEAM in-Use is used for old building and LEED New Construction is used for new building. In Finland, LEED silver is the government legislation level and LEED gold is required for the developer. (MT) - Energy efficiency has been main interests for the government because it will be environmentally friendly and lead to cost reduction. (MT) ・ From 2025, LCA will be mandatory for the building permission? (DS) - Now still in the parliament stage and next government will make a final decision. It depends on the next vote and election. (MT) ・ It is interesting that the criteria for the certificate are different from each country. Does this really work when you need to evaluate each project? (HI) - Some countries will take A, other will exclude B. There are differences but they are small. (MT) (2) Forecast of future of wood construction/木造建築の将来的な見通し ・ Lately in Finland, cutting forest is getting bigger concern because of carbon sink capability? (DS) - Yes, it is true. Concrete industry and wood industry are pulling the market behind. Using too much wood is not good thing in terms biodiversity. The best way is to use good quality wood for longer like cascading use and long product life cycle to store carbon in products. (MT) ・ Market might think that concrete building can last 100 years, but wood building does not last. What do you think of building life span?(HI) - This is not necessarily true. For longer use or longer life cycle will be key and maintenance plan will be even more important in the future. (MT) ・ There is a lot of discussion that wood construction is beneficial for environment in Japan. How about in Finland? (DS) - Yes, same situation. (MT) - At least Miisa's opinion wood structure is generally environmentally beneficial if you do not cut too much wood, or we use product longer and longer lifecycle. (DS) ・ What is the barrier for the spread of wood construction? (SM) - Cost effectiveness, lack of expertise, fire regulations and concrete industry is strong in the market. Especially big contractor such Skanska, SRK and YRT will keep traditional way of concrete construction. They belong to green building association, but they are not eager to do wood construction. (MT) ・ The durability of wood building will be an issue when you build wood building? (HI) - Normally not. The durability of wood will be used as excuse to avoid wood structure. (MT) （日本語訳）

	(1) 木造建築に関する一般的な状況とLCA ・あなたの組織はどのような組織か。(SM) - FIGBCは、建築事務所と建設会社からなる300の企業によって組織され、認証書を発行している。FIGBCは、70カ国のGBCが加盟する世界グリーンビルディング評議会に所属し、ヨーロッパ地域ネットワークに加盟している。(MT) ・フィンランドの木造建築の規制はどうなっているか？ - 火災の規制があるため、木造で建物を建てる場合は8階建てが限度である。8階建ての場合、一般的に2時間の耐火が必要である。(MT) - フィンランドでは、RC造と木造のハイブリッド構造で建物を建てる場合、建物全体が木造であるとして規制がかかるため、高い建物になればなるほど木造建築は規制を満たすことが難しくなる。(MT)。 ・フィンランドの政府や行政などの公共部門は木造建築に肯定的か？(DS) - 政府や市は、一般的にLCAの性能が良いため、木造を推し進めようとしていると感じている。(MT) - そのため、FIGBCは、産業界と政府のために、この分野の持続可能な発展に貢献するよう努力する。また、FIGBCは、グリーンビルディングと持続可能性のためのガイドブックや分析報告書のような共通の指標を発行している。(MT)。 ・ガイドブックはEUやフィンランドで一般的に使われているのか？ - フィンランドでは一般的に使われている。例えば、フィンランドでは、基準となる指標のうち、A1-A5, B6, C1-C4 のみが基準として使用されている。B1-B5は使用段階であり、将来が不透明なので除外している。(MT)。 ・この基準は、新築か古い建物か？ - 新築と古い建物の大規模改修が対象である。BREEAM In-Useは古い建物に、LEED New Constructionは新しい建物に使われるものである。フィンランドでは、LEEDシルバーは政府の法律レベルであり、LEEDゴールドはデベロッパーに要求されるレベルとなっている。(MT)。 - 特にエネルギー効率に関する指標は、環境に優しく、コスト削減につながるため、政府にとって主要な関心事となっています。(MT)。 ・2025年以降、LCAは建築許可に必須となるのか？(DS) - 現在はまだ議会の段階であり、次の政府が最終的な決定を下すことになる。次の投票と選挙によって結果は変わる可能性がある。(MT) ・グリーン認証などの基準が国によって違う点が興味深い。プロジェクトごとに評価する必要があるのに、本当にこれでいいのだろうか？(HI) - Aを取る国もあれば、Bを除外する国もある。実際のところ、国によって差はあるがその差は小さい(MT)。 (2) 木造建築の将来的な見通し ・最近、フィンランドでは、炭素固定のために森林を伐採することが懸念されていると聞いたが、そういった情報があるのは事実か？(DS) - 情報があるのは事実である。ただし、コンクリート業界と木材業界が市場で綱引きを

	しているケースが多く、その一部である。もちろん、木材を使いすぎることは、生物多様性の観点からもよくないことではある。(MT) - ベストな方法は、良質な木材を長く使うこと、例えばカスケード利用や製品のライフサイクルを長くして、製品に炭素を貯めることである。(MT) ・RC造の建物は100年もつと思われているが、木造建築はもたないと言われているが寿命についてどの様に考えているか。(HI) - これは必ずしも正しいとは言えない。長く使うこと、ライフサイクルを長くすることが重要で、今後はメンテナンスプランがより重要になる。(MT) ・日本では、木造は環境に良いという議論が多い。フィンランドではどうなのでしょうか？(DS) - 同じ状況である。(MT) - 少なくともあなたの意見では、木を切りすぎなければ、あるいは製品のライフサイクルを長くすれば、木造建築は一般的に環境に良いということだと理解した。(DS) ・木造建築が普及するための障壁は何であるか？(SM) - 費用対効果、専門知識の不足、火災の規制、コンクリート業界の市場における強さが挙げられる。特に、Skanska、SRK、YRTのような大手建設会社は、伝統的なRC造の建物の方法を維持している。彼らは、グリーンビルディング協会に属していますが、木造建築には熱心ではない。(MT)。 ・木造建築を建てる場合、耐久性は問題にならないか？ - 通常は問題ない。木材の耐久性は、木造建築を避けるための言い訳に使われる場合がほとんどである。(MT)
備考	・特になし

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Towards embodied carbon benchmarks for buildings in Europe

#1 Facing the data challenge

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Towards embodied carbon benchmarks for buildings in Europe
#1 Facing the data challenge

Project name	Towards EU embodied carbon benchmarks for buildings
Date	March 2022
Authors	Martin Röck, Andreas Sørensen, Jacob Steinmann, Lise Hvid Horup, Buket Tozan, Xavier Le Den, Harpa Birgisdottir
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In this report, the widely used term 'embodied carbon' is applied. It is considered to be synonymous with 'embodied GHG emissions' herein. The data and values presented in the following consider both CO2 and non-CO2 GHG emissions, the reference unit applied is kilogram CO2e (equivalent) expressed per m^2, per capita, or m^2 and year, respectively.

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Executive summary

Rationale – Why is this important?

"Embodied carbon" consists of all the greenhouse gas (GHG) emissions associated with the materials and construction processes used throughout the whole life cycle of a building[1]. While past efforts have mostly focused on increasing energy efficiency in building operation, recent research on the GHG emissions across the full life cycle of a building highlights the increasing importance of embodied GHG emissions in relation to producing and processing construction materials. The urgent state of climate change requires rapid action without any further delay.

The "Towards Embodied Carbon Benchmarks for buildings in Europe" project was set up by Ramboll Build AAU - Aalborg Universitet with the support of the Laudes Foundation. Through a series of four reports[2], the objective is to improve our understanding of embodied carbon in buildings and to set framework conditions for reducing it. In order to do so, the project explores the concept of embodied carbon baselines, targets, and benchmarks for buildings in Europe. In particular, the focus is on upfront embodied emissions which represent the largest share of embodied carbon and can be shaped at the design stage.

For this purpose, data on the GHG emissions from building construction is essential for calculating the current baseline levels of embodied carbon. Additionally, the current data landscape will shape the options available to us for monitoring future buildings against specific benchmarks, once these have been established. Therefore, this report describes the experience gained in collecting building-level embodied carbon data from life cycle assessments (LCAs).

Results – What did we find?

The objective of this part of the project was to compile LCA data from European countries, for which 50 cases or more could be found. Each case represents a building where LCA data was available which could be used to provide information on the current level of embodied carbon in buildings. This would allow relatively robust conclusions to be made regarding the baseline level.

However, the data collection process conducted across Europe resulted in only five countries being identified for which sufficient data could be used. These were Belgium, Denmark, Finland, France and the Netherlands. Figure 1 summarises and illustrates the situation across Europe.

The data collection process highlighted a series of data challenges which resulted in the low number of cases which could be used. These challenges are summarised in Table 1.

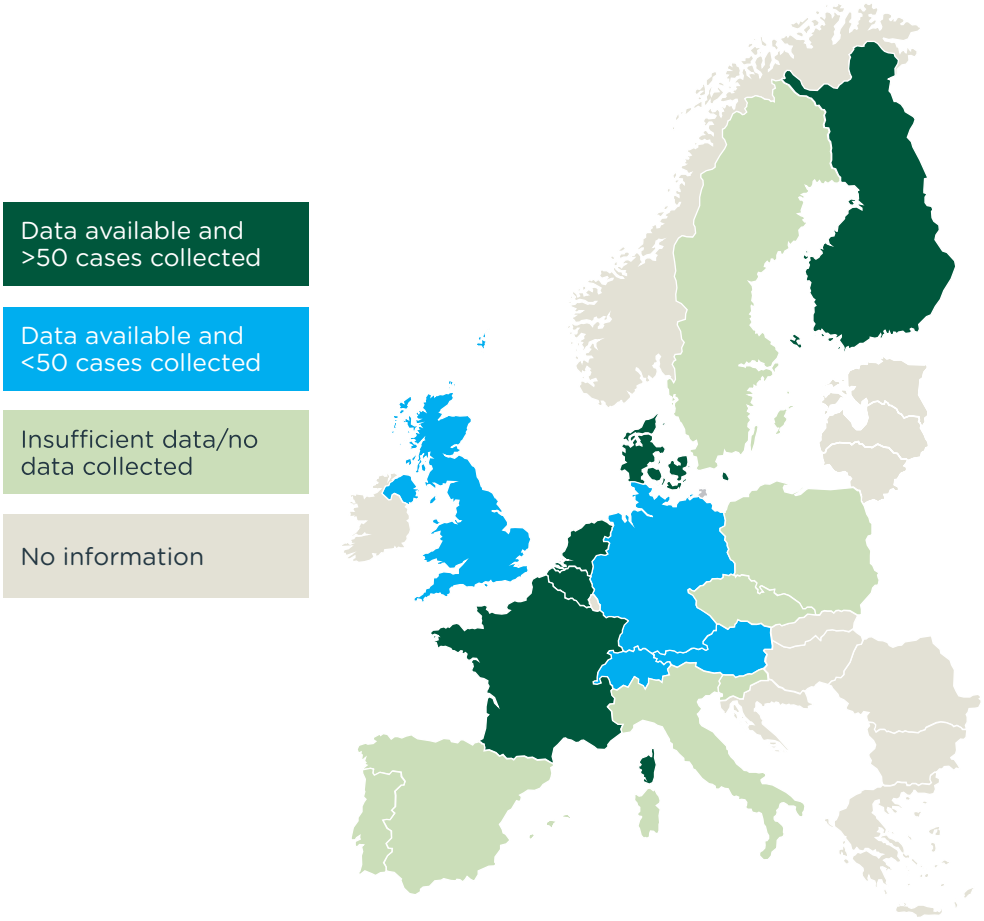
[1] Embodied carbon therefore includes: material extraction, transport to manufacturer, manufacturing, transport to site, construction, maintenance, repair, replacement, refurbishment, deconstruction, transport to end-of-life facilities, processing, disposal.

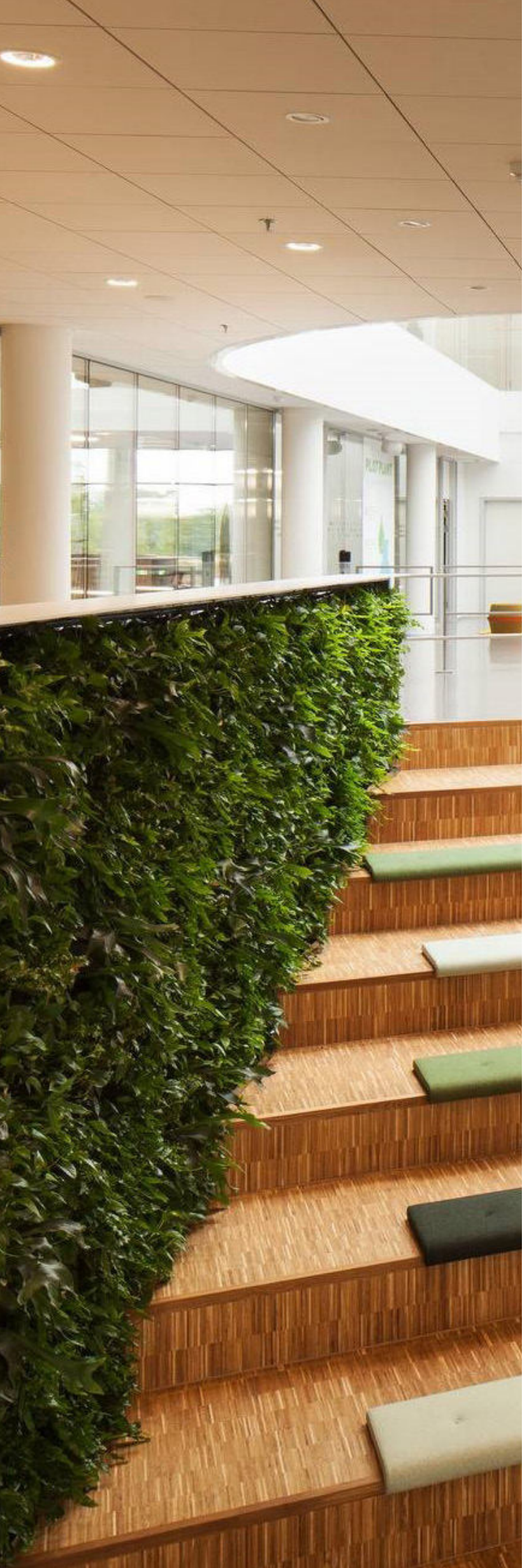
[2] Reports: #1: Facing the data challenge; #2: Setting the baseline; #3: Defining a carbon budget; #4: Bridging the gap

Table 1: Key challenges encountered in the LCA data collection

Challenge	Definition	Effect on building LCA data
Availability	Existence of data at the national level	In many European countries, the practice of conducting LCAs does not exist, or the results are not fed into a central repository.
Accessibility	Possibility to access existing data	LCA data may be collected into a central repository but is not shared by the owner because of data protection or intellectual property concerns.
Quality	Data meets accuracy, completeness, timeliness, validity, and uniqueness criteria	Entries in national databases vary in completeness, have unclear time origins or include duplications.
Comparability	Data scope and collection method are comparable with each other	The scope of life cycle stages, building parts or environmental impacts, or the data collection and results calculation methods differ. This is a particular challenge when comparing data across countries.
Representativeness	The data represents the building stock, in terms of new construction, well	Even if all the above factors are met, data can come from selected buildings with high environmental performance, for instance where obtaining sustainability certification is envisaged. This delivers a skewed and incomplete picture of the embodied carbon in new buildings. Sufficient data points are needed for each different building type to be able to draw representative conclusions. The larger the sample, the better it is in this respect.

Figure 1: Overview of data availability in Europe

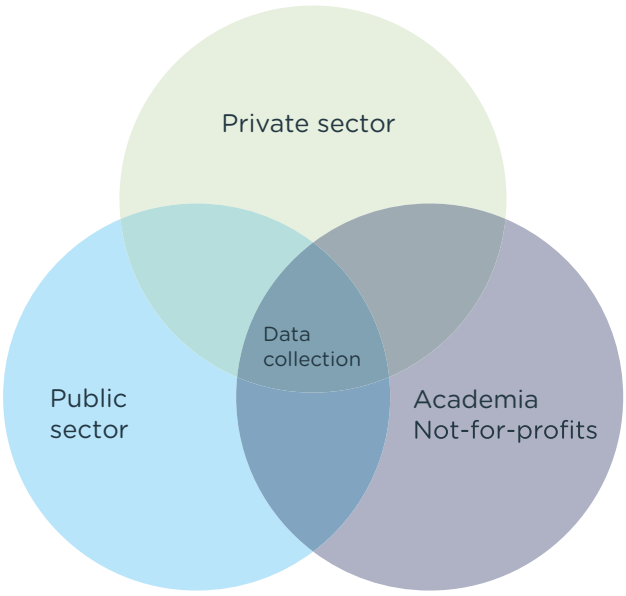




Conclusions – What does this mean?

In conclusion, we found that the LCA data required for a benchmarking system to reduce embodied carbon in new buildings needs to be more extensive. Furthermore, the challenges identified in this report need to be addressed and overcome quickly in order to avoid any delay to action being taken.

The experience from those countries for which data could be collected shows that overcoming the challenges is the result of incentives to conduct LCAs and to make the results available being included in national legislation and other policy initiatives. Additionally, the effectiveness of data collection can be increased through triple-helix cooperation between the public and private sectors, as well as academia and not-for-profit partners.



Call to action – What should we do?

Based on the findings of this work, we arrive at the following recommendations:

National LCA methods and data collection systems are urgently needed to avoid any further delay in this fundamental step towards measuring and reducing embodied carbon as part of whole life carbon emissions.

To this end, legal or sectoral requirements that mandate the production of LCAs in accordance with standardised calculation and documentation methodologies are highly relevant at national level, as well as harmonisation at EU level through tools such as the Level(s) framework. Standardisation based on coordination between stakeholders in the building design and construction value chain should, for example, include: scope of life cycle modules, scope of building elements, reference study period, environmental data on building materials, etc.

Data collection and compilation efforts are needed from all those involved in designing and assessing buildings. For this purpose, collaboration and complementary activities between public institutions, building designers, investors, certification organisations and researchers are needed. This step requires a common language and standardised method for LCAs, as described in the first point above.

As this process may take some time, the challenge of gaps in data could also be mitigated through the following approaches. These should be considered complementary.

- **Data on recent and current building projects could be generated at a centralised level by applying a single LCA method in order to provide information on these specific cases, as it is likely that this data can still be obtained.** This exercise would benefit from input from the different actors involved, including the building industry, certification bodies, researchers and public bodies. This cooperation could be greatly facilitated through the use of standardised calculation methods and software tools to form a central database. A similar approach has provided a large database in France.
- **Existing data, that has been created in a scattered form using varying methodologies by different stakeholders, has the potential to be gathered together and harmonised to form a centralised database**. Harmonisation methods, adapted to the specific differences between the LCA methodologies, could be agreed upon by a coalition of actors to support this undertaking. Examples of such action are the international activities in Annex 72 to the IEA-EBC Programme, as well as the UK initiatives LETI and BRE.
- **Where empirical data faces the challenges described in this report, relying on results from modelled building archetypes could provide an insight into the life-cycle impacts.** Building archetypes offer the advantage of providing representative and comparable values. However, limits remain in translating building stock models into LCA data, which is challenging, particularly for the diverse landscape of non-residential buildings. Also, monitoring future buildings, in comparison with benchmarks, is not possible. Nonetheless, efforts to translate this data can help in the transition towards standardised empirical LCA data. This approach has been used successfully in projects such as the Tabula/Episcope project.

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1. Introduction

As the effects of the accelerating climate and ecological crises are becoming evident, the need for transformational climate action is rising. Based on decades of climate science and driven by the increasing pressure from civil society, policymakers in the European Union (EU) and beyond are making bold claims to reduce greenhouse gas (GHG) emissions for their respective regions and activities.

Building construction and operation are amongst the most significant activities driving current GHG emissions, representing 37% of global GHG emissions[1]. At the same time, increasing the energy efficiency of both existing and new buildings, as well as shifting to sustainable construction practices, are considered to be major opportunities for decarbonising the economy in the coming decades.

Altogether, the total amount of embodied and operation emissions is referred to as whole-life carbon emissions. Reducing this total sum of emissions in a building is of the highest priority, to which this work aims to contribute.

While past efforts have mostly focused on increasing energy efficiency in building operation, recent research on GHG emissions across the full life cycle of buildings highlights the increasing importance of embodied GHG emissions, in relation to producing and processing construction materials. "Embodied carbon" refers to all the greenhouse gas (GHG) emissions associated with materials and construction processes throughout the whole lifecycle of a building[3].

These embodied emissions in buildings are rarely addressed in policy strategies and instruments. However, if embodied carbon is not included in building decarbonisation targets, a failure to meet global decarbonisation targets is highly likely. This is because the total climate impact of buildings would remain only partly addressed. Thus, the need and potential for reducing embodied emissions require attention and alignment as part of European and global efforts to combat climate change. Against the backdrop of increasing efforts to understand and reduce the whole life cycle of carbon in buildings, the project "Towards Embodied Carbon Benchmarks for the European Building Industry" was set up.

In particular, setting a performance system for embodied emissions at the building level can provide relevant guidance for policymakers and the building industry. Developing the foundations of such a performance system for new buildings has been the objective of the project "Towards Embodied Carbon Benchmarks for buildings in Europe", set up by Ramboll and Build AAU - Aalborg University, with the support of the Laudes Foundation. This includes a baseline of current embodied carbon levels in new buildings, as well as considerations of the available carbon budget for these emissions. Together with a review of data availability and quality, these elements form the basis of a performance system in the form of benchmarks for reducing embodied carbon.

This project focused on the European Union (EU). This is due to its position as a pioneer in GHG emission reduction policies with instruments such as the Energy Performance of Buildings Directive, the Taxonomy for Sustainable Activities and the EU Climate Transition Benchmark Regulation. Additionally, the life-cycle perspective of buildings is receiving increased policy awareness. These instruments and initiatives will have an increased impact on the building industry. This project seeks to inform the current debate involving policymakers and industry alike and to stimulate the development and application of benchmarks for embodied carbon in the EU and beyond.

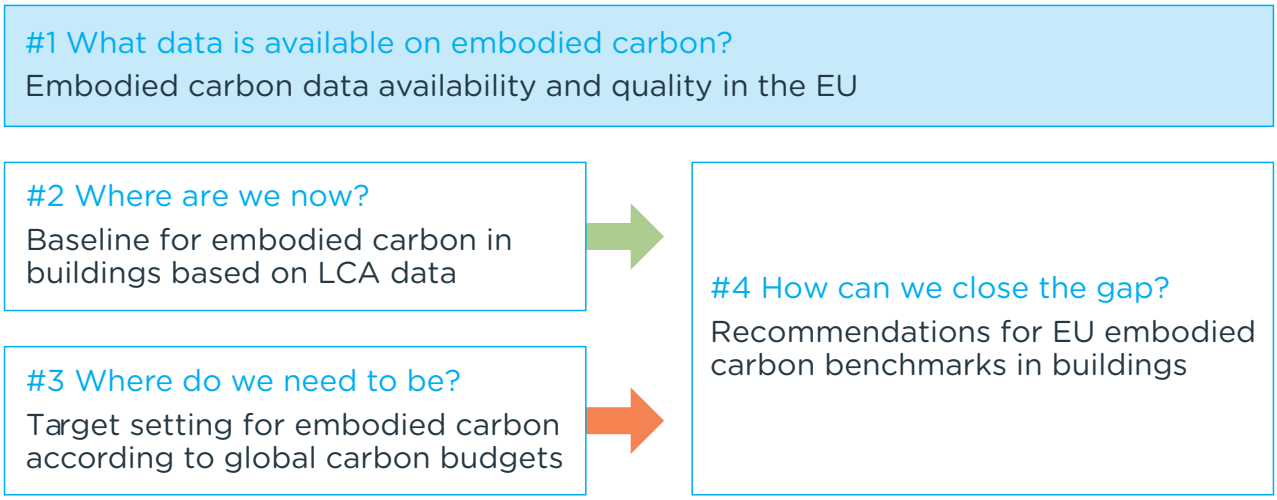
[3] Embodied carbon therefore includes: material extraction, transport to manufacturer, manufacturing, transport to site, construction, use phase, maintenance, repair, replacement, refurbishment, deconstruction, transport to end of life facilities, processing, disposal.

The series of reports produced as part of this project provides insights and developments on the following questions:

1. What data is available on embodied carbon in the EU?
2. Where are we now? What is the current status of embodied carbon in new buildings?
3. Where do we need to be? What level of embodied carbon is aligned with the available carbon budget?
4. How can we close the gap? How can benchmarks to reduce embodied carbon be set?

The report herein is the first report in this series.

Figure 2: Overview of the series of reports produced under the "Towards Embodied Carbon Benchmarks for buildings in Europe" project



The purpose of the report herein is to summarise the insights gained on embodied carbon data from life cycle assessments (LCA). A search for such data was carried out across EU countries (and the United Kingdom) to form a basis for the baseline setting process and for drawing up a benchmarking framework.

The report presents the current situation as encountered in the EU countries and the UK, points to the key issues in LCA data and provides solutions for overcoming these challenges. The findings in the report are supplemented with country sheets for the five countries for which sufficient data was available: Belgium, Denmark, Finland, France and the Netherlands.

2. What is the situation on building LCA data in Europe?

2.1 The ambition

Developing robust recommendations for a benchmarking system for embodied carbon in buildings requires an evidence base in order to be able to understand the status quo and to set the baseline for reduction efforts.

For calculating the baseline of embodied carbon in new construction in the EU, this study aimed at gathering **national datasets consisting of at least 50 cases** of high-quality building LCA data per country from EU Member States and the United Kingdom. This target was set to create a sample for analysis that was as broad as possible, while taking into account the currently limited collection of building LCA data.

However, considering the overall number of construction projects, this target number was deemed sufficient for making feasible statements on the embodied carbon levels in new buildings.

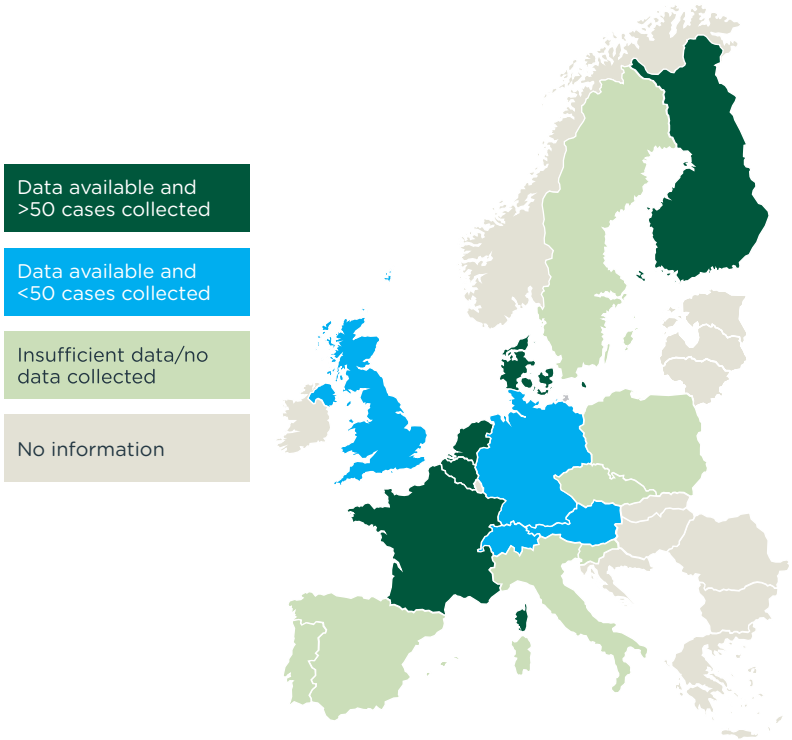
2.2 The reality

The research into the national methods and cases of available LCA data for all EU Member States revealed that obtaining a larger amount of data is impossible in the majority of countries. **The results show that the majority of EU Member States have low to no LCA data available for calculating bottom-up embodied carbon benchmarks**, with only five Member States identified as having 50 or more LCA cases available. The details for these five countries are compiled in the country sheets in Appendix 1, while an overview of the embodied carbon data landscape in all EU Member States is provided in Appendix 2.

Figure 3 summarises and illustrates the data available in European countries, as assessed during the data collection process for this project. It illustrates that, **within the countries included in the study, samples of sufficient size and quality could only be collected in Belgium, Denmark, Finland, France and the Netherlands**. In four additional countries, some data could be identified, but it did not pass the threshold of 50 cases.

This highlights a significant variation in the building LCA data available, which limited a broader coverage of countries to assess current embodied carbon levels. This impacted the calculation of the baseline and the carbon budgets, as well as the determination of benchmarks required to guide the reduction of said emissions. The variation in the data landscape and the need for this evidence base highlights the urgency for expanding and improving data collection, and suggests that lessons could be learnt from the Member States included in this study at the forefront of data collection. The following sections provide additional analysis and discussion of what drives data development and data accessibility in these countries.

Figure 3: Overview of data availability in Europe



3. What are the issues with LCA data?

This section summarises the key issues encountered in the data collection and analysis process. As suggested by the map of data availability in Figure 3, embodied carbon LCA data can be challenging to come by, as in most EU Member States there is no precedent or requirement to develop LCAs which include embodied carbon in buildings. However, other factors may also pose data challenges when using LCA data to develop embodied carbon benchmarks. This includes the following points (as summarised in Table 2 above) which will be discussed below, based on the experience gained from the data collection at national level.

Table 2: Key challenges encountered in LCA data collection

Challenge	Description
Availability	Existence of data at national level
Accessibility	Possibility to access existing data
Quality	Data meets accuracy, completeness, timeliness, validity and uniqueness criteria
Comparability	Data scope and collection methods are comparable with each other
Representativeness	Data represents the building stock, in terms of new construction, well

3.1 Data availability

As already outlined, finding existing LCA data for buildings has proved challenging in most countries. In many of the countries in which the expected sample size could not be reached, LCAs are not commonly performed in practice or are not collected. The reasons for this can be a lack of awareness, guidance on methodology, or incentives for LCAs for building projects. Two examples highlight the challenges of data availability from countries in which data could not be collected.

Firstly, in **Poland**, where there is no regulation on whole life carbon, the Polish Green Buildings Council expressed difficulties in accessing data on embodied carbon as the results of LCAs are not systematically gathered into a central repository. In this case, the development of LCA data was driven by investment companies and developers expressing an interest in conducting LCAs on construction projects to achieve voluntary sustainability certifications. Thus, the data was found to remain with the private sector (building owners, consultancy companies conducting the LCAs, the LCA tool owner, or certification bodies); and was not readily accessible by research institutions or the green building council. This case was found to be representative of the majority of EU Member States where the lack of a central LCA repository and private sector data holding were found to create barriers to developing nation-wide embodied carbon benchmarks. This case, therefore, is emblematic of the data availability and accessibility challenges.

In the **Czech Republic**, an active academic research project (CVUT) was identified on the topic of building LCA, its implementation in the design process, and the definition of carbon targets for buildings. However, the limited number of available building LCA case studies prevented the inclusion of these LCA cases in this study's analysis. This suggests that future support for local actors to build on this experience in order to increase the number of LCA cases could enable a suitable database to be established in the future. Consequently, this is representative of the lack of data availability.

3.2 Data accessibility

If data is collected through LCAs at the building level, this **data may still not be usable in a general assessment of embodied carbon in the country due to challenges in accessing the data**. In the countries for which data has been successfully collected for this study, the data partners were able and willing to share their data. In other countries, this was not possible. In such cases, the consideration of an EU level baseline for embodied carbon is not possible in the current situation.

For instance, in **Germany**, we found a different landscape. Here, due, on the one hand, to the requirement for federal buildings to conduct a BNB assessment including an LCA, and, on the other hand, a popular uptake of the DGNB buildings certifications, LCA data was found to be available and held by the DGNB. However, barriers were encountered in accessing it due to data protection and intellectual property considerations. This became such a challenge that the data could not actually be accessed for this study. By the end of this project, and as a useful and timely contribution to the overall discussion around embodied carbon benchmarks, the DGNB published their own report on benchmarks for embodied carbon in buildings in Germany [2]. The findings of this report proved to be consistent with the findings present in report #2 “Setting the baseline” of this study.

3.3 Data quality

To be able to use the data as an evidence base for a robust assessment of current embodied carbon levels, **quality criteria have to be met**. This relates to the accuracy of building data, the completeness of reported data for each of the cases in the datasets, the timeliness of reporting to reflect the current level of embodied carbon, and duplications in the dataset. Variations in these criteria impacted the results and reduced confidence in the findings and related recommendations.

For instance, the embodied carbon data collection in France provides a contrast as, in this case, the data was both easily accessible and plentiful. This can be attributed to the existence of a central data repository held by a public body, and the key role of the Ministry of Ecological Transition in ensuring data is collected as per the E+C- experiment, and forthcoming RE2020. However, as the data was being processed, challenges were encountered regarding the completeness of the entries, where incomplete cases had to be removed. Consequently, what started as 1,197 LCA cases had to be reduced to 486 due to quality considerations.

3.4 Data comparability

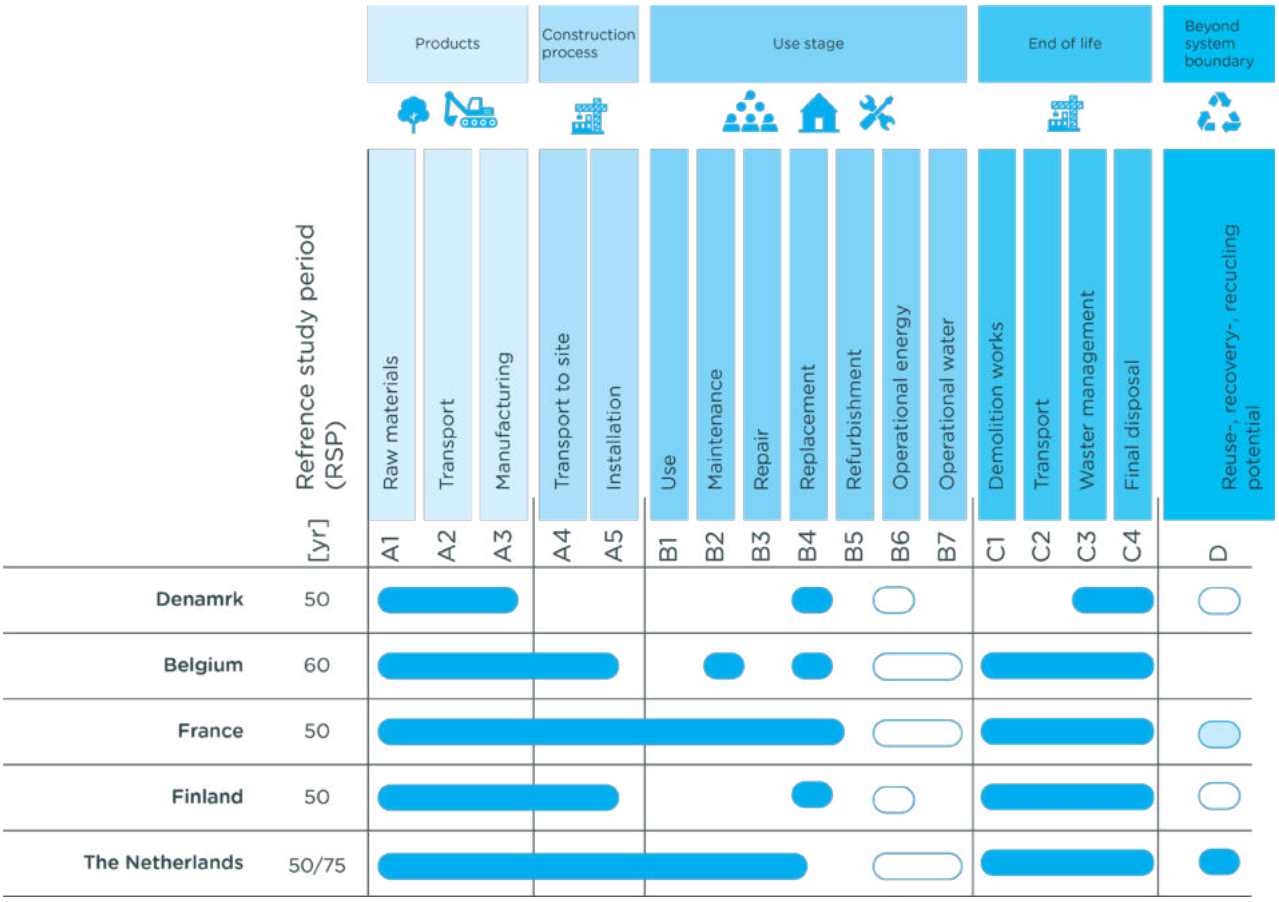
The consistency of the data quality is linked to the comparability of data based on the collection method. This challenge is particularly relevant when comparing and aggregating data from different countries in an EU-level baseline, or proposing actions such as a benchmarking system at EU-level. For these applications, the different approaches used further reduce the robustness of the evidence base.

Two main parameters can differ and impact the comparability:

- Scope of life cycle stages
- Assessment methods

Firstly, as Figure 4 shows, the inclusion of **life cycle modules in the scope** of the collected data differs between all of the five national LCA methods compared in detail in this project. The comparison illustrates that **France**’s LCA scope is the most encompassing, with **Denmark**’s being the least encompassing. Differences in the inclusion or exclusion of certain life cycle modules led to different baseline and LCA results. It is, therefore, important to consider, in the context of developing a harmonised baseline, which baselines can be used to set targets and benchmarks on embodied carbon, as the baseline for one country may be higher than another; not due to a higher embodied carbon footprint, but due to the inclusion of a broader scope.

Figure 4: Life cycle modules included in the scope of the collected data



Secondly, other elements in the assessment method can also vary and cause challenges in comparing the data. For example, the reference study period differs to some extent between the analysed cases (see Figure 4), which was also found to be the case for the scope of building parts included, and the background data used for modelling the building LCA. For instance, in France, the division of building parts was sometimes carried out using proxies, which could create biases as a result of their sources and the purposes they serve.

3.5 Data representativeness

Even if all of the aforementioned challenges are overcome, the data collected **may not be representative of the new buildings or building stock in total, and may therefore provide an incomplete and skewed picture of the embodied carbon situation**. For instance, this was discovered in the cases provided from Denmark and Finland, but also more generally for other EU Member States. The key challenge is that the majority of LCA studies are carried out for buildings which are already high-performance or new builds, and are less commonly carried out for average low-budget construction projects. This suggests that greater attention should be given to ensure the availability and accessibility of LCA cases for different building typologies to be able to ensure that the eventual national benchmark is representative of the general building stock. For this purpose, a large sample is highly beneficial, while smaller samples need to be particularly well-structured in order to be able to provide a full picture.

Conversely, there exist examples of alternatives. In **Belgium**, for example, KU Leuven could provide the required building case studies. There is a dedicated method for building LCA, called the MMG (Environmental Profile of Building Elements) method, and an open-access, online tool developed by the three regions in Belgium (Flanders, Walloon Region and the Brussels region) called TOTEM. KU Leuven had previously modelled the LCAs of various buildings as part of their research, these included studies of representative buildings, developed on the basis of the Belgian TABULA archetypes. KU Leuven could update their assessments and provide high quality case studies and detailed LCA results data.

4. What can be done about it?

The data challenges described in the previous chapter create a difficulty in establishing a robust benchmarking system for embodied carbon. On the one hand, this is caused by the challenges in establishing the baseline while, on the other hand, a comparison of future buildings against reference values also relies on a clearly defined methodology.

The data collection process and experience gained by the project team point to promising solutions in overcoming these barriers.

4.1 Incentives for LCA data collection in legislation and government initiatives

EU and national legislation or other forms of government initiatives can support LCA data collection by creating incentives, reducing barriers and promoting standard methods.

An assessment of regulatory measures covering embodied carbon across EU Member States found that very few Member States have developed legislation that includes requirements or standards for LCA methodology or embodied carbon in buildings (see annex 1). Thus far, Denmark, Finland, France and the Netherlands are the only Member States with existing or forthcoming regulatory measures covering embodied carbon.

However, to achieve an overview of embodied carbon legislation in the EU, the project team reached out to EU Member State infrastructure, development, and construction departments. The results indicate that additional Member States are in the process of planning legislation to set standards for both the level of embodied carbon emissions in buildings, and LCA methodology. For example, this is taking place in Sweden, where a second version of the Klimatdeklaration (a regulation to be enforced in 2022 making it obligatory to conduct LCAs on new builds [3]) is being planned for 2027, which will include limit values for LCA results.

In Switzerland, it was also noted that an LCA-based regulation is being planned, and a public official from Lithuania responded that plans are underway to prepare a methodology for modelling whole buildings life cycle emissions, including embodied carbon. Furthermore, in Ireland, a public official remarked that the international certification schemes for non-residential buildings LEED and BREEAM are driving interest amongst professionals wanting to calculate embodied carbon emissions, and that an increased interest from the investment community in embodied carbon has also been experienced. The official added that with these developments, alongside the Level(s) and the introduction of legislation in Finland, the Netherlands and France, they believed a plan for legislation would be forthcoming:The data collection and analysis in this study focused on the life cycle embodied carbon emissions of newly constructed buildings. In the context of the European renovation wave and the general need to revalue and further develop existing buildings stocks, there is an increased interest in understanding embodied carbon from retrofitting. We want to highlight a recent report by the European Academies Science Advisory Council (EASAC) on the 'Decarbonisation of buildings for climate, health and jobs' [9]. Therein, with regard to embodied carbon in both new building construction and building renovation, the author states:

> "There are currently no definitive plans in Ireland for regulations but there are a number of positive indicators that this is likely to happen over the next five years. Holland and France have already introduced regulations, with Finland introducing regulations in 2025 and other countries likely to follow.
>
> Changes to the EU Construction Products Directive will likely see a requirement for use of ecological footprinting of products through either EPD or Product Environmental Footprint (PEF) The EU commission has introduced the Level(s) framework"

Three key **types of regulatory measures on embodied carbon** and LCA methodology were identified. These are:

- A requirement to calculate LCAs on public buildings, as exemplified by Germany.
- A requirement to calculate LCAs on all buildings, as exemplified by France (progressively from 2022 onwards), the Netherlands and Denmark (from 2023 onwards for all buildings).
- A graduated standard for the level of embodied carbon allowed in buildings with the benchmark changing over time, as exemplified in Denmark and in France (both for whole life carbon, i.e. embodied and operational emissions).

The assessment suggests that requirements for LCA calculations on buildings leads to a greater number of LCA cases available per country and, as exemplified by the study, a greater number of available LCA cases allows for more accurate target-setting and benchmarking for policy making.

4.2 Effective data collection through triple-helix cooperation

In addition to government initiatives to promote and support data collection, greater effort is needed on implementing said collection. Here, the experiences from the five countries highlight that, where data is available, **triple helix cooperation between public, private, and research/not-for-profit partners** plays a significant role.

In **Denmark**, for example, the Danish Housing and Planning Authority could commission a study to calculate a baseline and an embodied carbon benchmark from the Build institute of Aalborg University, who were then able to use data collected by the Danish Green Building Council. This exemplifies the necessity for partnerships between the agencies driving action on whole life carbon in the building sector. In addition, it displays the key role of national governments in having a financial investment and internal motivation to develop embodied carbon benchmarks (in this case, for the purpose of regulatory development).

Similarly, in **Finland**, the 50 cases required were available due to a government-led initiative in 2016, where the Finnish Ministry of Environment began testing and planning for LCA-based regulation. In order to carry out such scoping and planning, technical assistance and data was provided by two Finnish consultancy firms: Granlund and OneClickLCA. The result was legislation that includes mandatory requirements for LCAs on new constructions including limit values on WLC.

In the **Netherlands**, data development was found to be driven by a mandatory requirement for LCAs to be conducted on new buildings in order to obtain a building permit. In addition, since 2018, the LCAs must also meet a limit value which includes a maximum impact from the global warming potential, in addition to other environmental impact categories (expressed in €/m2). The calculation tool and national database are maintained by the Stichting Bouwkwalitei foundation. However, for the purpose of the project, several data partners were also included in order to obtain the data required, with each having access to different building level calculations from private projects. The NIBE coordinated this process: collecting data at the level of the construction work and anonymising it. This case similarly suggests that it is the regulatory requirement which is driving the uptake of data development.

In **Belgium**, there is no requirement to produce LCAs or include embodied carbon in the certification schemes. In this case, data is available as three regional authorities, in collaboration with a research institution, developed an open-access LCA tool called TOTEM. As application of the tool makes the building eligible for BREEAM certification and achieving said certification is becoming more important to investors, use of the tool has become widespread. This has led to a database of MMGs (Environmental Profile of Building Elements) being created, from which, in this case, KU Leuven could develop building archetypes and model a baseline of embodied carbon for Belgium, based on the generic building archetypes provided by the Tabula archetype definitions.

In France, data availability can be attributed to the cooperation between the CSTB and the Ministry of Ecological Transition which, firstly through the E+C- labeling scheme, and very soon through the RE2020, have created strong incentives for LCAs to be conducted on new buildings. This encouragement has led to a sizable, open-access building LCA database, although with variable quality. A similar database will be set up for the RE2020 cases.

An additional case to note is that of the **UK**, where popular uptake of BREEAM and LEED has led to over 11,800 new buildings being certified, and 285 buildings already in use being certified [4].The wide use of BREEAM and LEED may explain why many of the bigger consultancy firms in the UK are familiar with conducting LCAs. Another example is London, where regional legislation lays down requirements for new residential buildings with more than 150 housing units or with a floor area exceeding specific limits, depending on the location in the London area. For these construction projects, an LCA must be conducted in order to gain a building permit. This has further increased the number of LCA cases in the UK. This was, in large part, attributed to the LETI public/private partnership. Additionally, advances in product-level environmental data in the BRE IMPACT database mean that data barriers to LCAs have been reduced.

In all cases, **governmental initiatives** and support, alongside **partnership approaches**, are highlighted as being key in driving data development. This suggests that methods to incentivise governmental buy-in to develop studies, or legislation to tackle embodied carbon, or standardising LCA methods may facilitate the calculation of future embodied carbon baselines, targets and benchmarks across the EU. Finally, the findings suggest that popular uptake of certifications and the new Level(s) framework, alongside increased investor interest in certified buildings (e.g. buildings with BREEAM certification), may further incentivise LCA harmonisation and thus data development on embodied carbon.

5. Conclusions and recommendations

5.1 Conclusions

This report has provided an overview of embodied carbon data availability from LCAs across EU Member States.

The process, and resulting dataset, show that LCA data on embodied carbon in the EU is sparse, and that there are data collection and analysis challenges to overcome in terms of accessibility, quality, comparability and representativeness. In Europe, it was only possible to obtain samples of more than 50 cases of buildings from Denmark, Finland, the Netherlands, Belgium and France.

The report herein highlights two relevant solutions for overcoming the current challenges, based on the experiences observed in the five frontrunner countries:

- Firstly, legislation in EU Member States that addresses embodied carbon and sets standards or requirements for LCAs is beneficial in creating the framework needed for harmonised data collection (e.g. the Level(s) framework), and it increases investor interest in certified buildings (e.g. BREEAM).
- Secondly, triple helix cooperation in the form of partnerships between governmental agencies, research and/or not-for-profit institutions, and private enterprise acts as a key component in the development of databases, legislation and benchmarks on embodied carbon in buildings. Governmental support in the commissioning of LCA-based studies to identify embodied carbon baselines, benchmarks or targets was found to be of particular importance.

5.2 Recommendations

Based on these findings, we arrive at the following recommendations:

National LCA methods and data collection systems are urgently needed to avoid any further delay in this fundamental step towards measuring and reducing embodied carbon as part of whole life carbon emissions.

To this end, legal or sectoral requirements that mandate the production of LCAs in accordance with standardised calculation and documentation methodologies are highly relevant at national level, as well as harmonisation at EU level through tools such as the Level(s) framework. Standardisation based on coordination between stakeholders in the building design and construction value chain should, for example, include: scope of life cycle modules, scope of building elements, reference study period, environmental data on building materials, etc.

Data collection and compilation efforts are needed from all those involved in designing & assessing buildings. For this purpose, collaboration and complementary activities between public institutions, building designers, investors, certification organisations and researchers are needed. This step requires a common language and standardised methods for LCAs as described in the first point above.

As this process may take some time, the challenge of gaps in data could also be mitigated through the following approaches. These should be considered complementary.

- **Data on recent and current building projects could be generated at a centralised level by applying a single LCA method in order to provide information on these specific cases as it is likely that this data can still be obtained**. This exercise would benefit from input from the different actors involved, including the building industry, certification bodies, researchers and public bodies. This cooperation could be greatly facilitated through the use of standardised calculation methods and software tools to form a central database. A similar approach has provided a large database in France.
- **Existing data, that has been created in a scattered form using varying methodologies by different stakeholders, has the potential to be gathered together and harmonised to form a centralised database**. Harmonisation methods, adapted to the specific differences between the LCA methodologies, could be agreed upon by a coalition of actors to support this undertaking. Examples of such action are the international activities in Annex 72 to the IEA-EBC Programme, as well as the UK initiatives LETI and BRE.

- **Where empirical data faces the challenges described in this report, relying on results from modelled building archetypes could provide an insight into the life-cycle impacts**. Building archetypes offer the advantage of providing representative and comparable values. However, limits remain in translating building stock models into LCA data, which is challenging, particularly for the diverse landscape of non-residential buildings. Also, monitoring future buildings, in comparison with benchmarks, is not possible. Nonetheless, efforts to translate this data can help in the transition towards standardised empirical LCA data. This approach has been used successfully in projects such as the Tabula/Episcope project.

Appendix 1- COUNTRY SHEETS ON EMBODIED CARBON LCA DATA

BELGIUM

Overall data situation in the country, and the relation to the data collected for this project.

To date, Belgian building practitioners use the TOTEM tool[1] for the life cycle assessment of buildings. The TOTEM tool is an open-access online tool developed by the three regions in Belgium (Flanders, Walloon Region and Brussels region) and that uses the MMG (Environmental Profile of Building Elements) method. The tool has been available since February 2018 and is frequently updated to include new features, enlarge the database, include new methodological developments, etc. Although the use of the TOTEM tool in practice is not mandatory, it is being used by many practitioners and is often referred to in design contests.

Since March 2020 TOTEM is available for BREEAM certification[2]. It concerns the standards "BREEAM International New Construction 2013 and 2016" and "BREEAM International Refurbishment and Fit Out 2015 calculators", in the material criterion "MAT 01". TOTEM allows buildings to obtain a rating of "5+ EXEMPLARY", which is the maximum number of credits for this criterion.

GRO is a sustainability meter that the Facilities Company of the Flemish government uses for all construction projects, regardless of scale and function, in order to realize its ambition in the field of sustainability and circular construction. The GRO refers to TOTEM for the assessment of the environmental impact of materials and hence TOTEM is also used by building practitioners using the GRO.

KU Leuven was, and still is, involved in the development of the MMG method and the TOTEM tool and has provided this project with 105 cases. The MMG method has been used for the data in this project.

Status on LCA methodology

The MMG methodology embedded in the TOTEM tool is common and widely accepted in the Belgian construction sector. All life cycle modules are included, except for module D. The MMG method version as used in this project, follows the EN 15804:A1 and a set of additional environmental impact categories (in line with ILCD[3]). The environmental impacts are reported both in characterized values and as a single score, expressed in EURO (external environmental cost).

The method has fixed transport scenarios, cleaning scenarios and waste scenarios for the construction materials. The service life of the building is fixed to 60 years.

Status on LCA-based regulation

There is no LCA-based regulation yet for construction in Belgium. It is expected that this will be the case in the near future, although no exact timing is given by the authorities yet.

Identified key actors on the topic

- KU Leuven: The Design and Engineering of Construction and Architecture unit at KU Leuven has taken part in developing the MMG method.
- VITO: has taken part in developing the MMG method.
- BBRI: has taken part in developing the MMG method.
- Public Authorities of Wallonia: Supported the development of the TOTEM tool for the life cycle assessment of buildings.
- OVAM, the Public Waste Agency Flanders: Supported the development of the TOTEM tool for the life cycle assessment of buildings.
- Brussels' Environment Office: Supported the development of the TOTEM tool for the life cycle assessment of buildings.

Data collected for this project

Number of cases and data source

Number of cases: 105

Source: Cases from KU Leuven (Karen Allacker, Martin Röck) based on the modelling of the Belgium TABULA[4] cases in the MMG LCA Tool with adaptation to contemporary energy performance requirements.

The cases were initially conducted as part of the work of the research group in the context of master thesis and PhD research. Cases are based on the modelling of the Belgium TABULA cases in the MMG LCA Tool with adaptation to contemporary energy performance requirements for the purpose of the Laudes/Ramboll project.

Scope of data

Modules: A1, A2, A3, A4, A5, B2, B4, B6, B7, C1, C2, C3, C4

Reference study period: 60 years

Square meter definition: Gross floor area (Belgian definition)

Tool: MMG-Building-LCA-Tool developed by KU Leuven (identical methodology as the TOTEM tool)

Background data: Ecoinvent 2.2 database

Other comments on scope: Module D not included

[1] https://www.totem-building.be/

[2] BREEAM is an environmental assessment method and rating system for buildings, with 200,000 buildings with certified BREEAM assessment ratings and over a million registered for assessment since it was first launched in 1990.

[3] https://publications.jrc.ec.europa.eu/repository/handle/JRC58190

[4] The TABULA/EPISCOPE projects developed Building Typologies for Energy Performance Assessment of National Building Stocks for various European countries - https://episcope.eu/welcome/

DENMARK

Overall data situation in the country, and the relation to the data collected for this project.

Until today the main incentive to conduct a building LCA in Denmark has been in relation to DGNB certifications of buildings. The DGNB certification is operated by Green Building Council Denmark, who has developed a Danish version of the DGNB system, that originates from Germany. The method description of Danish LCA criteria and reference values used differs slightly from the German version.

In 2020 The Danish Green Building Institute reported that 90 DGNB projects had been conducted over the past 8 years [4]. It is not mandatory to conduct an LCA as a part of a DGNB project, but as it counts so much in the final DGNB score, in practice, all projects get one done.

BUILD at Aalborg University conducted an analysis of the climate impacts of 60 building cases suggesting benchmark of whole life carbon in Denmark [5] . About 40 of the 60 building cases where DGBN certified buildings that all had been through conformity check in relation to the certification process. BUILD and Ramboll have provided this project with 60 and 12 cases, respectively.

Status on LCA methodology

The most LCAs in Denmark has been generated as a part of DGNB-projects. The Danish version of DGNB has been developed by the Danish Green Building Council with involvement from the industry and expertise form BUILD. The scope of the LCA includes the following life cycle modules: A1, A2, A3, B4, B6, C3, C4 and D. BUILD has been developing a Danish LCA tool called LCAbyg, which is most often used in DGNB projects today. The same scope is expected to be used in the forthcoming whole life carbon requirements in the building regulation from 2023.

In addition to DGNB and the forthcoming requirements in the building regulation, a Voluntary Sustainability Class for buildings was introduced by the authorities in May 2020 with a two-year test phase from mid-2020 to mid-2022. LCA is one of nine criteria in the Voluntary Sustainability Class. It builds upon the DGNB-scope, but with two further modules included: A4 and A5. The Voluntary Sustainability Class contains detailed guidelines for methodology and key assumptions, e.g. that must be performed in accordance with EN15978, EN15804 and relevant product category rules (PCRs).

Module A4 and A5 are also included as voluntary modules in the new DGNB-DK 2020 manual from 2021.

When reporting for the Voluntary Sustainability Class, it is recommended to use LCAbyg, but this is not mandatory. There is a strong acceptance in the industry of the LCA scope and method described in DGNB and the overlapping method described in the rather new Voluntary Sustainability Class.

Status on LCA-based regulation

A Voluntary Sustainability Class for buildings was introduced by the authorities in May 2020, and which now is in a testing phase with a two-year test phase from mid-2020 to mid-2022. LCA is one of nine criteria. The LCA criteria includes expansion of the scope compared to previous practice (including A4 and A5), but test phase of the Voluntary Sustainability Class includes no limit values.

In March 2021, the Danish government with cross-parliamentary support issued a new national strategy on sustainable construction including requirements on whole life carbon in new constructions in the building regulation enters into force in 2023. The forthcoming changes in the building regulation require that whole life carbon is assessed in all new constructions, and that buildings larger than 1000 m2 shall fulfill a mandatory limit value of 12 kg CO2/m2/year and that they have the possibility to fulfill a more ambitious voluntary CO2 class with a limit value of 8 kg CO2/m2/year. The strategy also includes phasing and tightening CO2 requirements in the period 2023 to 2029. From 2025 buildings smaller than 1000 m2 will also have to comply with limits on whole life carbon. The regulation will be reviewed every second year to set new, stricter requirements. The sketched pathway for tightening the regulation ends with limits in 2029 at 7,5 kg/CO2-eq/year for all buildings and 5 kg/CO2-eq/year for the voluntary CO2 class.

Identified key actors on the topic

- The Danish Housing and Planning Authority: Administrates and develops building regulation.
- The Danish Green Building Council (DK-DBC): Advocates for action on embodied carbon and provides certifications to buildings based on certain standards.
- BUILD, Department of the built environment, Aalborg University: Influential department on building research and on developing suggestions for future building regulation. BUILD is responsible for verifying the LCAs conducted as a part of the Voluntary Sustainability Class.

Data collected for this project

Number of cases and data source

Number of cases: 72 (60 from Build and 12 from Ramboll)

Source: The Ramboll cases have initial been conducted as a part of DGNB-DK projects. The 60 cases from build have been conducted or updated as a part of a report by BUILD for The Danish Housing and Planning Authority (BUILD, 2021). 37 of the 60 cases are also DGNB projects.

Scope of data

Modules: A1, A2, A3, B4, B6, C3, C4 and D

Reference study period: 50 years

Square meter definition: Gross floor area (Danish definition)

Tool: LCAbyg (developed by Build AAU)

Background data: LCAbyg includes the Ökobau database as generic data and possibility to use EPD's when appropriate. BUILD cases are mostly calculated with generic data based on Ökobau 2020. The updated version of the 60 building cases from 2021 also includes use of average sector EPD's for Danish concrete and wood (BUILD, 2021).

Other comments on scope: Module D is calculated separately

FINLAND

Overall data situation in the country, and the relation to the data collected for this project.

At present, there is no systematic collection of buildings-level LCA data in Finland. However, in the future, the government aims to develop requirements for collecting, analyzing, and aggregating generic reference data based on normative climate declarations of buildings.

Regarding product-level LCA data, there is an EPD operator (RTS) in Finland. This is, however, not run by authorities. The government has developed a generic database (www.CO2data.fi) for typical construction products and processes.

The data used for this project was created as a part of the test phase of upcoming regulation, the Climate Declaration for Buildings. Two different consultants (Granlund and OneClickLCA) were assigned by the Finnish Ministry of The Environment to deliver cases for this project.

Status on LCA methodology

The Ministry of The Environment published the 2nd version of the whole life carbon assessment of buildings in June 2021. It is based on European standards and Level(s), as well as feedback from the first public consultation round from the summer of 2020. The method is a draft developed for the upcoming LCA regulation and will be updated after the ongoing public hearing round in autumn 2021. Reporting following this method includes the following life cycle stages: A1-A5, B4, B6, C1-C4 and D.

Status on LCA-based regulation

In Finland the initial planning and testing of LCA-based regulation began in 2016 by the Finnish Ministry of The Environment, who developed a roadmap for reducing the carbon footprint of buildings. An upcoming regulation is currently being developed under the name of 'The Climate Declaration' and includes mandatory LCA-studies on all new construction as well as limit values to whole life carbon. The regulation will be implemented at latest in 2025.

Identified key actors on the topic

- The Ministry of The Environment: Responsible for developing the upcoming regulation and the related methods and reporting standards behind it.
- SYKE (Finnish Center of the Environment): In charge of CO2data.fi, the national generic database for building products and processes.
- Green Building Council Finland: In charge of Embodied Carbon Commitments (voluntary commitments for companies to decrease the embodied carbon of their products).
- OneClickLCA: An influential consultancy company and LCA tool provider with large amounts of data from Finish LCA studies (as well as data from other countries).

Data collected for this project

Number of cases and data source	**Number of cases:** 59 **Source:** 40 cases from Bionova and 19 cases from Granlund Oy.
Scope of data	**Modules:** A1, A2, A3, A4, A5, B4, (B5), B6, C1, C2, C3, C4, D **Reference study period:** 50 years **Square meter definition:** Heated floor area (Finnish definition) **Tool:** One Click LCA **Background data:** Various sources **Other comments on scope:** Cases from Granlund Oy do not include module B5 in the scope of the LCA while cases from OnceClickLCA do include module B5. Module D is calculated separately for all cases.

FRANCE

Overall data situation in the country, and the relation to the data collected for this project.

The collected LCA data from France comes from the Scientific and Technical Centre for Buildings (CSTB) database, which has been generated as a part of the voluntary reporting on whole life carbon encouraged in an experiment launched by the French Ministries in charge of construction and environment in 2016, in parallel of the second period of the RT2012 regulation. The database, called E+C- Observatory, is open source and contains 1197 cases. The LCA cases all follow the guidelines presented in the E+C- framework which has been used as an experimental precursor to the coming embodied carbon regulation for new buildings RE2020 (E as environmental) which enters into force from January 2022 (with several steps). CSTB has made an assessment of the quality of the LCAs in the database and found that they are of varying quality. For this project, CSTB has pointed us to 712 cases of good high quality. For the analysis in the Embodied Carbon Benchmarks project, these have been further filtered down to 486 cases, removing cases with missing data.

Status on LCA methodology

The LCA methodology defined in E+C-, which is based on the methods described in the European Standard EN15978 (2012), with minor variation, is common and widely accepted in the French construction sector and will help the transition to the mandatory RE2020 regulation in 2022. Nevertheless, the RE2020 LCA methodology differs from the E+C- one and from EN15978 on several points, and the GWP results obtained with RE2020 are not directly comparable to the one obtained with E+C- because a "dynamic" LCA method was introduced in RE2020 for GWP indicator.

Status on LCA-based regulation

In 2022 a substantial revision, called RE2020, enters into force. This replace the RT2012 regulation. It is applicable for new residential buildings from January 2022 and for new offices and schools from July 2022. So far conducting an LCA was optional, encouraged by voluntary certifications, but the new regulation introduces mandatory LCA-studies on these 3 building types. The next revision of the RE2020 regulation is expected to include LCA-requirements for all building types. The regulation also includes other sustainability measures, such as requirements to report on transportation of building materials, energy- and water use on the building site, as well as waste from the construction site. The regulation has been developed by the Ministry for Ecological Transition with technical support from CSTB and the involvement of many stakeholders.

For residential buildings (single homes and apartment buildings), regulatory thresholds were defined for operational energy-related carbon and embodied carbon, first for 2022 and becoming gradually stricter (smaller) until 2031. For embodied carbon, the 2031 value will be the 2022 one minus 1/3.

For other types of buildings, carbon thresholds are not defined yet, but they will probably follow a similar approach.

Identified key actors on the topic

- Scientific and Technical Centre for Building (CSTB): A public industrial and commercial company that supports the Ministry for Ecological Transition in collecting LCA data through certifications and classifications for buildings.
- HQE™: Certification that rewards buildings sustainable design, construction, operation and responsible management as well as urban planning projects. Accredited operators are Certivéa and Cerqual Qualitel Certification.
- Alliance HQE-GBC: French Green Building Council.
- Ministry for Ecological Transition: The governmental department responsible for the development and enforcement of the RE2020.

Data collected for this project

Number of cases and data source	**Number of cases:** 487 **Source:** Cases from the French database "E+C- Observatory". The cases have been selected with assistance from CSTB.
Scope of data	**Modules:** All life cycle modules **Reference study period:** 50 years **Square meter definition:** GFA (French definition, "surface de plancher") **Tool:** 9 tools were allowed in the E+C- experiment, among them the LCA tool ELODIE developed by CSTB. **Background data:** INIES database (including specific EPDs complemented by generic datasets) **Other comments on scope:** for materials, 1/3 of Module D is included if beneficial

NETHERLANDS

Overall data situation in the country, and the relation to the data collected for this project.

In the Netherlands, LCA data on product level is generated by industry, and after mandatory review, it can be uploaded to a National database known as the "Nationale Milieudatabase". From the national database, the data is provided to an approved software for calculations on the level of construction work (both building and infrastructural works). A team dedicated to the National Environmental Database maintains the system and the database and provides access (under license) to the data. The database contains both LCA on specific products (EPD's) and generic data.

The data for this project is collected on the level of construction works. The data was provided by several data partners that have access to building level calculations from their customers, or from the projects they have worked on. The data is made anonymous so it cannot be traced back to the specific building. NIBE has conducted the data collection and has a proprietary list of the individual buildings and data owners that have provided the data.

Status on LCA methodology

Conducting an LCA is mandatory for obtaining a building permit in The Netherlands. The requirements for the LCA are described in "Bepalingsmethode Milieuprestatie Bouwwerken" (method for calculating the environmental performance from buildings). All life cycle modules are included in the obligatory method. The "Bepalingsmethode Milieuprestatie Bouwwerken" follows the EN 15804:A2 and provides additional information regarding scenarios and default environmental profiles for transport and energy.

The method has fixed waste percentages for building materials. These are respectively 3% for prefab elements (e.g. concrete elements), 5% for in-situ applied materials (e.g. bricks) and 15% for 'assisting materials' (e.g. paint).

Status on LCA-based regulation

In the Netherlands it is required to conduct an LCA in order to get a building permit. This was introduced in 2012. The results from the LCA must live up to a limit value (since 2018), that sets a maximum of impact from GWP as well as other environmental impact categories. The limit is expressed in €/m2 and is calculated by a weighting of all impact categories (shadow prices). This implicates that one cannot derive the resulting GWP/m2, if one only has the results in €/m2.

The limit value is tightened periodically and is announced to decrease from 1,0 (introduction value)€/m2 in 2018 to 0,5 €/m2 in 2030. The Dutch software for performing calculations on Building level also provides the underlying environmental effects (like GWP). Consequently, the user can also obtain environmental effect data, per LCA module for the complete building.

Identified key actors on the topic

- Stichting Bouwkwaliteit (The Building Quality Foundation): In charge of developing the national LCA methodology. The members are both governmental representatives and industry players.
- NIBE: An influential, private consultancy firm specialized in services related to sustainable construction.
- Dutch Green Building Council: Advocates for action on embodied carbon and provides certifications to buildings based on certain standards.

Data collected for this project

Number of cases and data source	**Number of cases:** 50 **Source:** NIBE.
Scope of data	**Modules:** A1, A2, A3, A4, A5, B1, B2, B3, B4, C1, C2, C3, C4, D **Reference study period:** 50 or 75 years **Square meter definition:** Gross floor area (Dutch definition) **Tool:** SimaPro **Background data:** Ecoinvent 3.6 **Other comments on scope:** Module D is subtracted (credit)

Appendix 2 - EMBODIED CARBON LANDSCAPE IN THE EU

Country	Standardized LCA method/ scope (Y/N)	Embodied carbon regulation (Y/N)	Embodied carbon front runners (govt/ academia/ industry/ certification bodies)	Details / comments
Austria	No, but there is a nationally accepted methodology	No **Relevant regulations:** IBO ÖKOPASS	IBO – Österreichisches Institut für Baubiologie und -ökologie	While there is no formal government-set methodology, IBO – Österreichisches Institut für Baubiologie und -ökologie has published what constitutes the nearest to a national embodied impact evaluation methodology. The name of this methodology is Ökoindex 3 (Ökologischer Kennwert der thermischen Gebäudehülle). This methodology is a weighted score of global warming potential (carbon footprint), primary energy depletion, and acidification, expressed as an A to E rating. The scale of performance has been fixed by IBO. The calculation data applied for these analyses are provided by Baubook, which is a limited company owned by a regional energy association and IBO. Austria has a governmental environmental rating system called klimaaktiv, which applies the Ökoindex 3 as the methodology for the building materials environmental impact assessment. Materials assessment is a mandatory part of the certification. Performing well in this certification can make residential buildings eligible for an additional environment-related subsidy. This certification has been applied to over 500 buildings.
Belgium	No, but there is a nationally accepted methodology	No **Relevant regulations:** Circular Flanders: Green Deal Circular Building, Open Call Innovative Circular Economy Projects Brussels: 'Guide de gestion des déchets de construction, Programme Régional en Economie Circulaire (PREC) Wallonia: TOTEM: instrument to evaluate the environmental impact of buildings	See section above	See section above
Bulgaria	No	No	Data not obtained	Regulation soon to include operational energy "The upcoming legislation transposing the EPBD at national level will ensure that energy performance requirements are part of the building codes. It is also required by the EPBD to relate energy performance requirements to primary energy consumption, in order to have a more accurate picture of the energy quality and related CO2. No requirements for compulsory use of renewable energy in new buildings. However, in the Energy Efficiency Law it is mentioned that the renewable energy use should be considered as a possible option during the design phase of the buildings"

Country	Standardized LCA method/ scope (Y/N)	Embodied carbon regulation (Y/N)	Embodied carbon front runners (govt/ academia/ industry/ certification bodies)	Details / comments
Croatia	Data not obtained	Data not obtained	Data not obtained	
Cyprus	Data not obtained	Data not obtained	Data not obtained	
Czech Republic	No	No	Technical and Testing Institute of Civil Engineering Prague, sp (TZÚS Praha, sp) Research Institute of Civil Engineering – Certifikační společnost, sro (VÚPS)	**embodied carbon is optionalà SBToolCZ is Czech method for complex quality assessment of building performance in which the characteristics of the building and its surroundings are evaluated with respect to the sustainable development. Building's impacts on the environment, social-cultural aspects, functional and technical quality, economic and management issues and location of a building are included in the assessment. The method contains a set of criteria which is evaluated based on the basic characteristics of the building and its surrounding; and based on this evaluation the building obtain one of the three certificates (bronze, silver or gold)
Denmark	Yes	Yes **Relevant regulations:** The National Strategy for Sustainable Construction	Danish Ministry of Environment and Food; Ministry of Industry, Business and Financial Affairs; Danish Energy Agency Build Institute, Aalborg University Danish Green Building Council	See section above
Estonia	No	No **Relevant regulations:** Estonia's 2030 National Energy and Climate Plan (NECP 2030)	Ministry of Economic Affairs and Communications TalTech expert level knowledge working on the development of national methodology and creating LCA materials database (for CO2eq emissions).	Currently there is an ongoing study by TalTech, which should establish suitable method and scope, is carried out. The results of the study will be finalized by the end of the year 2021. The proposed method is carefully aligned with the European Standards EN 15804+A2:2019 and EN 15978, the European Level(s) framework, and with international best practice. Scope: A1-A5, B4, B6, D. Scope of functional systems: Ground, Wall, Slab, Roof. Impact of use stage operational energy (B6) is considered via EPC (EPBD) requirements. As Estonia has very high grid electricity emissions factor, it is important and can be considered as part of LCA assessment. An official from Estonia notes that the number of experienced individuals and enterprises capable of performing LCA assessments is low, and that less than 10 individuals/enterprises could be identified with such skillsets. It is estimated that less than 5 cases are available.
Finland	Yes	Yes	See section above	See section above

Country	Standardized LCA method/ scope (Y/N)	Embodied carbon regulation (Y/N)	Embodied carbon front runners (govt/ academia/ industry/ certification bodies)	Details / comments
France	Yes	Yes	See section above	See section above
Germany	No, but a nationally accepted method exists	No **Relevant frameworks**: Bewertungssystem Nachhaltiges Bauen or BNB Deutsche Gesellschaft für Nachhaltiges Bauen (German Sustainable Building Council, DGNB) BNB Assessment System for Sustainable Building.	DGNB BNB The Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety	In Germany there is no national LCA-based regulation. However, an official method for assessing the sustainability of a building, BNB (Bewertungssystem für Nachhaltiges Bauen), has been developed and introduced in 2009. Conducting an LCA is a part of this assessment, and the results from the LCA will be a part of the final score. The score determines whether the building obtains a bronze, silver or gold level. Since 2011 it has been obligatory for all federal buildings to conduct an BNB assessment, and as a part of this, an LCA. Federal buildings must obtain a silver level in order to get a building permit. Although there are no requirements at national level for the execution of building LCAs, there are some states that set regional requirements where they have also chosen to follow the BNB system, and also require a minimum of silver level. Deutsche Gesellschaft für Nachhaltiges Bauen (DGNB) is the most popular sustainability certification scheme in Germany. The results from an LCA counts in the overall score, and DGNB is therefore a driver in normalizing the use of LCAs in the German construction sector.
Greece	No	No **Relevant regulation:** National circular economy strategy	Not assessed	
Ireland	No, but a nationally approved method exists	No **Relevant regulation:** EN15978		EN15978 sets out how the full life cycle carbon and other environmental impacts should be calculated setting out the modules relevant to each part of the building lifecycle. There are currently no definitive plans in Ireland for regulations but there are a number of positive indicators that this is likely to happen over the next five years. Ireland's national certification scheme for homes – Home Performance Index awards credits for embodied carbon calculation and LCA. The international certification schemes for non-residential buildings LEED and BREEAM also award credits for the calculation of Life Cycle Assessment and embodied carbon. This is driving interest amongst professionals in calculation. However, there is also an increasing interest from the investment community in embodied carbon and this is likely to grow over the coming years.

Country	Standardized LCA method/ scope (Y/N)	Embodied carbon regulation (Y/N)	Embodied carbon front runners (govt/ academia/ industry/ certification bodies)	Details / comments
Italy	No	No **Relevant legislation:** Towards a Model of Circular Economy for Italy - Overview and Strategic Framework	Casaclima Nature, Casaclima Nature, GBC Home Ministry of Environment	No systematic collection of data on embodied carbon from of the Italian systems evaluate embodied carbon. There are is regulatory measures on embodied carbon. No national, common agreed LCA method or tools has been identified.
Lativa	Data not obtained	Data not obtained	No data obtained	
Lithuania	No	No	Environmental Protection Agency in Lithuania which is subordinate to the Ministry of Environment of the Republic of Lithuania is one of the main institutions involved in Lithuania's greenhouse gas (GHG) emissions inventory preparation.	There are plans to prepare the methodology for modelling whole building life cycle and to model all stages of life cycle it is important to have this information about construction products. The preparation should begin in 2023. One of the plans of the Ministry for the future is to prepare the methodology for modelling building life cycle to evaluate the impact of structures, buildings, construction products/materials on the environment, climate change, health, the opportunities of waste recycling, second use, circular economy principles in all stages of building life cycle (planning, design, construction, use, demolition). To evaluate these things like formation of waste, greenhouse gas emission in the whole cycle of the building in the early stages of planning and design would be very helpful and useful for all participating in the fields of waste and construction sectors. The preparation of the methodology is planned to start in 2023.
Luxembourg	No data obtained	No data obtained	No data obtained	
Malta	No data obtained	No data obtained	No data obtained	
Netherlands	No, but a nationally approved method exists	No **Relevant regulation:** A Circular Economy in the Netherlands by 2050 + Dutch Building Code (Bouwbesluit 2012), Article 5.9.	See section above	See section above

Country	Standardized LCA method/ scope (Y/N)	Embodied carbon regulation (Y/N)	Embodied carbon front runners (govt/ academia/ industry/ certification bodies)	Details / comments
Poland	No	No	Polish Green Building Council Institute of Innovation and Responsible Development Polish Circular Hotspot	There is no regulation of whole life carbon in Poland. Large investment companies and developers are showing interest in conducting LCAs on construction projects as a part of voluntary sustainability certifications. The Polish Green Building Council expressed difficulties on getting data on the topic of embodied carbon, since the results of the LCAs are not systematically gathered in a central repository. As in many other countries, the data stays with the building owners, the consultancy companies conducting the LCAs, the providers of the LCA tools or the certification bodies.
Portugal	No	No regulation includes embodied carbon. **Relevant regulation:** Action plan for circular economy in Portugal: 2017-2020 Green Growth Commitment	Certification: LiderA	LiderA: acronym for Leading for the Environment for sustainable construction, is the designation of a Portuguese voluntary system that aims to carry out.
Romania	No	No regulation includes embodied carbon. **Relevant regulations:** Romania's strategy for the transition to a circular economy (ROCES) 2020-2030	Romania Green Building Council and the Green Homes Certification Owners Association Office	In Romania, the energy performance certificate has been compulsory for new buildings since 2007. Romania has building code requirements only for new buildings and no whole building energy performance-based requirements for new buildings and renovations. Romania has prescriptive/ element-based criteria for thermal insulation and an overall heat transfer coefficient G-value. From 2011 energy certificates are mandatory whenever a flat or house is sold or rented, thus creating an awareness raising wave that could be used to push for a stronger refurbishment and a new nearly zero-energy construction programme.
Slovakia	No data obtained	No data obtained	No data obtained	
Slovenia	No	No **Relevant regulations:** Roadmap towards the circular economy in Slovenia	Ministry of the Environment and Spatial Planning ZAG	The majority of LCA in Slovenia is still done on product level (for EPDs). It is estimated there are less than 5 cases.

Country	Standardized LCA method/ scope (Y/N)	Embodied carbon regulation (Y/N)	Embodied carbon front runners (govt/ academia/ industry/ certification bodies)	Details / comments
Spain	No	No **Relevant regulations** *Climate Change law* (recently approved in 2021), "encourages the use of materials with the smallest possible carbon footprint" *VERDE certification* (GBC España), a volunteer Spanish sustainability rating system that used a qualitative LCA based approach in the assessment process.	• GBC (España) (https://gbce.es/blog/proyecto/buildinglife/) • ITEC(Catalunia) BEDEC database (https://metabase.itec.es/vide/es/bedec) • Instituto Torroja (Madrid) (https://www.opendap.es/) • Asociación Ecómetro (Madrid) (http://ecometro.org/evaluar-un-proyecto/) • University of Sevilla (TEP 130 and TEP 986) (Andalusia) • Other Spanish universities such as University of Granada (TEP 968), University of Zaragoza, UPM, UPC, UNESCO Chair in Life Cycle and Climate Change	Some academic studies have been made on embodied carbon in the Spanish building stock, but with variation in scope and method, since there is no agreed national standard on how to conduct an LCA (Soust-Verdaguer, 2021). It might be possible to collect enough data from these studies to do a baseline, but it would take a lot of effort to make the data comparable due to the different methodological approaches. There are no regulatory measures on embodied carbon in Spain, nor any official methods or tools. More than 50 Spanish LCA case studies indexed publications are detected in Scopus in the last 5 years, however, different methods and tools are used for the LCA implementation.
Sweden	Yes	Yes **Relevant regulation:** The Climate Declaration Act for new buildings	Boverket The National Board of Housing, Building and Planning	In 2022 regulation targeting sustainable construction called *Klimatdeklaration* (the climate declaration) will come into force in Sweden. As a part of this, it will become obligatory to conduct building LCAs on new build (Boverket, 2020). A second version of the regulation is to be implemented in 2027, where limit values for the results from the LCA will be introduced.
Switzerland	No	No	• LCA studies related to the SIA • PORR (construction company)	There is upcoming LCA-based regulation (BPIE, 2021). The construction company PORR provided a cross-country dataset of 22 cases for AT, DE, CH for the study.

Appendix 3 - REFERENCES

[1] GlobalABC, 2020 GLOBAL STATUS REPORT, (2020).

[2] A. Braune, L. Ekhvaia, K. Quante, Benchmarks for greenhouse gas emisisons from building construction. Results of a study with 50 buildings, (2021). https://static.dgnb.de/fileadmin/dgnb-ev/de/themen/Klimaschutz/Toolbox/2021_DGNB_Study_Benchmarks_for_greenhouse_gas_emissions_from_building_construction.pdf?m=1641813821 (accessed February 23, 2022).

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[4] T. Institute, Klimavenligt byggeri og LCA, (2021) 1–28. https://www.trafikstyrelsen.dk/da/-/media/TBST-DA/Byggeri/Lister/Publikationer/Klimavenligt-byggeri-og-LCA-2021.pdf.

[5] R.K. Zimmermann, C.M.E. Andersen, K. Kanafani, H. Birgisdottir, Whole Life Carbon Assessment of 60 buildings Possibilities to develop benchmark values for LCA of buildings (BUILD Report 2021:12), 2021.

Green Building Council Finland

Miisa Tähkänen
Leading Specialist
Miisa.tahkanen@figbc.fi

Green Building Council Finland aims for sustainable built environment

Strong expertise and extensive collaboration have been at the heart of our operations since FIGBC's founding in 2010.

The impact of our work is based on the cooperation of our members, experts, and our international network.

Our vision

Our vision is that in 2035 the Finnish built environment is a key part of the solution for mitigating climate change and operates as a circular economy

Our objective

Our objective is that in 2030

- Properties reach net zero energy consumption
- Production and constructions emissions are reduced 40 % from 2020
- Built environment operates as a circular economy

GREEN BUILDING COUNCIL FINLAND

World Green Building Council

We are part of the worldwide World Green Building Council network. At the moment the network consists of about 70 national GBCs located all around the world.

World Green Building Council network has five Regional Networks

FIGBC is part of Europe Regional Network.

WORLD GREEN BUILDING COUNCIL

Green Building Council Finland's Core Functions

Committees and Expert Groups

- FIGBC's Committees and Expert Groups are networks made up of our member organisations' experts
- Each has its own objectives that contribute to the sector's sustainable development

Common metrics matter

- Common understanding and agreement of essential terminology is important. Using common terms increases the reliability of claims on carbon neutrality or emissions compensation.

  - Green Building Council Finland published *Guidebook for responsible Voluntary Emissions Compensation in the Building Sector* in 2022
  - Green Building Council Finland published *Guidebook for applying DNSH 2, 4, and 6 Criteria of the EU Taxonomy* on in 2022
  - The Guidebook provides concrete instructions for the aqcuisition of high quality and responsibly sourced emission compensations

FIGBC's Committees' Publications

- Definition of Sustainable Infrastucture
- Net Zero Energy Consumption for Properties
- Definition of Sustainable Urban Planning
- Steps for Low-Carbon Property Energy Consumption

Just now

- Net Zero Carbon Buildings Guidebook has progressed to pilot phase

“Most people have good intentions and want to make a difference. The hard bit is we've all locked ourselves into patterns that make it very difficult to be the first person or company or industry to step forward. But I'm absolutely confident we can do this.”

Louise Kjellerup Roper, CEO of Volans, a UK think-tank [1]

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Sustainable Real Estate Market in Finland

Miisa Tähkänen

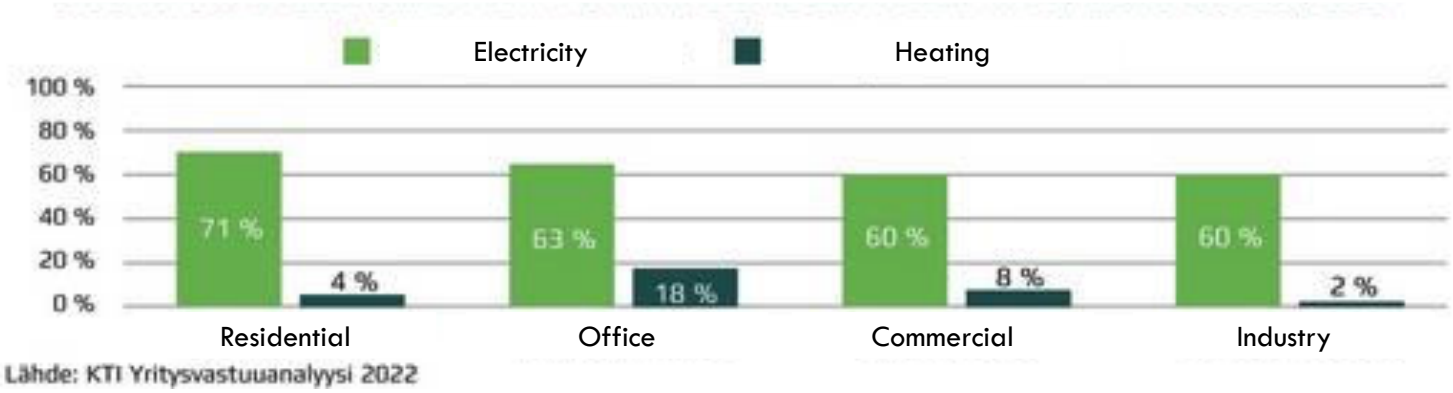
Background 1

- Traditionally the environmental impact of construction projects has been seen to largely be a result of the energy consumption of buildings. Though energy consumption does create a massive amount of greenhouse gases, we have come to notice that more and more attention should be placed on the embodied carbon of construction products.
- In modern energy efficient buildings over half of life lifecycle emissions might be produced before the building is even taken into use. *That's why it is key to also focus on the emissions resulting from the production of construction materials and of the construction sites themselves. These are called embodied emissions.*

Background 2

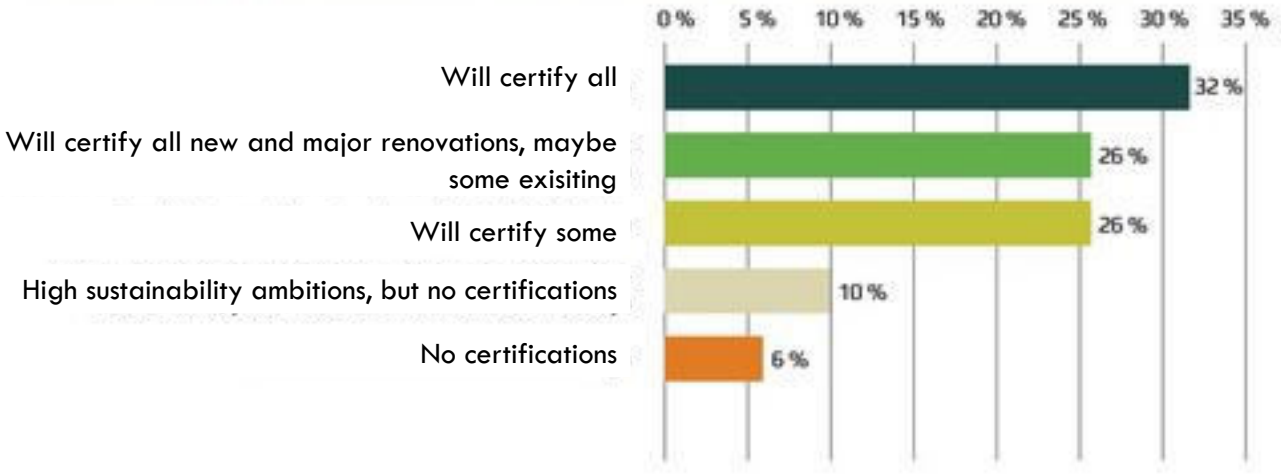
- Building emissions should always be evaluated as a lifecycle assessment. *The calculation of emissions should begin with the sourcing of natural materials, run through the construction product industry and construction sites into the energy consumption of buildings and finally the recycling of demolition waste.*
- There are generally accepted systems for analyzing such lifecycle emissions such as the EN Standard EN15978 and the EU Commission's Levels framework. Whole life carbon analysis has also been included in most of the major environmental certifications used in real estate projects. The certifications are voluntary but are more of a rule than an exception in the commercial real estate investment market.
- *A trend can be seen throughout the Nordic countries, and more recently also in the Baltics, to regulate the life cycle emissions of construction*. Life cycle emissions would be regulated as a part of the building permit process similarly as energy efficiency has been done for several years. Legislation is in place already the Netherlands, France, Sweden and Denmark and is being developed also in Finland, Norway and Estonia in the near future.

Renewable energy in the real estate sector



Lähde: KTI Yritysvastuuanalyysi 2022

Environmental certifications



Certifications in the market

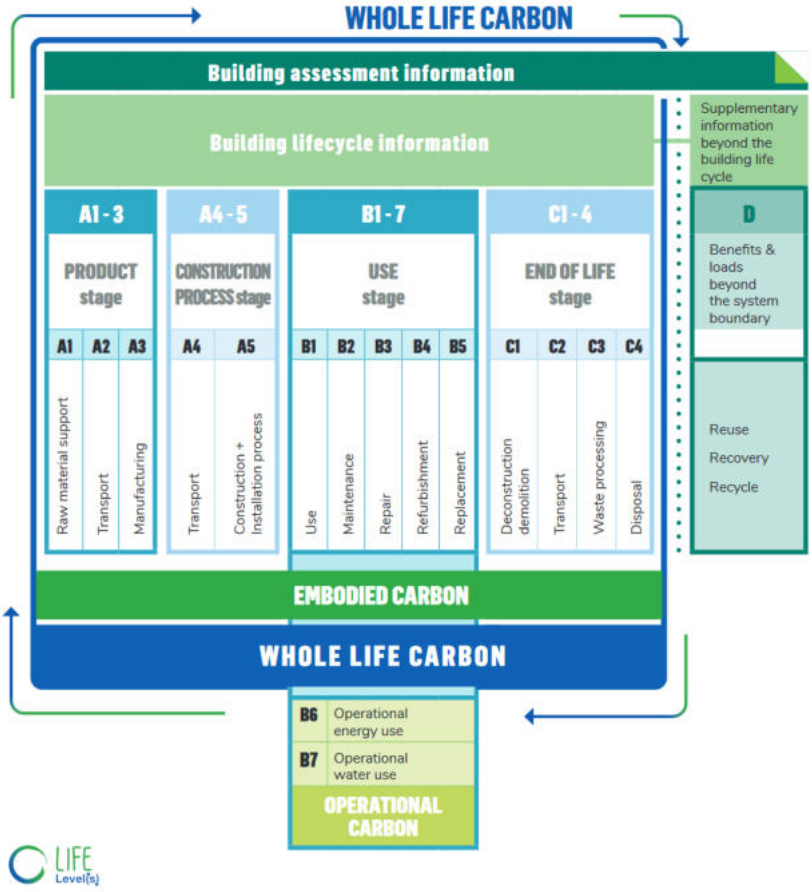
	2015	2016	2017	2018	2019	2020	2021
LEED New Construction & renovations	69	82	101	114			180
LEED Existing Buildings	18	27	32	32			85
BREEAM New Construction & renovations	37	54	66	73			64
BREEAM In-Use	3	24	52	76			279
Joutsenmerkki				0			15

GREEN BUILDING COUNCIL FINLAND

Whole Life Carbon in the Finnish Context

Miisa Tähkänen

- From energy efficiency to whole life carbon



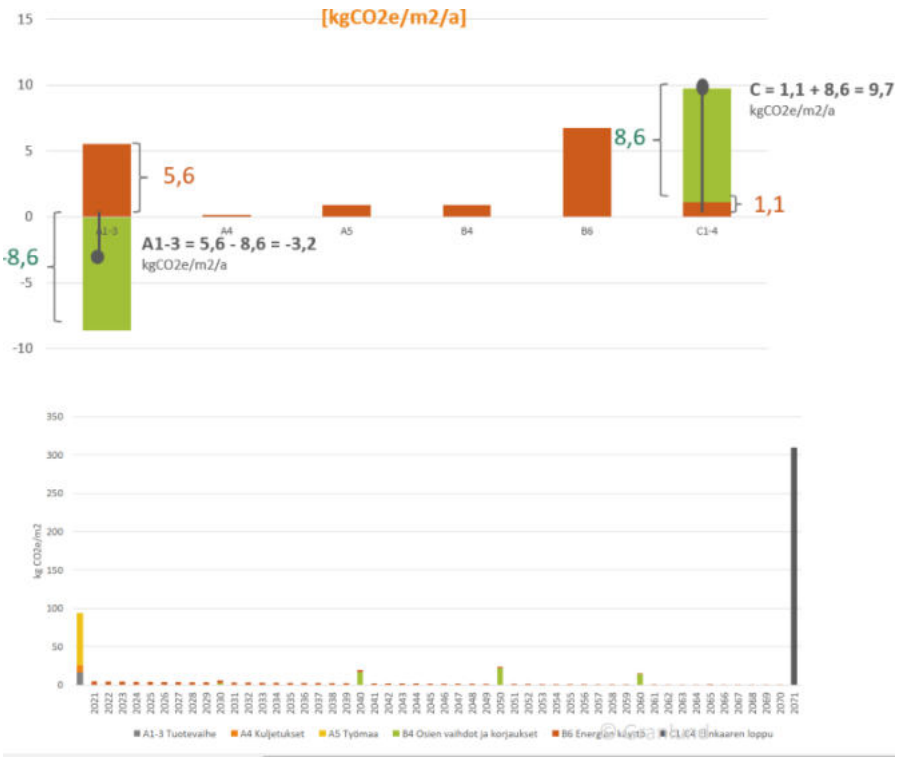
Nordic overview on low carbon construction

	Finland	Denmark	Sweden	Norway	Iceland	EU
Carbon goal	Carbon neutral 2035 Carbon negative soon after	70 % reduction in 2030 according to 1990-level Climate-neutral 2050	Carbon neutral in 2040	Carbon neutral in 2030	Carbon neutral 2040	55 % reduction in 2030 according to 1990-level Climate neutral 2050
Regulation on low-carbon construction	2025	2023	January 2022	January 2022	-	2027 (proposed)
Regulation incl. limit values	2025	2023: buildings above 1.000 m² 2025: all buildings	2027 proposed by Boverket	-	-	-

21

Helle Reder Momsen, Pohjoismainen ministerineuvosto, 2022.
Esitetty Vähähiilisen rakentamisen vuosiseminaarissa 4.4.2022

- How biogenic carbon in considered in LCA (YM, 20212). Source: Granlund 2022



Recomendations for timber construction 1

- Wood products help reduce the carbon footprint through lower emissions from production chains
  - The origin of wood must come from sustainably managed forests, or it will turn into an emissions source!
- There are many uncertainties related to the calculation of the temporary carbon stock of wood products as climate benefits
  - With current recycling methods, carbon stock is released at the end of the life cycle resulting to emissions just shifting
  - The assumption that the raw material is carbon neutral only applies in the very long term. In the short term, cutting down a tree can create "carbon debt".
  - → Increasing the stock cannot be considered comparable to emission reductions and is not recommended to be used in the pursuit of carbon neutrality

Source: Granlund 2022

Recomendations for timber construction 2

- Increasing the recycling of wood products to prevent the release of bound carbon at the end of the life cycle
- Use of wood for long-lasting products
  - Carbon stored in the frame is retained for the longest time
  - Improving the recycling of shorter-term parts very important
  - Site disposable timber (e.g. moulds) out of use / circulation!
  - NOTE: use in construction is the longest-term use
- Looking at the origin of wood and the use of the forest!
  - Can forest use control better promote the development of carbon stocks and avoid a drop in the development of carbon storage?

Source: Granlund 2022

GREEN BUILDING COUNCIL FINLAND

Näyttää suunnan, auttaa matkalla.

良質なストック形成等に向けた、木造建築物への融資における合理的な融資期間等に関する普及・広報			
会議名	**Interview meeting for wood construction in terms of finance and durability/木造のファイナンスと耐久性の観点からみたインタビュー会議**		
日時	5th January 2023 9:00-10:30/2023年1月5日9:00-10:30		
場所	Ylva, meeting room/Ylva, 会議室		
出席者	Antti Ruuska (AR), Ylva・Chief Sustainability Officer / ルウスカ アンティ（Ylva・チーフサスティナビリティオフィサー）, Shin Murakami (SM), Sugiyama Uni・Professor/ 村上心（椙山大・教授）, Hiroki Ishiyama (HI), Osaka City Uni・Associate Professor /石山央樹（大阪公立大・准教授）, Daishi Sakaguchi(DS), Nihon Fukushi Uni・Associate Professor /坂口大史（日本福祉大学・准教授）		
作成日	2023年1月6日	**記入者**	坂口大史

■ 議事	
議題	(1) General condition of wood building/木造建築の一般的な状況 (2) Forecast of future of wood construction/木造建築の将来的な見通し
内容	(1) General condition of wood building ・ Could you explain your organization? (SM) - Ylva is owned by student union of Helsinki university, 26,000 students. (AR) - Main business is student apartment and restaurant business. The profit is going back to student of Helsinki university. (AR) - Ylva is keen and responsible for the best of sustainability. Real estate team in Ylva has a project manager and hire a contractor for each project. (AR) - Two models for construction management and construction service. One is to provide a list of criteria for the contractor and they will oversee design and budget. The other is to manage the project as Ylva. The project decision will be mainly based on the competition. Construction service means that a contractor will be a part of Ylva team. (AR) - Sustainability for Ylva is highly important. Ylva owns different buildings with different ages. The first thing is managing existing building. The second one is to reach carbon neutral by 2025 buying emission free service like heat pomp system from domestic market. Emission free policy officially started from 2023. For emission free, cutting energy consumption is important and trying to develop the system. (AR) ・ What kind of policy do you have when you do a project? (DS) - For new building, whole lifecycle must be carbon neutral. Calculating carbon footprint for each project and comparing emission and cost of structure, concrete, and wood structure. Investigating reduction of emission by green strategy is converted to euro and make decision. (AR) (2) Forecast of future of wood construction/木造建築の将来的な見通し

	・ Sustainable material tends to be more expensive. What do you think of the cost? (HI) - Carbon is not economically visible, but carbon pricing way of thinking will be applied to think of the total cost and value in the market. Environment unfriendly building might be avoided by companies or market. (AR) - Ylva would like to do challenge and show new possibility to market and industry. - Active students will be interested in student politics and also sustainability, but Ylva is independent from the union and the board member of Ylva consists of professionals. (AR) ・ Does Ylva build or own wood building? (SM) - Yes, Ylva owned wood log cabin 60km from Helsinki and villa in eastern Finland. School, public buildings build in 1950-1960 had indoor air problem and replaced by wood structure. In this 10-15 years, the number of multistory wood buildings increased. But many of wood buildings must be covered by gypsum board and cannot feel that they are actually wood building. Fire safety and sound problem are also barrier for wood structure. (AR) ・ How about the cost of wood building? (DS) - Wood building has relatively more maintenance cost comparing concrete building if the facade is by wood. The details of wood buildings are more complicated and more demanding from the initial design stage, which will end up with longer design time. Concrete building is more standardized and better price competition. For wood building, the choices are more limited and tend to be more expensive. (AR) ・ Wood structure is provided by architect or material supplier? (HI) - Normally, wood structure system will be provided by the supplier. More experience will lead to shorter design and construction time. However, the number of wood structure engineer is still lacking even in Finland. The time for the development will be dependent on how many buildings you will build every year and more building experiences will surely help the development. For concrete building, the regulation is very simple in terms of fire regulation. But for wood structure, the regulations are different in areas and local rules, the suppliers are limited, which make the spread of wood structure more complicated. (AR) ・ Is there any open data base in Finland? (HI) - For instance, CO_2.fi is existing and sharing different kind of CO_2 emission for different parts and components. Puuinfo is also an example and showing different types of details. (AR) ・ For Ylva, sustainability is important but not focusing on wood structure. Why? (DS) - For example, Ylva tries to put wood structure (light weight) on top of existing building (concrete), but it was technically difficult. From this experience, Ylva understand it is not easy to use wood structure for renovation. For the case of new buildings, on the other hand, City of Helsinki will sometimes require wood construction in some areas and that will encourage companies to use more wood. According to newest research, carbon sink in Finnish forest decreases and Finland has been cutting so much forest

	lately and not sustainable. Using wood is not always sustainable and clearer LCA calculation is needed, and forest management should be also sustainable. To use wood, we need a link to forest. (AR) ・ Do you have something to add to your comments? (DS) - Another important perspective is to utilize existing building, materials, and structures. Demolishing old buildings and building new buildings even with wood is sustainable? This point must be included in the investigation project. Making best use of existing resource and material will be also important for sustainability. For the renovation purpose of existing building, wood is soft and easier to be redesign for renovation to extend lifecycle and to raise building performance. (AR) （日本語訳） (1) 木造建築の一般的な状況 ・ あなたの組織はどのような組織か。(SM) - Ylvaはヘルシンキ大学の学生組合によって運営されており、26,000人の学生が所属している。(AR) - Ylvaの主な事業は、学生アパートとレストラン事業となっている。この事業で得られる利益はヘルシンキ大学の学生に還元している。(AR) - Ylvaはサステナビリティにとても熱心であり、責任感を持って事業に取り組んでいる。Ylvaの不動産チームにはプロジェクトマネージャーがおり、プロジェクトごとに請負業者を雇うことでプロジェクトを行なっている。(AR) - 施工管理と施工サービスには2つのモデルがある。ひとつは、請負業者に基準のリストを提供し、彼らが設計と予算を監督する方式である。もうひとつは、Ylvaとしてプロジェクトそのものを自分達で管理することである。(AR) - プロジェクトの決定は、主にコンペで行われる。また、コンストラクション・サービスとは、請負業者がYlvaのチームの一員となることを意味している。(AR) - Ylvaにとって、サステナビリティは非常に重要である。Ylvaは様々な築年数の建物を所有している。まず、第一に、既存の建物をいかに管理するかが肝心である。もう一つは、国内市場からヒートポンプシステムのような排出ガスのないサービスを購入して2025年までにカーボンニュートラルを達成することである。(AR) - フィンランドでは、エミッション・フリー政策は、2023年から正式に開始される。その達成のためには、エネルギー消費量の削減が重要であり、そのためのシステム開発にも取り組んでいる。(AR) ・ プロジェクトを行う上で、どのようなポリシーをもっているのか？(DS) - 新築の場合、ライフサイクル全体がカーボンニュートラルでなければならない。プロジェクトごとにカーボンフットプリントを計算し、構造、RC造、木造の排出量とコストをそれぞれ比較する。また、グリーン戦略による排出量削減をユーロに換算して検討し、最終的に構造も含めたプロジェクトの詳細を決定する。(AR) (2) 木造建築の将来的な見通し ・ サステナブルな素材は高価になる傾向がある。このコスト増についてはどのように考えているか？(HI) - カーボンは経済的に見えないが、カーボンプライシングの考え方を応用して、市場でのコストと価値をトータルで考えて事業に取り組んでいる。また、環境に悪い建物は、将来的には企業や市場から敬遠されるかもしれない(価値がつきづらくなる)た

	め、避ける傾向にある。(AR) - Ylvaは挑戦し、市場や産業界に新しい可能性を示したいと思って事業に取り組んでいる。 - 組合に所属する活発な学生は学生政治やサステナビリティに興味をもつであろうが、Ylvaは組合から独立した運用をしており、役員は各部門の専門家で構成されている。(AR)。 ・ Ylva は木造建築を所有又は建設しているか？(SM) - Ylvaの所有する不動産の中には、ヘルシンキから60kmのところにログハウスがあり、東部には木造の別荘もある。1950年から1960年にかけて建てられた学校や公共施設は、室内空気の問題があり、木造建築に置き換えられることもあった。(AR) - この10-15年の間に、木造の多層階建築が増加してきた。しかし、多くの木造建築物は石膏ボードで覆われており、木造建築物であることを実感できないのが問題である。また、火災時の安全性や音の問題も木造建築の障害となっている。(AR) ・ 木造建築のコストに対してはどの様に考えているか？(DS) - 木造建築は、コンクリートの建築に比べ、特にファサードが木造の場合、コンクリートの場合と比べてメンテナンスコストが必然的にかかる。また、木造建築は、初期設計段階からディテールが複雑であり、設計期間が必然的に長くなる。一方で、RC造の建物はより標準化されており、市場での価格競争も激しい。木造建築の場合、選択肢が限られており、より高価になる傾向がある。(AR) ・ 木造のシステムや構法は、建築家または材料メーカーが提供するのか。（HI） - 通常、木質構造システムはサプライヤーから提供される。設計者の経験値が高ければ、設計・施工期間の短縮につながる。しかし、フィンランドでも木造建築の技術者はまだまだ不足している。(AR) - また、年間何棟の建物を建てるかによって、開発にかかる時間は変わってくるが、より多くの建築経験を積むことが開発に役立つことは間違いないである。また、RC造の建物の場合、防火に関する対策は非常にシンプルである。しかし、木造の場合、地域やローカルルールで規制が異なり、供給者も限られているため、木造の普及はより複雑になっている。(AR) ・ フィンランドにオープンなデータベースはあるのか？（HI） - 例えば、フィンランドでは、CO2.fiなどのオンラインサイトがあり、部品ごとに異なる種類のCO2排出量を共有している。Puuinfoもその一例で、様々な種類の詳細を示している。(AR）。 ・ Ylvaにとって、サステナビリティは重要だが、木の構造にはフォーカスしていない。なぜか？ - 例えば、Ylvaでは、既存のRC造の建物の上に軽量である木構造を載せようとしたが、技術的に困難であったことが度々あった。それもあり、リノベーションで木造を使うのは容易ではないと考えている。(AR) - 新しい建物の場合では、ヘルシンキ市が木造建築を要求することがあり、そういうケースが増えれば、企業はもっと木材を使うようになると考えられる。(AR) - 最新の研究によると、フィンランドの森林の炭素吸収量は減少しており、フィンランドは最近多くの森林を伐採しているため、持続可能ではないとの報告もある。木材を

	使うことは必ずしもサステナブルではなく、より明確なLCA計算が必要であり、森林管理もサステナブルであるべきである。木材を持続可能に使うには、森とのつながりが必要である。(AR) ・ 他に意見の補足はあるか？(DS) - もう一つの重要な視点は、既存の建築物、材料、構造物を活用することである。木造でも古い建物を壊して新しい建物を建てることがサステナブルになるのか？この点は、調査プロジェクトに含まれなければならないと思われる。既存の資源や材料を最大限に活用することも、サステイナビリティのために重要である。(AR) - - 既存建築物のリノベーションの場合、木材は柔らかく、ライフサイクルの延長や建築性能の向上のためのリノベーションのための再設計が容易であるため可能性がある。(AR)
備考	・特になし

■ 次回の予定	
日時	年　　月　　日（　　曜日）　　時　　分より
場所	

良質なストック形成等に向けた、木造建築物への融資における合理的な融資期間等に関する普及・広報			
会議名	**Interview meeting for wood construction in terms of durability/木造に関する耐久性の観点からみたインタビュー会議**		
日時	9th January, 2023 16:30-18:30/2023年1月9日16:30-18:30		
場所	Aalto University Main building/ アアルト大学メインビルディング		
出席者	Pekka Heikkinen (PH), Aalto Uni・教授/ヘイッキネン ペッカ, Daishi Sakaguchi(DS), Nihon Fukushi Uni・Associate Professor /坂口大史（日本福祉大学・准教授）		
作成日	2023年1月10日	**記入者**	坂口大史

■ 議事	
議題	（1）The general maintenance plan in Finland/フィンランドにおける一般的なメンテナンス計画について （2）Situation of Finnish market for wood construction and LCA/木造建築とLCAに関するフィンランドの市場の状況
内容	（1）The general maintenance plan in Finland/フィンランドにおける一般的なメンテナンス計画について - According to the interview from different companies, there seems that there is no specific maintenance plan for wood construction. Is it true?(DS) I think that it is somehow true. Only in the case of wood façade, it has specific plan for the maintenance according to the solutions. Also there is also service book for each project.(PH) - Is there any regulation or standard specifically for wood construction? (DS) As long as you do not use wood outside, the load for the maintenance should not different from structure or concrete structure. RakkenusTieto is providing the standard book for the maintenance in general construction and there is wood parts like floor and cladding as well in the book. (PH) - In Japan, when we build concrete building, we reserved maintenance budget, lets say 1.5% of the total cost. Is there any budget reserve for project in Finland. (DS) At lest as I know, there is no set up percentage of the budget in each project. City of Helsinki has several wood apartments and they should know the number or data for the maintenance cost. (PH) - From one agency we interviewed, I heard 3-5 euro per floor square meter for the maintenance they reserve. Does this sound reasonable for you as the budget of maintenance? (DS) It does not sound so much but it is of course better than nothing. Again, if wood is used as load bearing structure, wood is not exposed to outside and not affected by UV or water. Thus, the way for the maintenance should not be specific comparing

	other structure such as concrete structure or steel structure. (PH) （2）Situation of Finnish market for wood construction and LCA/木造建築とLCAに関するフィンランドの市場の状況 - About the lifecycle of wood construction, we heard that Finland is cutting too much wood and sustainable forestry is not achieved at the moment. Is it true? (DS) There are a lot of discussion but currently it depends on whom you will ask this topic. In my opinion, the amount of wood we used for construction is very limited and has not affected so much. (PH) - Do you have some experiences R&D project for renovation and some practical cases for concrete building renovation with wood? (DS) Yes, we do. Please refer to the slides provided. Timber based elements system with wood frame, insulation and duct space attached to concrete structure. Old concrete façade and insulation were removed and this timber panels were attached. (PH) - Did this timber panel become popular in the market? (DS) Unfortunately, not so much popular. It was not because of the property of the timber panel but because of difficulty of renovation. In the old building, the windows were also old so that the properties of window affected the cost competitiveness and performance of building. (PH) - In Japan, the market still thinks wood construction is very expensive. It is also said that wood structure is not competitive enough in the market at the moment. The real estate company are also interested in utilizing existing buildings, lets say old concrete building, structure is utilized and wood parts or components will be attached to the concrete structure. (DS) Yes, the method for wood renovation could be more developed and could be an interesting international topic. (PH) - The ministry has been giving subsidies to wood structure in Japan. How is the situation in Finland? (DS) Wood apartment has also been popular in Japan but a bit more expensive that normal structure. But wood construction is easier to get subsidies for the project. The choice of wood construction is still attractive. (PH) （日本語訳） （1） フィンランドにおける一般的なメンテナンス計画について ・各社にヒアリングしたところ、フィンランドでは、木造建築といっても特にメンテナンスプランがないと聞いている。実際はどうなのか。(DS) - 実際そのように思われる。もちろん、木のファサードだけは、建物に使われている方法に応じた具体的なメンテナンス計画が立てられている。また、プロジェクトごとにサービスブックがあり基本的な事項はそこにまとめられている。(PH) ・ フィンランドでは、耐久性の面で木造建築に特化した規制や標準はあるのか？(DS) - 屋外に木材を使用しない限り、メンテナンスのための負荷は、構造物やRC造の建物と

	変わらないはずである。例えば建設情報を提供するRakennustietoでは、一般的な建築物のメンテナンスのための標準本を提供しており、その中に床や外壁の板材などの木部も含まれている。(PH)。 ・ 日本では、RC造の建物の場合、総工費の1.5%程度のメンテナンス予算を確保していると言われている。フィンランドでは、このような全体予算にかかるメンテナンス予算はあるのか？(DS) - 私の知る限りでは、プロジェクトごとに予算の割合が決められているわけではない。ただし、ヘルシンキ市は既に建設した木造アパートをいくつかあるため、メンテナンス費用に関するデータをもっていると考えられる。(PH) ・ ARAにメンテナンス費用について聞いたところでは、1フロア1平方メートルあたり3～5ユーロのメンテナンス費用を確保していると言っていた。これは予算として妥当だと感じるか？(DS) - 予算としてはあまり高くはないと思うが、もちろん何もないよりはましである。繰り返しになるが、構造体に木を使う場合、これが木造建築であるが、その場合は、木は外気にさらされず、紫外線や水の影響も受けない事になる。したがって、メンテナンスの方法は、他の構造物であるRC造やS造と比べても特別なメンテナンスが必要になるとは考えにくい。(PH) （2）木造建築とLCAに関するフィンランドの市場の状況 ・ 木造建築のライフサイクルについてであるが、フィンランドは森の木を切りすぎていて、持続可能な森林経営が今ひとつ実現できていないという話を聞いた。これは本当なのであろうか？(DS) - いろいろな議論がありますが、今のところ、このテーマを尋ねる人次第で回答が変わるのではないかと思われる。私の考えでは、建築に使う木材の量は非常に限られているため影響は限定的である。(PH) ・ RC造の建物を木造に改修するための研究開発プロジェクトや実用例はありますか。(DS) - 実例が存在する。この後に添付するスライドを参照してほしい。簡潔に説明すると、木造のフレーム、断熱材、ダクトをコンクリート構造物に取り付けた木質系エレメントシステムである。古いコンクリートのファサードと断熱材を取り除き、この木製のパネルを取り付けたものになっている。(PH) ・ このティンバーパネルシステムは市場で人気があるのか？(DS) - 残念ながら、それほどで人気が出てわけではない。それは、このパネルの質と言うよりも改修の難しさに起因している。古い建物では、窓も古かったので、窓の特性が建物のコスト競争力や性能に影響を及ぼしていた。(PH)。 ・ 日本では、まだ木造は高いというイメージがある。現在、木造は市場競争力がないとも言われる。不動産会社も既存の建物を利用することに興味があり、例えば古いコンクリートビルを利用し、そのRC造に木造の部品や部材を取り付けるということも考えているのではないかと思う。(DS) - 木材を使ったリノベーションの方法は、構造を問わず使用できる可能性があるため、もっと発展させることができる可能性があると感じる。国際共同研究等で取り組め

	ば、面白いトピックになるのではないかと考えられる。(PH) ・ 日本では、林野庁が木造に補助金を出しています。フィンランドではどこが補助金を出しているか？ (DS) - 日本でも木造アパートは人気があると聞いている。フィンランドでも、通常の構造（例えばRC造）と比較して、木造は依然として少し高い。しかし、木造の方が補助金をもらいやすいという利点がある。事業全体でみれば、木造という選択肢はまだまだ魅力的な選択肢になると考えられる。(PH)
備考	・特になし

■ 次回の予定	
日時	年　　月　　日（　　曜日）　　時　　分より
場所	

良質なストック形成等に向けた、木造建築物への融資における合理的な融資期間等に関する普及・広報			
会議名	**Interview meeting for wood construction in terms of durability/木造に関する耐久性の観点からみたインタビュー会議**		
日時	10th January, 2023 8:30-11:00/2023年1月10日8:30-11:00		
場所	Ministry of Environment, meeting room /環境省会議室		
出席者	Teppo Lehtinen (TL), Ministory of Environment・Director General /レフティネン テッポ（環境省・局長）, Matti Kuittinen(MK), Ministory of Environment・Senior Ministerial Advisor/クイッティネン　マッティ（環境省・大臣官房参事官）, Simo Le Roux(SLR), Ministory of Environment・Project Specialist /サイモン レ　ルー（環境省・プロジェクトスペシャリスト）, Daishi Sakaguchi(DS), Nihon Fukushi Uni・Associate Professor /坂口大史（日本福祉大学・准教授）		
作成日	2023年1月11日	**記入者**	坂口大史

■ 議事	
議題	（1）Wood construction and the general maintenance plan in Finland/フィンランドにおける木造建築と一般的なメンテナンス計画 （2）Situation of wood construction and future of LCA/木造建築とLCAの将来性に関する状況
内容	(1) Wood construction and the general maintenance plan in Finland - How is the situation of wood construction in Finland and what is the current hot topics? (DS) Please refer to the document provided (in Finnish) for the status of wooden buildings in Finland. Wood in public construction in Finland. Current hot topics in wood construction in Finland are energy efficiency, material and renewable aspect and circular economy. (TL) Finland follows EU policy for sustainable forestry and wood construction. (TL) 30% use of the total material use is currently used in the construction and circular economy is not enough. Using more wood is necessary. But cutting more wood will ruin the diversity of forest. There are conflict between forest policy and wood construction policy. (TL) Sustainability Finland policy is limit carbon foot prints and life cycle assessment will be taken into account to the building permission. The policy is already in the parliament. (TL) - The commons argument for life cycle assessment of wood construction is that wood is good in the construction stage and demolition stage but the stage of in-use is much longer. Thus the structure does not affect so much of LCA. What is your opinion? (DS) That is common in Finland too. When we think of LCA, energy efficiency is important

	but materiality especially for wood has to be considered. We need to find the best balance of LCA in any structure no matter of concrete, steel or wood. (TL) - How much is the maintenance budget in general? (DS) There is some budget. For the case of residential building, housing association will set up budget for the maintenance. The association will reserve the cost for the maintenance on the top of normal rent. For the case of public building, government will prepare for the service book and also set up the budget for the maintenance in each project. The budget will be dependent on the floor area and way of structure. The percentage for maintenance is not regulated in the legislation. (TL) - So there is no difference in the budget for maintenance in concrete building or wood building? (DS) The case of the maintenance does not so differ in concrete or wood. The only difference case will be wood used in exterior wall. Let's say concrete façade does not require maintenance but wood façade need to be repainted every 10 years in general. (TL) - When higher wood construction will be built, what is problem here? (DS) There is no problem here expert cost and the necessity of tall building because Finland is not so populated. In Japan, it will be typhoon. The strong wind will shake the building and rigid structure will be broken down, which means more flexible structure like wood will be better. (TL) - Generally, wood construction is more expensive 5-10% than concrete building. Is it true? (DS) Yes, it is true. The bottle neck is lack of designer and engineer for wood construction. In the design phase of wood construction, more consideration in the details and design will be required, which tend to lead to longer design duration and cost. Let's stay that you do not have to think if you use concrete but you have to think and consider more when you use wood construction. More experiences, standardization and competitions will reduce the difference in the cost. (TL) - Any other reasons for the higher cost? (DS) Yes. Technologically, sound proof and fire proof will be needed in wood construction but not in concrete building. These will raise the price of wood construction. However, if the building has sprinkler, the building will be safer, which will be good for the tenant and owner of building. (TL) (2) Situation of wood construction and future of LCA - What do you think of future of wood construction? (DS) Wood construction will have benefit as well. Wood is dry construction so that the construction period will be relatively shorter than concrete construction. This will contribute cost down especially when the building scale is larger. (MK)

	- Finland has longer experience in wood construction. Almost 30 years. You still think that designer and engineer for wood construction are still lacking in Finland? (DS) Yes, I think still lacking because we have a slow start for wood construction even though we started a first wood project in 1996. After we started wood construction, company felt risk to start new method and wood construction did not become so popular in the beginning. (SLR) - What will be needed to make wood construction more popular? (DS) The standardization is mandatory. The standardization will reduce the risk of structure, durability and also the building cost, which will encourage company or private sector to try wood construction. Architecture and cultural aspect are also important. Japan has also traditions for wood building in long time and the key is how Japanese people can respect the history and culture and utilize the knowledge to modern technology to develop wood construction. (TL) - What is the situation in Finland with regard to LCA, environmental certifications, subsidies, etc. for wooden buildings? (DS) The subsidies for wood construction are about 6million euro in a year. Let's say one school building will cost 20million euro, so our subsidies is quite small but private companies are trying to build wood construction and the market is moving to next stage. Financial investor is more interested in green building and environmental values for the building, which will drive wood construction forward. (MK) In terms of environmental investment and carbon footprint, wood construction could have more advantages comparing steel or concrete structure. The building types such as day care center or some size of school made by wood construction would be cheaper than concrete or steel. (SLR) In LCA, how we could take into account of effect to biodiversity in the forest by wood construction would be an interesting theme and project. (MK) - What are your thoughts on maintenance regarding wooden buildings? (DS) One of the cases in Putajavesi log school by YIT had a contract for life cycle of 25 years including maintenance. Student house developer would be a good contact to know the exact number of percentages for maintenance. The maintenance budget will be also dependent on the type of building such as commercial, residential or education. (MK) - In conclusion, the key to making wood construction more rational is standardization of wood construction, education of professionals, LCA and presentation of environmental values that attract investors. (DS) - （日本語訳） (1) フィンランドにおける木造建築と一般的なメンテナンス計画 ・ フィンランドにおける木造建築の状況についてと現在の木造に関するホットトピックは何か？（DS） - フィンランドにおける木造建築の状況については提供する資料（フィンランド語）を参照してほしい。フィンランドの公共建築における木材、フィンランドにおける木造建築の現在のホットトピックは、エネルギー効率、材料としての特性及び木材の再生

	可能な側面、そして循環型経済が挙げられる。(TL) - フィンランドは、持続可能な林業と木造建築のためのEUの政策に従って進められている。(TL) - 現在、建設分野に使用されている材料は全体の材料使用量の30%と言われており多くを占めるが、循環型経済が十分機能していないといえる。建設分野に限らず、より多くの木材を使用することが必要である。しかし、より多くの木材を伐採すると、森林の多様性が損なわれる恐れもある。森林政策と木造建築政策の間にはやや矛盾が生じる場合がある。(TL) - フィンランドの持続可能性に関する政策は、カーボンフットプリントの制限とライフサイクルアセスメントを建築許可に考慮することにある。この政策はすでに国会に提出されている。(TL) ・ 木造建築のライフサイクルアセスメントに関する一般的な議論は、木材は建築段階と解体段階では良いが、使用段階ではもっと長い時間を要する。したがって、木造に限らず構造躯体は使用段階の消費エネルギーなどを考慮すると、LCAにそれほど影響を与えないという指摘もある。これについてはどう思うか？(DS) - フィンランドでもそれは同じである。LCAを考えるとき、使用段階におけるエネルギー効率は重要である、特に木材の場合は物質性を考慮しなければならない。RC、鉄骨、木造にかかわらず、どんな構造でもLCAの最適なバランスを見つける必要があるのは共通している。(TL) ・ 一般的に、メンテナンスの予算はどのくらいを見込んでいるか？(DS) - ある程度の予算は確保されている（具体的な数字は把握していない）。住宅の場合、住宅組合がメンテナンスのための予算を設定する。また、住宅組合は、通常の家賃に上乗せして維持管理費を確保している。公共建築の場合は、政府がサービスブックを作成し、各プロジェクトに維持管理のための予算を設定している。予算は、床面積と構造によって決定されるが、維持管理費の割合は、法律では規定されていない。(TL)。 ・ では、RC造の建物でも木造建築でも、メンテナンスのための予算に違いはないという理解で正しいか？ (DS) - RCでも木造でも、メンテナンスのケースではそれほど変わりはない。唯一違うのは、外壁に木が使われている場合である。例えば、RCのファサードはメンテナンスが必要ないが、木造のファサードは通常10年ごとに塗り替えが必要となる。(TL)。 ・ より高層の木造建築を建てる場合について、問題点や課題はどこにあると考えられるか？(DS) - フィンランドは人口が少ないので、高層建築の必要性とコストの専門的な問題はそれほどないと考えて良い。逆に日本では、台風が頻繁に発生する。台風などの強風で建物が揺さぶられと、硬い構造は壊れてしまうので、その場合は、木造のような柔軟な構造の方が良い場合もある。(TL)。 ・ 一般的に、同じ建物を木造で建てる場合、RC造より5〜10%程度コスト面で割高と言われている。それについてのあなたの意見は？(DS) - それは、現状として正しいと言える。木造のボトルネックは、木造に関わるデザイナーやエンジニアが不足していることにある。木造建築の設計段階では、より詳細な

	設計が必要となり、設計期間とコストが一般的に長くなる傾向にある。また、RC造なら考えなくて良いことが、木造ではもっと考えなければならない場合が多々ある。木造に関する経験を積み、標準化し、競争することで、コストの差は少なくなっていくと考えられる。(TL)。 ・ 他に木造のコストが高くなる理由は何が考えられるか？(DS) - 例えば技術的な面では、防音や防火が木造建築には必要となるが、RC造の建物には必要ない場合が多い。これらは木造建築の価格を押し上げることになる。しかし、木造で必要とされることの多いスプリンクラーは、木造の建物でもスプリンクラーを設置すれば、建物はより安全になり、テナントやビルのオーナーにとって利点になるケースもある。(TL) (2) 木造建築とLCAの将来性に関する状況 ・ 木造の将来性についてはどの様に考えているか？(DS) - 木造にもメリットがある。例えば、木造は乾式工法なので、RC造よりも工期が比較的短くなる。これは、特に建築規模が大きくなると、コストダウンに貢献していく重要な事項である。(MK) ・ フィンランドは、木造建築に長く取り組んでおり、ほぼ30年になると思われる。それでもフィンランドでは、木造建築のデザイナーやエンジニアがまだ不足している状況なのか？ (DS) - 実際のところ不足している。1996年に最初の木造プロジェクトを開始したが、RC造やS造などの他の構造体に比べて、木造建築のスタートが遅かった。その点からもまだまだ技術者は不足していると思われる。木造建築が建てられ始めた後でも、企業は新しい方法を始めることにリスクを感じ、当初は木造建築がそれほど普及しなかった実情がある。(SLR)。 ・ 木造建築を普及させるために必要なことは何でしょうか？(DS) - 標準化が必要である。木造の標準化を進めることで、構造のリスク、耐久性、建築コストを下げることが可能となり、企業や民間企業が木造建築に挑戦するきっかけになると考えられる。(TL) - また、建築や文化的な側面からも重要であると考えられる。日本には古くから木造建築の伝統があり、日本人がいかに歴史と文化を尊重してきた。その知識を現代の技術に生かしながら、いかに木造建築を発展させられるかが鍵になると思われる。(TL) ・ 木造建築に関するLCA、環境認証、補助金などの取り組みついてフィンランドの状況はどうなっているか？(DS) - 木造建築に対する補助金は、1年間で約600万ユーロである。例えば、学校の建物1棟が2,000万ユーロであれば、その額と比較して補助金の総額はかなり少ないといえる。(MK) - 一方で、民間企業が木造建築に挑戦し始めており、市場は次のステージに移行している段階にあると感じる。また、金融投資家は、グリーンビルディングや建築物の環境価値によりとても関心を寄せており、それがフィンランドにおいても木造建築を前進させる原動力となっている。(MK) - 環境投資とカーボンフットプリントの観点から、木造建築はS造やRC造よりも多くの利点があると思われる。特に建物の用途としては、デイケアセンターやある程度の規

	模の学校のような建物では、木造建築はRC造やS造の建物よりも安価で建設できるケースが増えている。(SLR)。 - また、LCAにおいて、木造建築が森林の生物多様性に与える影響をどのように考慮するかは、興味深いテーマであり、共同研究として取り組んでも面白いプロジェクトになると思われる。(MK) ・ 木造建築に関するメンテナンスに関する考え方はどうか？(DS) - YITのPutajavesi log schoolの事例では、メンテナンスも含めて25年のライフサイクルで契約していた事例がある。特に、学生寮を建てているデベロッパーや建設会社などは、メンテナンスのための正確なパーセンテージを知るための良い窓口となるであろう。なお、メンテナンスの予算は、商業施設、住宅、教育施設など、建物のタイプによって異なるので注意が必要である。(MK) - 結論として、木造建築をより合理的にするためには、木造建築の標準化と専門家の教育、LCAや投資家を惹きつける環境的価値の提示が鍵になることがわかった。(DS)
備考	・特になし

■ 次回の予定	
日時	年　　月　　日（　　曜日）　　時　　分より
場所	

SUOMALAINEN PUUKERROSTALOHANKEKANTA

Suunnitteilla ja rakenteilla olevat suomalaiset puukerrostalohankkeet, 06/2022

Ympäristöministeriö
Miljöministeriet
Ministry of the Environment

JOHDANTO

Suomalainen puukerrostalohankekanta koottiin alun perin kesällä 2012 Puuinfon, työ- ja elinkeinoministeriön sekä Invest in Finlandin käyttöön. Puukerrostalohankekantaa on päivitetty sittemmin työ- ja elinkeinoministeriön toimeksiannosta vuosina 2014 ja 2015 sekä ympäristöministeriön toimeksiannosta vuosina 2017, 2018, 2019 ja 2020. Tämä kevään 2022 päivitys on teetetty ympäristöministeriön toimesta, ja on siis hankekannan seitsemäs päivitys. Hankekantaan kerätään kaikki suunnitteilla tai rakenteilla olevat vähintään 3-kerroksiset puukerrostalohankkeet sekä kaikki merkittävät suuren mittakaavan puurakenteiset julkiset rakennukset Suomessa. Hankekannassa ei esitetä jo toteutuneita kohteita.

Hankkeet on jaettu kolmeen eri luokkaan toteutumispotentiaalin mukaan:

1. varmat (osa 1)
2. todennäköiset (osa 2)
3. mahdolliset (osa 3)

Luokka kuvaa hankkeen toteutumismahdollisuutta nimenomaan puurakenteisena. Pääsääntöisesti hankkeet, jotka ovat laajoja ja vasta kaavavaiheessa, eikä puurakentamiseen sitoutunutta rakennuttajaa/rakentajaa vielä ole, on sijoitettu automaattisesti luokkaan mahdollinen. Luokitus ei siis kuvasta alueiden ja kohteiden toteutumistodennäköisyyttä ylipäänsä millä tahansa rakennusmateriaalilla, vaan ainoastaan toteutumista juuri puurakenteisena.

Suraavassa on koostettu hankkeiden tiedot yhteen ja esitetty laskelmia tulevasta rakentamisesta sekä visualisoitu hankkeet Suomen kartalle.

Hankekannan on koonnut oululainen arkkitehti Janne Tolppanen (janne.j.tolppanen@gmail.com).

LUKUJA JA LASKELMIA

FAKTAA SUOMALAISTEN ASUMISESTA

- Suomessa on n. 5,549 miljoonaa asukasta (Tilastokeskus 04/2022).
- Asuntoja on 3,124 miljoonaa kpl (Tilastokeskus 10/2021).
- Yhdessä asunnossa asuu keskimäärin 1,81 henkilöä.
- Kerrostaloasuntoja 1,468 miljoonaa. Maamme kaikista asunnoista noin 47 % sijaitsee kerrostaloissa (Tilastokeskus 10/2021).
- Suomalaisen asunnon keskipinta-ala (kun otetaan mukaan kaikki maamme asunnot) on 79,4 m² (Tilastokeskus 10/2021).
- Suomalaisen kerrostaloasunnon keskipinta-ala on 55 h-m² (Tilastokeskus 10/2021).
- Jokaista suomalaista kohti on asuinpinta-alaa keskimäärin 40,8 h-m² (Tilastokeskus 05/2019).

LASKELMIA TIETOKANNAN PUUKERROSTALOHANKKEISTA

- Uutta puukerrostalorakentamista tulossa varmoissa kohteissa n. **475 797 k-m²**, josta;
  - **n. 394 882 k-m²** on asumista.
  - **n. 80 915 k-m²** on julkista, toimisto-, liike- tai hotellirakentamista.
- Uutta puukerrostalorakentamista tulossa todennäköisissä kohteissa n. **128 327 k-m²**, josta:
  - **n. 124 727 k-m²** on asumista.
  - **n. 3 600 k-m²** on julkista, toimisto-, liike- tai hotellirakentamista.
- Uutta puukerrostalorakentamista tulossa mahdollisissa kohteissa n. **466 981 k-m²**, josta:
  - **n. 466 431 k-m²** on asumista.
  - **n. 550 k-m²** on julkista, toimisto-, liike- tai hotellirakentamista.
- Uutta puukerrostalorakentamista tulossa yhteensä **n. 1 071 105 k-m²**, josta:
  - **n. 986 040 k-m²** on asumista.
  - **n. 85 065 k-m²** on julkista, toimisto-, liike- tai hotellirakentamista.

- Uusia puukerrostaloasuntoja tulossa:
  - **Varmat:** 394 882 k-m² / (1,25 x 55 h-m² = 68,75 k-m²) = **n. 5 740 asuntoa**
  - **Todennäköiset:** 124 727 k-m² / (1,25 x 55 h-m² = 68,75 k-m²) = **n. 1 810 asuntoa**
  - **Mahdolliset:** 466 431 k-m² / (1,25 x 55 h-m² = 68,75 k-m²) = **n. 6 780 asuntoa**
  - **Yhteensä:** 986 040 k-m² / (1,25 x 55 h-m² = 68,75 k-m²) = **n. 14 340 asuntoa**

- Uusia asukkaita tulossa puukerrostaloihin:
  - **Varmat:** 394 882 k-m² / (1,25 x 40,8 h-m² = 51 k-m²) = **n. 7 740 asukasta**
  - **Todennäköiset:** 124 727 k-m² / (1,25 x 40,8 h-m² = 51 k-m²) = **n. 2 450 asukasta**
  - **Mahdolliset:** 466 431 k-m² / (1,25 x 40,8 h-m² = 51 k-m²) = **n. 9 150 asukasta**
  - **Yhteensä:** 986 040 k-m² / (1,25 x 40,8 h-m² = 51 k-m²) = **n. 19 330 asukasta**

HANKKEIDEN KERROSALAT TAULUKOITUNA

Luvuissa on pyritty huomioimaan vain suunnitteilla ja rakenteilla oleva kerrosala, ei hankkeissa jo toteutunut kerrosala. Mikäli hankkeen kerrosalasta on esitetty vaihtoehtoja, esitetään tässä taulukossa lukujen keskiarvo.

HANKE	KERROSALA ASUMINEN (k-m²)	KERROSALA MUU (k-m²)
VARMAT HANKKEET		
Espoon Djupsundsbäckenin puukerrostalot	6 600	–
Espoon Keilaniemen Portti	–	23 105
Espoon Metsäpirtintien puukerrostalot	9 000	–
Helsingin Jätkäsaaren Wood Cityn toimistorakennus ja hotelli	–	19 000
Helsingin Katajanokan Laituri	–	23 000
Helsingin Karhukallion puukerrostalokorttelit	52 050	–
Helsingin Kuninkaantammen Etelärinteen puukerrostaloalue	28 600	–
Helsingin Kuninkaantammen Lammenrannan puukerrostaloalue	38 300	–
Helsingin Leankadun puukerrostalo	2 100	–
Helsingin Oulunkylän puukerrostalot	6 317	–
Helsingin Pasilan Postipuiston Reformikortteli	11 900	–
Järvenpään Kirjastokadun ja Myllytien puukerrostalot	7 200	–
Kajaanin Sammonkaari	17 500	–
Keravan Kurkelan puukerrostalot	6 063	–
Kirkkonummen Pyssysepänkaaren puukerrostalo	5 970	–
Kuopion Julkulan puukerrostalot	5 787	–
Porvoon Länsirannan puukerrostalokortteli	15 245	–
Porvoon Tehtaanpuiston puukerrostalot	13 750	–
Tampereen Hervantajärven puukerrostalot	5 000	750
Tampereen Hippos	35 000	–
Tampereen Rauhaniementien puukerrostalo	3 000	–
Tampereen Vuoreksen Isokuusen alue	46 000	–
Turun moderni puukaupunki − Linnanfältti	23 500	–
Tuusulan monitoimitalo Monio	–	8 800
Vantaan Puu-Kivistön puukerrostaloalue	50 000	6 260
Vantaan Tikkurilan puukerrostalot	6 000	–
Yhteensä	**394 882**	**80 915**
TODENNÄKÖISET HANKKEET		
Espoon Mäkkylän Bokylän puukerrostalot	13 000	–
Helsingin Aarteenetsijäntien puukerrostalot	18 900	–
Jyväskylän Kuokkalan Kalon	9 250	–
Kangasalan Lamminrahkan puukerrostalot	11 600	–
Keravan asuntomessujen puukerrostalo	3 754	–
Kirkkonummen Juhlakallion puukerrostalot	3 973	–
Kirkkonummen Tolsanmäen puukerrostalot	6 050	–
Kokkolan Kaustarinkadun puukerrostalo	1 090	–
Lahden Svinhufvudinkadun puukerrostalo	2 200	–
Oulun Ranta-Toppilan puukerrostalot	3 400	–
Pirkkalan Turrin puukerrostalo	2 000	–
Tampereen Hatanpään puukerrostalo	1 700	–
Tampereen Itsenäisyydenkadun puukerrostalot	9 780	–
Tampereen Kalevan puukerrostalokohde	10 500	–
Tampereen Pinninkadun puukerrostalo	6 000	–
Tampereen Tuomiokirkonkadun puukerrostalo	7 730	–
Vantaan Satomäentien puukerrostalot	13 800	–
Wasa Innovation Centerin Katedral	–	3 600
Yhteensä	**124 727**	**3 600**

MAHDOLLISET HANKKEET		
Helsingin Ala-Malmin puukerrostalot	6 700	–
Helsingin Hermanninrannan puukerrostaloalue	250 000	–
Helsingin Honkasuon puukerrostalot	6 350	550
Helsingin Jätkäsaaren kiertotalouskortteli	10 251	–
Joensuun Penttilänrannan puukerrostalokorttelit	24 900	–
Kokkolan Kosilan puukerrostaloalue	23 500	–
Kouvolan Brankkarin puukerrostalo	1 762	–
Kouvolan Tornionmäentien puukerrostalo	1 200	–
Mustasaaren Sepänkylän keskustan puukerrostalot	2 420	–
Oulun Hartaanselän Varikon Torni	7 550	–
Oulun Puu-Linnanmaan Virkakadun puukerrostalot	ei tietoa	–
Oulun Toppilansaaren puukerrostalot	13 250	–
Rauman Papinpellon puukerrostaloalue	5 200	–
Seinäjoen vanhan paloaseman seudun puukerrostalokortteli	9 000	–
Tampereen Ranta-Tampellan puukerrostalo	3 500	–
Uudenkaupungin Ketunkadun puukerrostalot	10 448	–
Vihdin Pajuniityn alue	90 400	–
Yhteensä	**466 431**	**550**
KAIKKI YHTEENSÄ	**986 040**	**85 065**

HANKKEIDEN KERROSALAT TAULUKOITUNA MAAKUNNITTAIN

MAAKUNTA / HANKE	KERROSALA ASUMINEN (k-m²)	KERROSALA MUU (k-m²)
1. Lappi	**–**	**–**
2. Pohjois-Pohjanmaa	**24 200**	**–**
Oulun Hartaanselän Varikon Torni	7 550	–
Oulun Puu-Linnanmaan Virkakadun puukerrostalot	ei tietoa	–
Oulun Ranta-Toppilan puukerrostalot	3 400	–
Oulun Toppilansaaren puukerrostalot	13 250	–
3. Kainuu	**17 500**	**–**
Kajaanin Sammonkaari	17 500	–
4. Pohjois-Karjala	**24 900**	**–**
Joensuun Penttilänrannan puukerrostalokorttelit	24 900	–
5. Pohjois-Savo	**5 787**	**–**
Kuopion Julkulan puukerrostalot	5 787	–
6. Etelä-Savo	**–**	**–**
7. Etelä-Karjala	**–**	**–**
8. Keski-Suomi	**9 250**	**–**
Jyväskylän Kuokkalan Kalon	9 250	–
9. Etelä-Pohjanmaa	**9 000**	**–**
Seinäjoen vanhan paloaseman seudun puukerrostalokortteli	9 000	–
10. Pohjanmaa	**2 420**	**3 600**
Mustasaaren Sepänkylän keskustan puukerrostalot	2 420	–
Wasa Innovation Centerin Katedral	–	3 600
11. Keski-Pohjanmaa	**24 590**	**–**
Kokkolan Kaustarinkadun puukerrostalo	1 090	–
Kokkolan Kosilan puukerrostaloalue	23 500	–
12. Pirkanmaa	**141 810**	**750**
Kangasalan Lamminrahkan puukerrostalot	11 600	–
Pirkkalan Turrin puukerrostalo	2 000	–
Tampereen Hatanpään puukerrostalo	1 700	–
Tampereen Hervantajärven puukerrostalot	5 000	750
Tampereen Hippos	35 000	–
Tampereen Itsenäisyydenkadun puukerrostalot	9 780	–
Tampereen Kalevan puukerrostalokohde	10 500	–
Tampereen Pinninkadun puukerrostalo	6 000	–
Tampereen Ranta-Tampellan puukerrostalo	3 500	–
Tampereen Rauhaniementien puukerrostalo	3 000	–
Tampereen Tuomiokirkonkadun puukerrostalo	7 730	–
Tampereen Vuoreksen Isokuusen alue	46 000	–
13. Satakunta	**5 200**	**–**
Rauman Papinpellon puukerrostaloalue	5 200	–
14. Päijät-Häme	**2 200**	**–**
Lahden Svinhufvudinkadun puukerrostalo	2 200	–
15. Kanta-Häme	**–**	**–**
16. Kymenlaakso	**2 962**	**–**
Kouvolan Brankkarin puukerrostalo	1 762	–
Kouvolan Tornionmäentien puukerrostalo	1 200	–

17. Uusimaa	**682 273**	**80 715**
Espoon Djupsundsbäckenin puukerrostalot	6 600	–
Espoon Keilaniemen Portti	–	23 105
Espoon Metsäpirtintien puukerrostalot	9 000	–
Espoon Mäkkylän Bokylän puukerrostalot	13 000	–
Helsingin Aarteenetsijäntien puukerrostalot	18 900	–
Helsingin Ala-Malmin puukerrostalot	6 700	–
Helsingin Hermanninrannan puukerrostaloalue	250 000	–
Helsingin Honkasuon puukerrostalot	6 350	550
Helsingin Jätkäsaaren kiertotalouskortteli	10 251	–
Helsingin Jätkäsaaren Wood Cityn toimistorakennus ja hotelli	–	19 000
Helsingin Katajanokan Laituri	–	23 000
Helsingin Karhukallion puukerrostalokorttelit	52 050	–
Helsingin Kuninkaantammen Etelärinteen puukerrostaloalue	28 600	–
Helsingin Kuninkaantammen Lammenrannan puukerrostaloalue	38 300	–
Helsingin Leankadun puukerrostalo	2 100	–
Helsingin Oulunkylän puukerrostalot	6 317	–
Helsingin Pasilan Postipuiston Reformikortteli	11 900	–
Järvenpään Kirjastokadun ja Myllytien puukerrostalot	7 200	–
Keravan asuntomessujen puukerrostalo	3 754	–
Keravan Kurkelan puukerrostalot	6 063	–
Kirkkonummen Juhlakallion puukerrostalot	3 973	–
Kirkkonummen Pyssysepänkaaren puukerrostalo	5 970	–
Kirkkonummen Tolsanmäen puukerrostalot	6 050	–
Porvoon Länsirannan puukerrostalokortteli	15 245	–
Porvoon Tehtaanpuiston puukerrostalot	13 750	–
Tuusulan monitoimitalo Monio	–	8 800
Vantaan Puu-Kivistön puukerrostaloalue	50 000	6 260
Vantaan Satomäentien puukerrostalot	13 800	–
Vantaan Tikkurilan puukerrostalot	6 000	–
Vihdin Pajuniityn alue	90 400	–
18. Varsinais-Suomi	**33 948**	**–**
Turun moderni puukaupunki − Linnanfältti	23 500	–
Uudenkaupungin Ketunkadun puukerrostalot	10 448	–
19. Ahvenanmaa	**–**	**–**

VISUALISOINTIT KARTALLA

PUUKERROSTALOHANKEKANNAN KERROSALAMÄÄRÄT MAAKUNNITTAIN

1. Lappi
–

2. Pohjois-Pohjanmaa
4 hanketta
24 200 k-m² 2,3 %

3. Kainuu
1 hanke
17 500 k-m² 1,6

4. Pohjois-Karjala
1 hanke
24 900 k-m² 2,3 %

5. Pohjois-Savo
1 hanke
5 787 k-m² 0,5 %

6. Etelä-Savo
–

7. Etelä-Karjala
–

8. Keski-Suomi
1 hanke
9 250 k-m² 0,9 %

9. Etelä-Pohjanmaa
1 hanke
9 000 k-m² 0,8 %

10. Pohjanmaa
2 hanketta
6 020 k-m² 0,6 %

11. Keski-Pohjanmaa
2 hanketta
24 590 k-m² 2,3 %

12. Pirkanmaa
12 hanketta
142 560 k-m² 13,3 %

13. Satakunta
1 hanke
5 200 k-m² 0,5 %

14. Päijät-Häme
1 hanke
2 200 k-m² 0,2 %

15. Kanta-Häme
–

16. Kymenlaakso
2 hanketta
2 962 k-m² 0,3 %

17. Uusimaa
30 hanketta
762 988 k-m² 71,2 %

18. Varsinais-Suomi
2 hanketta
33 948 k-m² 3,2 %

19. Ahvenanmaa
–

良質なストック形成等に向けた、木造建築物への融資における合理的な融資期間等に関する普及・広報			
会議名	**Interview meeting for wood construction in terms of durability/木造に関する耐久性の観点からみたインタビュー会議**		
日時	13th January, 2023 14:00-16:00/2023年1月13日14:00-16:00		
場所	City of Helsinki, meeting room/ヘルシンキ市会議室		
出席者	Sanna Merilainen(SM・Development Manager), City of Helsinki/メリライネン サンナ（ヘルシンキ市・開発マネージャー） ,Daishi Sakaguchi(DS), Nihon Fukushi Uni・Associate Professor /坂口大史（日本福祉大学・准教授）		
作成日	2023年1月16日	**記入者**	坂口大史

■ 議事	
議題	（1）The general maintenance plan in terms of City of Helsinki/ヘルシンキ市の観点からみた一般的なメンテナンス計画について （2）Situation of Finnish market for wood construction/木造建築に関するフィンランドの市場の状況について
内容	(1) The general maintenance plan in Finland - Is there regulations or budget plan for multi-story wood construction by City of Helsinki? (DS) For city, wood structure or concrete structure are same in terms of maintenance. Lifecycle for wood building or concrete building are also set as the same in Finland. Only the case for exterior wall with wood has different stories. For this case, maintenance is more carefully considered. (SM) - I understand that Wood City in the Jäkkasaari area is led by the City of Helsinki, but is it promoted by the city? (DS) - The city plan is drawn up by the City of Helsinki, the office building is owned by supercell and the residential buildings are owned by HEKA. (SM) - According to the previous interviews, only wood exterior is the issues. Do you have more opinions? (DS) Exterior wood outside will require more regular maintenance every 5 years or 10 years but when we must change them completely, it is relatively easier to change it to new ones. (SM) - It is said that about 1.5 % of total building cost is reserved as maintenance cost. Do you have regulated percentage or cost in City of Helsinki? (DS) -Details are unknown as the city has not set regulations, but should depend on the type and size of the building. (SM) - How is the situation of wood construction for City of Helsinki? (DS) City is also trying to promote wood construction for lower emission and reduce CO2.

	Some of urban planning will require the project to do wood construction in specific areas. (SM) （2） Situation of Finnish market for wood construction - As the city, the trend for wood construction will be continued? (DS) City is interested in modular and industrialized method for small apartment buildings in countryside. In particular, I feel that if industrialization is promoted, cost reduction and quality stabilization will become possible, leading to the spread of wooden construction. (SM) - I heard the same thing from the Ministry of Environment. Is there a common understanding between the City of Helsinki and the Ministry of Environment that the industrialization of wooden buildings will affect the future spread of wooden buildings? (DS) It is the same idea. The current regulations regarding wooden structures will expand the market possibilities, since the previous law and the return to the previous law allow for a little higher buildings (specifically, up to 8 stories). Wooden construction is also a trend in Finland. Finland is also trying to build taller buildings with wooden structures. (SM) （日本語訳） (1) ヘルシンキ市の観点からみた一般的なメンテナンス計画について ・ ヘルシンキ市による高層木造建築に関する規制や予算計画はどの様なものがあるか？(DS) - ヘルシンキ市としては、木造もRC造もメンテナンスの点では同じであると認識している。また、ライフサイクルも木造、RC造とも同じである。ただ、外壁が木造の場合だけ、話が異なる。外壁に木を用いる場合、メンテナンスはより慎重に検討される必要がある。(SM)。 ・ ヤッカサーリ地区にあるWood Cityはヘルシンキ市が主導している聞いているが、実際に市が推進しているのか？(DS) - 都市計画はヘルシンキ市によって策定されており、オフィス棟はsupercell社が所有、住宅はHEKAの所有になっている。(SM) ・ これまでのインタビューでは、木造と言ってもメンテナンス面では他の構造と違いはなく、木の外装だけが問題視されていた。これについてヘルシンキ市として、他ご意見はあるか？(DS) - 木による外壁は、5年、10年と定期的なメンテナンスが必要となるが、外壁を完全に交換する場合は、RCの外壁に比べると新しいものに変えるのが比較的簡単であるという利点もある。(SM) ・ 日本では、総建築費の1.5%程度がメンテナンス費用として確保されていると言われている。ヘルシンキ市では、メンテナンスに関して、その割合や費用に規制は存在するのか？ (DS) - 市としては規制を設定していないため詳細は不明であるが、建物のタイプや規模に

	よって異なるはずである。(SM) ・ ヘルシンキ市の木造建築の現在の状況はどうであるか。(DS) - 市も低排出ガス、低CO2のために木造建築を推進しようとしている状況である。また、都市計画の中には、特定のエリアでは木造建築を行うことを要求するプロジェクトもある。カーボンニュートラルも含めた市の取り組みや将来的な計画については添付の資料を参考にしてほしい。(SM) （2）木造建築に関するフィンランドの市場の状況について ・ ヘルシンキ市として、木造建築のトレンドは継続されると考えているか？(DS) - ヘルシンキ市は、田舎の小さなアパートのモジュール化・工業化工法にとても関心をもっている。特に産業化が進めばコストダウンや品質の安定化が可能となり木造建築の普及につながると感じる。(SM) ・ 私も環境省から同じような話を聞いた。木造建築の工業化が今後の木造建築の普及を左右するという点はヘルシンキ市と環境省でも共通認識となっているのか？(DS) - 同じ考えである。今の木造に関する規制では、以前の法律と帰省して、もう少し高い建物（具体的には8階建まで）を建てることができますから、市場の可能性は広がると思われる。また、フィンランドでも木造建築がトレンドになっている。フィンランドも木造でより高い建物を建てようとしている。(SM)
備考	・特になし

■ 次回の予定	
日時	年　　月　　日（　　曜日）　　時　　分より
場所	

Helsinki

Carbon Neutral Helsinki

Action Plan

City of Helsinki, publications of the Central Administration 2022:34
Publication name: Carbon Neutral Helsinki Action Plan
https://helsinginilmastoteot.fi/en/
Publication year: 2022
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Emissions reduction target and development

Emissions reduction target

Helsinki has set a target of becoming carbon neutral by 2030, attaining carbon zero status by 2040 and aiming to become carbon negative afterwards (City of Helsinki 2021).

The target of this emissions reduction plan is carbon neutrality, i.e. reducing the direct emissions level of the year of comparison, 1990, by at least 80% by 2030 and compensating for the remaining emissions (up to 20%). In the later target of attaining carbon zero status, the option of external compensation will no longer be available: the emissions must be reduced down to a level where the City's own carbon sinks can compensate for the remaining emissions. The actions determined for achieving the target are presented in Appendix 1.

In 2021, the total direct emissions of Helsinki were 2,345 kt CO_2e, which means that the emissions were reduced by 33% from the year of comparison, 1990 (Figure 1). The numerical target for the total emissions reduction is 80% by 2030. The target applies specifically to direct emissions, i.e. emissions generated within the City's geographical borders. Even so, some actions are also aimed at indirect ('Scope 3') emissions.

- Emissions in 1990: 3,514 kt CO_2e.
- To achieve the carbon neutrality target, the City must reduce emissions from the 1990 level by 80%, or 2,812 kt CO_2e, at the minimum.
- Only up to 20%, 702 kt CO_2e, can be compensated for.

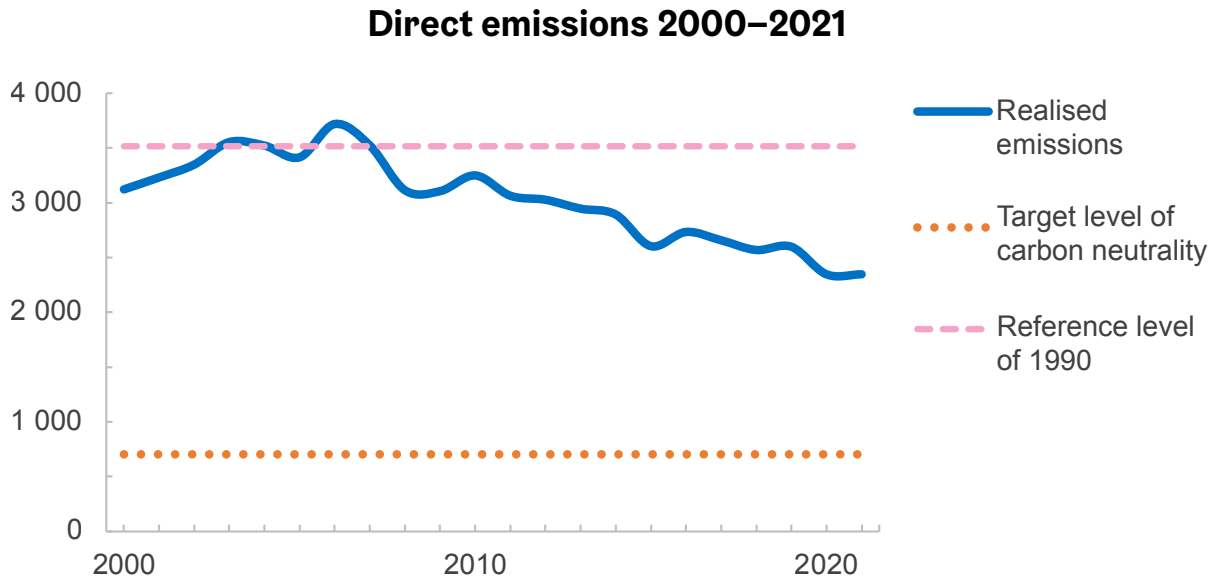

Figure 1. Development of total direct emissions (kt CO_2e) in Helsinki in 2000–2021 (HSY 2022A).

Key sources of emissions

In Helsinki, the most significant sources of direct emissions are heating, transport and electricity (Figure 2). The action plan focuses especially on emissions reductions in these sectors.

Distribution of direct emissions in 2021

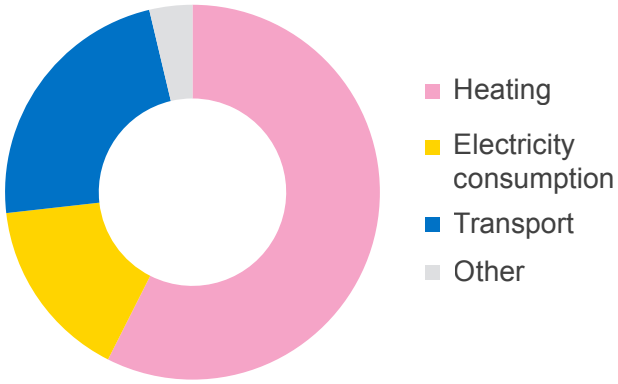

Figure 2. Distribution of direct sources of emissions in Helsinki in 2021

Heating

Of the direct emissions in Helsinki, a significant majority (58%) come from heating. The emissions from heating are influenced by the amount of heating consumed and the emission factor for heating production. The amount of heating required can primarily be influenced by improving energy efficiency, while the emission factor of heating production can be influenced with zero-emission production methods.

A significant proportion of the emissions from heating in Helsinki (91%) comes from district heating consumption. As such, the specific emission factor for district heating production (an indicator in Helen's development programme) heavily dominates the emissions development (Figure 3).

The specific emissions of district heating 2000–2021 and forecast for 2030

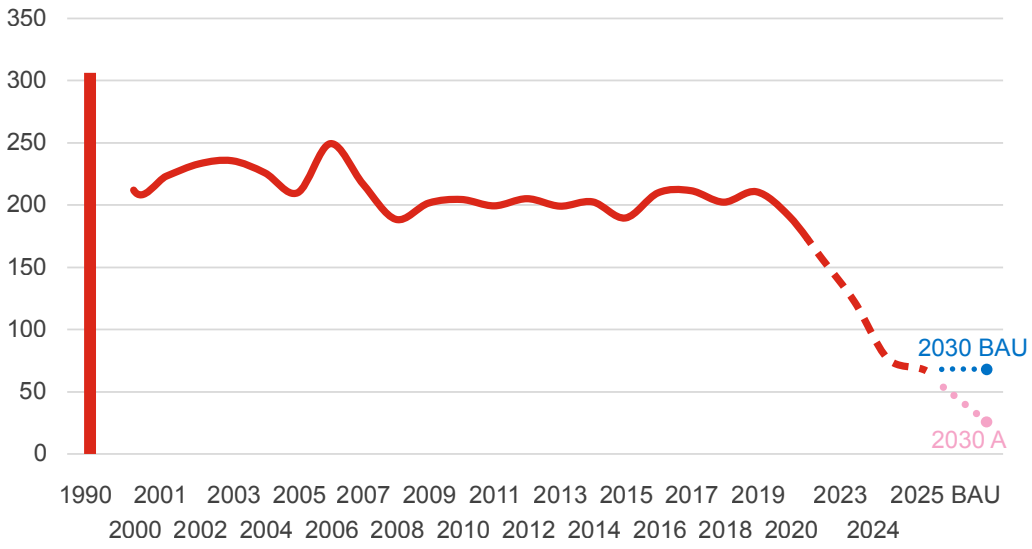

Figure 3. Specific emissions from district heating g CO_2e per kWh.

The total amount of heating energy in Helsinki has not changed very much over the years (Figure 4). In this context, 'heating energy' includes district heating and oil heating, whereas electricity used for heating is included in electricity consumption. Even as the City has grown rapidly, it has been able to take energy efficiency measures to cut down the need for additional energy caused by the growth. The systematic improvements to energy efficiency made since 2020 cannot yet be seen in the development due to the long urban development cycle.

However, the City presume that the need for heating energy will decrease over time thanks to these measures. In the estimate for total emissions from heating, the City have presumed that the consumption of district heating will not decrease (~6,300 GWh/year). However, if the total consumption of district heating decreases by 10% from the current level, it would reduce the total BAU emissions of 2030 by 7%. Compared to the emissions level of 1990, the emissions would decrease from -69% to -71% thanks to the above.

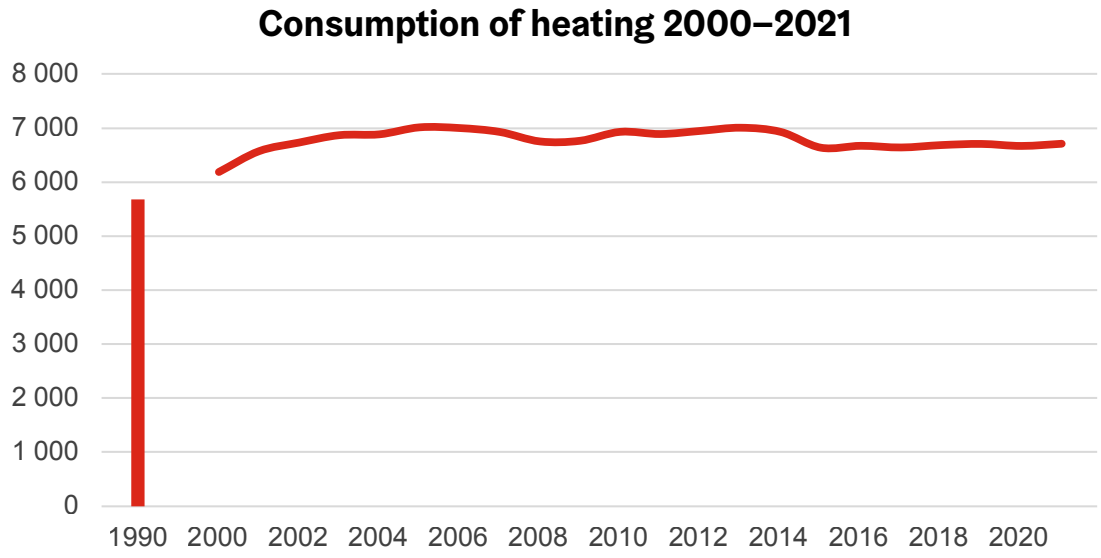

Figure 4. Heating consumption in Helsinki (GWh).

Transport

The second-largest emissions sector in Helsinki is transport (24%). Emissions from transport are influenced not only by mileage, but also the specific emissions of the modes of transport used. Most transport emissions (58% in 2021) come from passenger car traffic, with heavy traffic accounting for 18%, buses for 6% and ship traffic for 16% (HSY 2022). As for mileage, the most impactful measure is reducing the volume of passenger car transport. The specific emissions of modes of transport can best be influenced by moving on to low-emission motive power. The total emissions from transport are already on the decrease, but development without additional measures will lead to a significantly lower emissions reduction than desired for transport by 2030 (Figure 5).

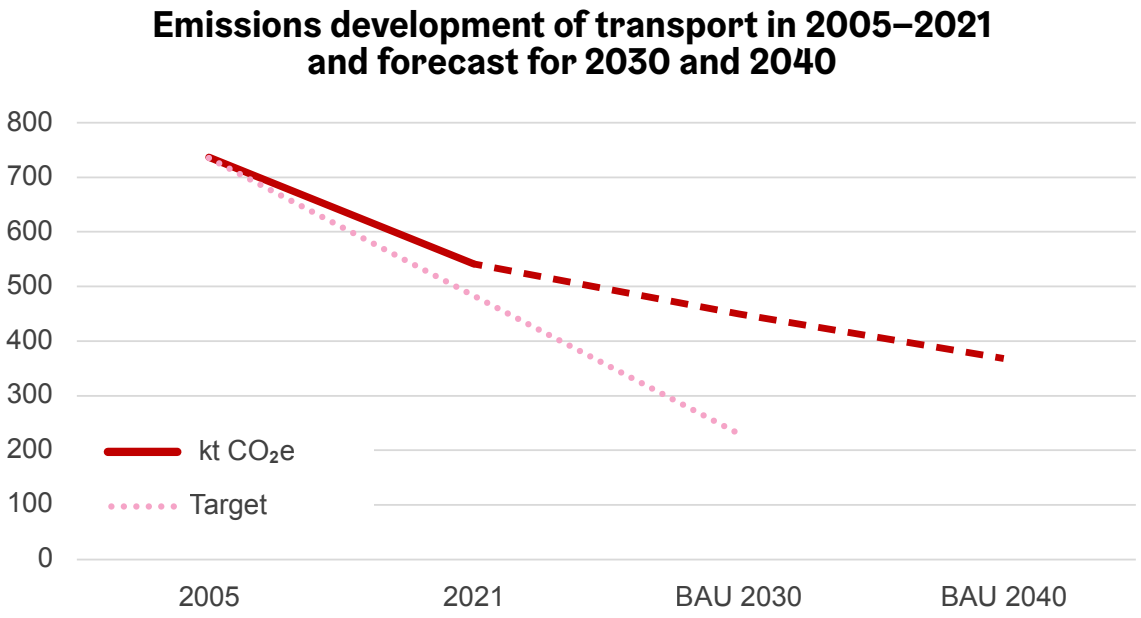

Figure 5. Using the current measures, the emissions reduction in 2030 will be -37% from the 2005 level, while the target is set at -69% (WSP Finland Oy 2022).

Electricity

Of the direct emissions in Helsinki, 13% come from the consumption of electricity. The emissions from electricity consumption are influenced by the amount of electricity and also the emission factor for electricity production. The emission factor for electricity production is currently decreasing rapidly (Figure 6); even now, as much as 67% of electricity produced in Finland is CO_2-free. However, electricity consumption will likely increase over time as vehicles and heating are being increasingly powered by electricity, but this increase in consumption will be compensated by the rapidly increasing share of CO_2-free electricity production.

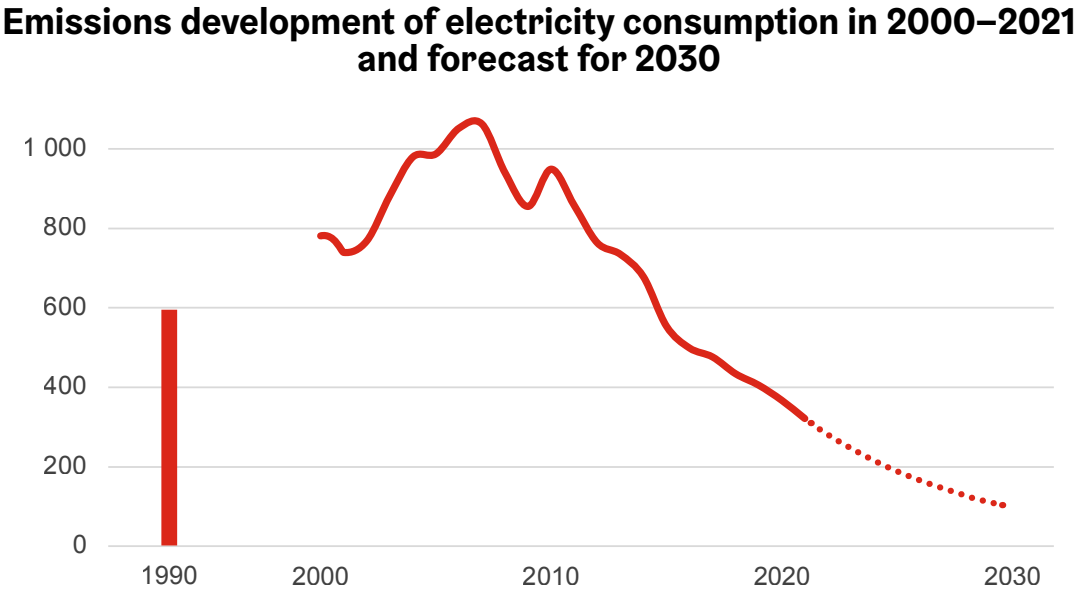

Figure 6. The emissions from electricity consumption are on the decrease (HSY 2022).

Development and monitoring of emissions

An essential indicator to follow is the development of total direct emissions in Helsinki (Figure 7). Emissions are being monitored by using a verifiable calculation model. To ensure the availability of up-to-date information, the aim is to accelerate the assessment cycle. At the moment, the realisation of direct emissions (Scopes 1 and 2) is being monitored through the shared GHG emission calculation system of the Metropolitan Area, produced by the Helsinki Region Environmental Services Authority (HSY). The monitoring is based on the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC) and built on the framework of the IPCC's calculation methods and parameters for national emission inventories and emission factors for fuel classifications as defined by Statistics Finland (more information on the method: HSY 2022A).

With the currently existing actions, the emissions will be 1,098 kt CO_2e in 2030, whereas carbon neutrality requires that the emissions are cut down to the level of 702 kt CO_2e. The reduction from the 1990 level is 69%.

Emissions development in 2000–2021 and forecast for 2030

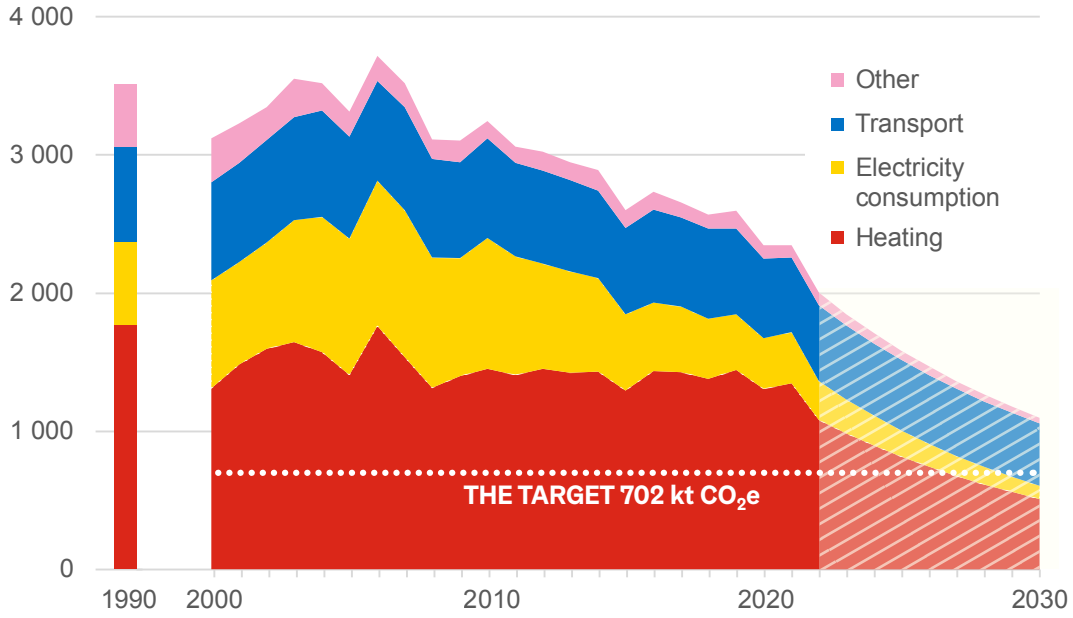

Figure 7. Development of total direct emissions in Helsinki by sector (Realised emissions: HSY 2022A).

The plan' s sector-specific estimates for emissions development will be carried out so that they are compatible with HSY's emissions monitoring. The development of the specific emission factor for district heating was assessed by HSY based on the production scenarios delivered by the energy company Helen (HSY 2022B). The development of specific emissions from electricity consumption is based on Fingrid's (2022, p. 65) growth forecast for electricity consumption in Finland and on Finnish Energy's (2020) forecast for the development of specific emissions from electricity consumption. The emissions development for transport is based on an estimate by WSP (WSP Finland Oy 2022).

The achievement of the emissions reduction target can primarily be influenced through actions that directly reduce emissions (Category 1). As for previous and currently proposed actions, 50% of the actions will reduce emissions directly, 33% will facilitate emissions reductions, and 17% involve surveys to determine new emissions reduction actions (Figure 8).

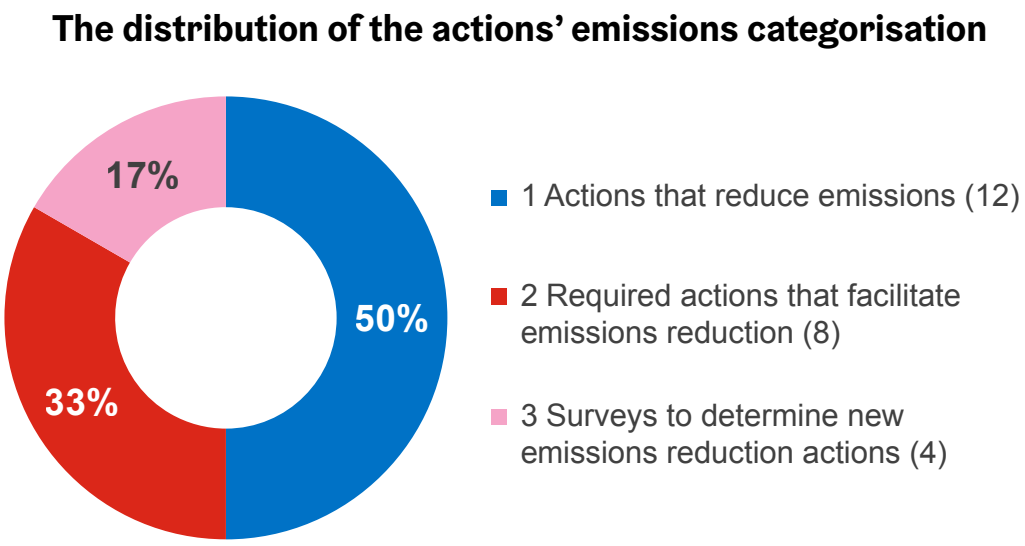

Figure 8. The distribution of the actions' emissions categorisation for both the previous actions and the new actions proposed.

Principles of the emissions reduction plan

Definitions of the actions

The purpose of the actions is to realise the target in question. When operating on a tight schedule and with limited resources, the effectiveness of the actions to be selected into the plan is emphasised. To ensure sufficient effectiveness, most actions will be directed so that, instead of short-term pilots, the operations' continuous change towards the target will be ensured. For example, cooperation on projects and networks will only occur when they significantly support the achievement of the strategic objectives. In the action preparation phase, the City will ensure that the actions' additionality, effectiveness of emissions reductions, indicators, cost effects and parties responsible will be defined clearly and that the actions are justified.

The additionality ensures that resources in the plan are allocated primarily to actions that are not already a part of official work or actions that have been defined elsewhere. This plan will only include such actions that would not be realised without the support from the plan and that are essential for the achievement of the emissions reduction target. The definition of the actions is tied to sector-specific scenarios for direct emissions. With them, the City can ensure that the gap between the BAU development and emissions reduction target is bridged. The effectiveness of emissions reductions will be defined for category 1 actions that promote direct emissions reductions. For category 2 and 3 actions, the effectiveness is not calculated, as they have an indirect impact on the emissions reductions, they are difficult to verify, and they are strongly dependent on the premise selected.

The actions are divided into three categories based on the effectiveness of the emissions reductions. The distribution of the categories will be monitored annually:

1. Actions that reduce emissions: the action has a direct impact on the sectors selected as focal areas; moving forward, most new actions will be in this category.
2. Required actions that facilitate emissions reduction: the action is a prerequisite for implementing the category 1 actions, even though the action itself does not involve a direct impact on the emissions reductions.
3. Surveys to determine new emissions reduction actions: the actions require additional preparation or studies with the aim of preparing category 1 and 2 actions.

An indicator determines what is the essential aspect to monitor in terms of the action and the level at which the action can be considered to be completed. The indicators will be monitored at the same cycle as the total emissions, and they will include a target schedule whenever possible. Reviewing the cost effects is a way to ensure that an action is realisable with the resources being used or allocated separately. The party responsible is an unambiguous definition of who is responsible for implementing an action and/or the coordination of any cooperation required by it. In principle, only these operators are involved in the work on the plan.

Target monitoring and updates to the actions

There are about two council terms left to achieve the carbon neutrality target. In order to rapidly react to factors that influence technological development, political and other types of guidance and other emissions, the actions will be updated annually, moving forward. Sets of actions that extend over a council term are no longer suitable. With carefully targeted monitoring, the City can ensure that the City is making progress towards the emissions reduction target. Monitoring will be carried out annually to define the sufficient additional actions. Based on the monitoring, necessary actions based on the latest information may be added to the plan regularly. The Ambitious Climate Responsibility programme group and the operative Carbon Neutral Helsinki group will report on the target monitoring to the City Board every autumn, about 6 months before the closing of the accounts. The reporting will pay special attention to the definition of the emissions reduction actions, the progress of the actions, and additional actions when they are needed.

Moving forward, the actions in the emissions reduction plan will be updated annually and approved as a part of the budget proposal. In connection with this, reports will also be submitted for the realised emissions development by sector and the estimated impact of new actions proposed on future emissions development. In connection with the update, the City will ensure that the new additional actions will support the achievement of the emissions reduction target even when the City has fallen behind from the target in the previous periods. This approach corresponds, for the relevant parts, to the programming method of the City of Oslo called the climate budget.

The key indicator for monitoring is the development of the City's total emissions. The progress on the target will also be monitored through the following sector-specific indicators:

- specific emission factor for district heating (an indicator in Helen's development programme);
- total heating consumption;
- total emissions of transport; and
- emissions of electricity consumption (including the volume of electricity consumed and the emission factor for electricity production).

In addition to this, the distribution of the actions' emission categorisation and the progress on individual actions will be monitored when this is necessary for seeing the strategic overview, maintaining situational awareness and allocating resources appropriately. The indicators for individual actions are defined when the action is established. Indirect emissions, i.e. consumption-based Scope 3 emissions, will be taken into consideration in a more target-oriented manner. To prioritize effective actions through which the City itself can make a difference, the focus of indirect emissions will be on construction - in accordance with the City strategy.

A platform based on the plan's structure will be established for monitoring the emissions reduction plan.

In the future, the suitability of the existing monitoring and networking practices will be assessed in terms of their actual contribution to achieving the targets. Additional monitoring practices and networks will be abandoned if they do not add significant value for the work on emissions reductions. Based on this assessment, it has already been decided that CDP reporting will cease.

For its part, the Carbon Neutral Helsinki Action plan supports several of the UN's sustainable development goals (SDGs), and progress is also reported in the City's Voluntary Local Reviews (VLR) report.

Management

The Climate Unit within the City's Urban Environment Division will be in charge of the coordination, updates, monitoring and continuous development related to the Carbon Neutral Helsinki Action plan.

Ambitious climate responsibility, and the Carbon Neutral Helsinki Action Plan as a part of this, is one of the City's four cross-administrative strategic programmes. The work will be directed by a programme group chaired by the Mayor.

To ensure the implementation and impact of the actions agreed on and to prevent delays, a Carbon Neutral Helsinki coordination group will be formed of the managers in the City organisation who hold decision-making power in the plan's focus areas. The group will be chaired by the City Manager. The group in question will streamline the steering of the implementing organisation and monitor the progress on the actions.

The steering of companies owned by the Helsinki City Group is ensured through Helsinki City Group steering, as defined in the administrative regulations.

Other climate-related work

Actions that influence direct emissions and that are carried out as a part of official work have not been included in the Carbon Neutral Helsinki Action Plan. Also actions related to indirect emissions have mainly been excluded. They will be supported and monitored through the Environment and Climate Network coordinated by the Environmental Management Team and the Climate Unit of the City's Urban Environment Division. The network includes experts that are responsible for environmental and climate-related work in public divisions and enterprises. HSY will be the primary operator to carry out consumption-related influencing and communication directed at residents, based on the City's strategic steering.

The first Carbon Neutral Helsinki Action Plan (City of Helsinki 2018) included many actions that focused on indirect emissions (actions #90–#128, in particular). Some actions were completed during the first period of the plan. Some actions were integrated into other operations, and their implementation will continue as a part of ordinary official work. The actions that require separate resourcing and where the implementation is still underway have been transferred to the City's other action plans where relevant (Appendix 2).

In accordance with the existing ownership strategies, most of the City's subsidiary communities have prepared or are about to prepare carbon neutrality plans, through which they can contribute to the City's carbon neutrality objectives. In the new City Strategy, A Place for Growth (City of Helsinki 2021), it is stated that the energy company Helen must update its own development programme. In addition to this, the Port of Helsinki Ltd (2022), Helsinki City Housing Company Ltd Heka (2022) and Metropolitan Area Transport Ltd (2022) all have their own emissions reduction plans. The City's subsidiary communities carry out their climate work independently, and they are directed through ownership steering. The steering of subsidiary communities' climate work will be developed as needed and supported by the Climate Unit and the Environmental Man-

agement Team of the Urban Environment Division.

In the work on the Carbon Neutral Helsinki Action Plan, the indicators of key subsidiary communities will be monitored insofar as they significantly impact the City's total emissions development. An essential indicator is the specific emission factor for district heating as defined by the energy company Helen, which has a direct and significant impact on the City's heating emissions.

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APPENDIX 1:

Actions in the emissions reduction plan

Previous policies and their progress

Theme	Action	Progress
CATEGORY 1: Actions that reduce emissions		
Heating	Planning and implementing City facilities and service buildings so that the E value will be -30% of the national threshold value for the use class.	**Well underway**
Heating	Renovation projects of City facilities and service buildings will be implemented so that the E value will decrease by 34% of the buildings' original E value.	**Well underway**
Heating	Requiring energy class A of residential blocks of flats (use class 2) in the property conveyance conditions.	**Well underway**
Heating	Requiring energy class A of residential blocks of flats (use class 2) in detailed planning.	**Well underway**
Heating	In detailed planning, buildings other than residential ones will be required to be of a class that is -20% of the national norm set for that type of building.	**Well underway**
Heating	The main heating system selected for the City's facilities and service buildings will be a heat pump system if its repayment period is under 15 years and its implementation is technically feasible.	**Progressing moderately well**
Transport	Exchanging City-owned passenger cars for electric cars in 2021–2025.	**Not on schedule:** Delays in the construction of charging stations; cars have not been replaced as planned.
CATEGORY 2: Required actions that facilitate emissions reduction		
Heating	Launching Energy Renaissance guidance services.	**Well underway**
Heating	Allowing the construction of geothermal heating systems in public areas.	**Well underway:** the principle has been approved (Urban Environment Committee 1 February 2022); first advance enquiries have been answered
Transport	The plot conveyance conditions will require that new sites' parking spaces be implemented so that they are electrified and one third of the spaces are equipped with a charging station.	**Well underway**
Transport	Implementing the Bicycle Action Plan.	**Not on schedule.** Indicators to be monitored: Construction of the inner city target network : 50.0 km (target of 130 km); construction of the Baana cycling network: 20.1 km (target of 130 km); modal share of cycling: 9 % (City of Helsinki 2022).

New actions proposed in 2022

Theme	Action	Party responsible
CATEGORY 1: Actions that reduce emissions		
Heating	Adjusting the ventilation in City facilities to an appropriate level.	Urban Environment Division
Heating	Lowering temperatures in City-controlled facilities.	Urban Environment Division
Construction (Scope 3)	Low-emission concrete in infrastructure projects.	Urban Environment Division
Construction (Scope 3)	Reducing the emissions from the preconstruction at the former Malmi Airport area by 50%.	Urban Environment Division
Electricity	Replacing outdoor lights with LED lights.	Urban Environment Division
CATEGORY 2: Required actions that facilitate emissions reduction		
Heating	Principles for low-temperature regional heating entities.	Urban Environment Division
Transport	Reprogramming the implementation plan of the Baana cycling network and the target network up to 2030.	Urban Environment Division
Transport	Constructing charging stations for electric cars in line with the forecast on the number of electric cars.	City Executive Office/Urban Environment Division
Heating, electricity	Establishing tendering processes for the energy solutions for City-owned facilities.	Urban Environment Division
CATEGORY 3: Surveys to determine new emissions reduction actions		
Heating, construction (Scope 3)	Review on steering construction through carbon footprint.	Urban Environment Division/City Executive Office
Heating, electricity	Accelerating the energy efficiency improvements on City-owned properties outside renovation projects (Definition of the implementation process for energy surveys).	Urban Environment Division
Transport	Review of emissions reduction methods for transport.	Urban Environment Division
Transport	Promoting the definition of effective regional emissions reduction measures on mobility.	Urban Environment Division/City Executive Office

Category 1: Actions that reduce emissions

ACTION: Adjusting the ventilation in bookable City facilities to an appropriate level.

Controlling ventilation according to demand is an essential action to be taken between renovation projects to improve the energy efficiency of buildings. Appropriate use of the system refers to the ventilation system not being used at night when there is no one in the building, and as such, there are no sources of humidity. It also refers to controlling the air flow based on the number of people in the room. Ventilation requires heating energy to increase the air supply temperature to the desired level. When the ventilation machines are not running while there are no activities or people in the building, a significant amount of heating energy can be saved, and good indoor air quality can still be ensured when the buildings are occupied. The potential of adjusting the operating hours of ventilation systems has been studied together with the City's divisions. Based on the study, the most cost-effective way is to equip facilities that operate outside regular hours with carbon dioxide meters based on which the ventilation is controlled.

- Indicator: Facilities that can be booked outside regular hours will be prioritised, and carbon dioxide meters will have been installed in all such sites by the end of 2025.
- Impact on emissions reductions: -20,000 tCO_2e/year in comparison to a situation where the ventilation system is running full-time. There is no information available on the current usage rate of the ventilation systems.
- Cost effect: -11 million euros/year in comparison to a situation where the ventilation system is running full-time. There is no information available on the current usage rate of the ventilation systems.
- Party responsible: Urban Environment Division

ACTION: Lowering temperatures in City-controlled facilities.

Helsinki employs guidelines approved in October 2020 and based on the National Supervisory Authority for Welfare and Health's guidelines for applying the Housing Health Act. These guidelines offer instructions on controlling temperature conditions in various facilities and weather conditions. The guidelines also include target temperatures. At the same time, the City will perform energy surveys on dozens of service buildings and implement the necessary energy conservation measures on them. In addition to this, the Urban Environment Division has launched planning on what sort of quick and, if necessary, temporary additional measures can be implemented in the coming autumn and winter to cut down energy consumption and costs so that working conditions will remain at a sufficiently good level. To ensure rapid action, a clear decision will be made on how and in which locations temperatures will be decreased.

- Indicator: Decision to be made by the end of 2022 on how temperatures will be lowered wherever possible.
- Impact on emissions reductions: The consumption of district heating in properties directly owned by Helsinki was 391 GWh in 2021. If the temperature could be decreased by 2°C in half of the properties, the consumption of district heating would drop by 5%, or 20 GWh (with the assumption that a drop of 1°C in indoor temperature corresponds to a drop of 5% in heating energy consumption). With the emissions of 2021, the drop equals an emissions reduction of 3.7 kt CO_2e.
- Cost effect: To be carried out as official work. Lowering the temperature will reduce the consumption of heating energy. When calculated using the assumptions above, the savings achieved would be 5% of the district heating costs of properties directly owned by the City. The action is cost-positive.
- Party responsible: Urban Environment Division

ACTION: All infrastructure projects commissioned by the City will use low-carbon concrete that meets the class GWP.85 requirements as defined by Betoniyhdistys. The class required of low-emission concrete will be reviewed and updated annually, at the minimum.

Most of the carbon footprint of concrete-intensive infrastructure comes from the use of concrete. For example, 92% of emissions from the construction of the Jokeri Light Rail came from the materials' emissions, and in turn, 50% of these came specifically from the emissions of concrete. Since the volume of concrete used is often high, especially in infrastructure that requires subgrade reinforcement or concrete tiles, large reductions in Scope 3 emissions can be achieved by reducing the emissions from concrete. Often, there are not many alternatives for concrete in infrastructure construction, which is why using low-emission concrete is the simplest and quickest way of reducing the emissions of infrastructure construction. The concrete industry association (Betoniyhdistys) has published classifications for low-emission concrete. By using this classification, it is possible to set comparable and consistent criteria for low-emission concrete. The classification also makes it easier to hold tendering processes for

concrete. As such, it can also influence the procurement costs. Betoniyhdistys studied the availability of GWP.85-class concrete and discovered that all types of concrete used in infrastructure are available from multiple suppliers, so availability will not become a problem (Betoniyhdistys, to be published in spring 2022). Along with the criteria for low-carbon construction, the supply of low-emissions concrete will also grow. The decisions of the City of Helsinki also have a wider impact on the society, since the City's requirements as a major client set incentives and pressure for the construction product industry to develop their products and production processes. The pioneer status of a leading operator has a wider impact on the construction market beyond the operator's own actions.

- Indicator: The requirement of using low-carbon concrete is to be added in the procurement criteria. The requirement will enter into force on 1 January 2023. The level of the requirements will be reviewed annually.
- Impact on emissions reductions: -15% (GWP.85) compared to conventional concrete.
- Cost effect: +10–20% compared to conventional concrete. The estimate is based on the experiences from the Kalasatama–Pasila project. As competition increases, the price difference is expected to diminish. Furthermore, it must be taken into account that the price of concrete is only a fraction of a project's total costs. In the pilot site, the cost effect of low-emission concrete was only parts per thousand in the overall costs of the project. The price of conventional concrete will increase in the future, which will reduce the price difference even further.
- Party responsible: Urban Environment Division

ACTION: The emissions of the preconstruction of the former Malmi Airport will be reduced by 50% in 2020–2030, compared to the preliminary preconstruction plan.

The former Malmi Airport is located on clay soil typical of the Metropolitan Area. Before such areas are constructed on, the City of Helsinki will carry out preconstruction following a procedure developed in the 1970s–80s. The emissions estimate for the preconstruction in the former airport area is based on the preliminary preconstruction plan from 2017 (Figure 9). In the preliminary plan, the preconstruction is assessed to be carried out mainly by deep-stabilising the soft clay layer to control dents formed during use. Preconstruction by pillar stabilisation has been widely used in Helsinki since the 1980s, at which time the use of a burnt lime and cement mix ('compo') as a stabilisation binding agent started. When calculated in this fashion, the emissions of preconstruction were estimated to be 340 kt CO_2e. Based on the calculation, the most significant source of emissions is the production and transport of the binding agent for deep stabilisation, the proportion of which is 95% of the emissions. By replacing the binding agent used for the stabilisation with an available recycled agent, emissions can be reduced by 60–70%. When using binding agents in the commissioning phase,

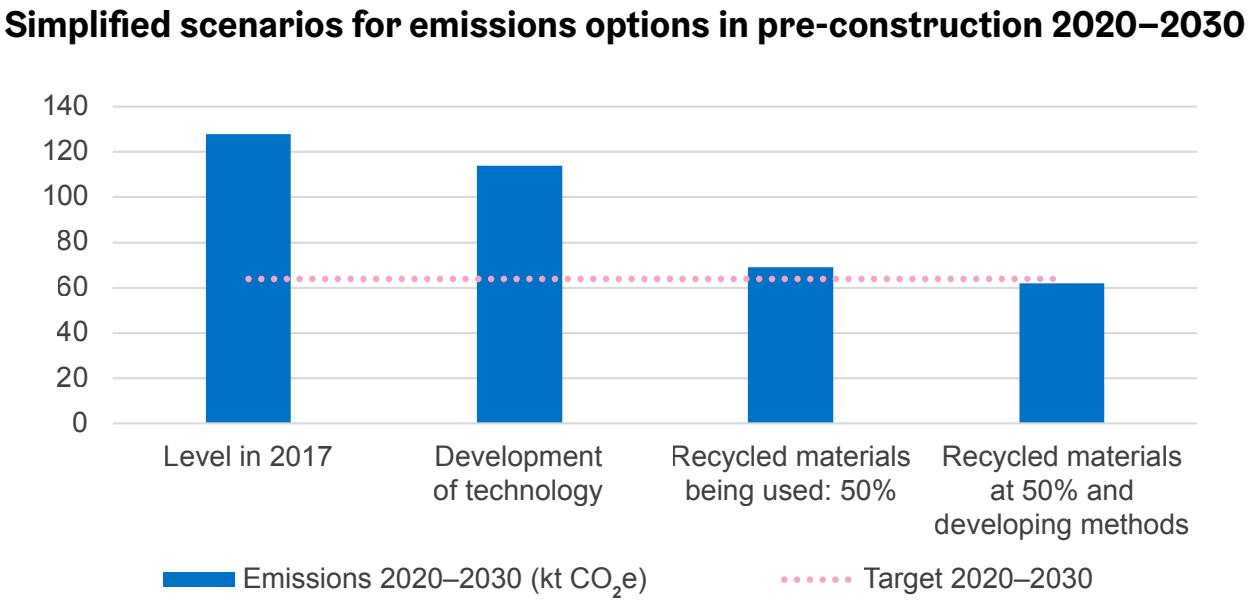


Figure 9. Simplified scenarios for emissions options in preconstruction 2020–2030.

the emissions reduction potential is even greater. Recycled binding agents are already being piloted at the first preconstruction sites in Malmi. By developing the stabilisation methods, emissions can further be reduced in the 2020s. In terms of the preconstruction that is underway in the area, it has been estimated that a cumulative emissions reduction target of 50% could be possible compared to the conventional solution by 2030. As materials, technologies and subgrade reinforcement methods develop, the level of the emissions reduction target can be reassessed.

- Indicator: Emissions reduction in preconstruction (-50%) compared to the conventional solution.
- Impact on emissions reductions: Direct impact on emissions reduction: a minimum of 64,000 tCO_2e by 2030 (-50% from the reference level of 2020–2030).
- Cost effect: Lower-carbon preconstruction will likely incur lower costs than the conventional option. The costs of the preliminary option for a preconstruction plan are increased due to the costs of burnt lime increasing along with the emissions trading in the EU. The objective will not affect the construction schedule.
- Party responsible: Urban Environment Division

ACTION: Replacing the City's outdoor lights with LEDs by 2030.

The area of Helsinki currently has about 70,000 outdoor light sources that use technology other than LED. Even now, all new lighting fixtures are automatically built to be based on LED technology. In addition to this, existing outdoor lights will be replaced so that the number of LED lights increases by about 4,000 pieces annually. A LED light source consumes about 80% less electricity than the existing lamps based on discharge technology. The service life of LEDs is remarkably long, which also allows us to save in maintenance costs. The repayment period of adopting LEDs is 5–7 years, depending on the type of fixture. This supports the adoption of LEDs also from a financial standpoint with regard to the average service life. The increasingly strict EU legislation will also make it more difficult to access the discharge lamps that are currently in use. To realise the action, the number of lamps being replaced by LEDs should double.

- Indicator: Number of lamps replaced by LEDs per year in relation to the annual target (8,000 pcs/year).
- Impact on emissions reductions: Direct impact on emissions reductions in relation to the City's total target for emissions reductions: less than 1%. The energy saving estimated for a single lamp is 50–75% compared to a discharge-based light source.
- Cost effect: additional cost €2.5 M/year in 2023–2025 and €2 M/year in 2026–2030. Depending on the type of lighting fixture, the repayment period is 5–7 years. The lifecycle costs will be added.
- Party responsible: Urban Environment Division

Category 2: Required actions that facilitate emissions reduction

ACTION: Principles for low-temperature regional heating entities.

In the heating roadmap prepared for the City of Helsinki in 2021, the promotion of low-temperature regional heating solutions was identified as a prerequisite for accelerating the development of a low-carbon heating ecosystem not based on combustion. The City will promote low-temperature grids by establishing processes to facilitate regional heating solutions. The City will create both the processes for the provision of regional commercial low-temperature solutions and the model for the implementation of block-specific solutions, and promote the adoption thereof. The preparation will be carried out through extensive cooperation with companies that offer heating solutions in this highly competitive market.

- Indicator: Principles for regional geothermal solutions to be approved in September 2022.
- Impact on emissions reductions: Facilitation of emissions reduction measures; no direct reduction of emissions.
- Cost effect: No additional cost effect; to be carried out as official work.
- Party responsible: Urban Environment Division

ACTION: Reprogramming the implementation plan for the Baana cycling network and target network up to 2030.

Moving the carbon neutrality target from 2035 to 2030 also means that the target for cycling as a mode of transport must be achieved five years earlier. The programming of the Baana cycling network and the target network must be accelerated at the same pace.

- Indicator: Reprogramming to be carried out in 2022.
- Impact on emissions reductions: Facilitation of emissions reduction measures; no direct reduction of emissions.
- Cost effect: No additional cost effect; to be carried out as official work.
- Party responsible: Urban Environment Division

ACTION: Ensuring that the number of charging stations for electric cars will grow in the City area, in line with the predicted increase in electric cars.

For the predicted vehicle electrification rate to be realised, there must be a sufficient number of charging stations for electric cars. In the coming years, the number of charging stations will also determine the emissions reduction realisation of plug-in hybrids: if there are no charging stations, combustion engines will be used, and the predicted emissions benefits will not be achieved. Most passenger cars will be charged at the parking areas and carparks of residential buildings, but this is not possible everywhere in the city. Charging stations are also needed for public and commercial properties, public areas and parking areas. The City must also prepare for acquiring an electric fleet of its own. The City applies various methods to promoting the construction of charging stations. For example, there is an existing process for the charging stations to be implemented in public areas, but not all types of charging stations have such a plan. The City is also lacking an overall view of how many charging stations have been built. The number of different types of charging stations around the city varies, which should be taken into account when implementing the action.

- Indicator: Annual number of charging stations in relation to the forecast on electric cars. The plan for promoting charging stations to be made in 2022.
- Impact on emissions reductions: Facilitation of emissions reduction measures; no direct reduction of emissions.
- Cost effect: The direct costs incurred by the City come from the implementation of the charging stations in the City's own properties.
- Party responsible: City Executive Office/ Urban Environment Division

ACTION: Establishing a tendering process for the energy solutions for City-owned facilities.

During the work on the City's Roadmap for Carbon Neutral Heating, one of the measures identified as being within the City's sphere of influence was that the City would open the implementation of the heating systems in its facility complexes and area construction sites for tendering. At the moment, heating solution providers do not have the opportunity to offer their solutions due to the missing process phase. The current process does not support the business development objectives or ensure the realisation of best heating solutions in the City's own properties. The City will establish and implement a process that allows the providers of various energy solutions to offer their solutions to the City's facilities and area construction sites.

- Indicator: Process to be established and implemented by 30 June 2023.
- Impact on emissions reductions: Support for emissions reduction measures; no direct impact on emissions reductions.
- Cost effect: No additional cost effect; to be carried out as official work.
- Party responsible: Urban Environment Division

Category 3: Surveys to determine new emissions reduction actions

ACTION: Carrying out a survey through which the threshold value for the carbon footprint can be defined in the steering for building construction.

The City is currently steering new construction using an E value criterion. Whether the criterion is fulfilled is especially influenced by the structural energy efficiency of the building, its main heating system and the volume of renewable energy produced. Since, in addition to reducing direct emissions, more attention needs to be paid on reducing the indirect emissions generated during construction, steering measures should also be aimed at the latter emissions. Instead of steering individual solutions, it has been recognised as financially beneficial and helpful for market development to set threshold values for the results desired, while letting the project participants choose the means of reaching the results. The carbon footprint, which also includes emissions from the construction process, in addition to emissions from the use, is recognised as a good potential steering method. In the future, even the legislation will require calculation. The Ministry of the Environment is currently developing a method for this purpose. In the future, an actor engaging in a project must state the building's carbon footprint in the building permit. The survey to be implemented aims to define a sufficiently ambitious carbon footprint through which new construction can be steered through detailed planning, property conveyance conditions and/or the management of construction on the City's own facilities.

- Indicator: The proposal for the threshold value to be used in steering will be finished by 30 June 2023.
- Impact on emissions reductions: Support for emissions reduction measures; no direct impact on emissions reductions.
- Cost effect: No additional cost effect; to be carried out as official work.
- Party responsible: Urban Environment Division/City Executive Office

ACTION: Implementing financially feasible energy efficiency improvements in City-owned facilities outside renovation projects.

There is notable energy conservation potential in the City's own facility and service buildings even outside renovation projects. As improvements to energy efficiency are financially feasible, it is also worthwhile from a financial standpoint to focus on implementing them. The aim of this action is to ensure efficient implementation of financially feasible projects identified in the energy surveys.

- Indicator: The implementation process of financially feasible energy efficiency projects identified in energy surveys is to be defined in 2022.
- Impact on emissions reductions: Support for emissions reduction measures; no direct impact on emissions reductions.
- Cost effect: To be carried out as official work.
- Party responsible: Urban Environment Division

ACTION: Carrying out a review of the most impactful emissions reduction measures for transport available to the City by 2030.

The actions identified previously are not sufficient to achieve the carbon neutrality target for transport. The proportion of electric cars of cars registered for the first time is growing rapidly. However, the vehicles will not be renewed to such an extent by 2030 that the emissions reduction objectives could be achieved through an upgraded vehicle population alone. Furthermore, heavy vehicles are not becoming electric at the same rate, and the blending obligation will not reduce emissions from diesel vehicles to such an extent that the objectives could be achieved for them. New national or EU-level measures will likely enter into force before 2030, which will also reduce the emissions from Helsinki traffic as well. However, the schedule of the actions is not consistent with the City of Helsinki's targets, and binding decisions have not yet been made regarding emissions trading for road traffic, for example. The City's own actions will be required to realise the remaining emissions reductions on time. Based on the experiences so far, promoting sustainable mobility alone will not yield a sufficient transition from car traffic to sustainable modes of transport. To achieve the targets, the City should also look at new actions that will directly influence the volume of car traffic.

- Indicator: Review to be completed in 2022.
- Impact on emissions reductions: Support for emissions reduction measures; no direct impact on emissions reductions.
- Cost effect: No additional cost effect; to be carried out as official work.
- Party responsible: Urban Environment Division

ACTION: Promoting the definition of effective regional emissions reduction measures on mobility.

The regional emissions from transport are also highly influenced by traffic across the city's borders. The City will actively promote the definition of impactful regional emissions reduction actions through the shared land use, housing and transport planning (MAL) for the Helsinki Metropolitan Area. Helsinki will actively promote such measures that are in line with the City's own emissions reduction target for transport.

- Indicator: The most impactful emissions reduction measures for regional transport are to be defined.
- Impact on emissions reductions: Support for emissions reduction measures; no direct impact on emissions reductions.
- Cost effect: No additional cost effect; to be carried out as official work.
- Party responsible: Urban Environment Division/City Executive Office

APPENDIX 2:

Actions in the Carbon Neutral Helsinki 2035 Action Plan

No	Action	After the update
1	Services offered at traffic nodes and improved smoothness of transfers	Action plan for Helsinki Regional Transport Authority's (HSL's) 'Solmu' node project and park-and-ride services in the Helsinki region
2	Target network of cycling routes in the inner city	Bicycle Action Plan 2020–2025
3	Cycling network	Bicycle Action Plan 2020–2025
4	High-quality winter maintenance on the cycling network	Bicycle Action Plan 2020–2025
5	A pleasant and safe environment for pedestrians	Development Programme for Traffic Safety 2022–2026
6	Services for cycling	Bicycle Action Plan 2020–2025
7	Development Programme for tram traffic	Development Programme for tram traffic
8	Sustainable transport and land use planning	Part of the official work of the City, City Transport and Helsinki Regional Transport Authority
9	Bicycle Action Plan and Bicycle Parking Development Programme	Bicycle Action Plan 2020–2025 and General Plan and Implementation Programme for Bicycle Parking 2021–2025
10	A pricing system for vehicle traffic	Part of the regional cooperation related to the MAL agreements (Helsinki Regional Transport Authority, the City, the national government)
11	Parking policy and pricing	Helsinki Parking Policy 2022
12	Scaled parking fees	Helsinki Parking Policy 2022
13	Parking fee zones	Helsinki Parking Policy 2022
14	Urban structure and sustainable modes of transport	Part of the City's official work
15	Updating the parking norms	Helsinki Parking Policy 2022
16	Land use planning and sustainable modes of transport	Part of the City's official work

No	Action	After the update
17	Developing an environmental zone	Part of the City's official work; City of Helsinki Air Protection Plan 2017-2024
18	Construction of public charging infrastructure for electric cars	Part of the City's official work
19	Procurement criteria for freight transportation and machinery projects	Part of the City's official work
20	Procurement criteria for the freight transportation fleet and driving powers	Part of the City's official work
21	City logistics and delivery traffic	City Logistics Action Plan
22	Promoting a zero-emission bus fleet	Part of the sustainability work of Helsinki Regional Transport Authority
23	Charging infrastructure for buses	Part of the official work of the City and Helsinki Regional Transport Authority
24	Carbon Neutral Port 2035 Action Plan	Carbon Neutral Port 2035 Action Plan
25	Smoothening traffic in the West Harbour	Master plan and Environmental Impact Assessment (EIA) for the harbour tunnel (a project of the Port of Helsinki)
26	Smart mobility services	Situational awareness and statistical system for traffic data (LIDO-TIKU); partially, the Jätkäsaari Mobility Lab project
27	New mobility services	Situational awareness and statistical system for traffic data (LIDO-TIKU); partially, the Jätkäsaari Mobility Lab project
28	Helsinki Intelligent Transport System Development Programme	Helsinki Intelligent Transport System Development Programme 2030 and Action Plan 2020–2024
29	Promoting sustainable modes of transport through communication	Part of the official work of the City, City Transport, Helsinki Regional Transport Authority and Helsinki Region Environmental Services; also included in many action plans
30	Mobility plans	Part of the official work of Helsinki Regional Transport Authority and the City
31	Energy surveys	Part of the official work of the City and Helsinki City Housing Company Ltd
32	Recovery of heat loss	Binding energy criteria for City facilities
33	Allocating energy and waste treatment costs to end users	Not to be implemented (input-output ratio not feasible)
34	Monitoring the energy efficiency of facilities	The system is in use; part of the City's official work
35	Piloting a demand response system	Part of the City's official work

No	Action	After the update
36	Opportunities for energy storage	Part of the official work of Helen Ltd and the City
37	Preparing a target programme for renewable energy for the City's buildings	Binding energy criteria for City facilities
38	Procurement criteria for construction and maintenance	Binding energy criteria for City facilities
39	Increasing competencies in construction and maintenance	Part of the City's official work
40	Procedures for prioritising interests	Part of the City's official work
41	Developing project planning	Binding energy criteria for City facilities
42	Minimising lifecycle emissions	Partial energy criteria for City facilities
43	Energy-plus construction	Part of the City's official work
44	Increasing the proportion of recycled materials in construction	Action Plan for Circular and Sharing Economy
45	Principles of groundwork	Action plan on utilising excavated earth, rock material and demolition material in groundwork
46	Zero-emission worksite machinery	Green Deal
47	Improving heat recovery in renovation projects	Binding energy criteria for City facilities
48	Energy efficiency in the City's renovation projects	Binding energy criteria for City facilities
49	Long-term maintenance plans and renovation projects	Binding objectives for City facilities
50	Upgrading the property automation systems of Helsinki City Housing Company Ltd, KOy Auroranlinna and Helsingin Asumisoikeus Oy	Part of the official work of Helsinki City Housing Company Ltd, KOy Auroranlinna and Helsingin asumisoikeus Oy
51	Renewable energy in City-owned building stock	Part of the official work of Helsinki City Housing Company Ltd
52	Geothermal/ marine heating pilot	Part of the Helen Ltd's official work
53	Promoting renovation projects through conceptual solutions	ELENA project
54	LED street lighting	Helsinki LED project
55	Taking renewable energy production into account in detailed planning	Part of the City's official work
56	Energy-efficient infill and renovation construction	Part of the City's official work

No	Action	After the update
57	Guidance for residents' energy consumption	Part of the City's official work
58	Developing regulations on land use planning	Part of the City's official work
59	Energy efficiency conditions for plot conveyance	Part of the City's official work
60	Smart energy solutions in plot conveyance conditions	Part of the City's official work
61	Plot conveyance competitions based on the carbon footprint	Part of the City's official work
62	Plot conveyance conditions focused on carbon neutrality and S&C growth	Part of the City's official work
63	Proactive guidance provided by the building control services	Part of the City's official work
64	Renovations of protected buildings	Part of the City's official work
65	Building code and climate objectives	Part of the City's official work
66	Developing guidance for construction	Part of the City's official work
67	Energy Renaissance Programme	The Energy Renaissance model is in use
68	Ending oil heating and replacing electric heating with renewable sources	State programme
69	3D Energy and Climate Atlas	Part of the City's official work
70	Improving energy competencies among decision-makers in housing companies	Part of the Helsinki Region Environmental Services' official work
71	Helen Ltd achieving carbon neutrality by 2035	Helen Ltd's Development Programme
72	Acquiring renewable district heating	Not to be implemented
73	Acquiring renewable electricity	Not to be implemented
74	Key measurements of water consumption	Not to be implemented
75	Assessment tool for buildings' energy efficiency (as a part of the 3D Atlas)	Part of the City's official work
76	Two-way district heating	Helen Ltd's Development Programme
77	Promoting hybrid heating	Helen Ltd's Development Programme
78	Taking the needs of renewable energy production into account in land use	Part of the City's official work
79	Utilising heat waste	Binding energy criteria for City facilities

No	Action	After the update
80	Utilising local renewable energy (e.g. geothermal)	Part of the City's official work
81	Surveying areas suitable for geo-energy (survey for geothermal heating potential)	Land use planning and survey on geothermal heating
82	Utilisation of landfill gases	Part of the of Helsinki Region Environmental Services' official work
83	Promoting funding for energy renovations	Not to be implemented
84	Financial obstacles to energy efficiency	Part of the City's official work
85	New funding and procurement models	Part of the City's official work
86	ESCO piloting	Part of the City's official work
87	Supporting energy renovations	Part of the City's official work
88	Promoting wooden construction through detailed planning	Part of the City's official work
89	The City will promote wooden construction in its own projects.	Part of the official work of the City, Helsinki City Housing Company Ltd, KOy Auroranlinna and Helsingin asumisoikeus Oy
90	Climate change in schoolwork	Part of the City's official work
91	Cooperation with schools and other educational institutions	Part of the City's official work
92	Environmental education	Part of the City's official work
93	Climate change education	Action Plan for Circular and Sharing Economy
94	Promoting urban agriculture	Complete; guide for urban agriculture
95	Adding climate-friendly dishes in menus	Part of the City's official work
96	Increasing the proportion of vegetarian meals in schools, day-care centres, healthcare facilities, home meal services and personnel lunches	Part of the City's official work
97	Reducing food waste in the City's food services	Action Plan for Circular and Sharing Economy
98	Climate emissions of food transport	Completed; emission criteria, optimising order and delivery occasions and routes
99	Utilising surplus food in the City's operations	Action Plan for Circular and Sharing Economy
100	Reducing the environmental impact of events	Helsinki Tourism and Event Operating Plan 2022–2026

No	Action	After the update
101	Personal emission trading	Not to be implemented (emissions trading is not a feasible model)
102	Maritime Strategy	Completed; Helsinki Maritime Strategy 2030
103	Waste sorting at source	Part of the City's official work; required by law
104	Optimisation of waste transport	Completed; piloted with Helsinki Region Environmental Services
105	Allocating the expenses of waste management	Not to be implemented (input-output ratio not feasible)
106	Increasing the number of customers at Pakila Work Centre, Uusix workshops, Stara Reuse Centre and Metropolitan Area Reuse Centre	Action Plan for Circular and Sharing Economy
107	Developing climate criteria for procurements	Procurement Strategy 2020
108	Identifying and assessing the climate emissions from procurements	Part of the City's official work; work is also carried out within the Canemure project
109	Innovative procurements, pilots and business cooperation	Part of the City's official work
110	Updating the objectives related to the procurement strategy	Completed; Procurement Strategy 2020
111	Cooperation between public operators on sustainable procurements	Part of the City's official work
112	Developing guidelines and reporting for procurements	Part of the City's official work; Procurement Strategy 2020
113	Climate criteria for food and meal service procurements	Environmental policy (update)
114	Roadmap for Circular and Sharing Economy	Completed
115	Facility and equipment booking platform	Action Plan for Circular and Sharing Economy
116	The library network as a pioneer in sharing economy	Action Plan for Circular and Sharing Economy
117	Recycling of furniture within the City organisation	Action Plan for Circular and Sharing Economy
118	Use of surplus food	Action Plan for Circular and Sharing Economy
119	Utilisation of green waste	Action Plan for Circular and Sharing Economy
120	Sharing economy in the Property Strategy	Completed, Property Strategy

No	Action	After the update
121	Cooperation on circular economy	Circular economy cluster
122	Participatory budgeting	Part of the City's official work
123	Increasing Smart & Clean business	Part of the City's official work
124	Promoting the S&C market	Part of the City's official work
125	Residents' opportunities to participate in the development of Smart & Clean solutions	Part of the City's official work
126	Economic development policy and emissions reductions	Part of the City's official work
127	Company participation	Part of the City's official work
128	Co-development of Smart & Clean business	Part of the City's official work
129	Carbon neutrality plans of the City's subsidiary communities	Completed; the ownership strategy requires that relevant subsidiaries have a plan in place
130	Maintaining carbon storage in green areas and the urban environment	Climate change adaptation policies for 2019–2025
131	Network of urban forests and wooded areas	Climate change adaptation policies for 2019–2025
132	Viable forests	Climate change adaptation policies for 2019–2025
133	Vegetation on plots	Complete; guide for urban cultivation
134	Green factor method	Climate change adaptation policies for 2019–2025
135	Information about carbon storage and carbon sinks	Completed; review in 2020
136	Assessing emissions compensation methods	Part of the City's official work
137	Finishing the preparation of the adaptation policies and bringing them into decision-making	Completed; approved by the City Board on 27 May 2019
138	Communication and interaction plan for the action plan	Completed
139	Using engagement and interaction models	Completed
140	Borough liaisons	Part of the City's official work
141	Carbon Neutral Helsinki 2035 steering group	Completed
142	Division-specific objectives	Part of the City's budget process

No	Action	After the update
143	Business forum	Not to be implemented; there are several other networks
144	Open policy practice	Completed
145	Assessment tools for the action plan	Completed
146	Reporting emissions reductions	Completed
147	Assessment of the Action Pan	Completed

APPENDIX 3:

Cost effects of emissions reductions

Action	Emissions reduction	Cost of the emissions reduction	Cost per tCO_2e
CATEGORY 1: Actions that reduce emissions			
Adjusting the ventilation in City facilities to an appropriate level.	-20,000 tCO_2e/year in comparison to a situation where the ventilation system is running full-time. There is no information available on the current usage rate of the ventilation systems.	-11 million euros/year in comparison to a situation where the ventilation system is running full-time. There is no information available on the current usage rate of the ventilation systems.	€-550 per tCO_2e
Low-emission concrete in infrastructure projects.	-15% (GWP.85) compared to conventional concrete.	+10–20% compared to conventional concrete. The estimate is based on the experiences from the Kalasatama–Pasila project. As competition increases, the price difference is expected to diminish. Furthermore, it must be taken into account that the price of concrete is only a fraction of a project's total costs. In the pilot site, the cost effect of low-emission concrete was only parts per thousand in the overall costs of the project. The price of conventional concrete will increase in the future, which will reduce the price difference even further.	

Action	Emissions reduction	Cost of the emissions reduction	Cost per tCO_2e
Reducing the emissions from the precon-struction at the former Malmi Airport area by 50%.	-64,000 tCO_2e by 2030 (-50% from the ref-erence level of 2020–2030).	Lower-carbon preconstruction will likely incur lower costs than the conventional option. The costs of burnt lime will increase significantly due to the EU's emissions trading, which will contribute to a positive cost effect.	
Replacing out-door lights with LED lights	Direct impact on emis-sions reductions in re-lation to the City's total target for emissions re-ductions: less than 1%. The energy saving esti-mated for a single lamp is 50–75% compared to a discharge-based light source.	Additional cost €2.5 M/year in 2023–2025 and €2 M/year in 2026–2030. Depending on the type of lighting fixture, the repayment period is 5–7 years.	
Lowering tem-peratures in City-controlled facilities	If the temperature could be decreased by 2°C in half of the properties, the consumption of district heating would drop by 5%, or 20 GWh (with the assumption that a drop of 1°C in indoor temperature corresponds to a drop of 5% in heating energy consumption). With the emissions of 2021, the drop equals an emis-sions reduction of 3.7 kt CO_2e.	Lowering the temperature will reduce the consumption of heating energy. When calculated using the assumptions above, the savings achieved would be 5% of the district heating costs of properties directly owned by the City.	

Helsinki

良質なストック形成等に向けた、木造建築物への融資における合理的な融資期間等に関する普及・広報			
会議名	**Interview meeting for wood construction in terms of durability/木造に関する耐久性の観点からみたインタビュー会議**		
日時	13th, January 2023 9:00-11:00/2023年1月10日9:00-11:00		
場所	VTT, Meeting room/VTT会議室		
出席者	Edgar Bohner (EB), VTT・Vice President / ボフナー エドガー（VTT・副社長）, Daishi Sakaguchi(DS), Nihon Fukushi Uni・Associate Professor /坂口大史（日本福祉大学・准教授）		
作成日	2023年1月16日	**記入者**	坂口大史

■ 議事	
議題	（1）Situation of concrete building and the general maintenance plan in Finland/フィンランドにおけるコンクリート造の建物とメンテナンス計画の状況 （2）Possibility for using wood in case of renovation of concrete building and the examples/コンクリート造の建物に対する木造リノベーションの可能性と実例
内容	（1）Situation of concrete building and the general maintenance plan in Finland - What is the status of concrete buildings in Finland?(DS) In Finland, there are also a lot of concrete building, which was built after world war 2 and they need to be renovated. Main topics are energy efficiency and how to use resource effectively including renovation. (EB) - I would like to know how you feel about the idea of using wood in the renovation of a concrete building. (DS) The topic for using wood in renovation has not been research in Finland either. The cost and time for renovation are very dominating factor to push this theme more. (EB) - What kind of projects is VTT working on? (DS) One interesting research is “Industrial metaverse project” just launched last year. This project aims to optimize the whole chain by digitalization and automation with construction company. (EB) - How about general building lifecycle in Finland? (DS) Generally speaking, concrete building has 50 years and brick building has 100 years life cycle but the building could be used as long as the quality is sufficient. (EB) （2）Possibility for using wood in case of renovation for concrete building and are there the examples - What would be interesting topics to renovate concrete building with wood? (DS) Surely, way of optimized renovation and precise calculation will be the key. In my opinion, demolition is the bad thing for sustainability. To avoid demolition, new method for renovation is important to reduce using materials and emission(EB)

	- What are some of the issues and challenges that we face in achieving a sustainable society including the utilization of wood? (DS) To achieve sustainability and low carbon society, only wood is very challenging. For instance, there is low carbon emission concrete material now. The suitability and choice of material depends on the project. (EB) - Do you have experience for the calculation of cost or CO2 in practical case? If you have, could you give me the examples? (DS) VTT has been doing project on the calculation of cost and CO2 emission for building lifecycle. This project was developed for the government decision that all the new buildings need to do LCA calculation for building life cycle, otherwise building permission is not issued for the project. (EB) - These topics will be crucial to encourage the market towards sustainability? (DS) Yes. I do believe so. We have done already multiscale modeling project and optimize the calculation of LCA. The ideas from data driven circular economy project and 5G-timber project can be used also. These projects are focusing on lifecycle and the materials after demolition, which leads to the precision of LCA. (EB) - I can see the possibility of utilizing low carbon concrete and hybrid construction with wood, what is your opinion? (DS) For concrete, there is circulate concrete and carbon neutral concrete could be also interesting for our collaboration. By optimizing the process, CO2 emission of concrete could be dramatically reduced or could be negative in some cases. Concrete can be environmentally friendly as well. (EB) - Many discussions have been done about new construction but utilizing existing buildings and maximizing the material efficiency will be more important for sustainability. (DS) That is true. Wooden structures do not automatically achieve sustainability, and it is important to choose the right materials in the right places, such as using environmentally friendly concrete, including its service life, in addition to optimizing its overall life cycle. (EB) （日本語訳） （1）フィンランドにおけるRC造の建物とメンテナンス計画の状況 ・ フィンランドにおけるRC造の建物に関する一般的な状況はどうなっているか（DS） - フィンランドでは、第二次世界大戦後に建てられたRC造の建築物も多く、リノベーションが必要な状況になっている建物が多く存在する。その点で、RCの建物に関する主なテーマは、エネルギー効率と、リノベーションを含めた資源の有効活用が挙げられる。 ・ RC造の建物のリノベーションに木材を使うというアイデアがあるがどの様に感じるか。（DS） - リノベーションに木材を使うというテーマは、フィンランドでも研究されていないた

	め興味深いテーマである。リノベーションにかかる費用と時間は、このテーマをもっと押し進めるための非常に大きな要因になると考えられる。(EB) ・ VTTではどの様なプロジェクトに取り組んでいるか。（DS） - 最新の興味深いプロジェクトとして、産業用メタバースプロジェクトがあり、このプロジェクトは昨年始まったばかりである。具体的には、建設会社のデジタル化・自動化によってチェーン全体を最適化するプロジェクトである。(EB) ・ フィンランドの一般的な建物のライフサイクルはどうなっているか？ - 一般的に、RC造の建物は50年、レンガの建物は100年に設定されている。一方で建物品質が十分であることが確認されれば、引き続き建物を使用することが可能である。(EB) (2) RC造の建物に対する木造リノベーションの可能性と実例 ・ RC造の建物を木でリノベーションするとしたら、どんなことが問題や課題として考えられるか？ (DS) - もちろん、最適なリノベーションの方法の提示と緻密な計算が鍵になるであろう。私の考えでは、建物の解体はサステナビリティにとってとても悪いことだと認識している。建物の解体を極力避けるためには、建設時に使用する材料と解体時の排出を減らすための新しいリノベーションの方法が重要であると感じる。 ・ 持続可能な社会を目指す上で、木造の活用を含めてどんなことが問題や課題として考えられるか？ (DS) - 持続可能な低炭素社会を実現するためには、木材だけでは難しい。例えば、現在では低炭素化されたコンクリート材料が開発されている。この事例の様に、プロジェクトによって、どのような材料が適しているかを検討して、その都度最適な選択する必要がある。(EB) ・ コストやCO2の計算を実際に行った経験はあるか？もしあれば、具体例を挙げてほしい。(DS) - VTTは建築物のライフサイクルのコストとCO2排出量の計算に関するプロジェクトを行っている。このプロジェクトは、すべての新しい建築物はライフサイクルのLCA計算を行う必要があり、そうでなければ建築許可が下りないという政府の決定に基づいて開発された。(EB) ・ これらのトピックは、市場をサステナビリティに向かわせるために重要であると考えているか？(DS) - はい、私たちもその様に認識している。私たちは、すでにマルチスケールモデリングプロジェクトを行い、LCAの計算を最適化するプロジェクトに取り組んできた。また、データ駆動型循環経済プロジェクトや5G-timberプロジェクトからのアイデアも利用することができると感じる。これらのプロジェクトは、ライフサイクルと解体後の材料に焦点を当てており、LCAの正確性の向上に役立つはずである。(EB) ・ 低炭素コンクリートの活用や木造とのハイブリット構造の可能性が感じられるが、あなたの意見はどうか？(DS) - コンクリートには、循環型コンクリートやカーボンニュートラルコンクリートがあり、

	私たちのコラボレーションに興味深いと感じる。また、コンクリートのプロセスを最適化することで、CO2排出量を劇的に減らしたり、場合によってはマイナスにしたりすることも可能となる。コンクリートは環境に悪いイメージがあるが、環境に優しいコンクリートも開発されている。(EB) ・ 新築については多くの議論がなされているが、既存の建物を活用し、材料効率を最大化することは、サスティナビリティーにとってより重要なことだと感じた。(DS) - その通りである。木造が自動的にサスティナビリティーを実現する訳ではなく、ライフサイクル全体の最適化に加えて、耐用年数も含めた環境配慮型のコンクリートを採用するなど、適材適所の選択が重要である。
備考	・特になし

■ 次回の予定	
日時	年　　月　　日（　　曜日）　　時　　分より
場所	

良質なストック形成等に向けた、木造建築物への融資における合理的な融資期間等に関する普及・広報			
会議名	**Interview meeting for wood construction in terms of durability/木造に関する耐久性の観点からみたインタビュー会議**		
日時	23rd January 2023 9:00-11:00/2023年1月23日9:00-11:00		
場所	Zoom/ズーム		
出席者	Markku Karjalainen (MK), Tampere Univ・Professor/ カルヤライネン マルック（タンペレ大・教授）, Daishi Sakaguchi(DS), Nihon Fukushi Uni・Associate Professor /坂口大史（日本福祉大学・准教授）		
作成日	2023年1月23日	**記入者**	坂口大史

■ 議事	
議題	(1) The way of thinking of durability for wood building/木造建築の耐久性に対する考え方 (2) Maintenance for wood building/木造建築のメンテナンス
内容	(1) The way of thinking of durability for wood building ・ What is the situation of durability and maintenance for wood construction in Finland? Could you explain that briefly? (DS) - In Finland, the façade is always the matter when it comes to the topic of durability as you probably know. Wood façade surely requires more maintenance comparing other materials. (MK) - However, there is some benefits like wood façade. Compared to concrete facades, for example, it is relatively easy and simple to install on exterior walls, and the cost of maintenance itself is not so high. (MK) ・ How much does it generally cost for repainting of wood façade? (DS) - Re-painting cost is 50-100euro/m in general. There is additional cost for high rise building because there is need of the lift if the building is higher. (MK) ・ What kind of measures you take for longer durability of wood construction? (DS) - I think that the keys for longer durability are higher basement, long eaves, thicker board, dry lumber and structural protection and regular maintenance. (MK) （2）Maintenance for wood building/木造建築のメンテナンス ・ Is there maintenance plan generally for wood construction? (DS) - Client will make the plan normally for 50 years. (MK) - Wooden façade needs to be repainted during 5-10 years. (MK) ・ Is there a reserved budget for the maintenance? In Japan, it is said that 1.5% of the overall budget is set aside for concrete buildings. (DS) - The amount for the maintenance could be different in each area because the price for the building is quite dependent of each area. Generally speaking, more expensive in cities and cheaper in countryside. In the big cities, though there is no calculation, the

	price for the maintenance will be similar to Japanese percentage. But no specific budget for wood construction (wood structure). (MK) ・ Is there special maintenance method for load bearing wood structure? (DS) - In case of multi-story wood building, the structure will be covered with gypsum board and not exposed to the inside. Also, from three stories wood building need to install sprinkler 100 euro for square meter, which will provide a lot of safety for the building. For concrete building and steel building, the sprinkler will not be required but wood structure will be needed. (MK) ・ Installing sprinkler will be additional cost but people or market in Finland feel safer for wood structure? (DS) - Even concrete building has wood material and furniture in it, which will burn anyway. Thus, initial fire measure will take an important role in any type of structure. Now, the newest project for wood construction, 16 stories of complex building, which will be new highest building will start the construction next year in Oulu and fire prevention measures have been taken.. (MK) ・ What is the price difference between wood construction and concrete construction in general? I heard that wood construction is more expensive that concrete. What is your opinion? (DS) - I agree, with general calculation, it is said that in case of wood construction, 5-10% more expensive than concrete. (MK) - But wood buildings have special regulations that the buildings should have sprinkler if it is more than 3 stories, which will be the main cause of extra cost for wood building. (MK) - In addition, we should take into the account that concrete structure has much longer history for high rise building. In addition, the number of wood construction in the market is still much smaller than concrete construction. I mean that wood construction has still potentials. (MK) ・ Do you mean that wood construction is still new even for Finland though we think Finland has much longer history for multi-story wood construction? (DS) - Yes, that is how it is supposed to be. As for multi-story buildings with wood construction, please refer to the second document. Compared to wood construction, concrete construction has been mass-produced for a longer period of time, which has generally lowered its cost. Wooden buildings, especially multi-story buildings, are fairly new compared to the history of concrete. (MK). - When wood construction will be in the phase of mass production and industrialization, the cost competitiveness of wood structure will be quite good. (MK) ・ Market tends to think that wood construction is expensive but not necessarily true? (DS) - Almost the difference is caused by the additional cost due to the sprinkler and the sprinkler will make the building safer. This aspect should be considered more positively as the value of the building and this would encourage the market to build more wood buildings. (MK)

	（日本語訳） (1) 木造建築の耐久性に対する考え方 ・ フィンランドにおける木造建築の耐久性・維持管理はどのような状況にあるのか？簡単に説明をお願いしたい。(DS) - フィンランドでは、ご存知のように、耐久性の話題といえばファサードが常に中心になっている。木造のファサードは、他の材料に比べて確かにメンテナンスが必要になる。(MK) - しかし、木製のファサードには利点がある。例えば、コンクリート製のファサードと比べると、外壁への取り付けが比較的簡単容易にできメンテナンスのコスト自体はそれほど高くない。(MK)。 ・ 木造ファサードの再塗装は一般的にいくらぐらいかかるのか？(DS) - 一般的には50-100ユーロ/m²と言われている。一方で高層ビルの場合は、メンテナンス時にエレベーターが必要になるため、先程の費用に別途エレベーター分の費用がかかることになる。(MK) ・ 木造建築の耐久性を高めるために、フィンランドでは具体的にどのような工夫をしているか？(DS) - 資料を共有するのでそれを参照してほしい。具体的には、地下室を高くする、軒を長くする、板を厚くする、木材を乾燥させる、構造体を保護する、定期的にメンテナンスする、などが長持ちさせるポイントになると考えている。(MK) （2）木造建築のメンテナンス ・ 一般的に木造建築の場合、メンテナンス計画はあるか？(DS) - 木造建築の場合、通常50年で計画が立案されるケースがほとんどである。(MK) - 一方で、外壁に使われる木のファサードは5-10年で再塗装が必要になる。(MK) ・ メンテナンスのための予算は確保されているか？日本ではコンクリートの建物の場合、全体予算の1.5%を確保すると言われている。(DS) - 建物の価格は地域によってかなり異なるため、メンテナンスの金額は地域によって異なる可能性が考えられる。一般的な話として、都会はよりメンテナンス費用が高く、田舎は安いと言われている。実際に計算はしていないが、大都市では日本の割合と同じような金額になると思われる。しかし、木造建築（木構造）には特に予算が確保されているというのは聞いたことがない。(MK) ・ 木構造の躯体部分に関する特別なメンテナンス計画は何かあるか？(DS) - 高層木造の場合、構造体は石膏ボードで覆われ、内部に木材は露出しない。また、3階建て以上の木造建築からは、1平方メートルあたり100ユーロのスプリンクラーを設置する必要があり、建物の安全性を高めることができる。RC造やS造の建物にはスプリンクラーは必要ないが、木造の建物には必要である。(MK) ・ スプリンクラーの設置は追加費用になるが、フィンランドの人々や市場は木造の方が安全だと感じているのか？(DS) - RC造の建物でも、木の材料や家具は入っているので、いずれは燃えることになる。したがって、どのような構造であっても、初期火災対策は重要な役割を果たすのは言う

	までもない。現在、木造建築の最新プロジェクトとして、オウルで来年着工予定の16階建ての複合ビル（最高層ビル）があり、防火対策も取られている。(MK) ・ 一般的に木造とRC造の価格差はどのくらいになるのか？木造はRC造より高いと聞いている。この点についてどう思うか？(DS) - 正しいと思われる。一般的な計算では、木造の場合、RC造より5-10%高いと言われている。(MK) - しかし、木造の場合、3階建て以上の建物にはスプリンクラーを設置しなければならないという特別な規制があるため、木造にとってスプリンクラー分がコストアップの主な原因になっている。(MK)。 - また、高層建築ではRC造の方が、歴史が長いことも考慮しなければならない。また、木造建築はRC造の建物に比べるとまだ数が少ない。つまり、木造はまだまだポテンシャルがあるということです。(MK) ・ フィンランドは木造による多層建築の歴史が長いと思っていたが、実際はフィンランドでもまだ新しいということになるのか。(DS) - そういうことになる。木造による多層建築に関しては2つ目の資料を参照してほしい。木造に比べると、RC造の建物は、大量生産されている期間が長いので、一般的にコストが下がっている。木造建築、特に多層建築は、コンクリートの歴史と比べると、かなり新しいものになる。(MK)。 - 一方で、将来的に、木造が大量生産、工業化の段階に入れば、木造のコスト競争力はRC造と比べても相当なものになると思っている。(MK) ・ 木造は高いと思われがちだが、そうでもないのか？(DS) - RC造との差のほとんどは、スプリンクラーによる追加コストによるもので、スプリンクラーは建物の安全性を高める役割もある。この点は、建物の価値としてもっとポジティブに考えるべきで、そうすれば、市場はもっと木造建築を建てることに繋がる可能性がある。(MK)
備考	・特になし

■ 次回の予定	
日時	年　　月　　日（　　曜日）　　時　　分より
場所	

TAU, School of Architecture

Wednesday 11.1.2023

Multi-Story Timber Frame Houses in Finland

Markku Karjalainen

Professor (Architectural Construction)
Docent of timber construction and wood architecture
D.Sc. (Tech.), Architect

Tampereen yliopisto

Markku Karjalainen (born 1961), short CV

- 1988 Master of Science (Architecture), University of Oulu, Department of Architecture
- 1984 – 1997 Project architect in architects offices in Oulu, Finland
- 1992 – 2011 Lecturer and assistant in the architectural design laboratory of the University of Oulu, Department of Architecture
- 2002 Doctor of Science (Technology), University of Oulu, department of Architecture
- 2008 – Docent of timber construction and wood architecture
- 1997 – 2011 Project Manager of the national Modern Wooden Town - project in Finland
- 2012 – 2015 Developed Manager of the National Wood Contsruction Program, Ministry of the Employment and the Economy, Finland
- 2015 – TAU, School of Architecture, Professor (Architectural Construction)

Finland and forests

- Total area of Finland 338 000 km^2 / land area 304 000 km^2
- Area of forests 262 000 km^2 (= 78 % of total area and 86 % of land area)
- Protected forests 13 % of area of forests
- Most common species of wood: (In Finlad 23, in the world 60 000)
  - Pine 50 % (volyme of forests)
  - Spruce 30 %
  - Birch 17 %
  - Other hard woods 3 %

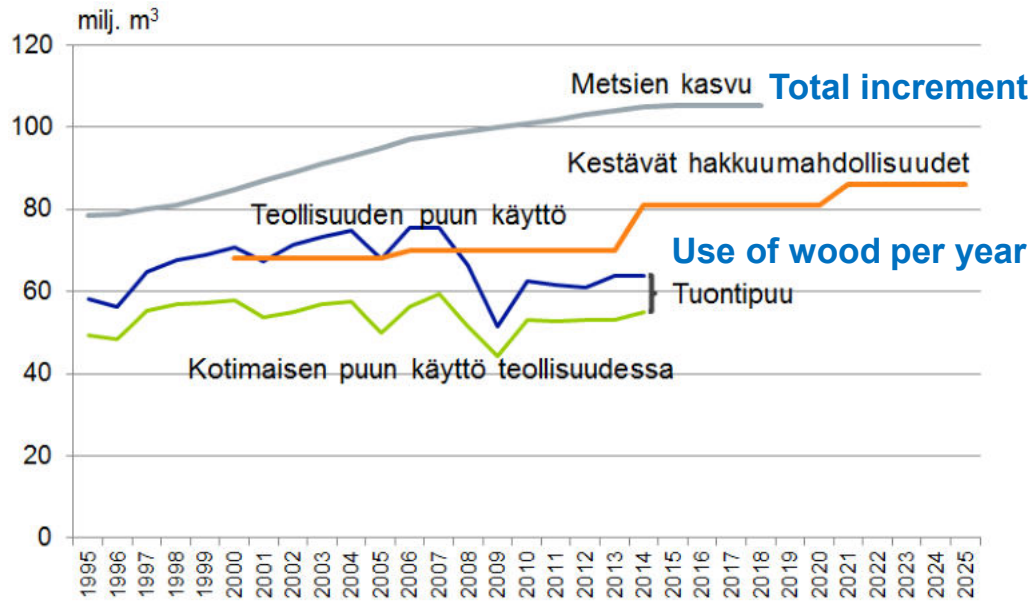
TAMPEREEN TEKNILLINEN YLIOPISTO

The forest sector is extremely important for Finland´s national economy

- Employs 200 000 Finns
- 5 % of the gross domestic product
- 20% of Finland´s export income
- Produces 70 % of the renewable energy in Finland

Growth of Finnish forests

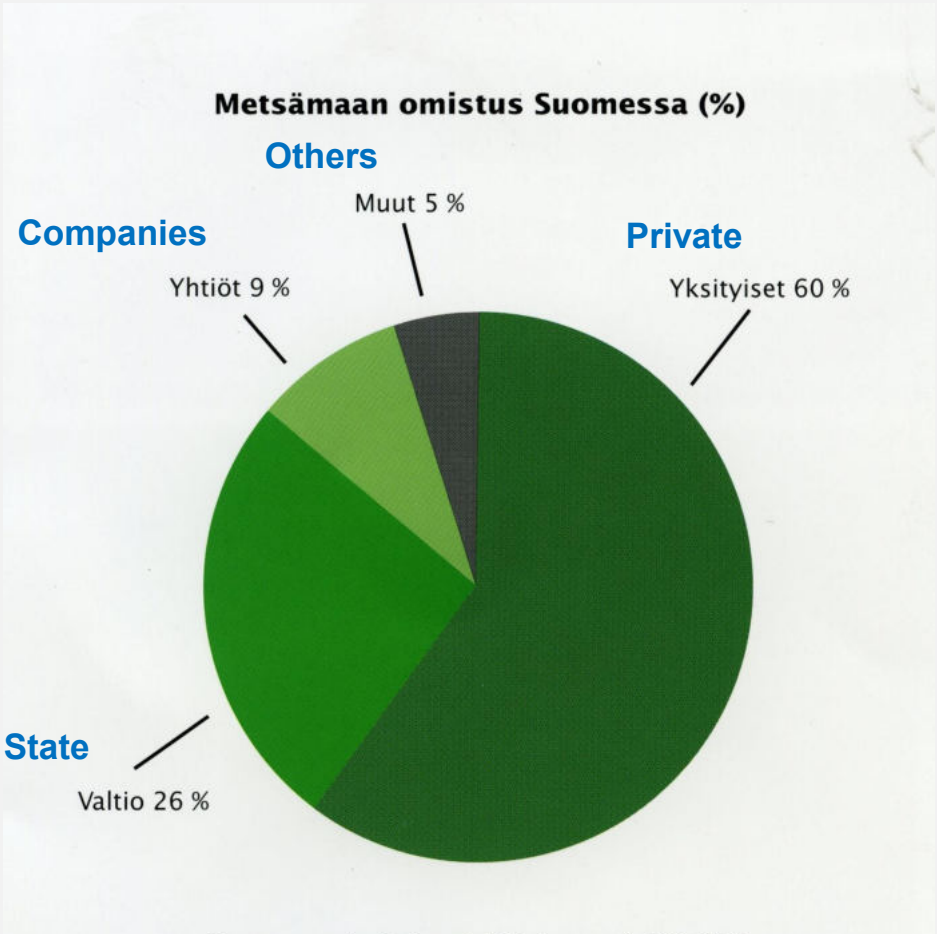
Kotimaisen puun käyttöä voidaan lisätä kestävästi

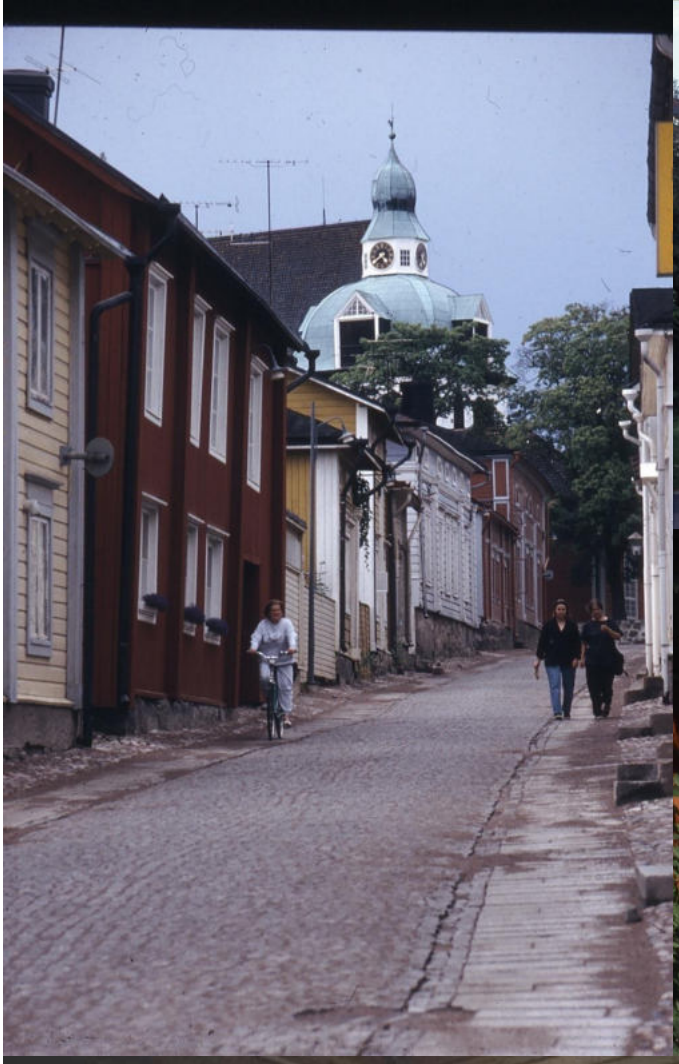


13.8.2015
LÄHDE: Luke, Metsäteollisuus ry

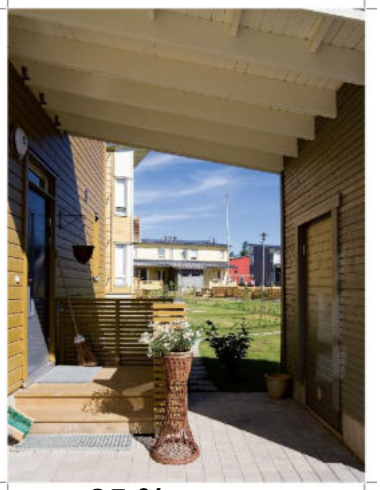
UUSIUTUVA METSÄTEOLLISUUS
MENESTYSTÄ BIOTALOUDESTA

Ownership of forests in Finland (%)






Leisure time
buildings 99 %



Detached houses, 85 %

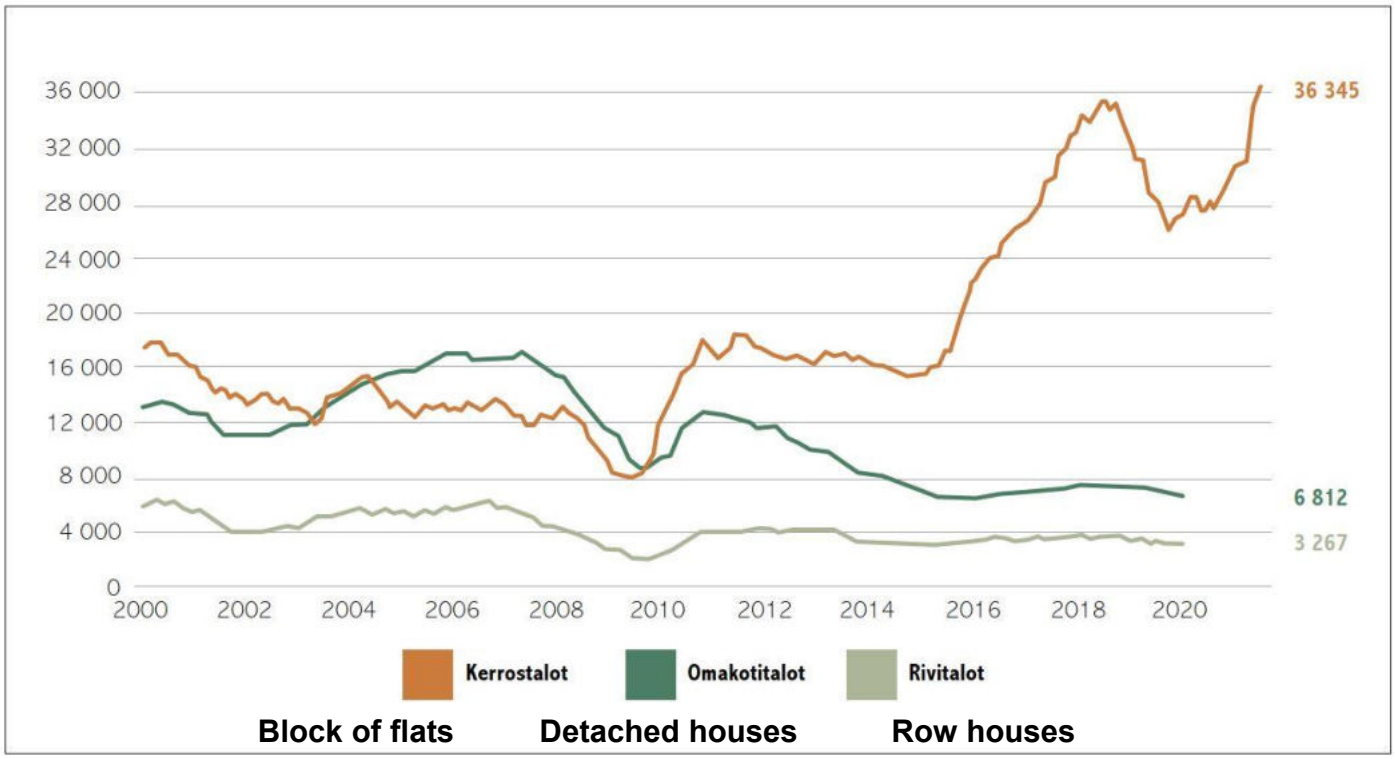
Tampereen yliopisto

Finnish housing statistics 2021

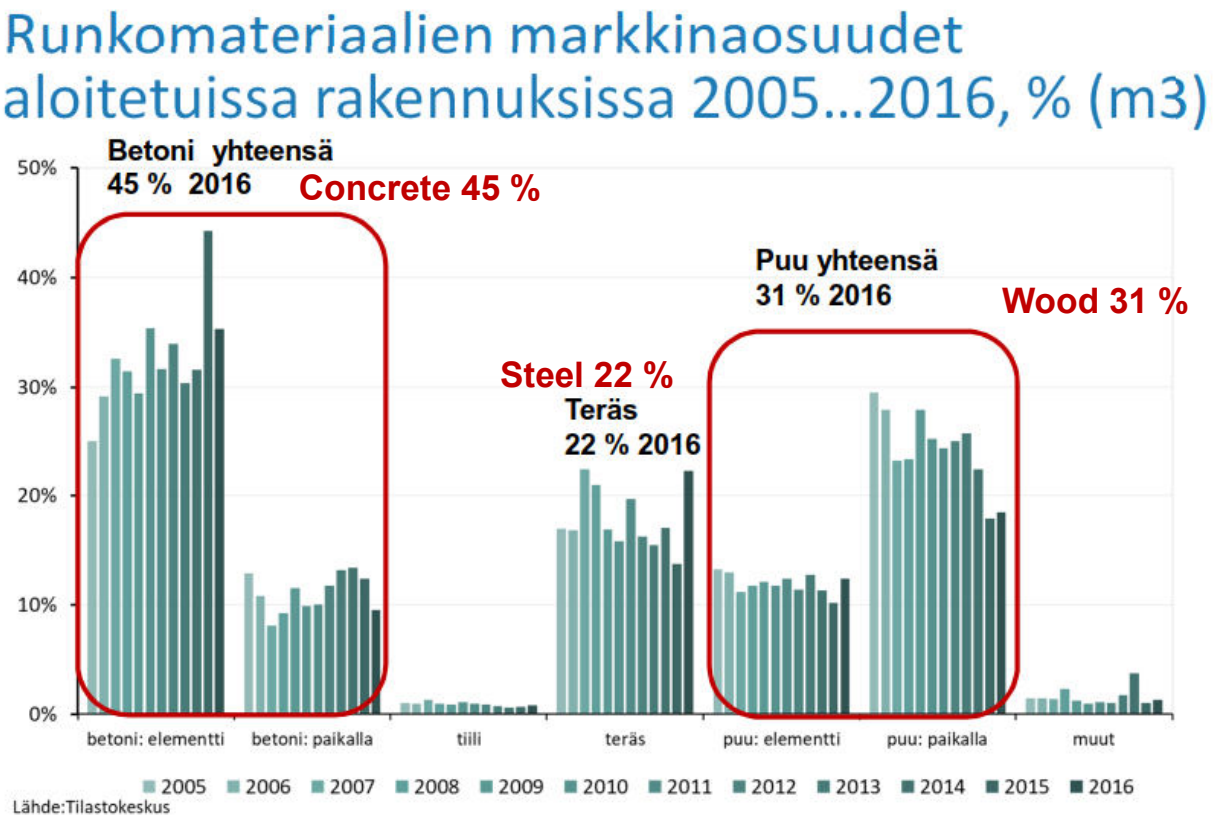
- Amount of housing is 65 % of all buildings
- Population of Finland is 5,55 milj. inhabitants
- Amount of homes is 3,1 milj. housing units
- Homes 1,46 milj. are situated in block of flats
- It means 47 % of all housing untits
- In year 2021 we built 46 400 new homes

> over 36 300 of them (78 %) in block of flats

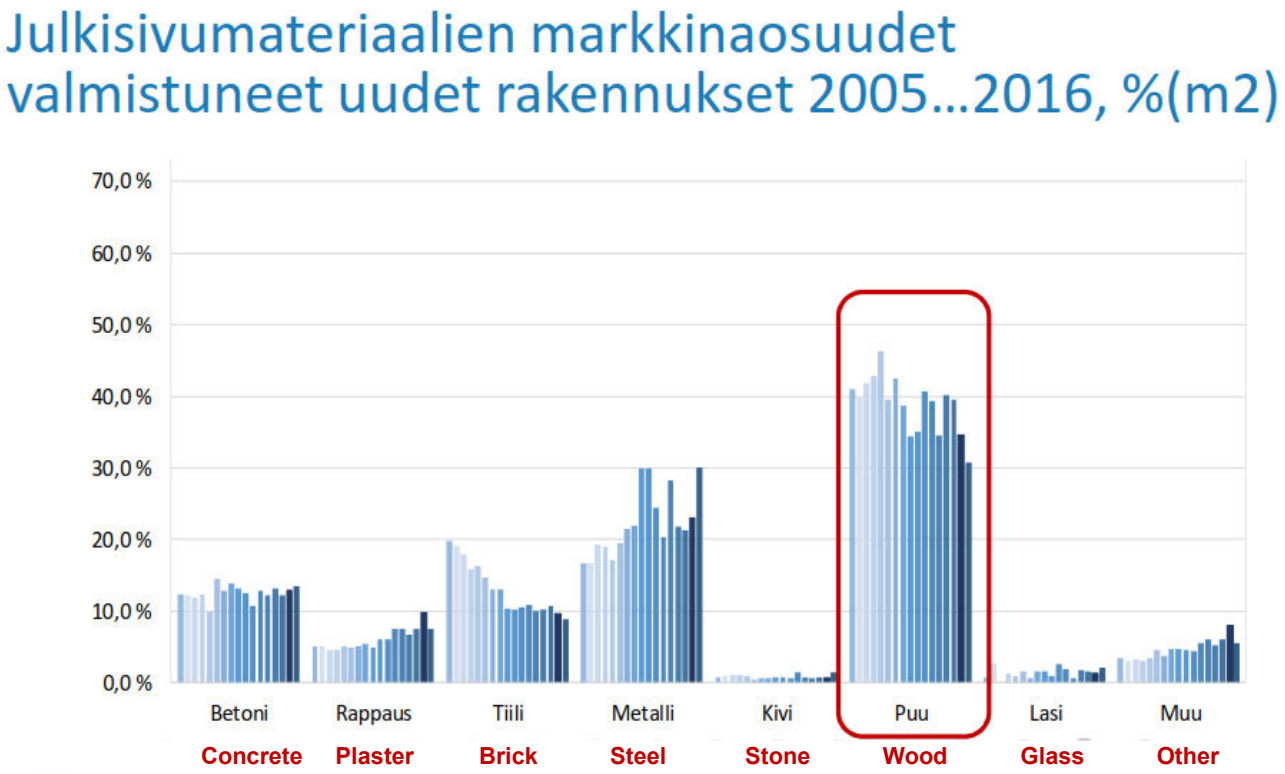
Building types of housing in Finland



Load bearing frame; market shares of concrete, steel and wood (% m³) during 2005 – 2016



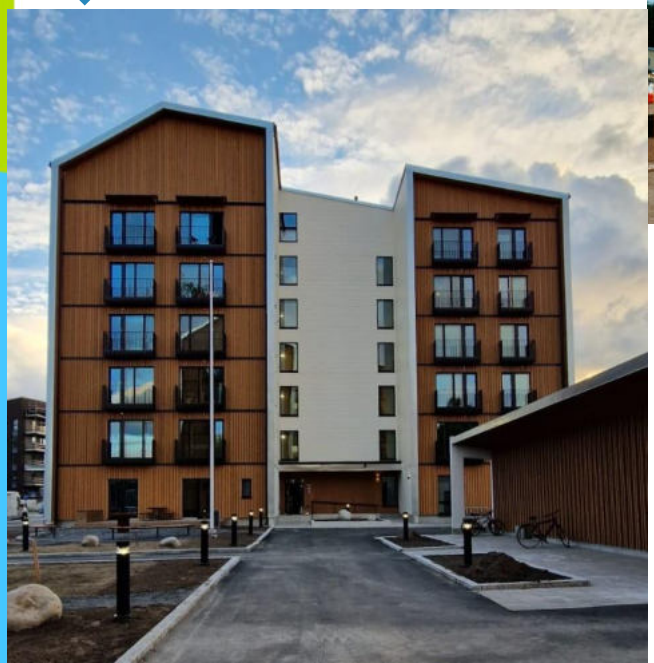
Facades; market shares of different building materials (% m²) during 2005 – 2016



Finnish multi-story timber frame houses

YLÖJÄRVI, 1996;
3 buildings, 19 apartments

TAMPERE, 2022;
2 buildings, 120 apartments



- 1.9.1997: max. high 4-storeys

- 15.4.2011: max. high 8-storeys

Built until 11.1.2023:

- 132 houses
- 4 208 apartments

Multi-story wooden apartment buildings

Situation January / 2023

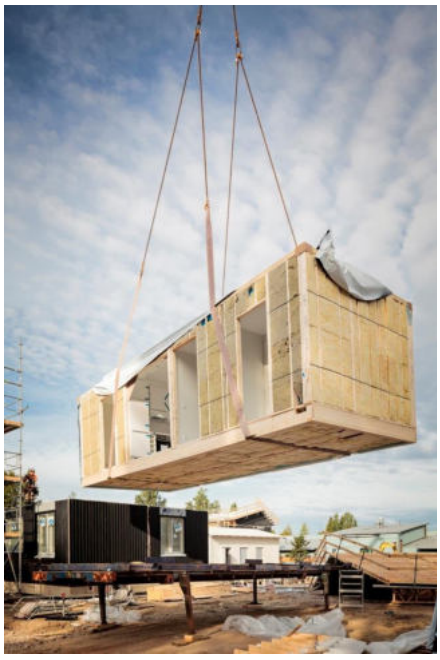
Tampere Univesity
Finnish Timber Council
Ministry of Environment

Coming: over 14 000 apartments in wooden multi-story apartment buildings!

The construction systems used in multi-story timber frame houses

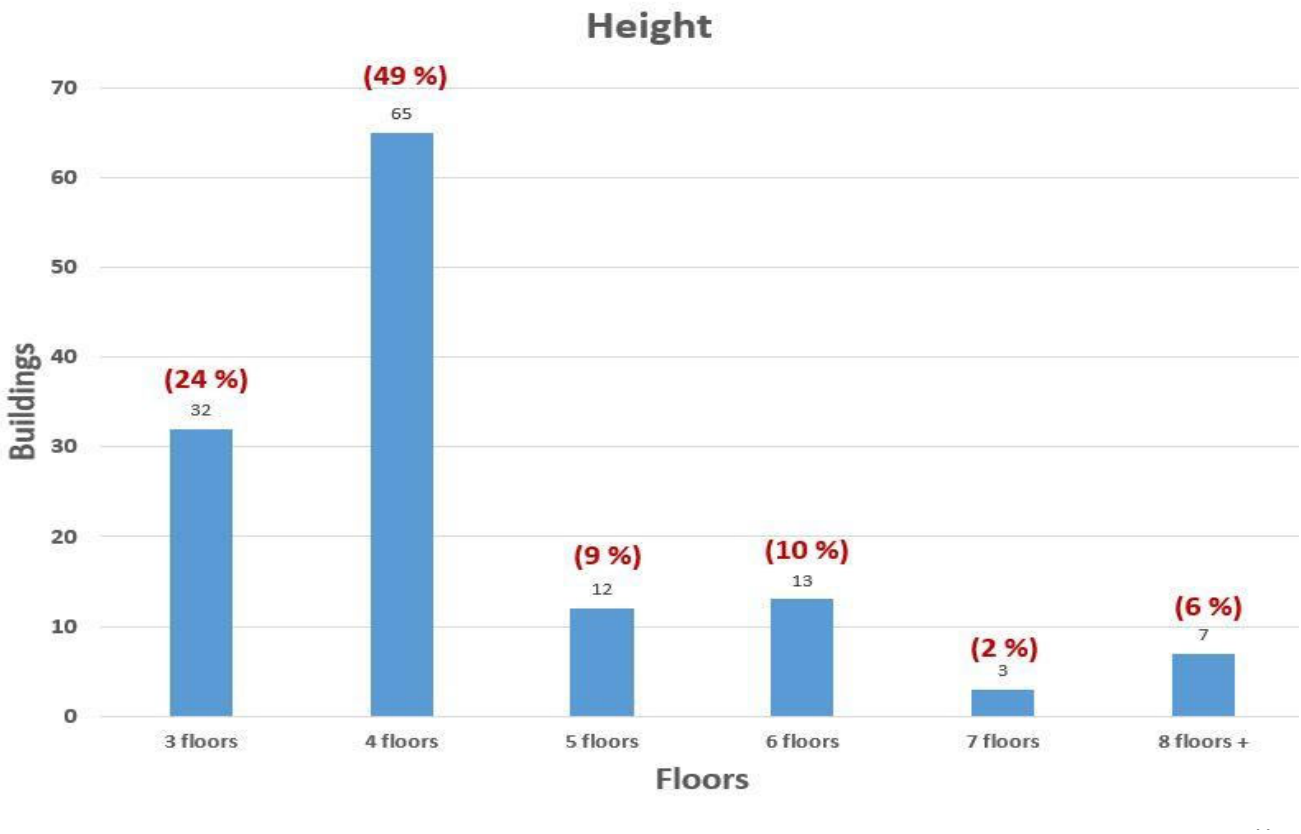
Large elements

Pillar-beam frames

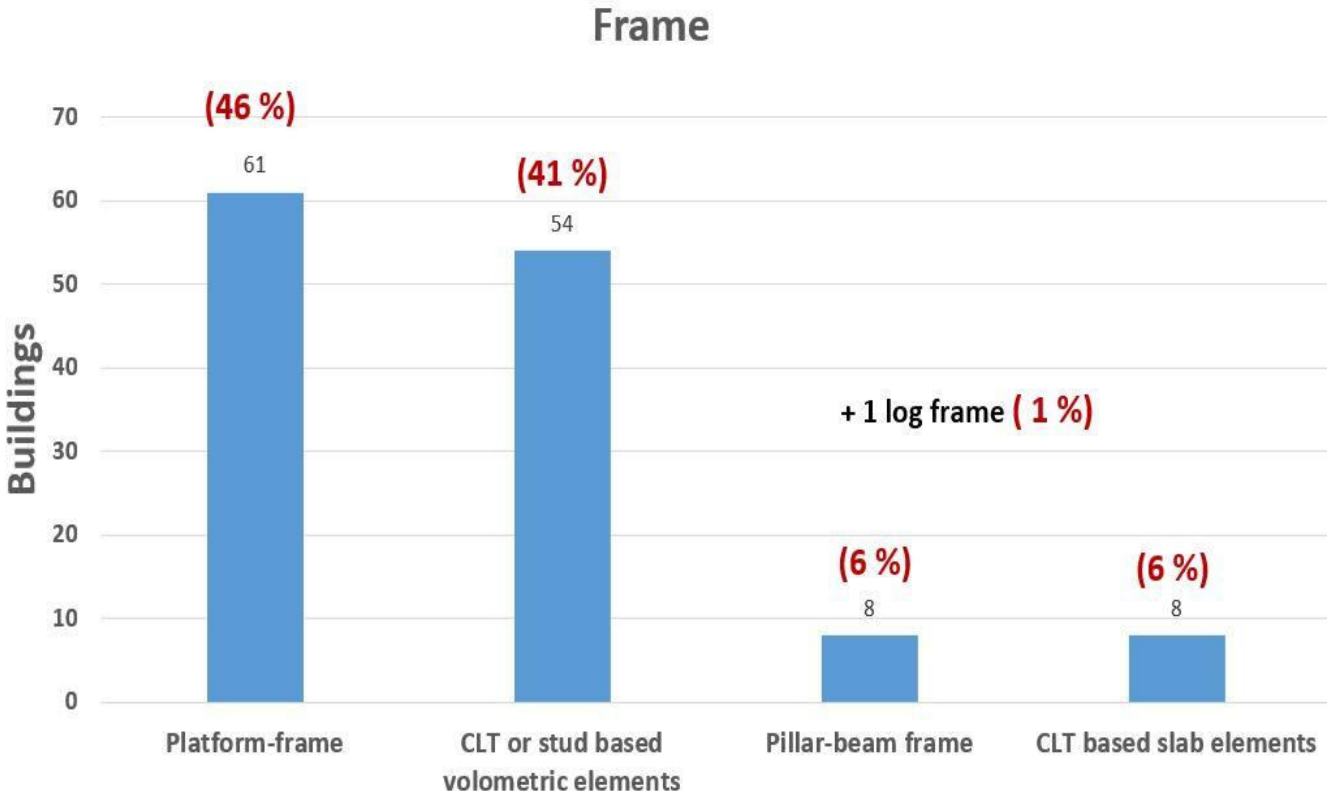


Modular elements

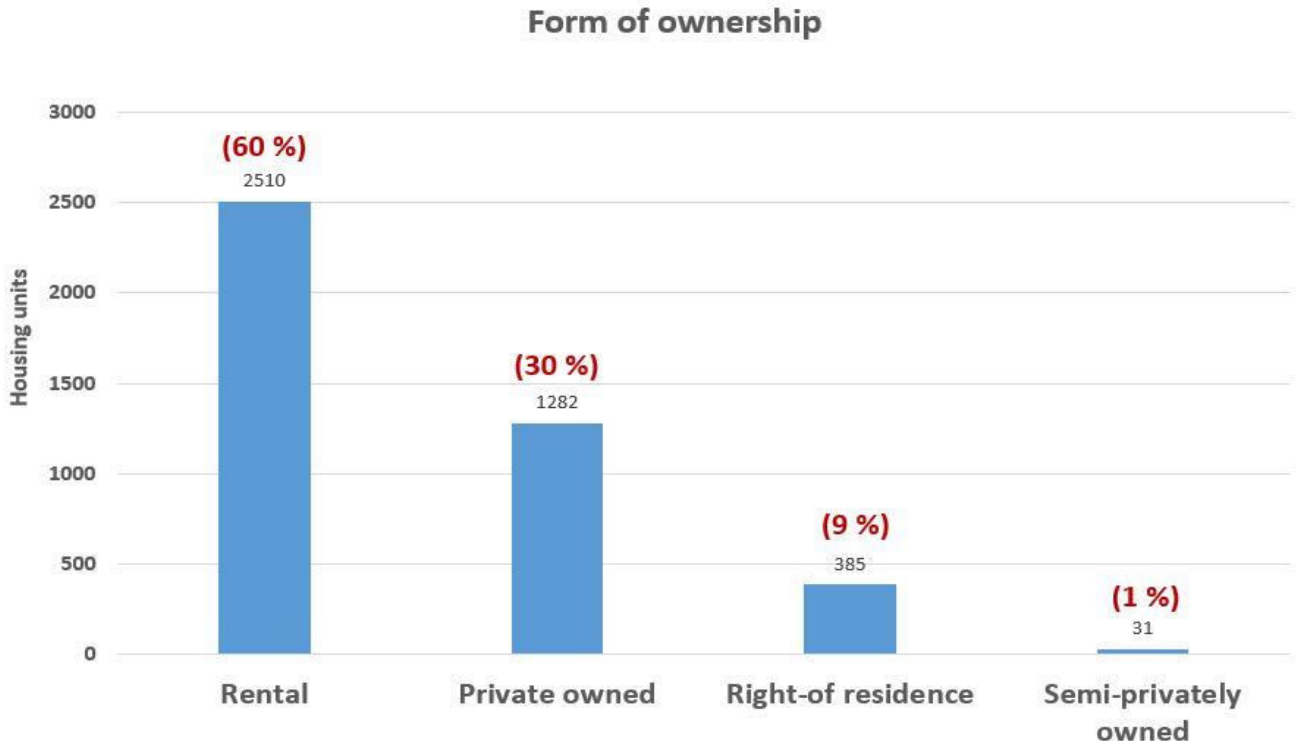
Finnish multi-story timber frame houses (January 2023); 132 houses, 4 208 apartments

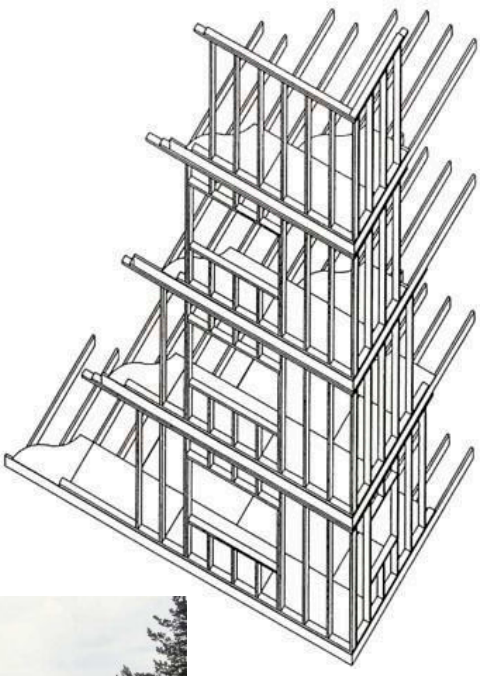


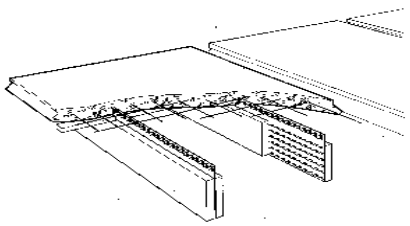
Finnish multi-story timber frame houses (January 2023); 132 houses, 4 208 apartments



Finnish multi-story timber frame houses (January 2023); 132 houses, 4 208 apartments







Platform-frame

Platform-frame wooden multi-story buildings in USA and Canada

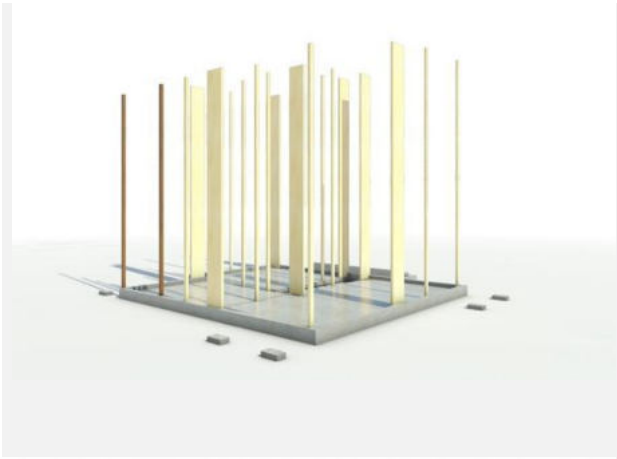
OULU, 1997; 3 houses, 33 apartments

Helsinki, Omenamäki, 2006; 3 houses, 131 apartments

Turku, Pernoo, 2019; 2 houses, 31 apartments

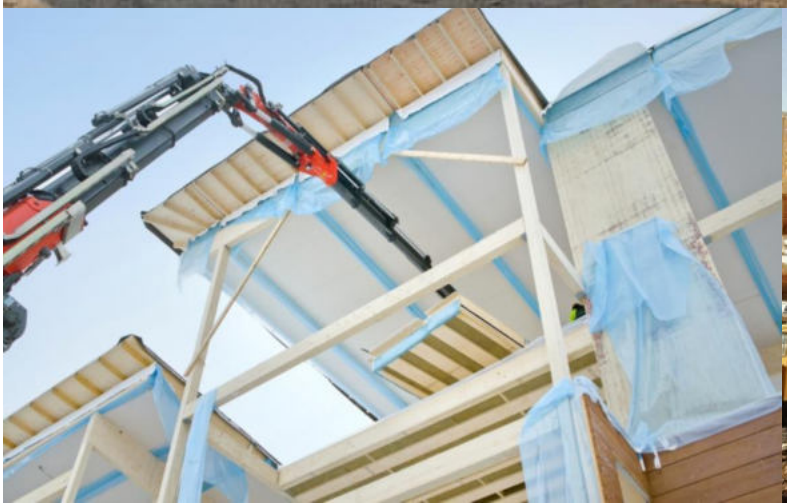
419

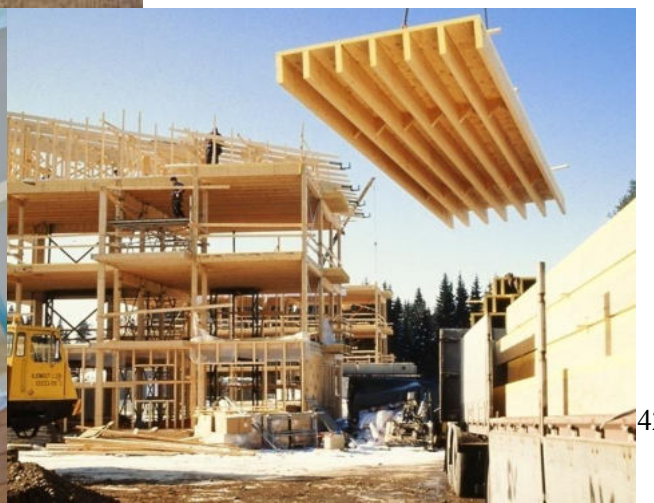
LVL-post and beam-construction



MetsäWood

LVL-based timber frame construction





Ylöjärven Housing Affairs Area 1996; 3 houses, 19 apartments

Viikki, Latokartano, Helsinki, 2012; 5 houses, 104 apartments

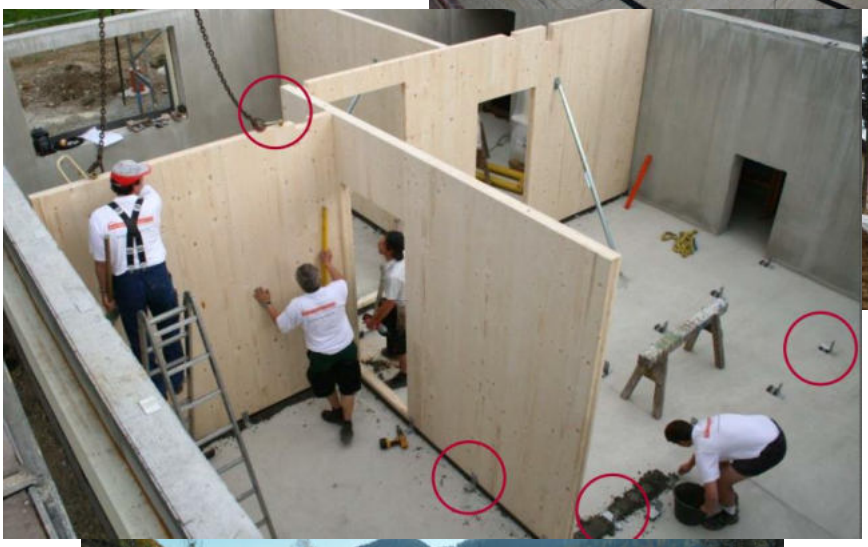




rethink.
storaenso

CLT



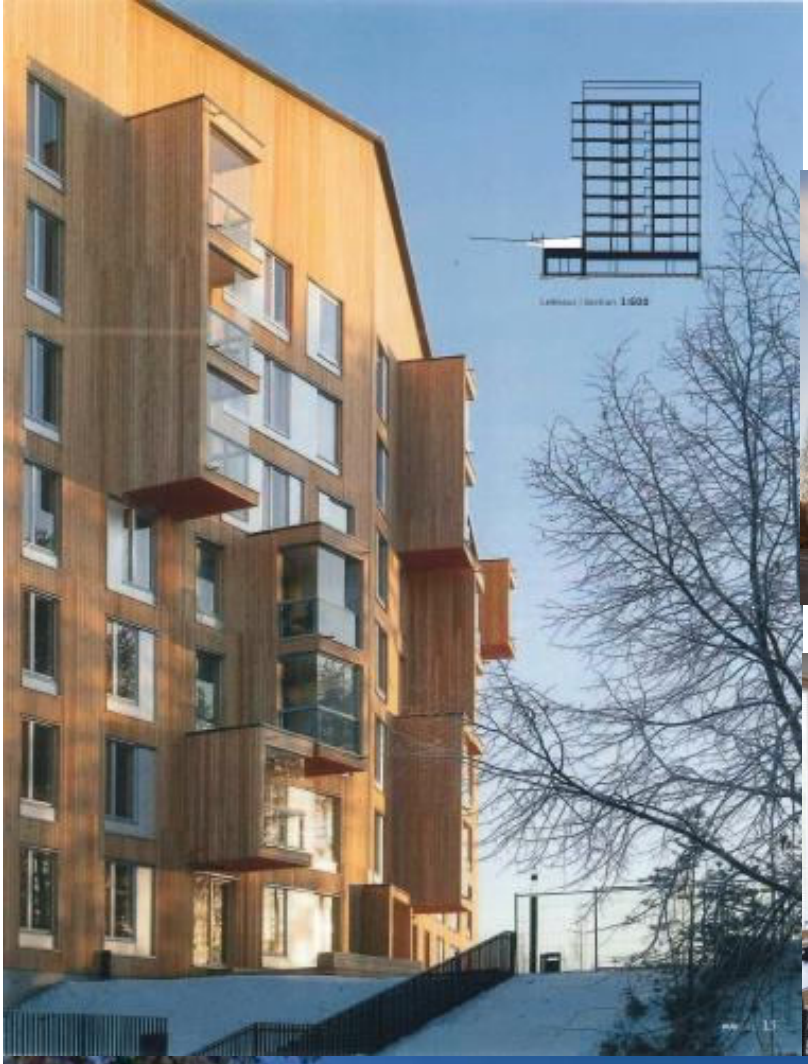



Wood framed volume elements

Volume elements; typical sizes:
4 500 (w) x 3 000 (h) x 13 500 (l)

Seinäjoki,
Lintuviita 2013;
1 house
50 apartments

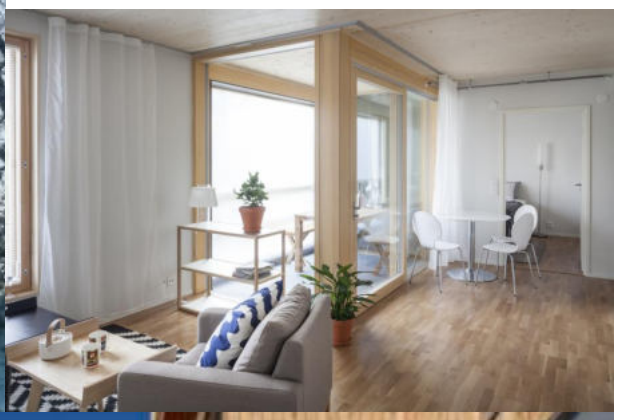
Helsinki, Pukinmäki, 2015; 4 houses, 93 apartments



Jyväskylä, Puukuokka 1, 2015;
1 house; 58 apartments

Finnish Wood Award 2015

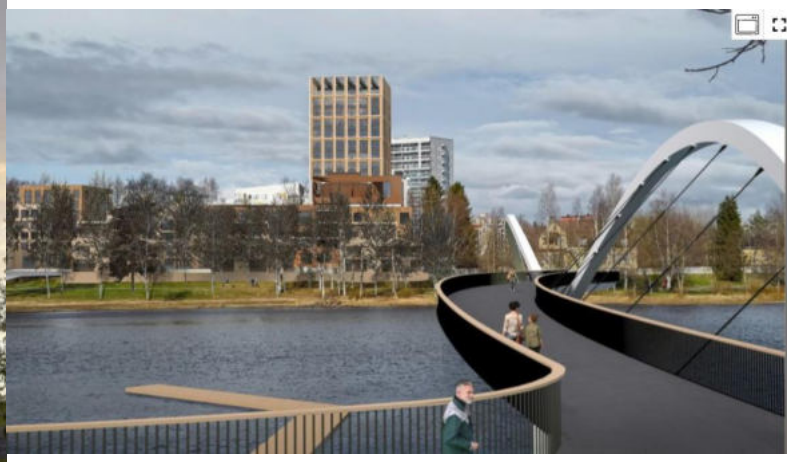
Finlandia of Architecture Award 2015



Rovaniemen DAS Kelo, 2019; 1 house, 103 apartments for students

Joensuun Elli, Light House; 14 floors
Wooden tower for students,
LVL-based vertical frame and CLT-based horizontal frame

16-story wooden apartment building to Oulu´s housing affair area 2025



Schauman Architects Helsinki Oy

4-floors high log-house; Naava Chalet, Ähtäri, 2016; 1 house, 16 leisure-time apartments

Vantaa Kivistö Housing Affairs Area 2015; 1 house,186 apartments

Kuva: Tiia Sorsa, RKL Reponen

Architecture of wooden multi-story buildings?

Multi-story timber frame houses in Sweden

Wooden ”skyscrapers”?

Itävalta, Ho-Ho Wien
24 floors, 2019

Kanada, Vancouver, 18 floors

Bergen, Norja
14 floors, 2015

PILKE-house, ROVANIEMI

METLA-house, JOENSUU

Wooden office buildings

FMO-house, ESPOO

Tampereen yliopisto

Possibilities of using wood in suburban apartment building renovations:

a) Improvement of the outer shell's energy efficiency and addition of a new "utility floor" on the roof.

b) Façade modifications give the apartment, entire building, and milieu a new look.

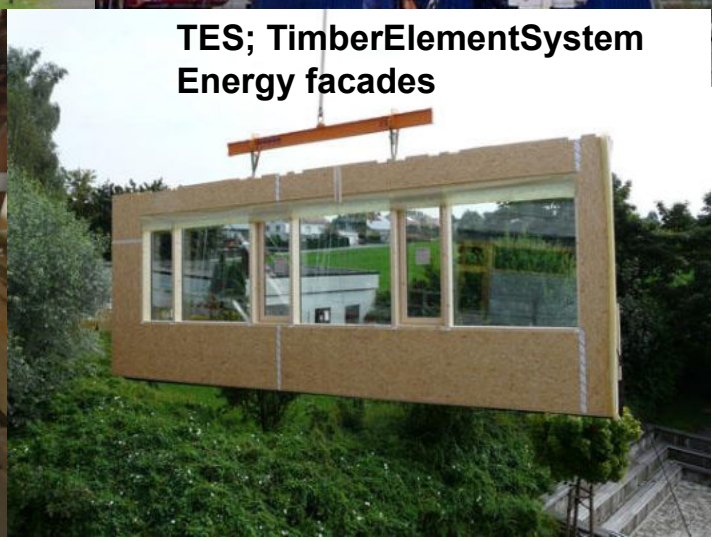
c) Construction of an additional floor and roof modifications.

d) Addition of balconies, either suspended from the frame or standing on its own lightweight footing.

e) High degree of prefabrication and rapid construction, so the period of susceptibility to disturbing factors is short.

f) The outward appearance of wood is valued and considered pleasant.

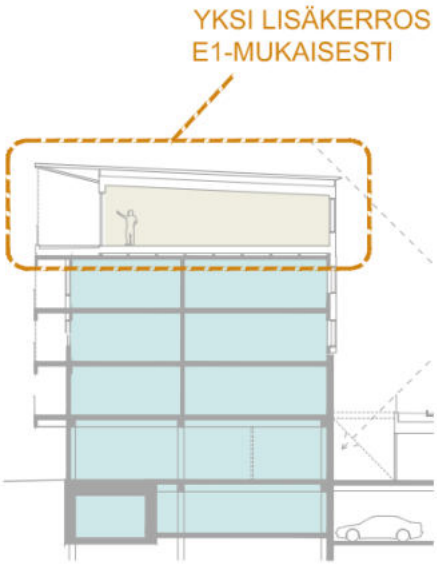
Extra storeys by wooden voyme elements



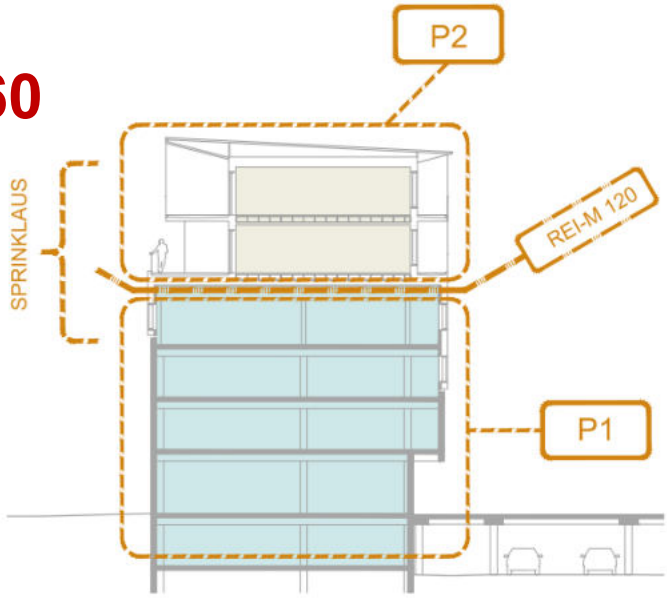
TES; TimberElementSystem
Energy facades

Finland´s fire code (1.1.2018 –): Only two wooden extra stories are allowed

One wooden extra story <u>without</u> sprinkler-system



R 60



Two wooden extra stories <u>with</u> spinkler-system

Extra wooden storeys in concrete block of flats!

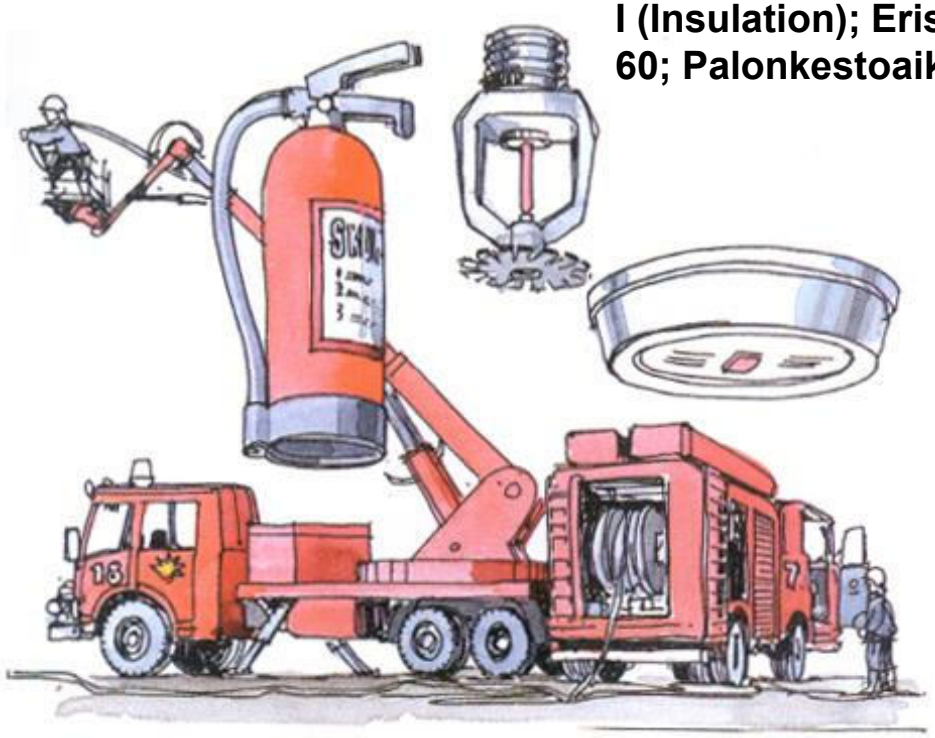
As Oy Tampereen Puolari Kuva: Koskisen Oy

Architect Office Helamaa & Heiskanen Lujatalo Oy

Fire safety

Fire classes P1, P2, P3, P0
REI 60

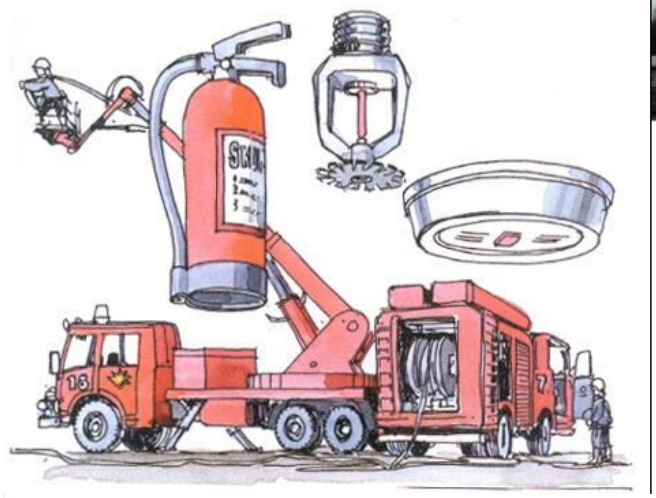
R (Resistance); Kantavuus
E (Integrity); Tiiviys
I (Insulation); Eristävyys
60; Palonkestoaika



KERROSTALOJEN ASUNTOSPRINKLAUS

Water mist sprinkler system;
0,5 mm water / 1 m² / minute

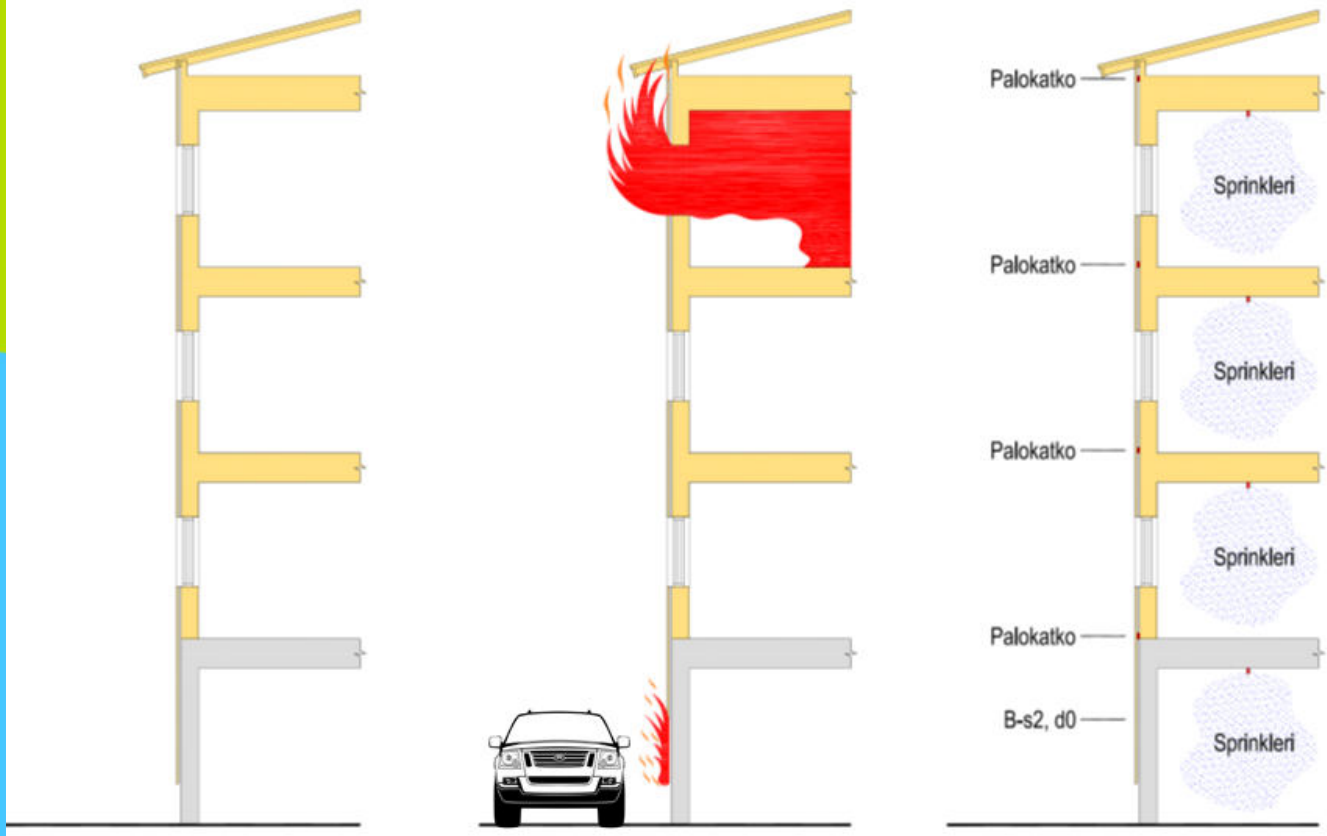
PUUINFO



Cost is about 100 € / h-m²

PALOSKENAARIOT

Scenarios of fire



PINTALUOKAT

Fire classes of building materials in EU

Suuntaa-antavia esimerkkejä seinä- ja kattomateriaalien paloluokituksesta

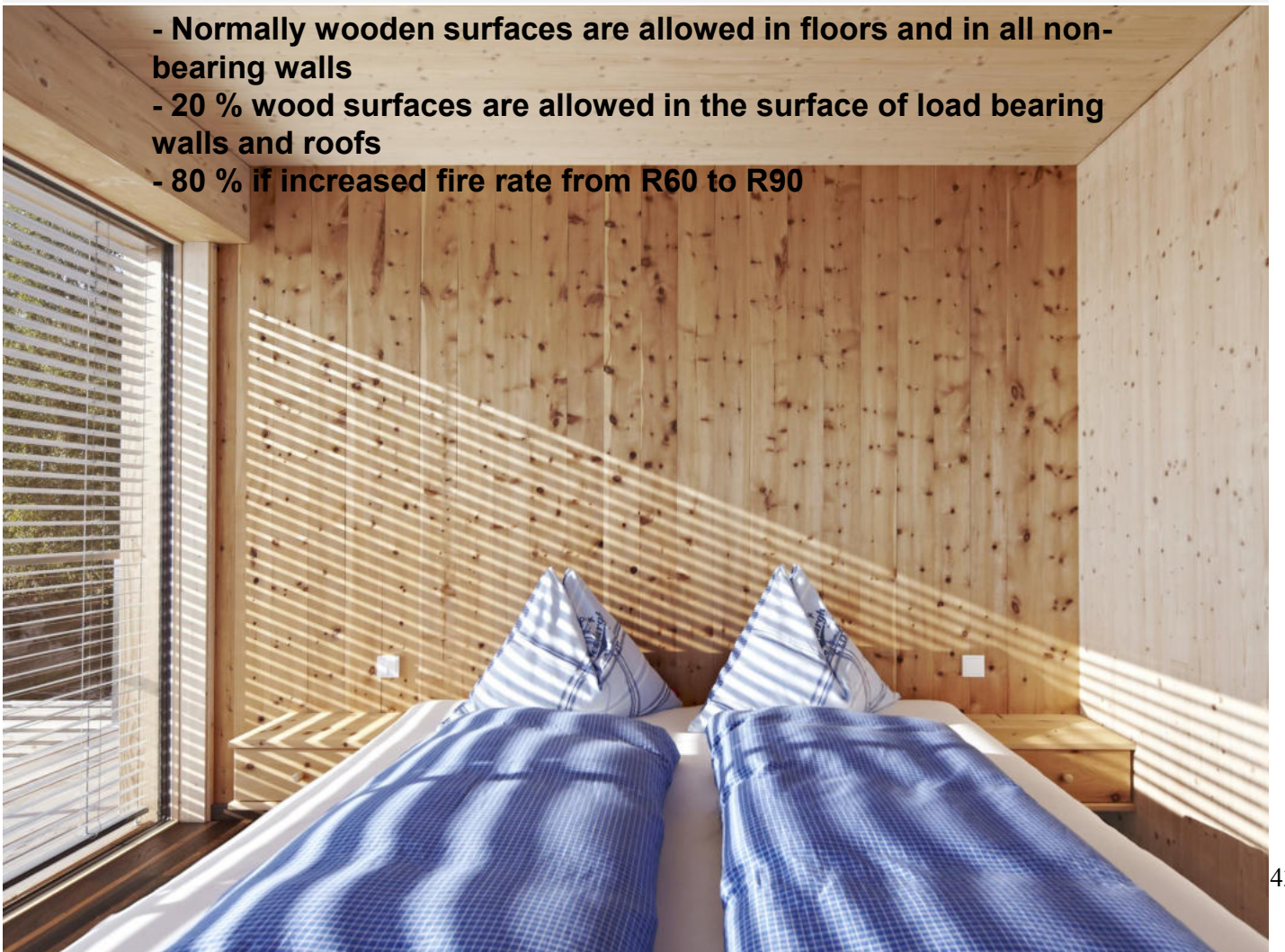
A1	A2	B	C	D	E	F
Kivi	Kipsilevyt	Kipsilevyt	Palosuojattu puu	Puutuotteet yleensä	Huokoinen puukuitulevy	Testaamatto-mat tuotteet
Betoni	Sementtikuitulevyt	Palosuojattu puu				
Tiili						
Lasi						
Teräs						

D: ”Normal wood”

B, C: Fire retardant wood

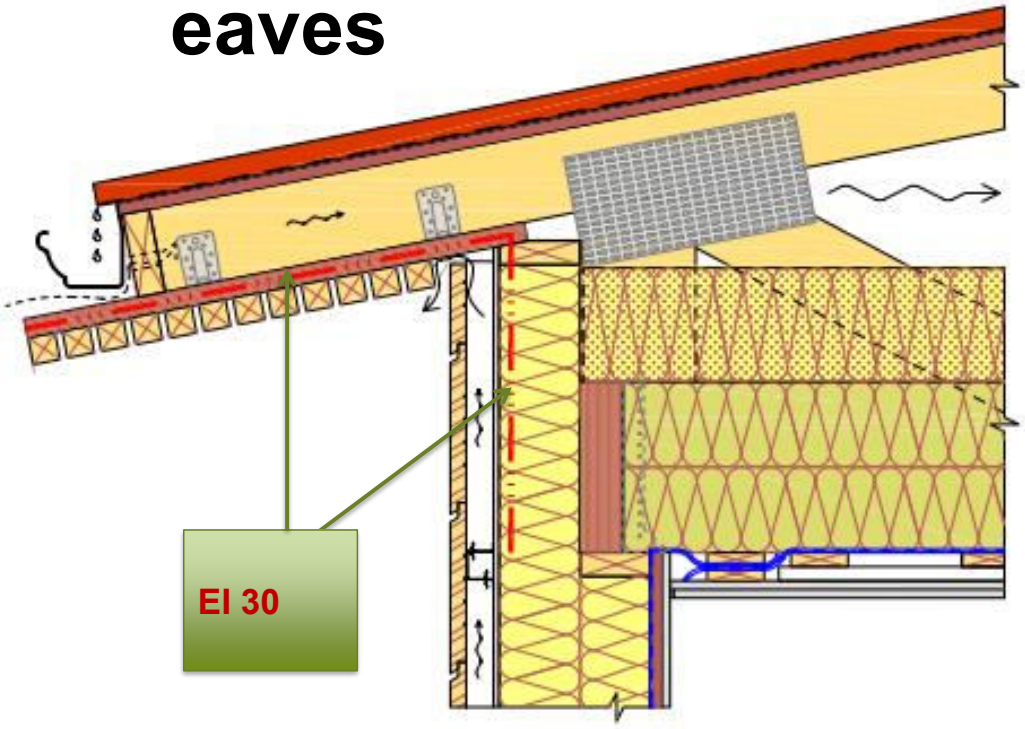
D-s2, d2

D = lämmöntuottoa ja liekin leviämistä kuvaava merkintä
s2 = savuntuottoa kuvaava merkintä
d2 = palavien pisaroiden muodostumista kuvaava merkintä




Kuva: M

Fire safe eaves

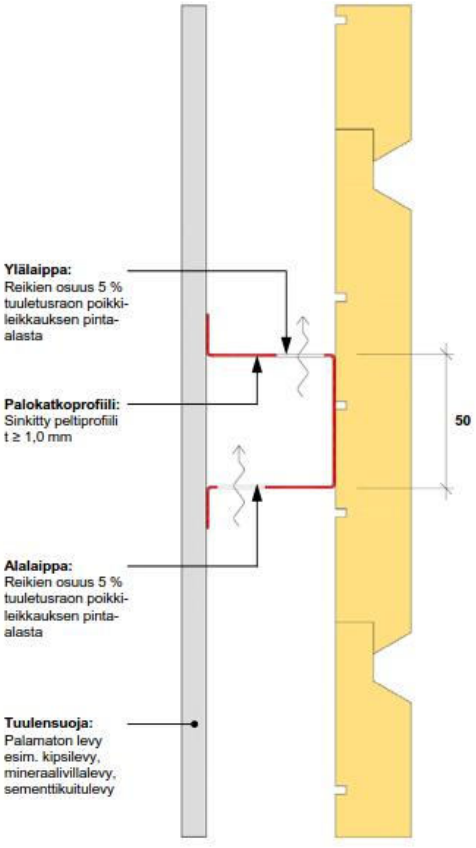


1 61

Kuopio rescue college,1998

Julkisivun palokatko

Fire stops of wooden facade

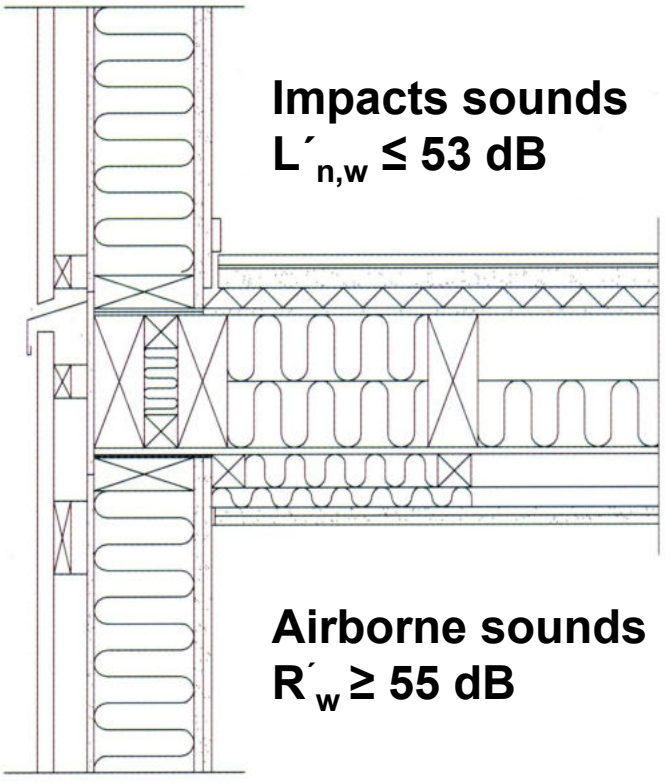


Main fire-codes in timber multi-storey buildings in Finland (after 1.1.2018-)

To use timber frame and/or wooden facades in 3 - 8 storey buildings:

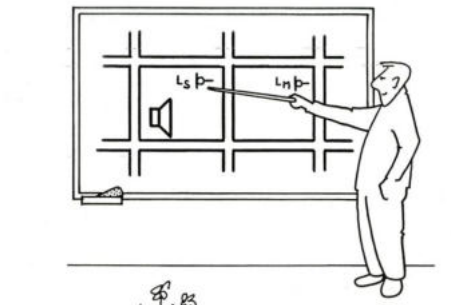
- **max. height: 8 storeys, 28 meters**
- **residential sprinkler-system**
- **fire-(smoke)detectors in every apartment**
- **non-combustible (A1) or “almost non-combustible”(A2) warm-insulation-material (=glasswool or rockwool)**
- **non-combustible (class B, s1, d0) inside-covering on ceilings and on walls (f.ex. gypsum-board) >>> wood is allowed in sauna and on the ceiling of bathroom, in floors and in non-load bearing walls**
- **fire stops in facades**
- **fire safe eaves**

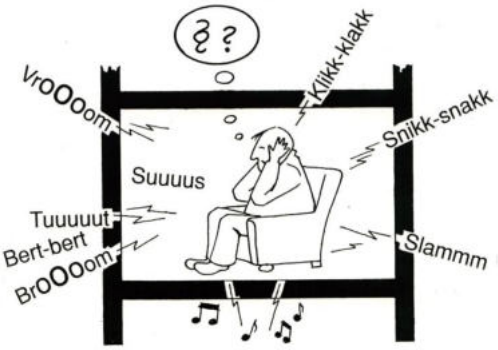
Sound insulation



Impacts sounds
$L'_{n,w} \leq 53$ dB

Airborne sounds
$R'_w \geq 55$ dB



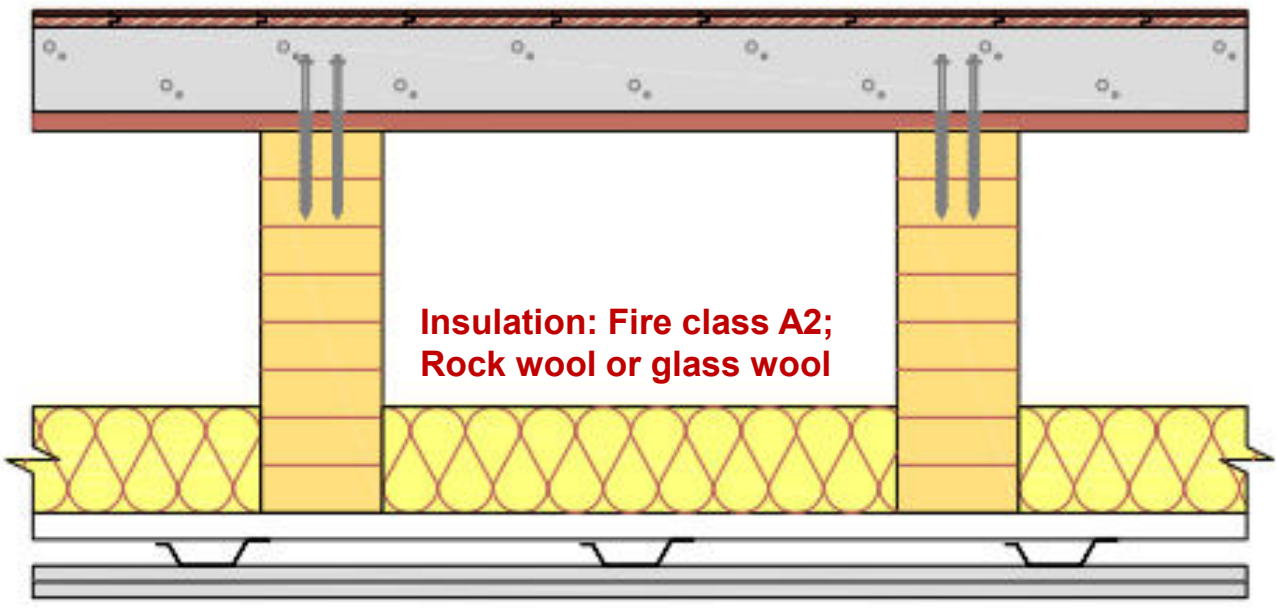


Lightweight intermediate floor

Impacts sounds:
$R'_w \leq 53$ dB

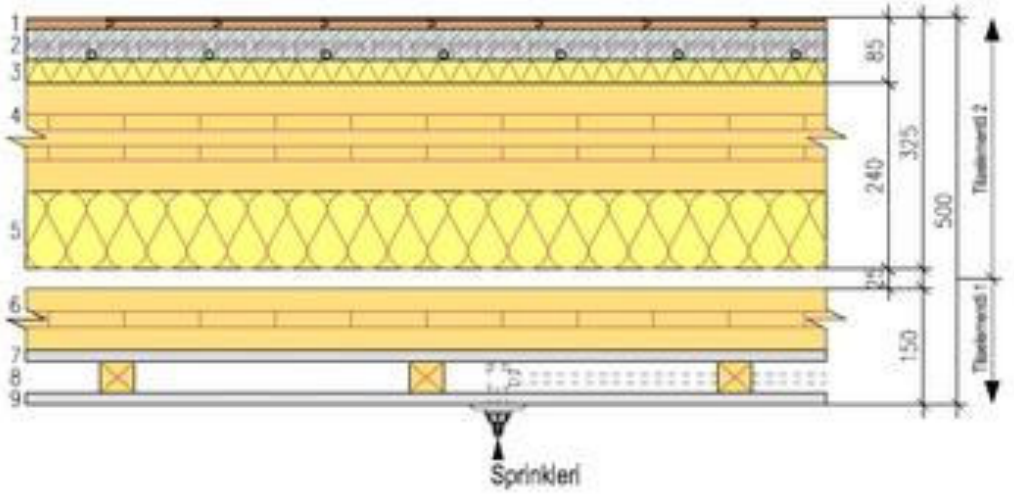
Airborne sounds:
$L'_{n,w} \geq 55$ dB

Fire rate: REI 60



Intermediate floor by CLT-volume elements

Massiivipuuvälipohja REI 60 tilaelementtiin R´w ≥ 55, L´n,w ≤ 53

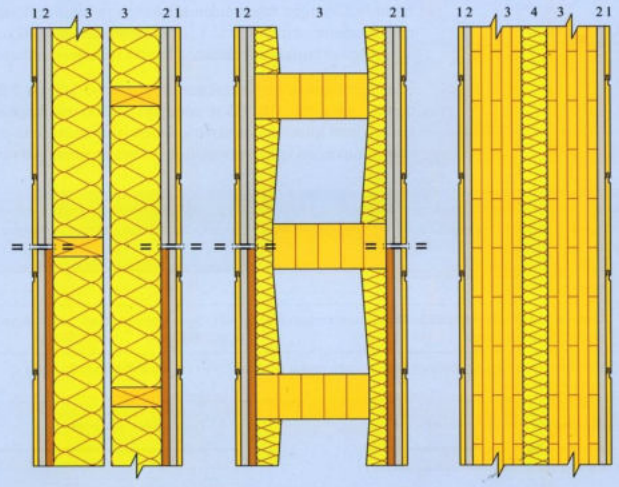


Double walls between apartments

Airborne sound insulation
$L´_{n,w} \geq 55$ dB

Asennusteknisistä syistä puurunkoisten keveiden seinien ylä- ja alajuoksut on hyvä tehdä peltirankaisina. Tämä mahdollistaa sen, että seinien pystytolpat voidaan jättää yläpäästään 15 millimetriä seinäkorkeutta lyhyemmiksi. Näin mahdollinen iän myötä tapahtuva vaakarakenteiden painuminen ei aiheuta vaurioita, koska väliseiniin on jätetty painumisvaraa. Tuulikaappien ja saunojen seinissä on lisäksi hyvä käyttää lämmöneristettä.

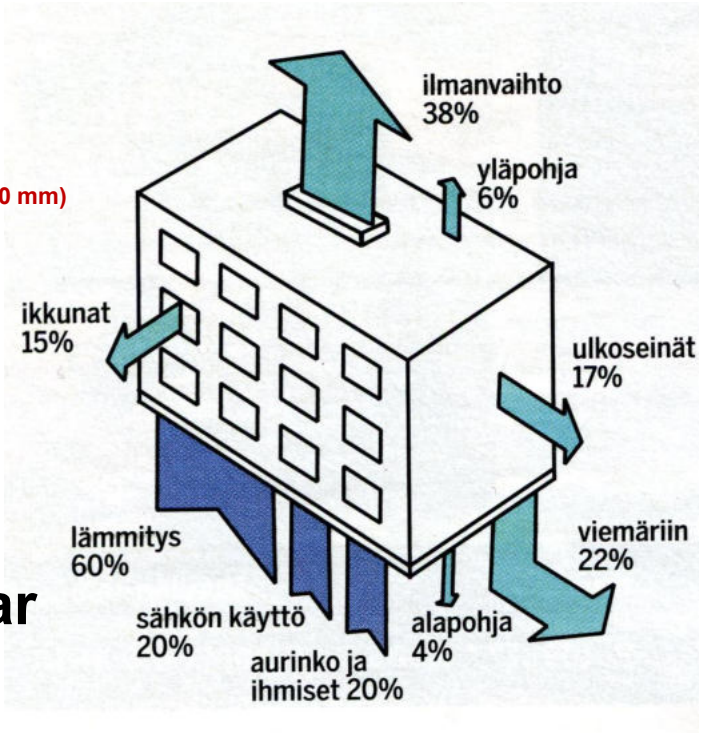
Esimerkit kantavista ja osastoivasta kaksoisrunkoisista huoneistojen välisistä seinistä. Vasemmalla kevyempiä kuormia ja matalampia rakennuksia varten oleva rankarakenteinen seinä, keskellä suurempia kuormia ja korkeampia rakennuksia varten oleva rankarakenteinen seinä ja oikealla CLT-rakenteinen seinä.



Nro	Rankarakenteinen seinä	Rankarakenteinen seinä	CLT-rakenteinen seinä
1	Pintaverhous		
2	Suojaverhous, palosuojaus ja jäykistävä levytys		Suojaverhous ja palosuojaus
3	Runko ja äänitekninen eristys		Kantava ja jäykistävä CLT-runko
4	–		Äänitekninen eristys

Energy efficience and thermal insulation:

- U values, W/(m²K)
  - **Outer wall 0,17** (insulation 220 – 250 mm)
  - **Roof 0,09** (insulation 400 – 450 mm)
  - Base floor 0,16
  - **Windows 1,0**
  - **Doors 1,0**
- E value, kWh_E/m^2 year

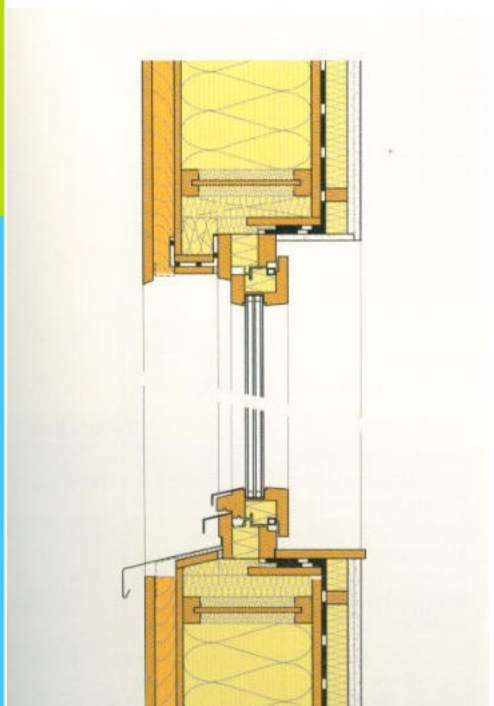


TAMPEREEN TEKNILLINEN YLIOPISTO

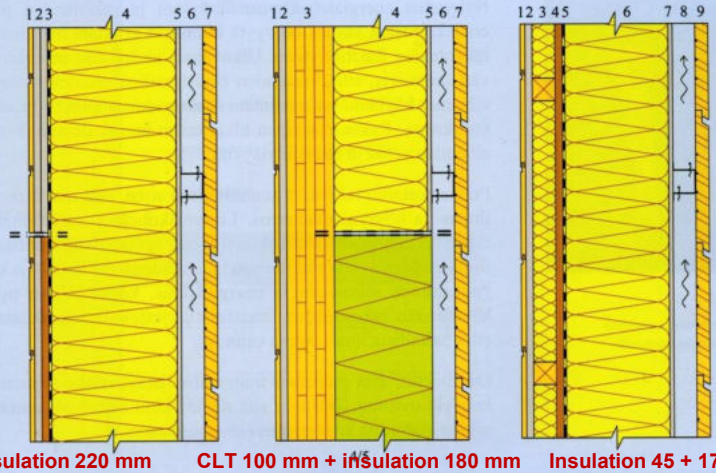
Outer walls

U value < 0,09 W/(m²K)
= insulation 220 – 250 mm

Insulation: Fire class A2;
Rock wool or glass wool



Esimerkkejä puukerrostalon ulkoseinärakenteista

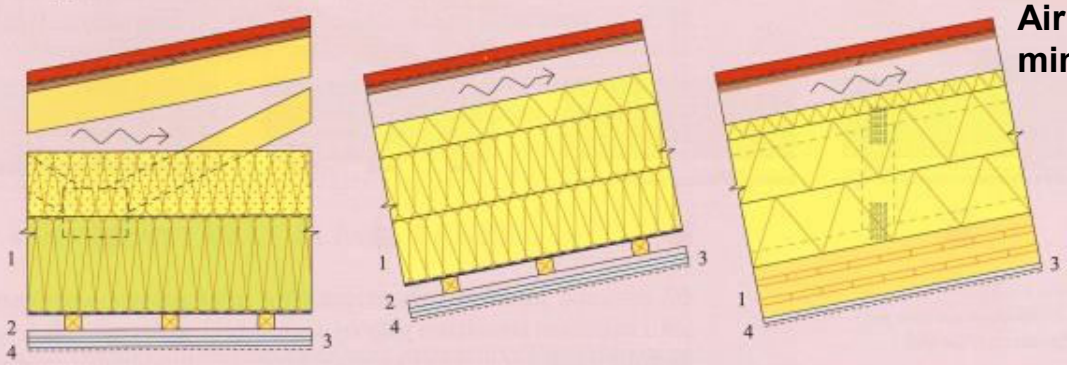


Insulation 220 mm | CLT 100 mm + insulation 180 mm | Insulation 45 + 175 mm

Nro	Rankarakenteinen ulkoseinä	CLT-rakenteinen ulkoseinä	Ristirunkoinen sisään koolattu rankarakenteinen ulkoseinä
1	Sisäverhous		
2	Suojaverhous, palosuojaus ja jäykistävä levytys	Suojaverhous ja palosuojaus	
3	Ilman- ja höyrynsulku	Kantava ja jäykistävä runko • *Lämmöneristys* • *Ilman- ja höyrynsulku*	Lämmöneristys ja tila sähköasennuksille
4	Kantava runko ja lämmöneristys	Lämmöneristys	Palosuojaus ja jäykistävä levytys
5	Tuulensuoja, suojaverhous ja jäykistävä levytys	Tuulensuoja ja suojaverhous	Ilman- ja höyrynsulku
6	Tuuletusrako, julkisivun kiinnitysalusta ja palokatkot		Kantava runko ja lämmöneristys
7	Julkisivu		Tuulensuoja, suojaverhous ja jäykistävä levytys
8	–		Tuuletusrako, julkisivun kiinnitysalusta ja palokatkot
9	–		Julkisivu

Roof structures, U value = 0,09 (insulation 400 – 450 mm)

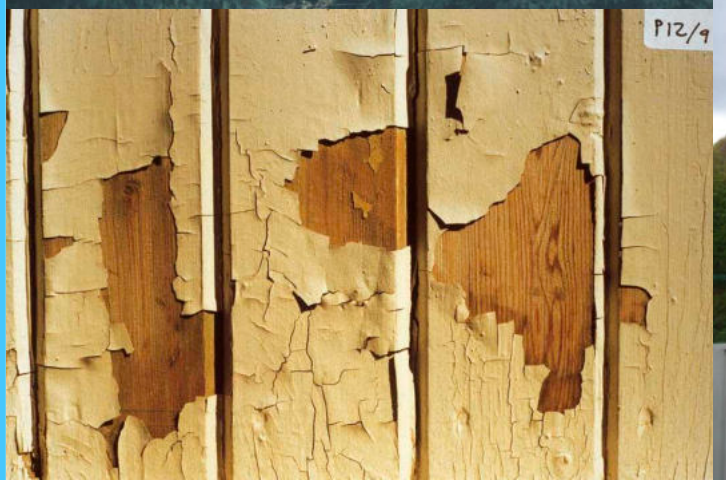
Rakenneleikkaukset REI 60 -paloluokituksen mukaisista puukerrostalon esimerkkiyläpohjista. Taulukossa esitetty paloturvallisuuden kannalta oleelliset rakennekerrokset.



Air gap; min 150 mm

Nro	Ristikkorakenne	Palkkirakenne	CLT-rakenne
1	Palkkirakenteinen alapaarre	Kantava palkisto	Kantava CLT-runko
	• *Kantava rakenne hiiltymämitoitetaan yläpuoliselle palolle* • *Kantava rakenne hiiltymämitoitetaan alapuoliselle palolle, mikäli levyt nro 3 eivät suojaa rakennetta hiiltymiseltä 60 minuuttia*		
2	Alakattoa ja lämmömeristettä kantava rakenne • *Hiiltymämitoitetaan, mikäli levyt nro 3 eivät suojaa rakennetta hiiltymiseltä 60 minuuttia*		–
3	Suojaverhous K_2 10 ja palosuojaus (3–4-krs.) • *Kipsilevy 2 x 13 mm* Suojaverhouksen korvaava EI 30 rakenne A2-s1, d0 -luokan tarvikkeista (5–8-krs.) • *Palokipsilevy 2 x 15 mm*		Suojaverhous K_2 10 ja palosuojaus (3–4-krs.) • *Kipsilevy 13 mm* Suojaverhous K_2 30 ja palosuojaus (5–8-krs.) • *Kuitukipsilevy 18 mm*
4	Sisäverhous *(katso määräykset sisäpintojen luokkavaatimuksista kohdasta 9.1.2)*		

Long term durability



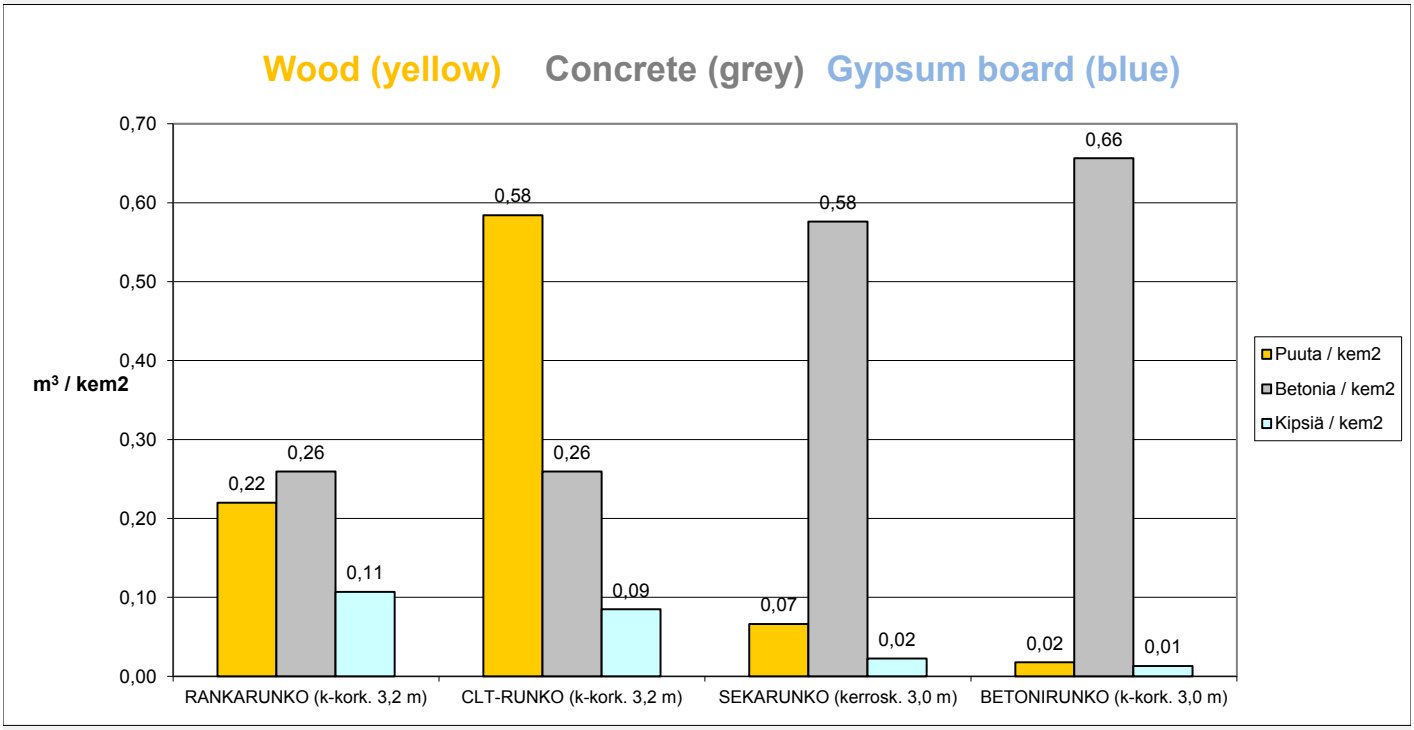
Houses for people

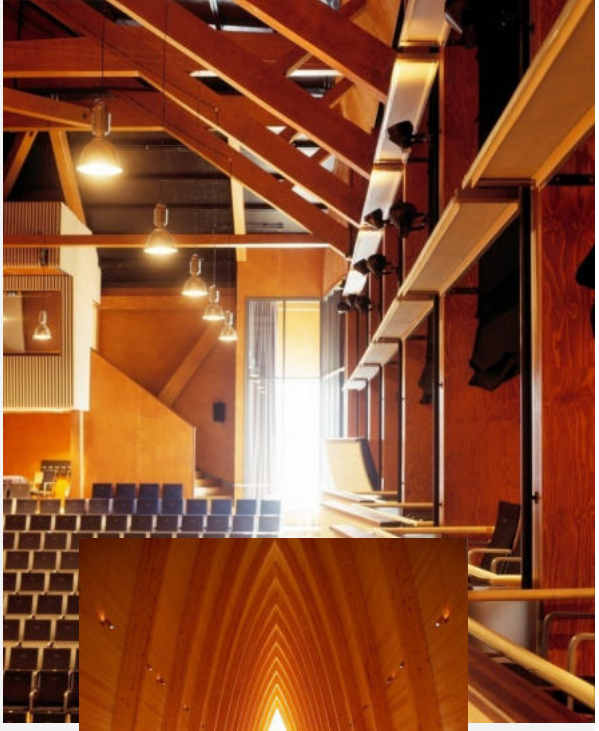
Good architecture

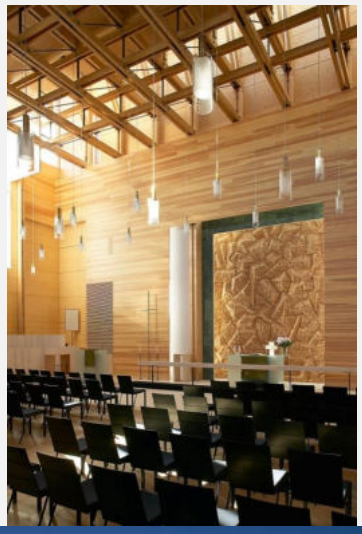
Wood or concrete?

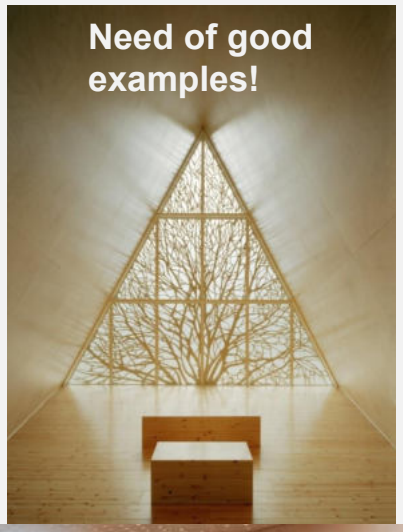
- **Concrete:**
  - 2 500 kg / m³
  - about 200 € / m³
- **Wood:**
  - 370 - 500 kg / m³
  - Stock 60 – 70 € / m³
  - Sawn timber 200 € / m³
  - CLT 500 - 650 € / m³

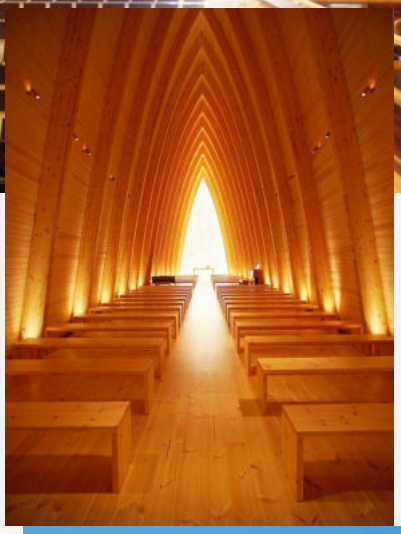
How much wood and concrete in block of flats?



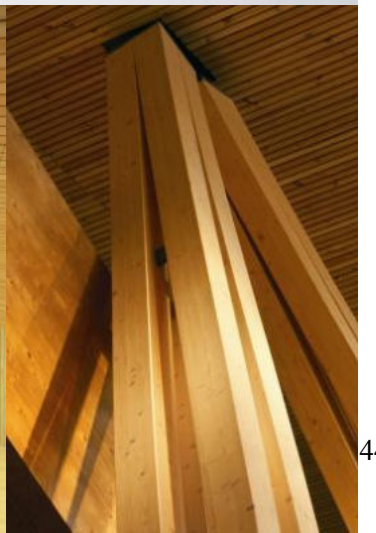




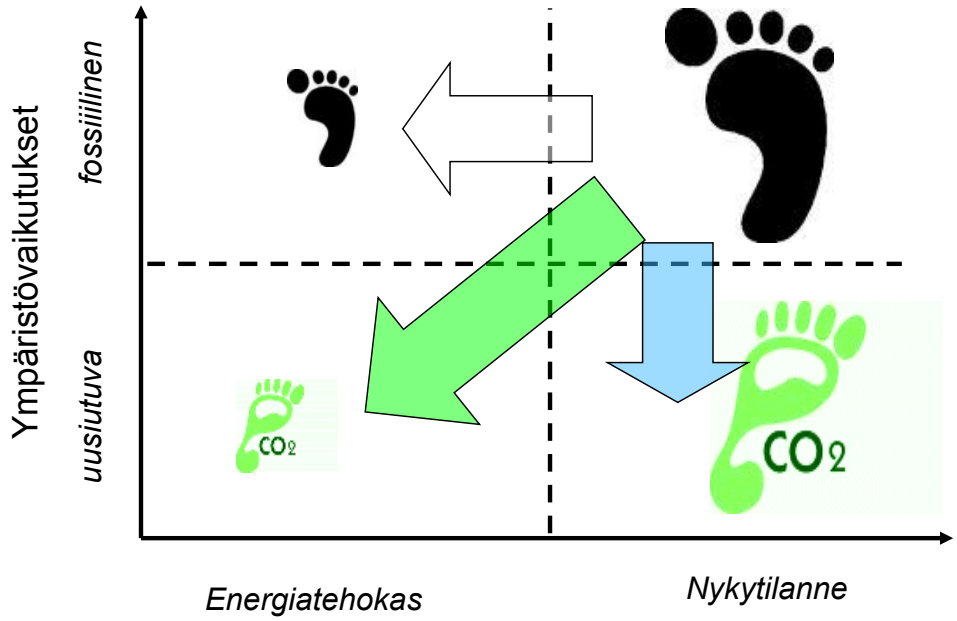

Need of good
examples!



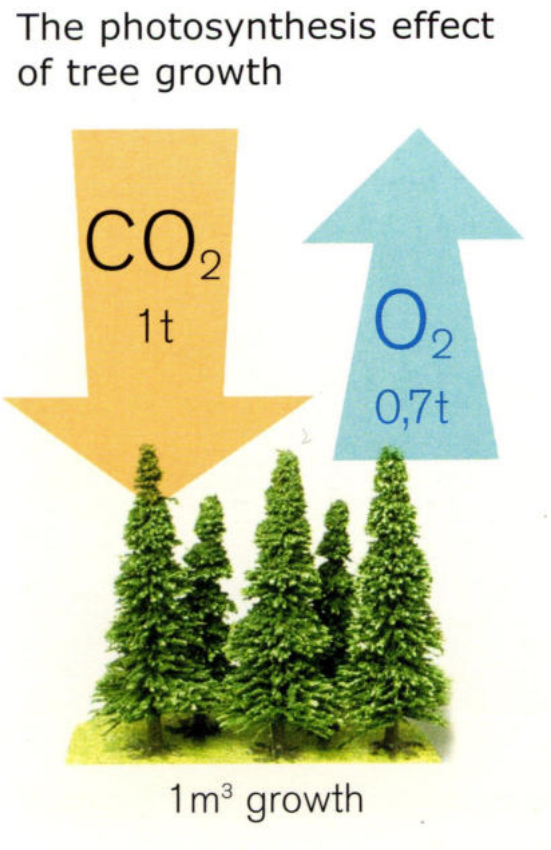

Need of good examples!



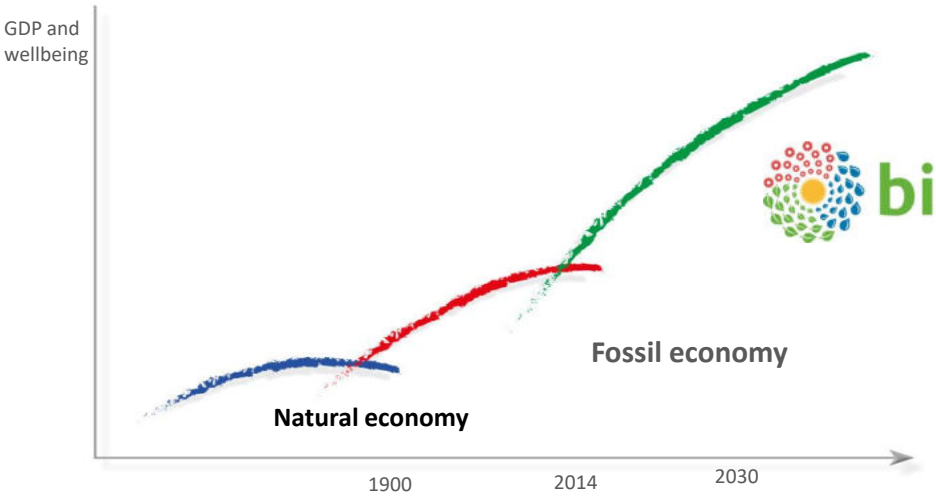
Today we build buildings to 2050



The environmental impact of producing different construction materials and building will be taken into cosideration in 2025 in Finland



Bioeconomy: The next economic wave



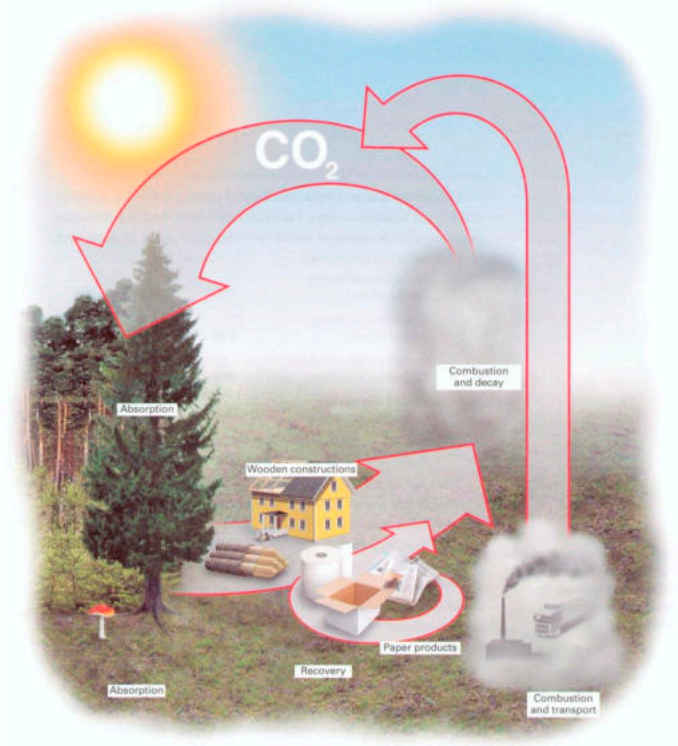
The value of bioeceonomy in Finland is 60 miljards euros

About half of Finland's bioeconomy consists of forest bioeconomy

Changing global trends in construction:

- Prevention of climate change
- Sustainable development
- Carbon footprint
- Resource efficiency
- Energy efficiency
- Recycling economy
- Bio-economy

>>>Timber construction could be the common denominator of all of these



TAMPEREEN TEKNILLINEN YLIOPISTO

Tampereen yliopisto
Tampere University

Tallest Timber Buildings
What are the Main Architectural and Structural Design Considerations?

23.01.2023

Dr. Hüseyin Emre Ilgın

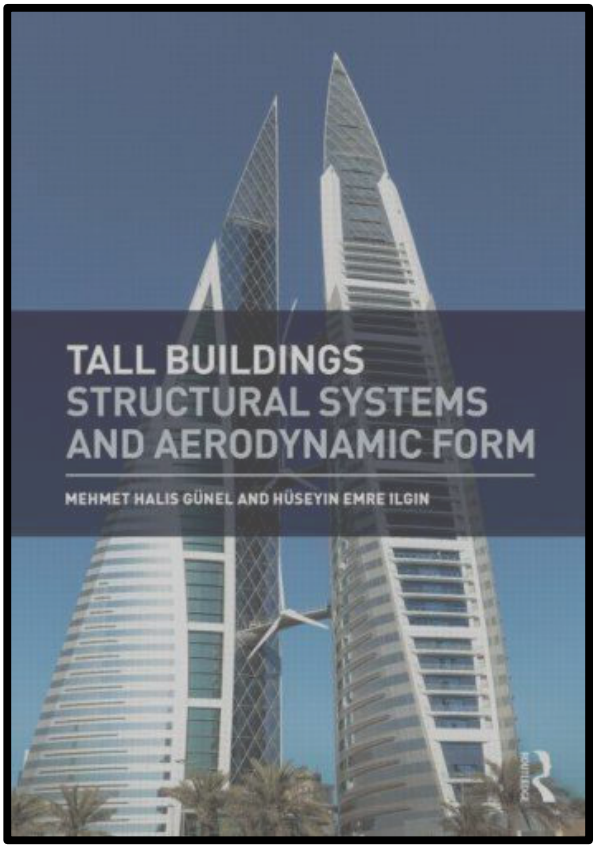
MAIN REFERENCES

Ilgın HE, Karjalainen M, Pelsmakers S. ***Contemporary Tall Residential Timber Buildings: What are the Main Architectural and Structural Design Considerations?,*** *International Journal of Building Pathology and Adaptation,* 2022

Ilgın HE, Karjalainen M, Pelsmakers S. ***Finnish architects' attitudes towards multi-storey timber-residential buildings,*** *International Journal of Building Pathology and Adaptation,* 2022

Ilgın HE, Karjalainen M. ***Tallest Timber Buildings: Main Architectural and Structural Design Considerations,*** *IntechOpen*, 2022

Karjalainen M, **Ilgın HE,** Tulonen L. ***Main Design Considerations and Prospects of Contemporary Tall Timber Apartment Buildings: Views of Key Professionals from Finland***. Sustainability, 2021



Tall Buildings: Structural Systems and Aerodynamic Form
Routledge, 2014

Terminology & definition

Term	Sample of the literature
Multi-storey (-story) timber building (or construction)	(Lattke and Lehmann, 2007) (Mahapatra and Gustavsson, 2008) (Lehmann, 2012) (Riala and Ilola, 2014) (Gosselin et al., 2015) (Ruuska and Häkkinen, 2016) (Zumbrunnen, 2017) (Kuzman and Sandberg, 2017) (Kaufmann et al., 2018) (Markström et al., 2019)
Multi-storey timber-frame construction	(Kairi, 2005) (Nord et al., 2011) (Xia et al., 2014)
Wooden (or Wood-based) multistory building (or construction)	(Mahapatra and Gustavsson, 2009) (Eliasson and Thörnqvist, 2010) (Östman and Källsner, 2011) (Mikkola, 2014) (Anttonen, 2015) (Federation of the Finnish Woodworking Industries, 2019) (Toppinen et al., 2019)
Wood-frame multi-story construction (WMC)	(Gustavsson et al., 2006) (Mahapatra et al., 2012) (Hurmekoski et al., 2015) (Hurmekoski et al., 2018) (Vihemäki et al., 2019) (Lazarevic et al., 2020)
Tall Wood (-en)	(Green and Karsh, 2012) (Salvadori, 2017) (Green and Taggart, 2017) (Wiegand, 2019)
Tall Timber	(Foster et al., 2017) (Kuzmanovska et al., 2018) (Landel, 2018)

Terminology & definition

No global consensus on the definition of timber building, **BUT,**

in Finland, **multi-story** or **tall timber** buildings

where ***main load-bearing frame mostly (>50%) made of timber***.

- low-rise building – 1-2-story
- multi-story building – over 2-story
- mid-rise building – 3-8-story
- ***tall building – over 8-story****

*** 8-story** *is the current maximum allowable height for the "P2 class" for wood construction in Finland. (**P0 class for over 8-story**)*

Main drivers

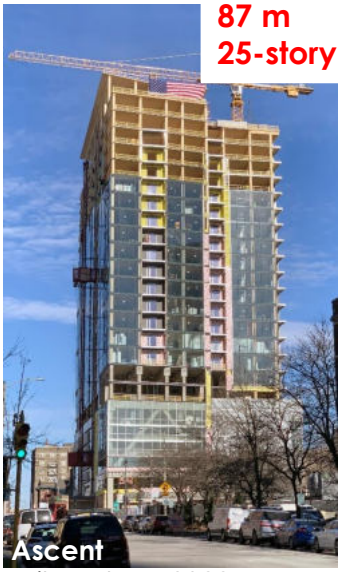
The use of timber in construction has seen a resurgence **since 1995**

(1) decarbonisation

(2) forest management and timber life-cycle

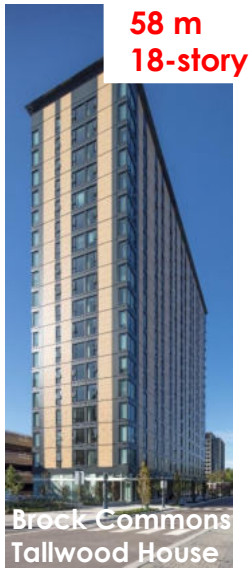
(3) urbanisation and densification

(4) productivity in the construction industry *e.g., fast prefabrication*



Milwaukee, 2022

Brumunddal, 2019



Vancouver, 2017

Joensuu, 2019

Main challenges

- lower stiffness and llightweight resulting in ***lateral sway***
- serviceability limit states *(**occupancy comfort**)*
- ***fire safety*** *(over 2-story often require a sprinkler system)*
- long-term durability and ***maintenance of facades***
- ***sound insulation*** *(particularly impact sound)*
- **cost** competitiveness
- **moisture** sensitivity
- *lack of* ***design practices***
- insufficient **design guidelines** & incomplete **standardization** and **regulation**

Lateral loads affecting tall buildings

Due to their ***extraordinary height***, tall buildings show a greater sensitivity to ***wind*** and ***earthquake loads.***

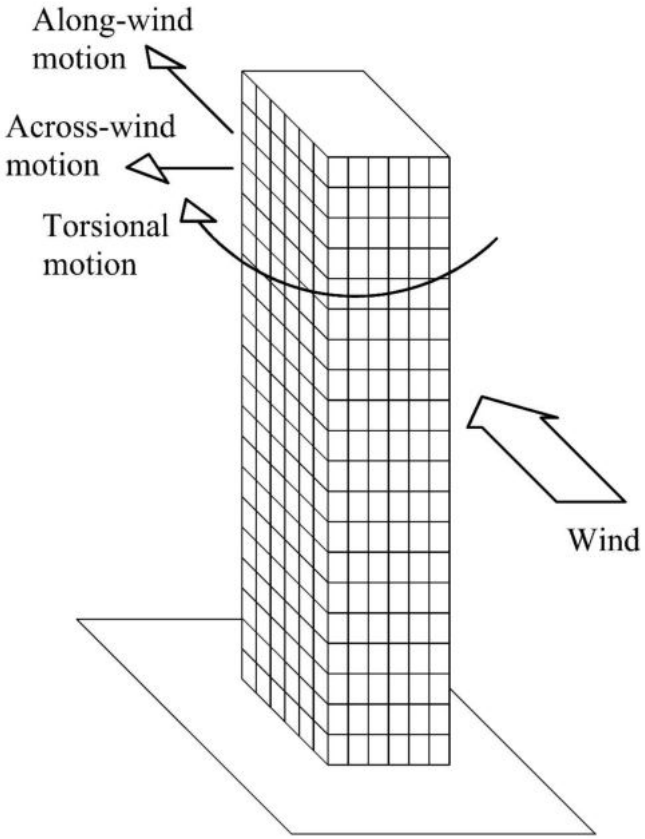
Earthquake loads increase according to the ***building weight***, while ***wind loads*** increase according to the ***building height***.

Wind loads can cause of large ***lateral drift*** (sway) that is ***more critical*** than from ***earthquake loads***.

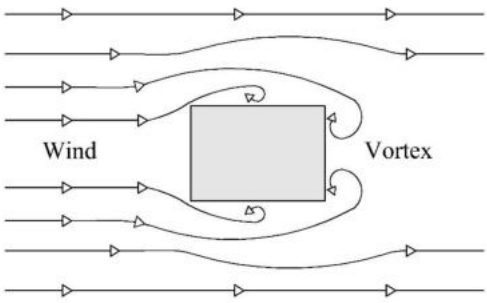
Necessary to ***limit the building sway***.

Maximum lateral top drift by lateral loads < ***1/500*** of building height.

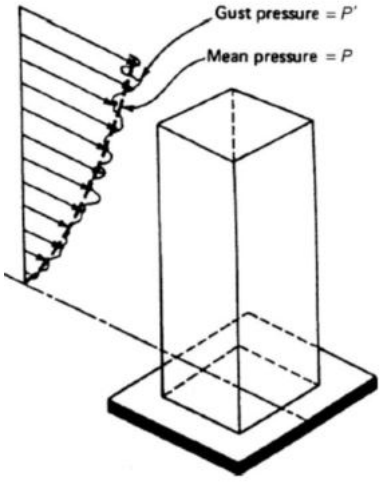
Lateral loads affecting tall buildings / Wind loads



Tall building motions under the effect of wind



The formation of turbulent air flow

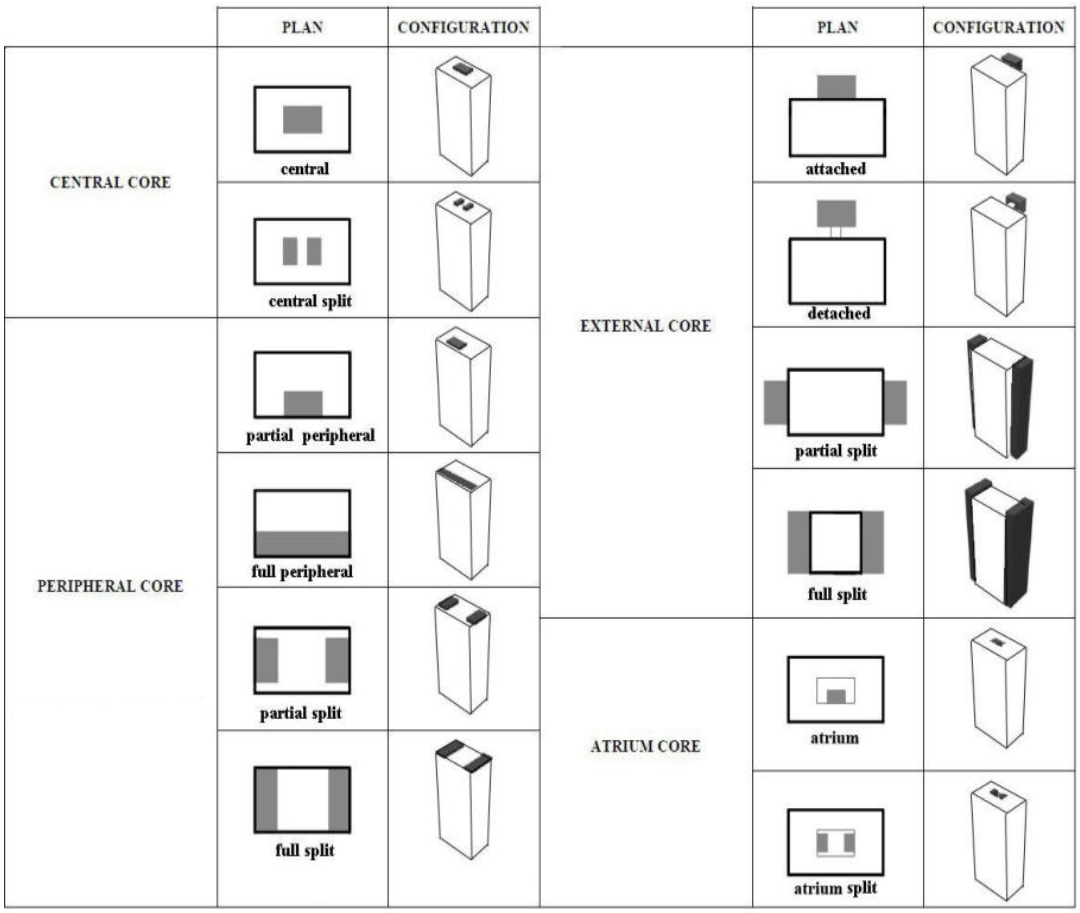


Wind loads on tall building

Architectural Design Considerations

- Function
- Lease span
- Floor-to-floor height
- **Core type***
- **Building form***

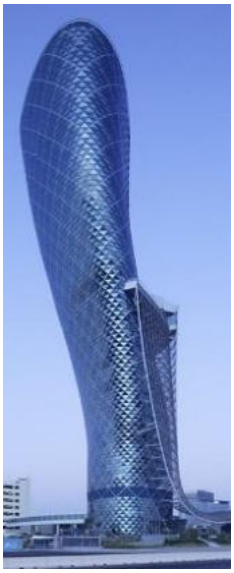
Architectural Design Considerations / Core type



Architectural Design Considerations / Building form

Prismatic / tilted / tapered / setback / twisted / **free forms**

Lighthouse Joensuu

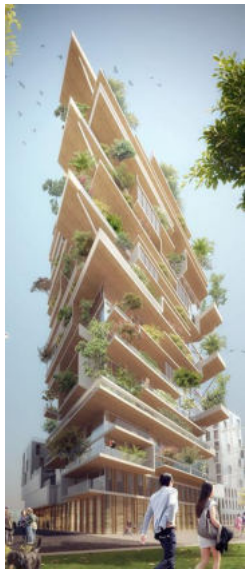


Capital Gate Tower

Lotte World Tower

Burj Khalifa

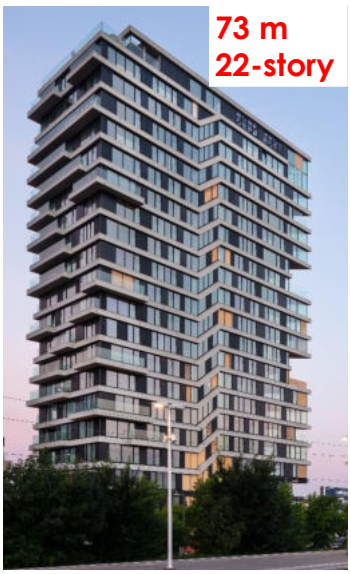
Cayan Tower

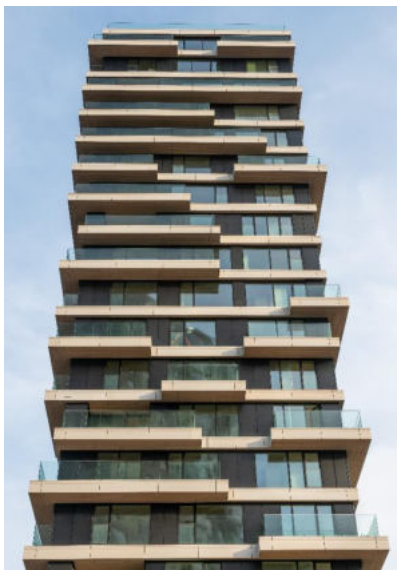


Hypérion

Architectural trends

- Even if most have prismatic forms, several free foms by
  - irregular vertical extensions formed by changing floor slabs,
  - disruption of the basic structural grid
  - asymmetrical configuration of facade opening





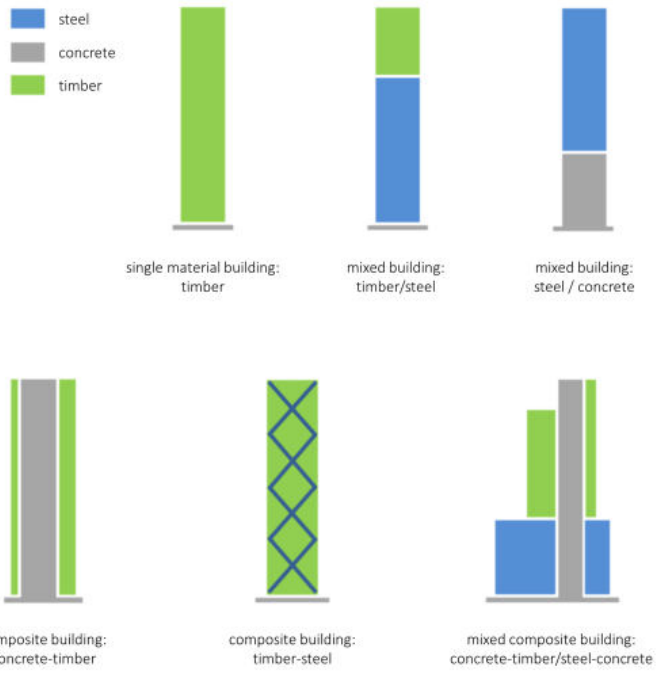
HAUT Amsterdam, 2022

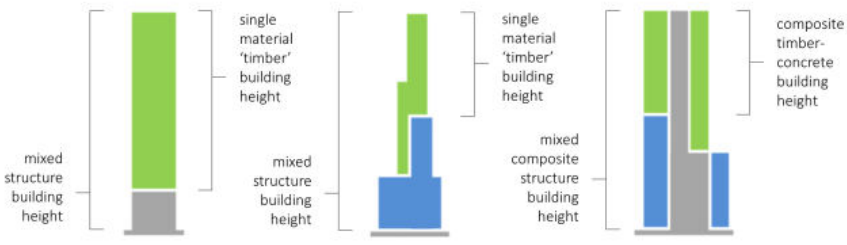
Hypérion Bordeaux, 2021

Structural Design Considerations

- Structural materials
- Structural systems

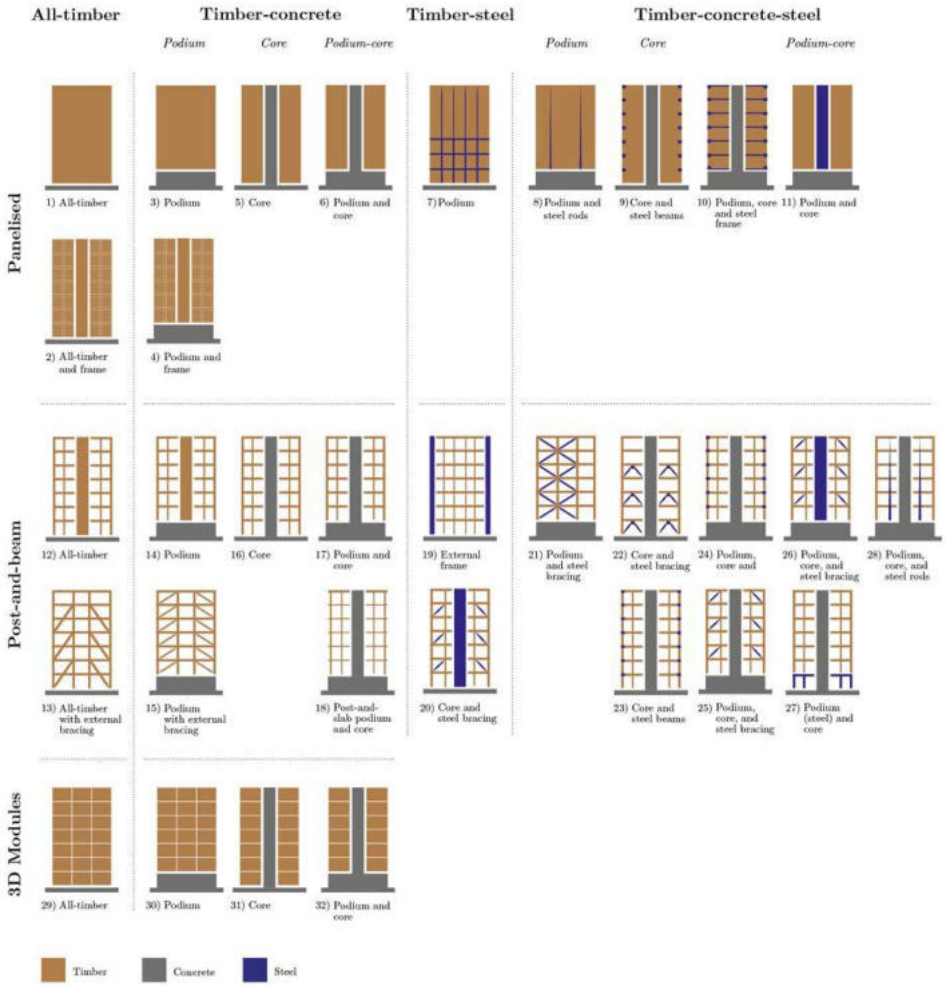
Structural materials





Source: CTBUH

Structural systems



Source: Salvadori, 2021

Structural systems

Panelised

Source: Salvadori, 2021

Structural systems
Post-beam

Source: Salvadori, 2021

Structural systems
3D modular element

Source: Salvadori, 2021

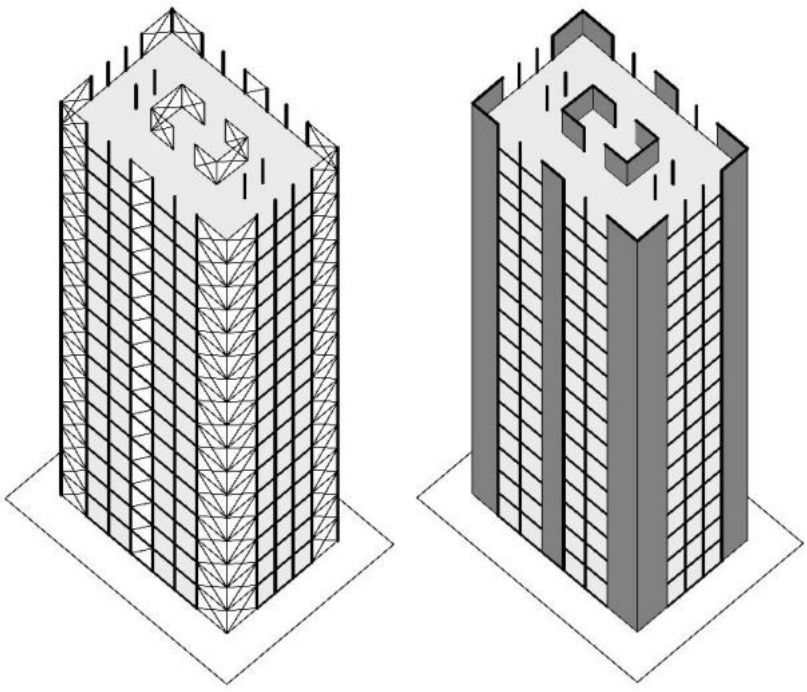
Structural systems

- Rigid frame systems
- Flat plate/slab systems
- Core systems
- Shear wall systems
- **Shear-frame systems**
  - Shear trussed frame
  - **- Shear walled frame**
- Mega column systems
- Mega core systems
- Outriggered frame systems
- **Tube systems**
  - Framed-tube
  - **- Trussed-tube**
  - Bundled-tube
- Buttressed core systems

For tall buildings

For the supertalls ≥ 300m

Structural systems */ Shear-frame system*

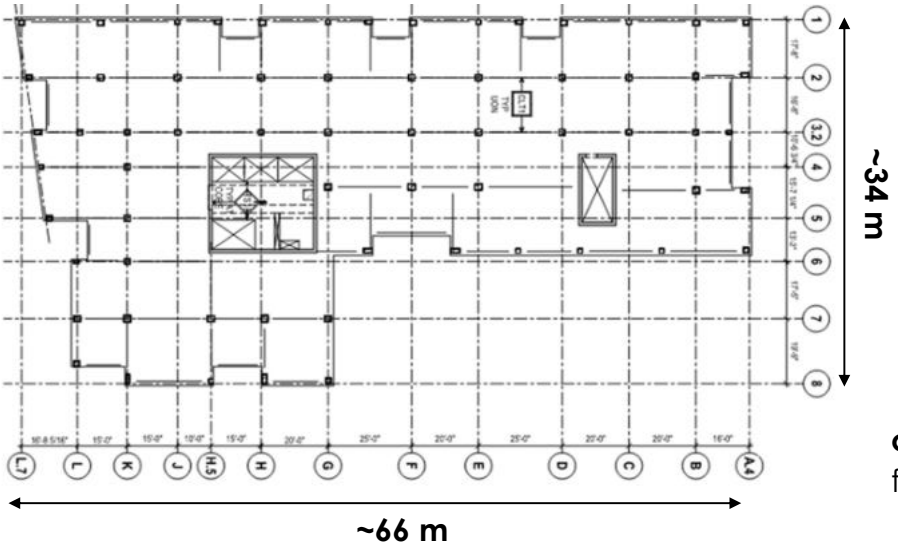


Shear trussed frame

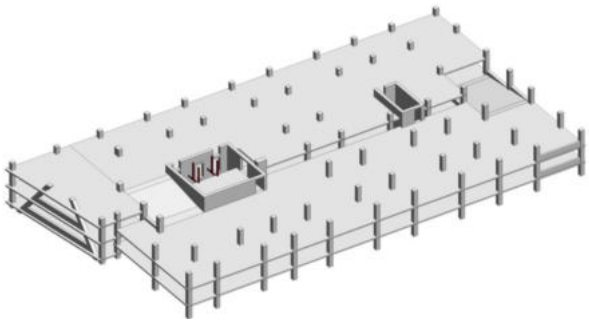
Shear walled frame

Official Name	**ASCENT**
Location	**Milwaukee, USA**
Function	**Residential**
Height	**87 m**
Number of Storeys	**25**
Construction Period	**2022**
Architect	**Korb + Associates Architects**
Structural Designer	**Thornton Tomasetti**
Structural System	**Shear walled frame**
Structural Material	**Timber (hybrid)**
Gross Floor Area	**30,136 m²**
Number of Apartments	**259**
Construction cost	**76 million €** *(2,500 €/m²)*

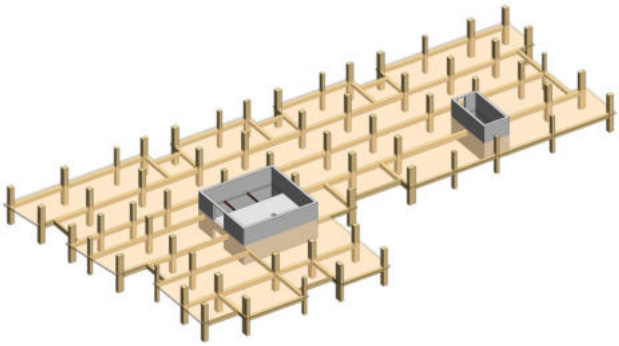
HORIZONTAL SECTIONS



central split core design
floor-to-floor height **3.2 m**

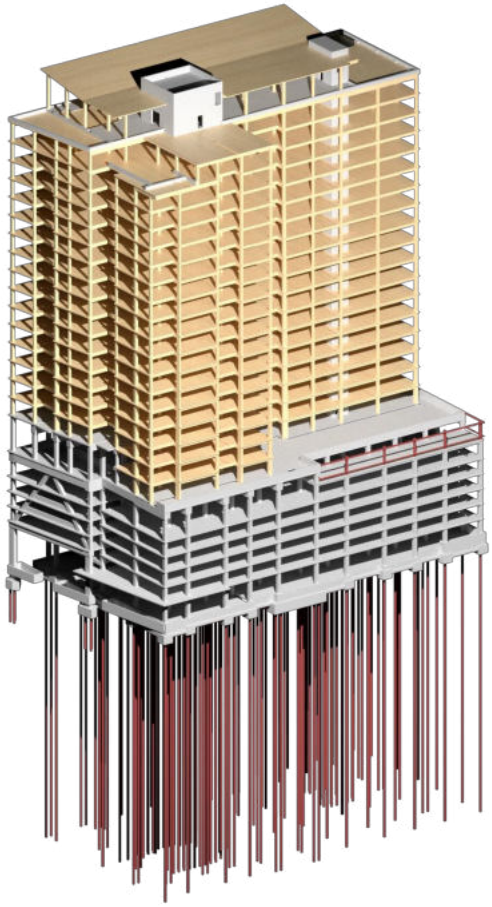


Typical parking floor



Typical mass timber floor

STRUCTURAL SYSTEM



(Image courtesy of Thornton Tomasetti)

- 7-story **concrete** parking podium and 2 **concrete** cores
- **Glulam columns** (and beams) on a **4.5-6 x 6-7.6 m** grid
- 180mm thick & 5-ply **CLT floor slabs** with 50mm gypsum concrete at the typical residential floors *(act as one-way slabs)*

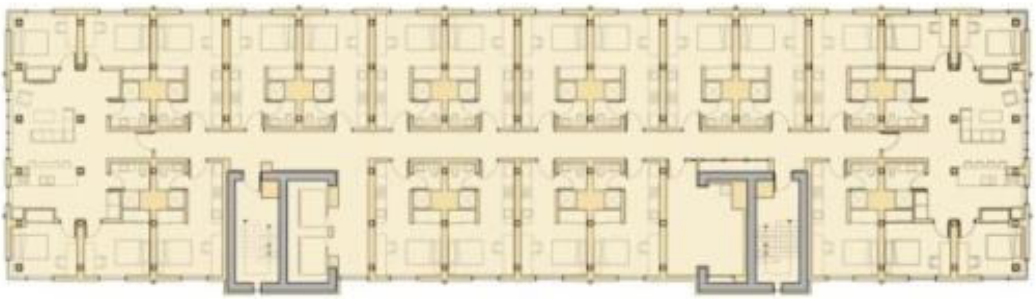
OTHER ASPECTS

- Fire resistance / MLB: up to**180** min & SLB: **120** min
- **7200 tonnes** CO2 stored
  CO2 benefits equivalent to **2400 cars** off the road for a year OR energy to operate over **1100 homes** for a year
- **Challenges**
  - ***Material sourcing (sourcing from a different country)*** e.g., difficulty in timely replacement for defective/ damaged product, various industry standards, dimensions and standard units
  - ***Connection design*** *e.g.,* pre-designed connections not commercially available in the North American market
  - ***Discrepancies between design codes*** e.g., *USA* vs *EU*
  - ***Reinforcing of glulam beams with large penetrations***

Official Name	**BROCK COMMONS TALLWOOD HOUSE**
Location	**Vancouver, Canada**
Function	**Residential**
Height	**58 m**
Number of Storeys	**18**
Construction Period	**2015 - 2017**
Architect	**Acton Ostry Architects, Inc.**
Structural Designer	**Fast+Epp**
Structural System	**Shear walled frame**
Structural Material	**Timber (hybrid)**
Gross Floor Area	**15,115 m²**
Number of Apartments	**404 bed capacity**
Construction cost	**44 million €** *(2,900 €/m²)*

Photo ctbuh.org

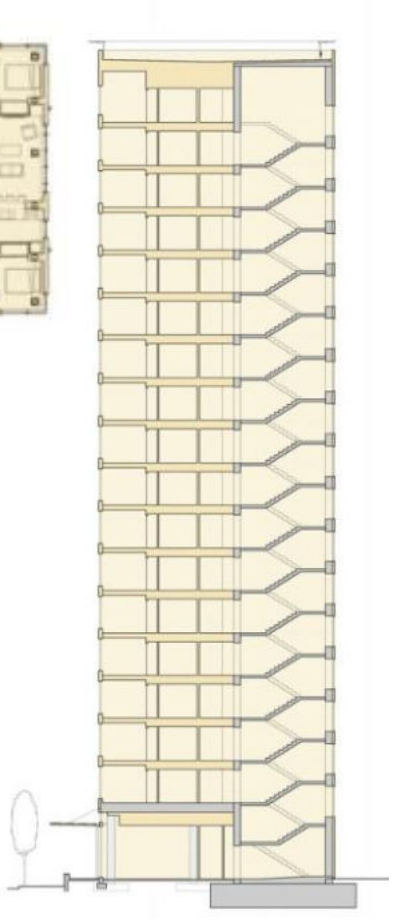
HORIZONTAL & VERTICAL SECTIONS



Typical floor plan

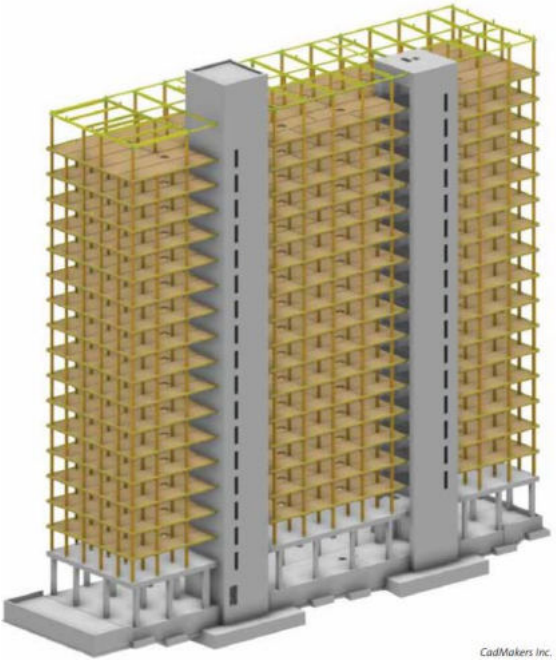
Footprint is **15 × 56 m *(840 m²)***

- **floor-to-floor height**, typically **2.8 m** and **5 m** on ground floor



Figures https://www.actonostry.ca

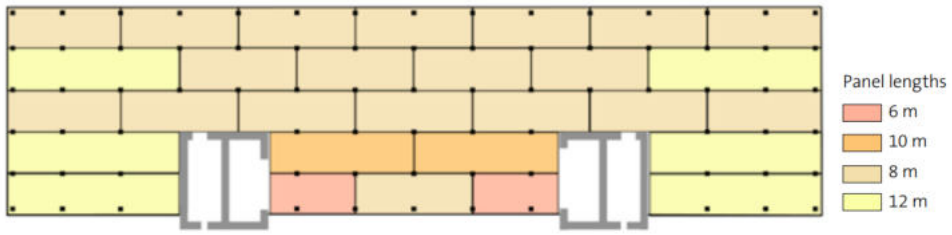
STRUCTURAL SYSTEM



- **Concrete** foundation, ground floor and 2nd floor slab, and two service cores

- **Glulam and PSL** (*parallel strand lumber)* columns on a **2.85 x 4** m grid with cross sections of **265×265**mm (floor 2-9), **265×215** mm (floors 10-18)

- 169 mm thick & 5-ply **CLT floor slabs** with **40** mm concrete topping
  (act as two-way slabs, no beams needed)



OTHER ASPECTS

- Mass timber structure erected in **9 weeks**

2-floor*/per week* * ***6-12min****/one CLT panel* * ***5-10 min****/one GLT column*

- Fire resistance
  MLB: **60–120** min
  SLB: **120** min

Airborne sounds ≥**50** dB
Impact sounds ≤**47** dB

to deal with sound absorption and to reduce vibrations e.g., ***concrete topping*** on CLT floor, ***air space*** into the ceiling, addition of ***carpet tile***

Structural systems / *Tube system*

- building exterior exhibits a tubular behaviour carrying all the lateral loads
- - Framed-tube
  - **- Trussed-tube**
  - - Bundled-tube

Cayan Tower

30 St Mary Axe

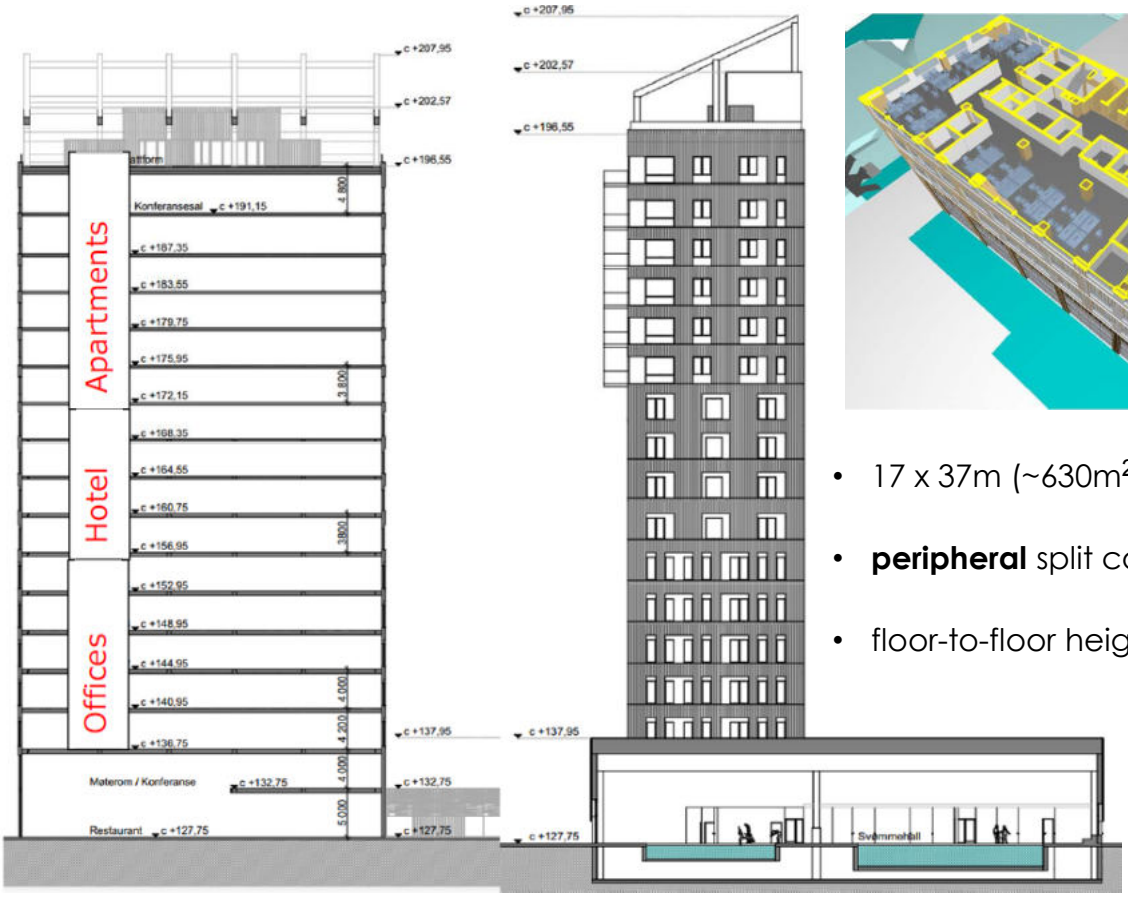
John Hancock Center

Willis Tower

FAST FACTS

Official Name	**MJØSTÅRNET**
Location	**Brumunddal, Norway**
Function	**Office & Hotel & Residential**
Height	**85m**
Number of Storeys	**18**
Construction Period	**2017 - 2019**
Architect	**Voll Arkitekter**
Structural Designer	**Moelven; SWECO AB**
Structural System	**Trussed-tube**
Gross Floor Area	**11,300 m²**
Number of Apartments	**33**
Construction Cost	**44.4 million €** *(3,930 €/m²)*

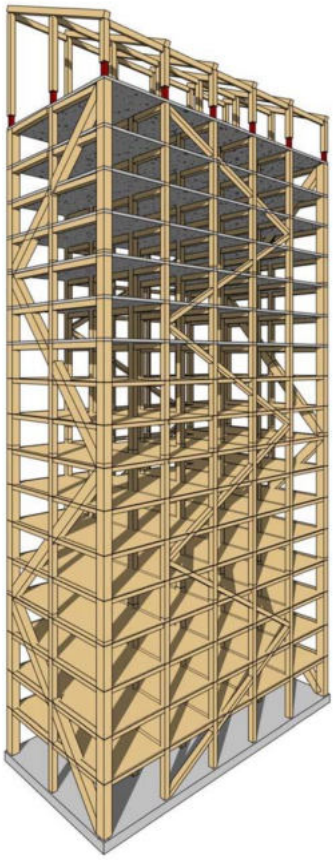
HORIZONTAL & VERTICAL SECTIONS



- 17 x 37m (~630m^2) plan area
- **peripheral** split core
- floor-to-floor height **3.8m**

Figures Internationales Holzbau-Forum IHF 2017

STRUCTURAL SYSTEM



- Maximum horizontal top deflection **140** mm
- Lateral & vertical loads mainly carried by **Glulam** exterior trusses with the largest size of 625x990 mm
- Non-structural **CLT** core & **CLT columns**
  - 4-corner columns / **1485 x 625** mm
  - internal columns / **725 x 810** mm & **625 x 630** mm
- **Glulam** & **LVL floor elements** with **10** m span

Figures Internationales Holzbau-Forum IHF 2017

OTHER ASPECTS

- Fire resistance
  MLB: **120** min
  SLB: **90** min

Airborne sounds ≥ **55** dB
Impact sounds ≤ **53** dB

- **2600 m3** of timber structures and 1 m3 Glulam stores **608 kg of CO2**
  so, **1580 tonnes** CO2 stored
  Carbon footprint estimated at about **65 kg CO2/m2**

Oulu Housing Fair 2025

Architectural competition for
16-story wooden residential building
to be tallest timber structure in Finland

Puukruunu (Wooden crown)

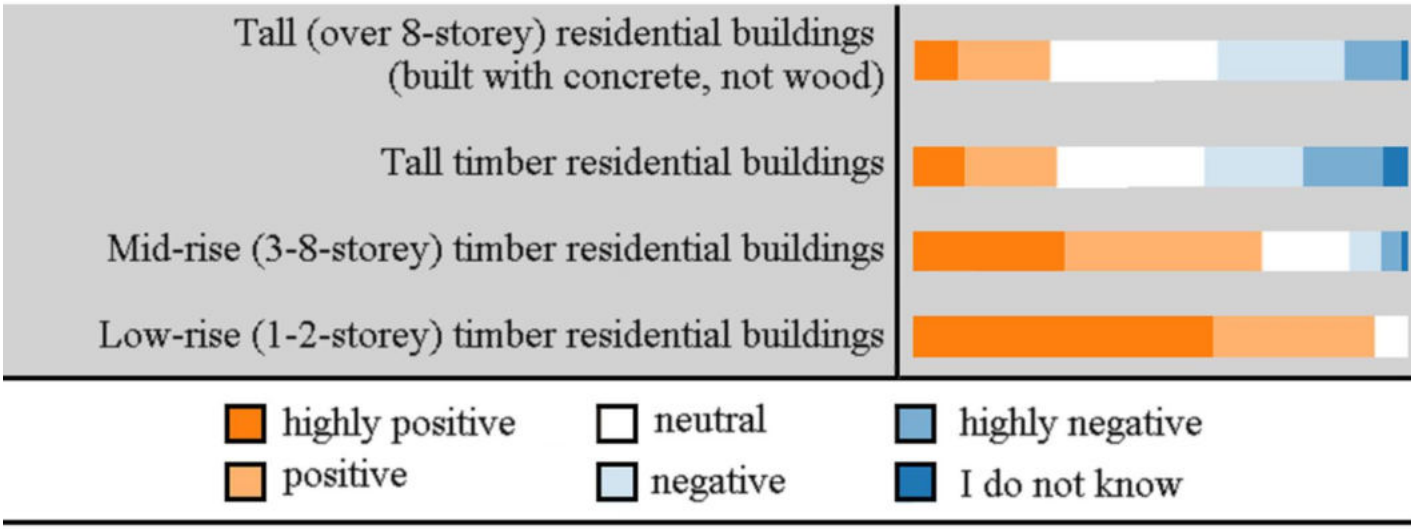
OULU

ASUNTOMESSUT OULU 2025

Ympäristöministeriö
Miljöministeriet
Ministry of the Environment

Finnish architects' attitudes towards tall timber residential buildings

- **2000** active SAFA members & response rate **7%** (147/2000)



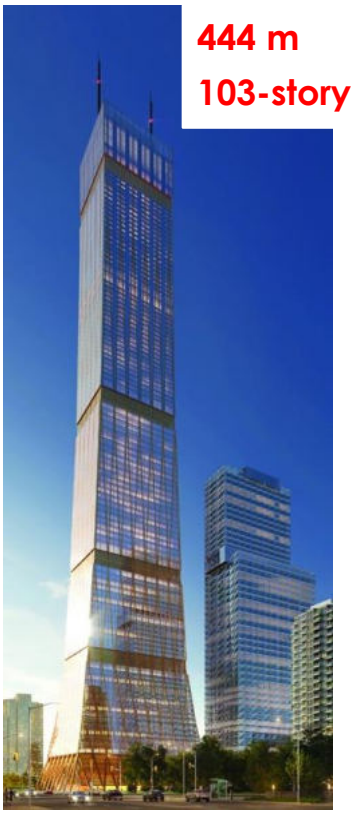
30% (+) & 29% (n) & **36%** (-)... **Tall timber residential building**

Ilgın, H.E., Karjalainen, M. and Pelsmakers, S. (2021), "Finnish architects' attitudes towards multi-storey timber-residential buildings", International Journal of Building Pathology and Adaptation, Vol. ahead-of-print No. ahead-of-print.

Future prospects ... *Supertall timber proposals (**≥ 300 meter**)*

Oakwood Tower (UK)
by PLP Architecture

W350 Tower (Japan)
by Sumitomo Realty & Dev.



HTT (Canada)
by DIALOG

Images by CTBUH

Future prospects ... *Adhesive- and metal-fastener-free dovetail massive wood board project* **(DoMWoB project)** *(202,680 €)*



Design, manufacturing and testing e.g., fire, structural resistant, sound insulation

Website:
https://www.tuni.fi/en/research/dovetailed-massive-wood-board-elements-multi-story-buildings-acronym-domwob

THANK YOU!

Emre Ilgın

emre.ilgin@tuni.fi