

File No.: 04-1000-20-2022-226

August 25, 2022

s.22(1)

Dear s.22(1)

Re: **Request for Access to Records under the Freedom of Information and Protection of Privacy Act (the "Act")**

I am responding to your request of April 28, 2022 under the ***Freedom of Information and Protection of Privacy Act, (the Act)***, for:

Internal and external correspondence (on City of Vancouver devices and personal devices) regarding the rezoning of 1477 West Broadway sent to and received by Neil Monckton, Anita Zaenker, Alvin Singh, Mayor Kennedy Stewart, Paul Mochrie, and Theresa O'Donnell. Date range: February 1, 2022 to April 27, 2022.

All responsive records are located on an FTP site (FTP instructions are included in the accompanying email). Some information in the records has been severed (blacked out) under s.13(1), s.14, s.15(1)(l), and s.22(1) of the Act. You can read or download these sections here: http://www.bclaws.ca/EPLibraries/bclaws_new/document/ID/freeside/96165_00

Under section 52 of the Act, and within 30 business days of receipt of this letter, you may ask the Information & Privacy Commissioner to review any matter related to the City's response to your FOI request by writing to: Office of the Information & Privacy Commissioner, info@oipc.bc.ca or by phoning 250-387-5629.

If you request a review, please provide the Commissioner's office with: 1) the request number (#04-1000-20-2022-226); 2) a copy of this letter; 3) a copy of your original request; and 4) detailed reasons why you are seeking the review.

Yours truly,

[Signed by Cobi Falconer]

Cobi Falconer, MAS, MLIS, CIPP/C
Director, Access to Information & Privacy
cobi.falconer@vancouver.ca
453 W. 12th Avenue Vancouver BC V5Y 1V4

If you have any questions, please email us at foi@vancouver.ca and we will respond to you as soon as possible. Or you can call the FOI Case Manager at 604-871-6584.

:FTP (Response Package)

:ma

From: "Mochrie, Paul" <Paul.Mochrie@vancouver.ca>
To: Kaye.Krishna@gov.bc.ca
Kevin.Volk@gov.bc.ca
Reg.Bawa@gov.bc.ca
CC: "O'Donnell, Theresa" <Theresa.O'Donnell@vancouver.ca>
["LaClaire, Lon" <lon.laclair@vancouver.ca>](mailto:Lon.laclair@vancouver.ca)
Date: 4/26/2022 12:51:31 PM
Subject: 1477 West Broadway - rezoning

Hi all,

\~

In the context of our conversation on Monday, I am writing to confirm that Council decided this morning to approve the rezoning of the above-referenced property at Granville and Broadway.\~ As you may be aware, the project is significant as it includes an integrated station for the Broadway subway.\~ It will also deliver a grocery store, office space and 223 rental units.\~ 20% of the rental floor area will be secured at below-market rents.\~

\~

With the new zoning, the building height will be increased from 5 stories to 39 stories. Notwithstanding the very significant increase in height/density, with the inclusion of the market rental and below-market rental, this project will not generate funding for any community amenity contribution.\~ In fact, to achieve the rental, the City is waiving \$3.3M in development cost levies; essentially representing a public subsidy toward the growth-related impact of the rental units on civic infrastructure and amenities.\~

\~

I was thinking this may be a useful case study to demonstrate the trade-off between housing affordability and the generation of development revenues to fund other investments.\~ If we continue to push for supply of market rental and below-market rental, those revenues just are not there.\~ \~

\~

Best,

Paul

\~

\~

Paul Mochrie \~(he/him)

City Manager

City of Vancouver

paul.mochrie@vancouver.ca

604.873.7666

\~



\~

The City of Vancouver acknowledges that it is situated on the unceded traditional territories of the xʷməŋ̓əm (Musqueam), ləwə́w mesh (Squamish), and səliwə́təł (Tsleil-Waututh) Nations.

\~

From: s.22(1)

To: "Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
"Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>
"Dominated, Lisa" <Lisa.Dominated@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>

Date: 4/19/2022 3:06:45 AM

Subject: [EXT] 4. CD-1 Rezoning: 1477 West Broadway Public Hearing recon. April 19 2022

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

Dear Mayor and City Council

RE: rezoning 1447 West Broadway

\~

I oppose this project.\~

\~

You talk about climate change and yet allow such a tall, dense, cement building to come before City Council.\~ What a bunch of hypocrites you are at Council and in the Planning Department. Cement is the worst polluter and destroys the environment to make cement.\~ YOU KNOW THIS!

\~

I know Council will pass this; you always do.\~ You haven't got the guts to stand up to the big money that runs City Council; by that I mean BC Transit and the real estate industry.\~

s.22(1)

From: s.22(1)
To: "Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>
"Dominated, Lisa" <Lisa.Dominated@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
Date: 4/10/2022 2:27:29 PM
Subject: [EXT] 40 Storey tower at Granville and Broadway

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

Dear councillors:

I strongly oppose the development of a 40 storey building at this site and any other "transit stop" site that you are deliberating over.

We do not need to house an additional ??? thousands of people in the downtown core of the city, and especially at Jericho lands.

This is a beautiful city and developing it with such dense apartment blocks would start to look like New York.\~ It would totally destroy the view that many people have.\~ It would cause havoc with parking, etc.

We have plenty of space in the suburbs which could be developed, and you could think about building rapid transit to link these suburbs to the downtown area of Vancouver.

Sincerely, s.22(1)
Point Grey

From: s.22(1)
To: "Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
Date: 4/14/2022 8:52:23 AM
Subject: [EXT] 40 storey tower

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

Please do not allow a 40 storey tower to be built at Granville and Broadway.\~

Regards,

s.22(1)

s.22(1)

From: s.22(1)

To: "Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
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"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>

Date: 4/14/2022 11:45:25 AM

Subject: [EXT] 40-storey Tower - Precedent for Broadway Corridor & Jericho Lands

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

I am a property owner in Kitsilano.\~ I vehemently oppose a 40-story Tower at 1477 West Broadway at Granville.\~\~

I caution beware of biting the hand that feeds you:\~ that is, the taypaying citizen.\~\~

Sincerely,

s.22(1)



Cambie Corridor?

\~□□□□□□□□□□□□□□□□~The developer CPI has applied for a Development Cost Levy waiver that could equate to a subsidy of \$77,733 per unit. That \$3.3 million in funds would still be needed by the city and would likely be collected through property taxes.\~ If, as you point out on the website, this revenue is to fund parks, childcare facilities, and social and non-profit housing, why are you waiving the fees?\~ This tells me that there seems to be little interest in ensuring parks, childcare facilities and social housing will\~ be included in the plan.\~ I hope I am wrong.\~\~

\~□□□□□□□□□□□□□□□□~There is no planning or budget to build new schools and parks. We currently don't even have enough school spaces for the current populations of these areas.\~ There is research on the benefits of parks in cities.\~ Why isn't this development including at least one park?

\~□□□□□□□□□□□□□□□□~The corner of Broadway and Granville is one of the busiest intersections in the City of Vancouver, so it does not make sense to have family-oriented housing in a densely populated high-rise as proposed.\~ And you are proposing to make it busier--how does that help?

\~□□□□□□□□□□□□□□□□~These large developments have been done in Vancouver in the past and have led to a lack of affordable housing, increased homelessness, and enriched developers.\~ How many rental units were actually built along the Cambie Corridor?\~ Will these developments follow the same pattern as the Cambie Corridor?

I understand the need for increased supply of affordable housing and rental units, but this type of rezoning will not help and will continue to contribute to the ongoing problems Vancouver has.

s.22(1)



Vancouver, BC

s.22(1)



s.22(1)

1~

From: s.22(1)
To: "Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
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"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
Date: 4/14/2022 3:59:24 PM
Subject: [EXT] 1477 Broadway and Jericho Lands

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

I'm writing to object to the giant tower being considered for Broadway and Granville, and also to strongly recommend that neither of the Jericho Lands plans be allowed to go through.

Vancouver has made excellent changes that increase density in a careful way over many years.\~ The low-rise buildings along Broadway and 4th Ave are a good example.

It is said that Vancouver "anticipates" a huge influx of people.\~ The truth is that the massive developments being considered by Council would have the effect of *inviting* that huge influx.\~ Vancouver is already crowded.\~ Traffic congestion is the norm, as you must know.\~ We need careful, gentle density increase.\~ Vancouver should be improved, yes, but not transformed.

I don't know who is in favour of the drastic plans for change being considered, but I do suspect it's not hard for ambitious developers to come up with supporters who will make it seem that Vancouverites love the idea of creating more and more expensive (of course expensive) high-rise buildings all along Broadway and throughout the Jericho Lands.\~ And I suspect that there is almost no one in Kits and Point Grey and along the Broadway corridor s.22(1) who wants the congestion, and the loss of character, that is being contemplated.

Sincerely,

s.22(1)



From: s.22(1)
To: "Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
Date: 4/14/2022 7:55:04 AM
Subject: [EXT] 1477 Broadway high rise

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

A bad plan...will change the affordable neighbourhood forever ... don't do it.

s.22(1)

Sent from my iPad

From: s.22(1)
To: "Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
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"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
"Dominated, Lisa" <Lisa.Dominated@vancouver.ca>
"Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
Date: 2/28/2022 6:04:30 PM
Subject: [EXT] 1477 Rezoning referral

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

Dear Councillors, I am writing to respectfully ask you to **~Oppose** the referral of CD-1 Rezoning: 1477 West Broadway to Public Hearing.~

This is another "spot-rezoning" being pushed ahead of the Broadway Plan approval process. As a renter in the Fairview neighbourhood and having been engaged in the Broadway Plan process and having read the reports to date, I continue to be unsettled and very unhappy with this project. It feels like my voice and those of my neighbours do not count.~

Please oppose this referral.~

s.22(1)

Fairview resident~\~

From: s.22(1)
To: "Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
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"Carr, Adriane" <Adriane.Carr@vancouver.ca>
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"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
Date: 4/13/2022 12:20:42 PM
Subject: [EXT] 1477 W. Broadway (Granville) Rezoning

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

To the Mayor and Council:

The proposed massive, precedent-setting increase in allowable density at 1477 W. Broadway\~**will result in massive increases in land value throughout the area**, as has happened in every other rezoning of this type (Cambie, West End, etc.).

The result will be decreased affordability -- there's no way to build affordable housing on unaffordable land.

Look at the Brenhill building at Helmcken & Richards St. downtown as just one example. It was billed as providing "affordable" housing. This massive tower, **on sale since 2016, still sits 80% vacant** —\~both the condos and the\~“affordable” rentals\~— because the costs for both\~condos and rentals\~are way out of line with what locals can afford.

Approving even more unaffordable housing won't solve our housing crisis.\~It only makes it worse.\~Don't repeat this mistake yet again!

We desperately need more affordable housing, not condos and rentals that the people who live here can't afford. Instead, adopt a low-rise, Vienna-style approach that can help retain the neighbourliness of the area, provide plenty of housing, *and*\~keep housing more affordable.\~

Please vote NO.

Thank you,

s.22(1)

s.22(1)

From: s.22(1)
To: "Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
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"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
Date: 4/14/2022 7:38:13 PM
Subject: [EXT] 1477 W. Broadway @ Granville rezoning

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

Dear Sirs/Mesdames:

I am opposed to the rezoning of the above noted site, as it is not in keeping with the general area.

While developers may be drumming up a few more responses to this issue in order to push through their agenda, you should not that the majority of public opinion is against this type of development. This will most certainly lead to an election in which your track record on this issue will be questioned.

Best,

s.22(1)

From: s.22(1)
To: "Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Dominato, Lisa" <Lisa.Dominato@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
"Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
"Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
Date: 3/1/2022 8:49:08 AM
Subject: [EXT] 1477 W Broadway - my msg to you DECLINED by City website & I'm re-sending

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

I'm now sending to your individual emails the msg I sent yesterday via the City website -- which declined to forward it to you due to a policy **THAT\~ SHOULD BE CLEARLY COMMUNICATED TO RESIDENTS with EACH agenda posting**.\~ Please read my message and get your darkly humorous laugh for today, Mardi Gras, March 1st.

My message that was declined:

Mayor and Council: Vote NO on 1477 W Broadway.\~ Is it amusing or tragic that Council's March 1st meeting takes place on Mardi Gras – a time in many cultures and traditions for buffoonery, mockery, borderline-lawlessness, and high-jinx that thumb noses at ordinary social norms?\~ It's up to you to decide, with your vote on 1477 West Broadway, a project that should NEVER have come this far – by so many measures.\~ Perhaps most easy to grasp is that this disruptive, unprecedented monster development will result in NO COMMUNITY BENEFITS, and I quote from the insightful analysis by the \~Fairview/South Granville Action Committee: "The developer (PCI) has applied for a Development Cost Levy waiver (saving \$3.3M) and will not have to make any financial Community Amenity Contributions, the money used to pay for parks, childcare facilities, social housing,

infrastructure, etc." \~<https://www.fsgac.org/1477-w-broadway-fsgac.org>\~\~ The Broadway Corridor belongs to all Vancouver residents - and this is NOT what Broadway should look like.

----- Forwarded message -----

From: <CouncilCorrespondence@vancouver.ca>

Date: Tue, Mar 1, 2022 at 7:54 AM

Subject: 1477 W Broadway

To: s.22(1)

PLEASE NOTE: Your comments have NOT been shared with the Mayor and Council as this item is still in the application stage and has not yet been referred to public hearing.\~

All correspondence regarding a rezoning application or heritage designation must be submitted through the appropriate channels, which vary depending on the stage that the application is in. This helps ensure that Council does not receive information that the public and applicant do not otherwise have before the items are scheduled for review at a public hearing.\~

Your comments have, however, been sent to the Planning Department to be summarized as part of the referral report to Council.

If the application is referred to public hearing, at that time you can submit further comments to Council through the public hearing web form: <https://vancouver.ca/your-government/contact-council-public-hearing.aspx>, which will be captured as part of the public hearing proceedings.

To learn more about the rezoning process and how to participate in public hearings, please visit: <https://vancouver.ca/home-property-development/how-rezoning-works.aspx>.

From: s.22(1)

To: "Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
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"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
"Dominated, Lisa" <Lisa.Dominated@vancouver.ca>
"Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>

Date: 4/11/2022 10:55:16 AM

Subject: [EXT] 1477 W Broadway (RBC Site) Public Hearing - 6 pm, Thursday, April 14th

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

Mayor and Council,\~

Please just STOP and take a breather issuing these high rises permits!\~

39 stories at South Granville, why!? Well under 10 stories should be more than enough for buildings along Broadway. Or just continue to do whatever your developer overlords tell you to do while ignoring, at least truly and honestly addressing, AFFORDABLE housing supply, that's the real issue. This city should have a transparent endowment in the billions from the insane building development we've experienced in the last decade or more, instead it's murky where all the city revenue has gone. Maybe you don't care about affordable housing for normal hard-working people and families, because their jobs are disappearing from your pro development policies that ignore the truly impactful steps you could be making to support small businesses and Mom & Pop shops, at least the few that are left. ...instead, I suspect you'll just keep paying lip service and fool yourself into believing you're doing a good job supporting these high-rise projects. Your staff must look at their pay cheques and then you with disdain because they can't live in the city they work. Please settle down and help guide the city to keep just a little heart and soul or your legacy will be so poor you'll be too embarrassed to mentioned you ever held your position, if you don't already.\~

Disappointedly yours,\~

s.22(1)

From: s.22(1)
To: "Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
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"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
Date: 4/16/2022 5:11:55 PM
Subject: [EXT] 1477 W Broadway/Granville Development

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

To whom it may concerns,

I oppose the development of this 40 story tower which would create a precedent for development along the Broadway corridor, and specifically for the the Jericho Land project, which lack transparency in the consultation of the community, and comes down to erecting a downtown in West Point Grey.

s.22(1)



From: s.22(1)
To: "De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
"Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
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"Dominated, Lisa" <Lisa.Dominated@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
"Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
Date: 4/10/2022 4:23:58 PM
Subject: [EXT] 1477 W Broadway Vancouver

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

Dear Mr. Major and Councillors,

"BIGGER IS NOT BETTER"

There are many reasons to oppose this project as is presented. The proposed tower is way too large and tall for this community. This project will no doubt increase the population density in this neighbourhood. However, it does nothing to correct the affordable housing problem in the Lower Mainland. Without proper consideration for green space, parks, schools and other amenities, this only serves to make our neighbourhood less livable.

Whilst I am not oppose to increasing the density of this neighbourhood, this can be brought about by a much more thoughtful planning and socially responsible project.

s.22(1)

From: s.22(1)
To: ["Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>](mailto:Rebecca.Bligh@vancouver.ca)
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["Carr, Adriane" <Adriane.Carr@vancouver.ca>](mailto:Adriane.Carr@vancouver.ca)
["De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>](mailto:Melissa.DeGenova@vancouver.ca)
["Dominato, Lisa" <Lisa.Dominato@vancouver.ca>](mailto:Lisa.Dominato@vancouver.ca)
["Fry, Pete" <Pete.Fry@vancouver.ca>](mailto:Pete.Fry@vancouver.ca)
["Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>](mailto:Sarah.Kirby-Yung@vancouver.ca)
["Wiebe, Michael" <Michael.Wiebe@vancouver.ca>](mailto:Michael.Wiebe@vancouver.ca)
["Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>](mailto:Kennedy.Stewart@vancouver.ca)
CC: ["Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>](mailto:Colleen.Hardwick@vancouver.ca)
["Mochrie, Paul" <Paul.Mochrie@vancouver.ca>](mailto:Paul.Mochrie@vancouver.ca)
["O'Donnell, Theresa" <Theresa.O'Donnell@vancouver.ca>](mailto:Theresa.O'Donnell@vancouver.ca)
["Swanson, Jean" <Jean.Swanson@vancouver.ca>](mailto:Jean.Swanson@vancouver.ca)
Date: 4/26/2022 11:40:14 AM
Subject: [EXT] 1477 W Bwy – Planners applauded as CONCIERGES, not gatekeepers

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

To:\~ Elected Officials

\~

You could die laughing -- if you were reading Lewis Carroll or Franz Kafka rather than listening to City Council deliberations.\~ Time after time, the majority of Council have sanctioned EVERY rezoning recommended by Planning (oh, except for the hospice) – and implicitly has approved all the convoluted financial calculations and trade-offs of the kind that Planner Mario Lee (and others) endeavoured to make even more incomprehensible to the public.

\~

Why not just *publicize* the fact that Planning runs the show?\~ It's hilarious to listen to Planners use the pronoun "we" when speaking for the developer's project.\~ And it's hilarious to watch Elected Officials do acrobatics to fit their own frequently espoused beliefs to FIT the 1477 proposal.

\~

As to who has egg on their face after this morning's fiasco - it's not the developer, it's not the Planning Department.\~ Is it the Elected Officials who cheered it on?\~ Time will tell.

\~

Regards,

s.22(1) (resident)

From: s.22(1)
To: "Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Dominated, Lisa" <Lisa.Dominated@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
"Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
"Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
Date: 4/14/2022 6:15:59 PM
Subject: [EXT] 1477 West Broadway (Granville)

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

Dear Mayor and Council,

I am strongly opposed to this precedent-setting application, which is completely out of scale with the surrounding community, and -- in my view -- entirely at odds with any reasonable understanding of Vancouver as a sustainable city -- let alone, the "Greenest City".

Frankly, as I see it, it's impossible to imagine that you could demolish the existing building, transport and dispose of resulting waste, produce (including resource extraction/processing/manufacturing), transport and assemble all of the necessary materials required to yield the proposed building, and expect that it could be net carbon neutral as a result of subsequent efficiencies/offsets within anything like a sustainable time-frame.
I don't believe it -- not even close.

Yes, I'm aware that there exists a related report entitled "Sustainable Design Strategy", and that the report asserts that "the whole building will align with the GREEN BUILDINGS POLICY FOR REZONING ("CoV GB RZ Opt 2")", and includes references to a variety of "green building" rating/classification schemes.\~ However, I have absolutely no confidence in any of these schemes to yield anything like a legitimate assessment of the actual net carbon cost of the proposed structure.

Frankly, I don't have the time to dig in, and work through the underlying physics, assumptions, and math to verify my lack of confidence.\~ The question is whether the City of Vancouver has?\~ And, regrettably, I very much doubt it.

But, short of confirming my expectations, it's worth pointing out that the proposed building, which would stand directly above a future rapid transit station -- which is also being promoted as part of a broader regional strategy to address the climate crisis through transportation mode shift -- would also include six full storeys of underground parking.

From: s.22(1)
To: "Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Colleen Hardwick" <colleen@colleenhardwick.com>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Dominato, Lisa" <Lisa.Dominato@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
"Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
Date: 4/21/2022 8:10:06 PM
Subject: [EXT] 1477 west Broadway

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In line with the comments of the last speaker, and in line with the unintended consequences of getting new rentals built:

a) Today, Median rent in Vancouver South Granville is \$1,500 with new rentals at \$2,200. When new things are built in 5 years, it will be \$2,800 (5% increase per year, a reasonable rate). New affordable rentals at 20% below market will be \$2,250, a 50% increase.

None of the existing tenants will be able to afford this, resulting in more people forced onto the street or into other neighbourhoods, far away from their current doctors, dentists, etc.

b) What do you say to the retiree whom I met yesterday? She is paying \$700 a month in rent. Someone bought her apartment on Cambie and is tearing it down to build a new rental building. She has only her pension and believes she will end up on her son's couch in the basement. She would be on the street if her son did not have spare space.

All these new rental units are of no comfort to people in existing affordable rentals who fear being displaced.

□ Thanks, s.22(1)

From: s.22(1)
To: "Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Dominated, Lisa" <Lisa.Dominated@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
"Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
"Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
Date: 4/13/2022 7:31:32 PM
Subject: [EXT] 1477 West Broadway 1

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Please!!\~OPPOSE the\~**CD-1 Rezoning:\~1477 West Broadway [google.com].\~**

No, no, no!! It would ruin the neighbourhood - huge high rises would be completely out of place!

Thank you,

s.22(1)

From: ["Ian Crook" <icrook001@outlook.com>](mailto:icrook001@outlook.com)
To: ["Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>](mailto:Rebecca.Bligh@vancouver.ca)
["Boyle, Christine" <Christine.Boyle@vancouver.ca>](mailto:Christine.Boyle@vancouver.ca)
["Carr, Adriane" <Adriane.Carr@vancouver.ca>](mailto:Adriane.Carr@vancouver.ca)
["De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>](mailto:Melissa.DeGenova@vancouver.ca)
["Dominato, Lisa" <Lisa.Dominato@vancouver.ca>](mailto:Lisa.Dominato@vancouver.ca)
["Fry, Pete" <Pete.Fry@vancouver.ca>](mailto:Pete.Fry@vancouver.ca)
["Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>](mailto:Colleen.Hardwick@vancouver.ca)
["Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>](mailto:Sarah.Kirby-Yung@vancouver.ca)
["Swanson, Jean" <Jean.Swanson@vancouver.ca>](mailto:Jean.Swanson@vancouver.ca)
["Wiebe, Michael" <Michael.Wiebe@vancouver.ca>](mailto:Michael.Wiebe@vancouver.ca)
["Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>](mailto:Kennedy.Stewart@vancouver.ca)
Date: 4/12/2022 10:44:24 PM
Subject: [EXT] 1477 West Broadway 3

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

Mayor Stewart and Councillors:

\~

I am writing to oppose the proposed rezoning of 1477 West Broadway, and ask that you vote against this rezoning for the reasons I discuss below.

First, this proposal displays the true extent of the disdain and contempt which staff and the developer have for the public and this council. This application is coming to council after the developer has already commenced construction of a smaller project, but it is being constructed with the below grade infrastructure appropriate for the rezoning application now under consideration.

The rezoning approval is being sought at this late date on the premise that an approval is required now for the larger project, as the site is part of the Broadway Subway project. The site is, indeed, a part of the subway project, but that begs the question of why the application was not brought some time ago given its significance to the Broadway subway. It isn't as if staff is unaware of the Interim Rezoning Policy applicable during the development of the Broadway Plan – staff used that Policy to secure your approval of the 28 storey behemoth located at 2538 Birch Street in 2020.

Indeed, it is worth remembering the former General Manager of Planning advised council, in a memo dated July 14, 2020\~ regarding the 2538 Birch rezoning application, that "It also became clear that this area of Broadway did not present significant structural barriers to increased height on this site, such as those that may be present along other areas of Broadway (i.e. important view corridors, VGH helicopter flight path, etc").\~\~ Put bluntly, staff concluded they wanted more density along West Broadway in 2018 in connection with the 2538 Birch rezoning; it would require a remarkable leap of faith to think staff had not also concluded that 1477 West Broadway would also meet that test at that time.

The construction now under way was commenced under the auspices of a development permit issued for a five storey mixed use building, with over 200 parking spaces – well in excess of what is required for a five storey structure.\~ In point of fact, I made the comment at the Development Permit Board meeting in December 2019 for the five storey project, that any additional below grade work

undertaken by the developer beyond that required for the five storey building should be understood to be at the developer's sole risk; Theresa O'Donnell assured the meeting the approval was only for the five storey structure.

I'm sure you have lost count of the number of times developers have told council that the City's parking requirements for new structures impose real financial hardship on the development community, and that those requirements leave them all in perilous financial condition. \~ It is therefore truly remarkable the developer would expend significant sums of money on excess parking stalls given the obvious financial burden on a five storey project, unless there was a tacit agreement between staff and the developer that staff would ensure the developer's proposal to construct a mega tower is approved. \~ You will no doubt be told otherwise but, to be blunt, I do not believe in the tooth fairy, and neither should you.

The Referral Report makes much of the fact this project is consistent with what is proposed in the Broadway Plan – but this is a circular argument which puts the cart before the horse. Official Plans are supposed to be in place before projects are presented for approval – but the opposite is happening here. \~ What is worse, if you did approve this project, it is a certainty that staff would cite your approval of this project as justification for the approval of the Broadway Plan.

There are a number of other troubling aspects to this proposal. \~ For example, the City is playing a game of chicken with both the Province and the Vancouver School Board, in that it is putting family-oriented housing in an area where all the schools in the catchment area are operating at full capacity. \~ No business would operate on the basis "if we build it, the other guys will deliver" yet that is exactly what staff is doing here. \~ Where is the additional greenspace and community centre? \~ Does the City have land it can actually make available for those purposes?

I would also draw your attention to the MIRHPP units. As you know, I have spent a lot of time looking at the MIRHPP Program, and this is the first time that I can remember that a rezoning application has come to council without specifics of the number of units proposed, or the sizes of those MIRHPP units. We know from any number of applications that the latitude in MIRHPP to go to smaller units (as was the case in 2538 Birch) results in unbelievably small units for families. \~ You are being asked to sign off on a proposal not knowing if further compromises have been made by staff.

This is a dangerous precedent: The City stipulates the absolute rent for each MIRHPP dwelling type, such as \$950 for a studio. \~ On page 12 the Report says the average unit size is 434 sq ft. \~ If you are paying \$950 for 434 sq ft. you are paying \$2.14/ sq ft. \~ What happens if the unit size reduces to, say 400 sq. ft. in the MIRHPP units? \~ Does the rent go down? No – the developer gets to charge the same rent, and at the tenant's rental cost per sq. ft. increases \$2.33 per sq ft, for a space that is actually 7.8% smaller. \~ This significantly improves the developer's proforma.

There is no question there is a housing shortage in Vancouver. In my opinion staff bears much of the responsibility for same since, for at least 10 years, they did not caution the previous Vision-dominated council that there were too many high-end condos being constructed, and not enough rentals the average working person could afford. It is no doubt tempting to say "we must charge ahead" so you can show voters in October you are looking out for them, but you aren't actually doing them any favours if you approve a project where you don't know anything about the MIRHPP units, and staff's proposal is indefensibly silent on critical infrastructure such as schools. Finally, sanctioning what would charitably be described as a very cozy arrangement between staff and the developer sends a terrible message to citizens, and one hopes, concerns you.

This application should not be presented (in revised form) until the Broadway Plan is approved. Please vote against the proposal and send it back to staff.

Regards

\~

Ian Crook

\~

From: s.22(1)
To: "Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
"Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Dominated, Lisa" <Lisa.Dominated@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
"Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
Date: 4/12/2022 12:17:26 PM
Subject: [EXT] 1477 West Broadway 4
Attachments: LETTER TO COUNCIL RE 1477 WEST BROADWAY.pdf

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Your Worship and Members of Council

\~

I am writing to express my opposition to the proposed rezoning of 1477 West Broadway based on the development application before Council.\~ My reasons are expressed in the attached letter.

\~

I thank you in advance for the opportunity to provide comment.\~ I hope this will assist you in your consideration of this application, and the broader implications of the draft Broadway Plan.

\~

Sincerely,

\~

s.22(1)

April 12, 2022

Mayor and Council
City of Vancouver
453 W 12th Avenue
Vancouver BC V5Y 1V4

RE: PROPOSED REZONING OF 1477 WEST BROADWAY

Your Worship and Members of Council,

The City of Vancouver is requesting public feedback on a rezoning application at 1477 West Broadway. According to the City's website, the proposed rezoning from C3A to CD-1 would provide for development of a 39-storey, mixed-use building above the South Granville SkyTrain Station, including:

- 223 rental residential units, 20% at below market rates
- Commercial retail space on the first and second storeys, including a grocery store
- 5-storeys of office space within the podium
- A floor space ratio (FSR) of 12.16
- A building height of 125 metres (410 feet)

I provide the following comments for Council's consideration:

1. This public hearing is an opportunity for Council to hear public feedback on the proposed rezoning of 1477 West Broadway. However, this could be the last opportunity for the public to comment on any future rezoning within the Broadway corridor:
 - Josie Osborne, former Minister of Municipal Affairs is quoted in an October 2021 news release from the Province as saying: *"We are working with local governments, the development sector and housing advocates to streamline local development processes to help get more homes built faster for people."* Notably absent from those discussions are existing residents.
 - The subsequent amendment to the Local Government Act **has removed the default requirement for local governments to hold public hearings for zoning bylaw amendments that are consistent with an official community plan.** It is my understanding that Council will be considering approval of the draft Broadway Plan in May, while the public will have only a few weeks to review, understand, and comment on the Plan and its implications.
2. The development proposal for 1477 West Broadway represents a collaboration between the developer, the Province of BC, and the City of Vancouver to advance construction of the Granville subway station and to secure a desired housing mix on this site. With that in mind, how amenable is the City to addressing public concerns about this project – given that excavation work on the station site and building foundations is currently underway?
3. It is noted in the staff report that the developer will not be required to provide a Community Amenity Contribution (CAC) and will be receiving a significant waiver of Development Cost Levies (DCLs) as development incentives, while permitted density will increase four-fold:

- It is important that local governments recognize the relationship between CACs and housing affordability; and make efforts to balance the opportunity to obtain public benefits, such as community amenities, with the goal of helping people to secure “affordable” housing.
 - In this case, only 20% of residential units would be offered at below market rates, while the market units will demand premium rents due to the potential views from this site. I do not see the project contributing to public spaces or facilities to meet a range of social, cultural, recreational, and infrastructure needs of the community (i.e., community amenities).
4. From a built form perspective, a building of 39-storeys is too tall for this location (i.e., at the top of a hill above the False Creek basin) and is very much out of scale with South Granville and the surrounding Fairview neighbourhood.
5. The rationale provided for considering this rezoning in advance of the Broadway Plan is that it could expedite construction of the South Granville Station by six months. By allowing for consideration of this proposal and two other tall buildings (one at Hemlock, the other at Birch) in advance of the Broadway Plan, Council has clearly set a development precedent for the entire Broadway corridor, which is confirmed by the recently released Plan.
- This is quite concerning from a process perspective because it could taint the whole Broadway Plan as a pre-determined outcome.
 - Based on my conversations with local area tenants, homeowners, business owners, and service workers who live or work in the Broadway Plan area, it is clearly apparent that public awareness of this transformational plan is very limited. I would ask that Council reconsider the stated timelines for formal consideration of the Broadway Plan and the just released City-Wide Plan to allow the public more time to understand these complex documents, and to provide meaningful input.
6. While the policy directions the City is pursuing are focussed on increasing housing supply along the Broadway corridor, I am already hearing of pending displacement of existing tenants of purpose-built rental buildings. Similarly, homeowners are concerned about being able to stay in their homes as assessments and property taxes increase based on future land use designations and redevelopment pressures. I provide this sampling of the discussions I have been having:
- s.22(1) woman living in a well-maintained 40-year-old rental building in Fairview. She noticed that her landlord recently stopped making typical investments in routine building maintenance and upgrades. He told her, “why should I bother when the building will be coming down in a couple of years?” She is asking “where will I go?”
 - s.22(1) resident who owns a modest bungalow with a secondary suite occupied by a s.22(1) s.22(1) asked me “how long do I have before they want to tear my house down?”
 - In Arbutus Walk, a master-planned multi-family community (rental, ownership, family co-op, and seniors’ housing) in Kitsilano, residents are coming to realize that the draft Broadway Plan designates their neighbourhood for 20-30 storey towers. The oldest buildings are barely 20 years old. I asked City staff why this model community would be targeted for redevelopment

and was told that the “CD sites would be left alone.” So, does that mean that the well-used public open spaces would be replaced with towers?

7. While we all agree that we need more varied housing options and the right kind of supply, Council must understand that existing Vancouver residents, both tenants and homeowners, are not the obstacle to achieving this:
 - A decade of rhetoric has been demonizing existing residents as “NIMBYs” and putting the blame for housing unaffordability on “mansion zoning” and lower density “legacy neighbourhoods.” In reality, there is no single-family zoning in Vancouver as virtually every lot can be developed with three housing units outright.
 - At the same time, the impacts of foreign investment on the local housing market are now grudgingly acknowledged by government and the development sector, both of which had been actively promoting it for years. Today, the new wave of redevelopment frenzy and price escalations in Vancouver appears to be fueled by large scale institutional investors entering the local real estate market.
8. I am fearful that the blind focus on housing “supply” is justification for silencing residents’ voices and enabling the potential ‘clear-cutting’ of an entire city:
 - During the urban renewal era of the 1950s and 1960s, Vancouver residents had to rise-up against ‘top-down’ planning by local technocrats and senior government agencies set on ‘slum’ clearance, resident displacement, and freeway development. Today, it seems that much of the city is being portrayed in the same light, except this time we need to make room for a subway and ubiquitous 40-storey towers.
9. True “Vancouverism” is not about towers built over street-friendly podiums; rather, it is a livable city built upon meaningful community engagement and active citizen participation in the planning process.

I thank you for the opportunity to provide my comments and trust you will give them your thoughtful consideration.

Sincerely,

s.22(1)



From: s.22(1)
To: "Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
"Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
"Dominated, Lisa" <Lisa.Dominated@vancouver.ca>
"Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
Date: 3/1/2022 8:39:18 AM
Subject: [EXT] 1477 West Broadway 6

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Dear Councillors.\~ Please be aware that you are being led by the nose by the mayor and Planning Department.

The latest document on the Broadway Plan and the application for the rezoning of the above property are full of misstatements, errors omissions and downright lies.\~ Please read the analyses prepared by the Fairview, and South Granville Action Committee.

s.22(1)



From: s.22(1)
To: "Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
"Dominato, Lisa" <Lisa.Dominato@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
Date: 2/28/2022 10:35:37 AM
Subject: [EXT] 1477 West Broadway 7

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~

Dear Councillors and neighbours,

Why are the Public input requests always **bait and switch**?

In the end, the City gets whatever it and the developers originally wanted, and the public rolls over and gets a city less desired. ~Again and again.

What happened to City Plan? ~What happened to Grand Broadway? ~What happened to view corridors? ~This crazy tall massive development brings shadow, thin-edge of the wedge massing, blocking sky and city entrance views, and for what real advantage?

Please keep in mind you are trustees of our city's future **you are city building**, you are not just functionaries of piles. ~With more imagination we can have density without extreme height.

Please oppose the referral of CD-1 rezoning. ~Shorter, denser, more neighbourly.

Thank you,

s.22(1)

~

From: s.22(1)
To: "Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
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"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
"Dominator, Lisa" <Lisa.Dominator@vancouver.ca>
"Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
CC: s.22(1)
Date: 2/27/2022 12:25:43 PM
Subject: [EXT] 1477 West Broadway 11

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Dear Mayor and council

\~

I am strongly opposed to any approvals of rezoning in the Granville Fairview and West Broadway neighbourhoods until the Broadway corridor study is complete. The massive increases in density that are proposed will have long lasting effects on the area and will set precedents for other developments. Buildings of this scale being thrust into existing sensitive commercial, particularly north of Broadway will impact the antique and fine art zone which is already suffering due to the destruction of affordable commercial space.

\~

Where will the public amenities be located? All those subtle spaces and facilities that support communities? There is so little consideration of these critical requirements for city building that more time has to be spent in planning.

\~

Just because it could be Manhattan north does not mean that it should. What is the rush?

\~

s.22(1)



From: s.22(1)
To: "Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
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"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
"Dominated, Lisa" <Lisa.Dominated@vancouver.ca>
"Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
Date: 4/13/2022 8:00:00 AM
Subject: [EXT] 1477 West Broadway proposal - strongly OPPOSED

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

Dear Mayor and Council,

I am writing to express my opposition to the massive tower proposed for 1477 West Broadway.

This is yet another one of those MIRHPP spot rezonings that sow contention wherever they go. MIRHPP continually insists on building structures local residents hate because they are excessive in size and density and give too many free gifts to developers in exchange for a paltry number of not-even-really so-called affordable units that are generally so tiny as to be barely livable. In the case of 1477 West Broadway, the actual number of "affordable" units and their rents have not even been specified. How can council even consider approving such a half-baked plan? We don't even know what we're getting here!

The report on this proposal states its height and density aligns with the Broadway Plan. How can that even be considered justification for 1477 Broadway given that the Broadway Plan is not yet complete? Stop putting the cart before the horse.

This tower would be ridiculously high, creating major shadowing issues. The existing shadow studies fail to assess shadows at winter solstice, the darkest time of the year. This oversight is unacceptable. Stop trying to pull the wool over our eyes by neglecting to provide the whole truth. Shadow studies have been inadequate and misleading on a variety of projects approved by Council.

The developer will be exempt from CACs and has applied for a DCL waiver. That will

force taxpayers to make up these\~lost millions in revenue. Not a fair trade for we don't even know yet how many supposedly affordable units!

The report provides no detail about the parks and schools needed to support this large scale development. Staff are not acknowledging\~that\~the closest schools to 1477 West Broadway are not only further away than the\~High-Density Housing for Families with Children Guidelines\~contemplate,\~ they are both operating at full capacity!

Towers above subways on busy streets lacking amenities for families are not the type of housing Vancouver needs. We need ground level, affordable housing in low rise structures, not more and more of these hideous towers that make the\~City a horrible\~place to live.

Towers like this one are NOT green. Building them sets us back from our climate change goals. So why does this Council keep pushing them on us? Please read this:\~https://brianpalmquist.substack.com/p/high-rise-hypocrisygreenest-city-a51?utm_source=url&s=r [brianpalmquist.substack.com]

And as usual, the City's engagement process is completely flawed and designed to manufacture consent. Please refer to the email I sent to you April 5 with subject "Vancouver's deeply flawed public engagement processes give biased results, need a major overhaul". The issues I raised there certainly apply in this case. For example,\~the Virtual Open House data is a confusing mess, intended to create the illusion of engagement. Buried in Appendix F we learn that\~207 respondents opposed the rezoning (vs. 197 in support, 20 mixed), but the data doesn't report where the respondents live. Based on previous experiences, the Fairview/South Granville Action Committee expects that most "support" comes from outside of Vancouver.\~Is that democratic? And even so, more respondents were opposed than in support!\~

Those are just some of the reasons Council should reject this proposal. I completely share the many concerns detailed at the following links.

https://www.fsgac.org/1477-referral-report-errors?utm_campaign=9e5c7ef2-647b-4445-9415-7c13d41a53a2&utm_source=so&utm_medium=mail&cid=0a4086f0-339d-4580-9b0f-b7e781e4f3f4 [fsgac.org]

<https://www.fsgac.org/1477-w-broadway-rezoning> [fsgac.org]

Sincerely,
s.22(1)

From: s.22(1)
To: "Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
"Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
"Dominated, Lisa" <Lisa.Dominated@vancouver.ca>
"Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
Date: 2/28/2022 11:19:31 PM
Subject: [EXT] 1477 West Broadway Rezoning - Please reject.
Attachments: 1477-w-broadway-rendering-with-mountains-feb-2022.jpg

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

Dear Council,

I am writing to strongly oppose the mid-construction\~rezoning of 1477 West Broadway\~to be a 39-storey tower. The building is too tall and its covert planning is more akin to the invasion of Ukraine than to a proper idea aimed at building a livable city for the future. I am disappointed with the poorly advertised Open House that was barely visible on the signage at the site.

In July, Council allowed for exceptional consideration of this rezoning ahead of\~the Broadway plan, and so it is implicit to this that the project should not take advantage of the exception and should rather align with a more\~complimentary height to the area, which would still recognize the importance to increase density. There is nothing\~more special about this site than its neighbour properties, and it does not "have to be built", as many alternative\~medium-rise buildings on\~the under-utilized surrounding properties\~could accommodate the added number of dwellings around the station. Indeed, much of the feedback for the Phase 3 of Broadway plan has objected to the excessive heights mentioned, so those rejected proposals cannot be used as justification for this building's rezoning to 39 storeys.

If increased density to such incredible heights was so important, why was it left so late in this planning process and also not included with so many of the 1-storey subway stations along\~the Broadway line. Is Council saying that they did not know what they were doing over the past number of years to get us to this point? Perhaps something to be considered in the upcoming civic elections.

Though its well-established that 6-8-storey buildings allow for vibrant urban communities, I can accept a 16-storey building that moves density towards a balance of liveability, neighbourhood voices, political considerations and developer pressures.

The height of this building looks like a middle finger from developers to the citizens of Vancouver; a symbol of greed unjustified in the cost to our livable city.

We know that there are inadequate community amenities along West Broadway, such as meaningfully sized parks and public areas to build healthy families, lifestyles, (let alone accommodate the stressors of whatever pandemic nature has in store for us). False Creek waterfront is not easily accessible to most people due to the slope, in particular those with mobility challenges, children or the elderly. Any amenities must be developed along the level of West Broadway to actually be benefit to the corridor's population. Nothing of this is funded or incorporated into this proposal.

It is notable in the recent Referral Report that there are not any images of the how the building obscures the view down the village feel of South Granville to the mountains. Nor does the report include winter shadow studies. Could you imagine if the Granville Bridge and Granville Island lived in the darkness of this and the other future buildings along West Broadway? What a miserable experience for one of our city's best attractions. Will no one south of the building catch a clean view of English Bay or the mountains? Will no one north be able to grow plants on their patios?

This building does not fit with the desired theme of the South Granville commercial corridor encouraging a village community feel with low-rise frontage, as suggested in the Phase 3 of the Broadway plan. There is so much potential to develop a commercial and entertainment corridor that connects South Granville with Granville Island and then downtown with the proposed pedestrian-friendly bridge renovations. Instead this building would form a barrier, a plug sticking up, not only breaking views but segregating the zones.

Thank you for taking the time to consider my comments.

Sincerely,

s.22(1)

Vancouver





From: "Ian Crook" <icrook001@outlook.com>
To: "Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Dominato, Lisa" <Lisa.Dominato@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
"Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
"Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
Date: 4/21/2022 3:09:10 PM
Subject: [EXT] 1477 West Broadway Rezoning & Gentrification

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

Dear Mayor Stewart and Councillors:

\~

Re: 1477 West Broadway and Gentrification

I am again writing you to oppose the rezoning application for 1477 West Broadway, based on new information I have become aware of in the past 24 hours.

One of the concerns many residents have when major rezonings are considered by Council is the gentrification effect of a new project on existing neighbourhoods, and I have an example which demonstrates this.

This link takes you to the listing for sale of a small group of older properties, located primarily in the South Granville area, with another one located on West 41st in Kerrisdale. \~ [Multifamily For Sale — British Columbia | Canada | CAN2009612 | Colliers \(collierscanada.com\) \[collierscanada.com\]](#) \~ With the exception of the Kerrisdale property, all the properties are on smaller lots and not likely to be redeveloped unless a developer puts together a land assembly.

There is one very significant comment in the listing: "With 13 of the 57 units (23%) held vacant at the Vendor's discretion, investors are presented with rare opportunity for immediate repositioning and rental upside realization. The Portfolio's ownership structure offers potential Property Transfer Tax savings ..."

This comment means that the owner is holding units off the market, and in the hope/expectation that the buyer will pay a premium purchase price given they have the ability to rent those vacant units at whatever price the market will bear. When you look at what rents are on the West Side now (based on the Referral Report), and recognize that the 1477 West Broadway market rental units will go at a premium to the average price, there is ample room for the new owners raise rents and still appear to be a bargain compared to the new properties at 2538 Birch St and 1477 West Broadway.

The other point that needs to be made here is that not only will the rents go up, but rental units are being held off the market. This creates a compound effect: units held off the market during a housing

crisis, and rent increases will be maximized when the properties are sold. It should be noted that this is not a unique situation in the South Granville area.

Please vote against this rezoning application.

\~

Ian Crook

April 21, 2020

\~

From: s.22(1)
To: "Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
"Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
"Dominated, Lisa" <Lisa.Dominated@vancouver.ca>
"Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
Date: 2/27/2022 11:30:11 AM
Subject: [EXT] 1477 West Broadway rezoning 12

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I urge you to oppose the referral of the CD 1 rezoning of 1477 West Broadway before the completion of the Broadway Plan.

s.22(1)

From: s.22(1)
To: "Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>
"Dominated, Lisa" <Lisa.Dominated@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
Date: 4/14/2022 3:32:25 PM
Subject: [EXT] 1477 West Broadway Rezoning

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Hello Council,

Please do NOT approve this project as it is stated. Yes, housing is needed, yes, transit corridors are a good location but the height of this (and other proposed projects on the docket) are not the solution. These towers and projects must be capped. These decisions are being made to benefit the developers - the number of floors that they need to build to compensate having rental units in the building (vs. the pre-sale, 100% ownership model) in order for the developers to make their desired profit. Taller does not benefit the neighbourhood and it forces concentrated densification on areas that cannot (now or in the future) support it. To appease Developers, you are going to start turning the neighbourhoods of Vancouver into Downtown hub extensions. This city keeps being voted high up on lists for livability, quality of life and natural beauty. You are going to cover all of this up, and create unsustainable areas with towers of this size. I have always defended progress and moving forward with changes that need to be made, but 40+ storey towers are not the solution. Look at the housing that has gone in along the Cambie corridor, low-rise buildings that offer needed new homes and work within the community that they are situated. Oakridge is a mess and the approved project with those huge towers is already the scorn of the neighbourhood. Please do NOT approve this (or future projects) that place 40+ storey towers with in the city. Thank you for your time,

s.22(1)

From: s.22(1)
To: "Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>
CC: "Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
"Dominated, Lisa" <Lisa.Dominated@vancouver.ca>
"Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
Date: 4/19/2022 7:25:26 PM
Subject: [EXT] 1477 West Broadway Spot Rezoning: Speaker 24 Notes
Attachments: _Paul Morris 1477 Hearing.docx

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Councillor Hardwick, Mayor and council.
Here are my speaker notes, as requested.
Regards

s.22(1)

GOOD EVENING, MAYOR AND COUNCILLORS. I AM s.22(1) RESIDENT OF FAIRVIEW, FIRST A RENTER, THEN A CONDO OWNER. I OPPOSE THIS SPOT REZONING AND THE PRECEDENT IT SETS. I WOULD LIKE TO ADDRESS THE ISSUE OF ENVIRONMENTAL IMPACT.

s.22(1)

s.22(1) VANCOUVER'S LEAKY CONDO CRISIS. THAT CRISIS WAS DUE MOSTLY TO A 1986 SURGE IN CONSTRUCTION, USING DESIGNS INAPPROPRIATE FOR OUR LOCAL CLIMATE, AND IGNORING BUILDING SCIENCE.

IN 1996, BOB MAKI, CHIEF BUILDING OFFICIAL, STOOD UP TO THE DEVELOPERS AND SAID THIS STOPS NOW. WE ARE GOING TO FOLLOW THE SCIENCE AND RETURN TO RAINSCREEN DESIGN. THE RELEVANCE OF THIS WILL BECOME INCREASINGLY OBVIOUS AS I CONTINUE.

IN 2011 VANCOUVER BROUGHT OUT ITS GREENEST CITY PLAN.

IN 2016 THE CITY PUBLISHED A PLAN TO ACHIEVE NET ZERO GREENHOUSE GAS EMISSIONS FROM THE OPERATION OF NEW BUILDINGS BY 2030.

IN 2020 THE CITY PUBLISHED ITS CLIMATE EMERGENCY ACTION PLAN.

IN 2022, WHY ON EARTH WOULD THE CITY BE ENCOURAGING THE WORST KIND OF BUILDING CONSTRUCTION FOR ADVERSE CLIMATE IMPACTS?

FIVE YEARS AGO, BUILDINGS WERE REPORTED TO GENERATE 56 PERCENT OF EMISSIONS IN VANCOUVER, EXCEEDING THE CONTRIBUTIONS OF TRANSPORTATION AND WASTE COMBINED.

HIGH-RISES ARE INCOMPATIBLE WITH VANCOUVER'S GREENEST CITY ASPIRATIONS.

THEY ARE EXTREMELY DIFFICULT AND EXPENSIVE TO BUILD TO NET ZERO. PERHAPS IMPOSSIBLE WITHOUT WIND TURBINES.

EVEN THE CITY'S NET-ZERO PLAN STATES "LOW-RISE MULTI-UNIT RESIDENTIAL BUILDINGS ARE THE IDEAL CONSTRUCTION TYPE FOR COST-EFFECTIVE, HIGH-PERFORMING BUILDING ENVELOPES AND VENTILATION SYSTEMS."

THERE ARE GOOD REASONS FOR THIS. UBC'S PROF. PATRICK CONDON SAYS "HIGH-RISE BUILDINGS ARE SUBJECT TOO MUCH SUN AND WIND. AND ALL-GLASS SKINS ARE, DESPITE MANY IMPROVEMENTS TO THE TECHNOLOGY, INHERENTLY INEFFICIENT."

FURTHERMORE, RDH SHOWED CONCRETE BALCONIES AND SLAB EDGES SUCK HEAT OF THE BUILDING IN WINTER.

A 2014 CITY-SPONSORED REPORT BY LIGHTHOUSE SUSTAINABLE BUILDING CENTRE FOUND, FOR OFFICE BUILDINGS "THE GREATER THE NUMBER OF FLOORS THE HIGHER THE RELATIVE EMISSION INTENSITY".

FOR MULTI-UNIT RESIDENTIAL BUILDINGS, THE ENERGY PERFORMANCE OF LOW-RISE WAS 22% BETTER THAN HIGH-RISE.

AH BUT, YOU MAY SAY, HIGH-RISES DESIGN IS IMPROVING IN ENERGY EFFICIENCY. NOT SO. RDH FOUND HEATING AND TOTAL ENERGY CONSUMPTION IN RESIDENTIAL HIGH-RISES INCREASED OVER 30 TO 40 YEARS DESPITE PERCEIVED IMPROVEMENTS IN ENERGY EFFICIENCY. THEIR WORDS.

A 2019 BC HYDRO REPORT STATED: “DESPITE MANY NEW, HIGH-END CONDO BUILDINGS BEING MARKETING AS ENERGY EFFICIENT, THOSE LIVING IN THEM HAVE A MUCH LARGER ENERGY FOOTPRINT THAN THOSE LIVING IN OLDER STYLE BUILDINGS.” 4 TIMES THE ENERGY USE OF LOW-RISES SEATTLE’S OFFICE OF SUSTAINABILITY CONCLUDED THEIR RESIDENTIAL HIGH-RISES HAVE 60% HIGHER ENERGY USE INTENSITY THAN LOW-RISE, AND 45% MORE THAN MID RISE, DESPITE ADVANCES IN ENERGY EFFICIENCY”

THAT IS A LOT OF DESPITES. THAT IS ALSO A LOT OF DIFFERENT PERCENTAGES BECAUSE OF THE VARIOUS WAYS OF COMPARING ENERGY PERFORMANCE, BUT LOW-RISE IS ALWAYS MUCH BETTER THAN HIGH-RISE.

SO FAR, WE HAVE TALKED ABOUT OPERATIONAL EMISSIONS. I BELIEVE THE CITY’S 2016 OPERATIONAL EMISSIONS TARGETS, WHICH THIS PROPOSAL WOULD MEET, ARE DUE TO BE UPDATED VERY SOON, AND PRESUMABLY REDUCED.

WE ALSO NEED TO CONSIDER EMBODIED EMISSIONS FROM EXTRACTION, MANUFACTURE AND CONSTRUCTION.

I NOTICE STAFF AND THE PROPONENT FAILED TO ANSWER COUNCILLOR SWANSON'S QUESTION ON THIS TOPIC

I UNDERSTAND THE CITY PLANS TO PUT IN PLACE EMBODIED EMISSIONS TARGETS VERY SOON. BUT NOT FOR THIS BUILDING.

CONCRETE IS THE WORST CONSTRUCTION MATERIAL FOR EMBODIED EMISSIONS

AT THE BROADEST LEVEL, LIFECYCLE EMISSIONS, INCLUDE EMBODIED AND OPERATIONAL EMISSIONS, PLUS THOSE FROM DEMOLITION AND WASTE DISPOSAL.

GREEN CONCRETE HAS A MINOR IMPACT ON OVERALL LIFECYCLE EMISSIONS OF HIGH-RISES.

STUDIES IN THE USA AND EUROPE HAVE SHOWN, IN A GIVEN AREA, THE SAME POPULATION DENSITY AS USING HIGH-RISES CAN BE ACCOMODATED BY LOW-RISE DEVELOPMENT WITH 45% OF THE LIFECYCLE EMISSIONS.

FOR RE-ZONINGS LIKE THIS, A 2019 CITY-SPONSORED REPORT BY ZERA SOLUTIONS RECOMMENDED FULL LIFE CYCLE ANALYSIS USING THE ATHENA SOFTWARE, DEVELOPED BY FPINNOVATIONS. THE CURRENT PRESIDENT OF THE, SPUN-OFF, ATHENA INSTITUTE IS JENNIFER O’CONNOR. s.22(1) s.22(1) TACKLE THE LEAKY CONDO CRISIS.

CONSEQUENTLY, I FIND IT IRONIC THAT VANCOUVER IS ABOUT TO EMBARK ON ANOTHER SURGE IN CONSTRUCTION, USING BUILDING DESIGNS INAPPROPRIATE FOR THE WORLD’S CLIMATE, AND YET AGAIN IGNORING THE SCIENCE.

PLEASE DON’T WAIT 10 YEARS TO RECOGNIZE A HUGE MISTAKE.

REMEMBER BOB MAKI, STAND UP TO THE DEVELOPERS AND THEIR SURROGATES. VOTE AGAINST THIS HARBINGER OF THE BROADWAY PLAN.

From: s.22(1)
To: "Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
"Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
"Dominated, Lisa" <Lisa.Dominated@vancouver.ca>
"Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
Date: 4/16/2022 5:50:51 PM
Subject: [EXT] 1477 West Broadway

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With an election coming, many of us will be interested to see who supports this nonsense.~ There is NO justification for developments that are contrary to everything Vancouver is trying to be.

VOTE AGAINST REZONING 1477 West Broadway

s.22(1)

A resident of Vancouver s.22(1)

From: s.22(1)
To: "Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>
"Dominated, Lisa" <Lisa.Dominated@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
Date: 4/14/2022 3:46:39 PM
Subject: [EXT] AGAINST:1477 W Broadway rezoning application

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I am strongly against the proposal of the 1477 W Broadway rezoning application. \~39th\~stories of that corner of W.Broadway x Granville st is unnecessary. Completely destroy the view, and does not harmonize, or does not fit the environment of Granville.\~

From: s.22(1)
To: "Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
Date: 4/20/2022 11:34:23 AM
Subject: [EXT] Broadway / Granville development

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

Your Honour,\~

It is inconceivable why the public has to fight constantly the excessive demands of developers. There is no benefit to the taxpayer and less and less livability in this beautiful city of ours.\~

When will 'City Hall' and Council do their job for those who got them elected? \~

Please stop the construction of these inhumane meat silos.\~

We need a plan for the future and not support people who want only to line their pockets without any consideration what permanent negative effects their heed has.\~

Sincerely

s.22(1)



From: s.22(1)
To: "Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
"Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
"Dominated, Lisa" <Lisa.Dominated@vancouver.ca>
"Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
Date: 3/1/2022 8:44:01 AM
Subject: [EXT] Building Proposal for 1477 West Broadway

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I have so many issues with the proposed building at 1477 West Broadway that I don't know where to begin.\~ This plan flies in the face of the plans for a liveable city that Vancouver has been touting for the last several years.\~ Not only will the building literally overshadow the entire neighbourhood, but it will create a density in the area that it is not equipped to deal with.\~\~

Please reconsider this mammoth construction.

s.22(1)



From: s.22(1)
To: ["Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>](mailto:Rebecca.Bligh@vancouver.ca)
["Boyle, Christine" <Christine.Boyle@vancouver.ca>](mailto:Christine.Boyle@vancouver.ca)
["Carr, Adriane" <Adriane.Carr@vancouver.ca>](mailto:Adriane.Carr@vancouver.ca)
["De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>](mailto:Melissa.DeGenova@vancouver.ca)
["Fry, Pete" <Pete.Fry@vancouver.ca>](mailto:Pete.Fry@vancouver.ca)
["Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>](mailto:Colleen.Hardwick@vancouver.ca)
["Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>](mailto:Sarah.Kirby-Yung@vancouver.ca)
["Swanson, Jean" <Jean.Swanson@vancouver.ca>](mailto:Jean.Swanson@vancouver.ca)
["Wiebe, Michael" <Michael.Wiebe@vancouver.ca>](mailto:Michael.Wiebe@vancouver.ca)
["Dominato, Lisa" <Lisa.Dominato@vancouver.ca>](mailto:Lisa.Dominato@vancouver.ca)
["Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>](mailto:Kennedy.Stewart@vancouver.ca)
Date: 4/16/2022 4:41:29 PM
Subject: [EXT] CD-1 Rezoning: 1477 West Broadway - "Don't look up!"

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

Dear Councillors,

Subject (address if applicable):	CD-1 Rezoning: 1477 West Broadway\~
Position:	Oppose
Comments:	The building of high rises is in conflict with the City's Climate Change Adaptation Strategy and also in conflict with the City's Zero Emissions Building Plan.

Buildings are directly responsible for nearly 40% of all greenhouse gas emissions according to the International Energy Agency. A Chicago study looked at 2,000 units and where they were sustainable in an unbiased way. They found out that the four-story courtyard uses the least energy per household. One other study conducted in the UK found that high rises of 10 stories and higher used 76% more electricity per sq-ft than buildings with five or less stories. Various peer-reviewed studies indicate that large buildings such as the one being planned at 1477 W Broadway account for more emissions than their smaller counterparts.

Another study, recently published in Urban Sustainability, a Nature publication, suggests that there is a growing belief that building taller and\~denser is better. However, urban environmental design often neglects life cycle GHG emissions. The results presented in the paper show that taller urban environments significantly increase life cycle

GHG emissions (+154%) and low-density urban environments significantly increase land use (+142%). However, increasing urban density without increasing urban height reduces life cycle GHG emissions while maximizing the population capacity. There seems to be growing evidence that building high rises is NOT the most efficient way to meet growing demand for urban space and if the City is serious about addressing the climate change emergency, it should not approve the building of high rises at this location and other locations that are part of the Broadway Plan. Prof Patrick Condo, from UBC, has also demonstrated that densification does not necessarily need to be achieved through the building of high rises.

The idea that the use of "green" concrete will reduce emissions at any significant level is not completely accurate. Concrete is the number one source of embodied carbon in buildings – accounting for up to 55%. And it is responsible for 8 to 11% of global CO2 emissions.

CarbonCure Technologies has a process that takes some CO2 out of the air and incorporates it into the concrete, which strengthens it, reducing the amount of cement needed. So far, CarbonCure concrete achieves a net carbon reduction of only 5 to 7%.

Lehigh and Lafarge, are blending cement with materials such as dried biosolids from wastewater treatment. Lafarge's EcoPact has a carbon footprint between 30% and 40% lower than the current industry average. The cement component creates 80% of the CO2 emissions of concrete, so the reduction in concrete's CO2 emissions is between 24% and 32%. Since the construction stage contributes 9% to 35% of the lifecycle GHG emissions, these reductions would only reduce total high-rise emissions by 2% - 11%. These reductions are even less impressive when one considers that taller urban environments increase lifecycle GHG emission by +154% (two and a half times).

I hope Councilors understand the severity of the climate change emergency, give a chance for better planning to be developed without the high rises, and oppose this specific rezoning, which is a prelude to the awful Broadway Plan.

Full name:

s.22(1)

Which neighbourhood do you live in?

Fairview

From: s.22(1)
To: "Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
"Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
"Dominated, Lisa" <Lisa.Dominated@vancouver.ca>
"Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
Date: 4/13/2022 5:30:26 PM
Subject: [EXT] CD-1 Rezoning: 1477 West Broadway 1

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

Dear Council Members -\~

This development is proceeding at high pace when the Broadway Plan has not even been completed.\~

Again and again City Staff tell us that each higher building will NOT be a precedent setter, the truth is that is a clear lie as each application proposes higher and higher towers along the corridor.

The Broadway Plan mailouts consistently say that what staff heard at each consultation phase was poor support for high rises, yet, they then plow on ignoring 'what they heard' in the next set of plans.

Where are kids from this building going to go to school? To Daycare, to recreation??? There are no viable plans alongside building this tower to accommodate the quality of life activities so important in a community.

Please press pause.\~

I've said it multiple times, do density better - it doesn't have to always be a sky high tower.

Thank you
s.22(1)

I am privileged to live, work, and play on the traditional unceded territories of

the\~x m dō`r m [\[musqueam.bc.ca\]](http://musqueam.bc.ca)\~(Musqueam),\~Mpqwú 7mesh [\[squamish.net\]](http://squamish.net)\~(Squamish)
and\~s lilw ta \~(Tseil-Waututh) Nations.\~\~

From: s.22(1)
To: "Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
"Dominated, Lisa" <Lisa.Dominated@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
CC: s.22(1)
Date: 4/13/2022 3:21:10 PM
Subject: [EXT] CD-1 Rezoning: 1477 West Broadway 2
Attachments: 1477 West Broadway.pdf

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April 13, 2022

Mayor Kennedy Stewart and City Council
3rd Floor, City Hall
453 West 12th Avenue,
Vancouver, BC V5Y 1V4

Dear Mayor Stewart, and City Council

I am writing to you a resident in the Fairview Slopes area of Vancouver to ask you to vote NO to the CD-1 rezoning application at 1477 West Broadway.

I am opposed to the rezoning for the following reasons:

- The building height at 39 stories is too high and it's not environmentally sustainable or healthy. It doesn't appear to improve energy efficiency and won't reduce greenhouse gases which are objectives in the city climate plan.
- There is no planning or budget to build new schools and parks. We don't have enough school spots for the current populations of these areas as it is.
- Part of the beauty of Vancouver, which attracts visitors and tourists are the small neighbourhoods, the greenery, and the views. Massive buildings will take away from these desirable attributes.
- There needs to be greater scrutiny of the MIRHPP program. The details of the plan favour the developer.
- The developer CPI has applied for a Development Cost Levy waiver that could equate to a subsidy of \$77,733 per unit. That \$3.3 million in funds would still be needed by the city and would likely be collected through property taxes.
- These large developments have already led to a lack of affordable housing, increased homelessness, loss of small businesses and enriched developers.

I understand the need for increased development and affordable housing and rental buildings, but this type of rezoning will not help and will continue to contribute to the ongoing problems Vancouver has. These types of developments will attract investors and tourists, not people wanting to raise families.

Sincerely,

s.22(1)

Cc: Councillors R. Bligh, C. Boyle, A. Carr, M. De Genova, L. Dominato, P. Fry, C. Hardwick, S. Kirby-Yung, J. Swanson, M. Wiebe

From: s.22(1)
To: "Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
"Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
"Dominated, Lisa" <Lisa.Dominated@vancouver.ca>
"Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
Date: 4/7/2022 3:06:14 PM
Subject: [EXT] CD-1 Rezoning: 1477 West Broadway 5

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I have just completed the questionnaire regarding the latest plan to make Vancouver livable, open to all - concerned with light, space, the environment, neighbourhoods, etc.

I wonder about how this rezoning fits in with the planning for Vancouver's future.\~ It seems to be the opposite of every principle embodied in the long term plan.\~

Election for the next city council is arriving.\~ Those of us that oppose this rezoning will be very vocal about the need to oppose those currently on council who support this rezoning.\~ It is time to end spending time and money on plans for Vancouver's future while council works in opposition to its basic tenants.

Say no to this abomination.

s.22(1)

V6j 4Z3

From: s.22(1)
To: "Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Dominated, Lisa" <Lisa.Dominated@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
"Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
"Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
Date: 4/2/2022 2:55:49 PM
Subject: [EXT] CD-1 Rezoning: 1477 West Broadway 6

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

Hello, \~

I live s.22(1), Vancouver and I strongly oppose the CD-1 rezoning plan. The plan for this site at 1477 needs significantly more consideration and should not proceed as currently laid out. \~

Happy to discuss further,

s.22(1)

From: s.22(1)
To: "Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
"Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
"Dominated, Lisa" <Lisa.Dominated@vancouver.ca>
"Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
Date: 4/16/2022 1:59:05 PM
Subject: [EXT] CD-1 Rezoning: 1477 West Broadway

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I am completely opposed to this rezoning.\~\~
The change in height and density is enormous. It preempts the Broadway Plan.\~
It will provide mostly market and luxury suites that we don't need, it's out of scale with the surrounding neighbourhood, shadow studies are incomplete (shade is an important factor, especially when a tower is located on a slope and in our city where gloomy weather contributes to mental health issues), will inflate property values and cause increased rents and displacement in Fairview where 40% are renters.\~ Parks, schools, emergency services and other necessities are already lacking here. Amenities and services are extremely costly and they need to be provided, not just promised. The developer is applying for a waiver that would spare it from contributing \$3.3 million in CACs that would pay for amenities. It will make enormous profits so why should it receive such a huge giveaway at taxpayers' expense?\~ The MIRHPP program also provides financial incentives that benefit the developer but how affordable will the units be relative to their miniscule size?\~\~
Your plan to use the height and density of this building as a precedent for towers along the Broadway corridor will only provide a minimal number of non-market units. How can you think it's a good idea to build a concrete jungle that will sacrifice liveability, displace existing affordable housing and cause increased unaffordability from inflation. Please don't do this.\~
I am very dismayed by the misinformation by staff and suggest that staff, planners and council walk in areas where rezonings are proposed.\~ \~
Scaling down building heights to a maximum of 10 storeys, demanding more than 20% below-market units, and providing a mix of lower, human-scale buildings (multiplexes, townhouses, secondary and laneway suites, infill with character house retention, more co-ops), protecting heritage, character, urban forest and views would densify while keeping neighbourhoods pleasant to live in, less alienating, more liveable, sustainable and affordable, that would benefit everyone.\~ I urge you to

vote against this rezoning.\~

From: s.22(1)
To: "Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Dominated, Lisa" <Lisa.Dominated@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
"Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
"Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
Date: 4/5/2022 10:50:04 PM
Subject: [EXT] CD-1 Rezoning 1477 West Broadway

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

Hello,\~

Im writing to tell you I\~OPPOSE the\~**CD-1 Rezoning: 1477 West Broadway.**\~

It's too high for the neighborhood.\~

s.22(1)



From: s.22(1)
To: "Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
"Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
"Dominated, Lisa" <Lisa.Dominated@vancouver.ca>
"Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
Date: 3/1/2022 11:08:00 AM
Subject: [EXT] CD-1 Rezoning at 1477 West Broadway

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

Vancouver Council,\~

I strongly oppose, and ask council to oppose, the referral report for CD-1 Rezoning at 1477 West Broadway. on your agenda today.

I site the Fairview/South Granville Action Committee review of the referral report which notes these again, found errors, omissions and inconsistencies which speak to staff's confidence that this rezoning is a fait accompli:\~

•

•

•

○

Sincerely,\~

s.22(1)

From: s.22(1)
To: david.eby.mla@leg.bc.ca
CC: george.heyman.MLA@leg.bc.ca
"Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
"Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
"Dominated, Lisa" <Lisa.Dominated@vancouver.ca>
"Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
Date: 4/21/2022 1:08:33 PM
Subject: [EXT] City of Vancouver Application for Rezoning of 1477 West Broadway

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

Dear Sir
\\~

In a front-page article in the Vancouver Sun this morning, Dan Fumano reported that earlier this month you wrote a letter to Vancouver City Council about this project.\\~ Apparently you encouraged the City to "urgently advance" the project so "proposed new rental homes can be built as soon as possible."

\\~

I presume you are aware that this project is very controversial in Fairview and South Granville where the property is located.\\~ The Public Hearing of the Rezoning Application is entering its third evening of hearings today.\\~\\~One of the issues in the controversy is the extent to which Vancouver City staff have attempted to accelerate the approval of this project to the detriment of the residents of the area.\\~ The City has been working on a plan for the development the lands along the Broadway Subway corridor for years.\\~ The plan is to provide guidance for the development of these lands.\\~ The plan is not completed and will not be approved by council without a further public hearing.\\~ \\~

Some weeks ago, as a resident of Fairview I completed a City survey about options for development of the Subway Corridor.\\~ I, and many of my neighbours, expressed grave concern about the height and density of the development the City appears to be planning.\\~ I have not had a response.\\~ It is, I submit, a slap in the face to the residents of Fairview and South Granville that the rezoning has been placed before Council before the Plan is finalized and approved by council.\\~ \\~This is aggravated by the fact that the application to approve the Plan is presently scheduled to go before council next month.

In addition, there are substantive problems with the proposed development of this tower.\\~ People

who have so far made submissions in opposition to the rezoning cited serious flaws with the application, including the lack of planning for amenities, a shortage of parks and elementary schools in the area, and concerns around the proposed building's negative effects on children (due to small living spaces, lack of family-oriented amenities in the area), health, affordability, the environment, and sustainability. Inexplicably, it appears that the developer has been excused from paying a Development Cost Levy of about 3.3 million dollars.

Please note that there is little dispute about a rental housing shortage. The concern that this 39-story building is not an appropriate way to address the shortage.

The City has not, so far as I am aware, shared your letter with the residents of the affected area. I have not seen it. However, from Mr. Fumano's description of its contents, with the utmost respect I submit your letter to Vancouver City Council this month was ill advised. It is an unfortunate interference with the efforts of the Council to reach a fair decision on the Rezoning Application. I hope that the members of the City Council will ignore it in their deliberations.

Yours truly,

s.22(1)

cc: MLA for Vancouver Fairview, The Honourable George Heyman;
The Mayor and Members of Vancouver City Council

Sent from Mail [go.microsoft.com] for Windows

From: s.22(1)
To: "Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
"Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
"Dominated, Lisa" <Lisa.Dominated@vancouver.ca>
"Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
Date: 2/28/2022 11:35:37 AM
Subject: [EXT] Concerns about the development on 1477 W. Broadway

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Hello,

I am writing to council as a concerned resident of the Fairview neighborhood.

I would implore on council to hold city staff accountable to provide clear details on such developments which are completely out of alignment with the character of the area and will ultimately overshadow the current residential units.

For many of these spot rezoning requests, there are too many details unanswered, and postponed. This is even despite the Broadway Plan not being complete or approved by council.

This leaves the impression for many residents that such developments are a "foregone" conclusion and has caused many long time residents such as myself to lose faith in the city's planning and permitting processes - City Staff seem intent on pushing through projects which are purely virtue signalling and ultimately negatively impact the residents of the area.

- 7 times throughout the Report, **City staff state that the proposed height and density of the proposal aligns with the Broadway Plan Refined Directions, even though the Broadway Plan is not finished, nor has it been approved by Council.**.\~
- The developer (PCI) has **applied for a Development Cost Levy waiver (saving \$3.3M) and will not have to make any financial Community Amenity Contributions.**.\~
- Staff claim that no major public parks or plazas are shaded by the building however, **they didn't assess shadowing at the winter solstice, the darkest time of the year.**.\~

- Per the Housing Vancouver Strategy, **this rental building is being planned for all family types and yet, the Report provides no details on the building's amenities, access to parks, nor space in nearby schools.** (Incidentally, \~catchment schools and other nearby schools have no capacity.)\~

Thanks,
s.22(1)

From: s.22(1)
To: "Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"Dominated, Lisa" <Lisa.Dominated@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
CC: "Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
Date: 3/1/2022 3:45:19 PM
Subject: [EXT] Council's Mardi Gras vote to refer 1477 W Broadway to public hearing

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To Councillors Boyle, Carr, \~Dominated, Fry, Swanson, Wiebe:

\~

To laugh or to cry - that your vote indicated an inability to understand the breathtaking logic of Councillor Hardwick's opening statement and the staggering difference in impact between the proposed 39-storey building and the original 5-storey proposal. (a gap SO profound that this proposal should NEVER have reached this stage)

\~

Your action today suggests that you are "developer-complicit" - it's not a suggestion that I will attempt to prove, but that's the kind of assumption that gets made when Council decisions erode public trust.

\~

In any case, NONE of you will have my vote in the 2022 Election.

\~

Yours sincerely,

s.22(1) (Vancouver resident)

From: s.22(1)
To: "Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
Date: 3/28/2022 10:50:18 AM
Subject: [EXT] Development on Broadway

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

Your Honor,
Please think of the future of Vancouver. Let's keep up a certain quality of life in this beautiful city. Do not allow skyscrapers indiscriminately for the sake of financial gain of a few.\~

There was a time when the opinion of the citizens counted: they prevented the construction of a\~

'city highway' !!!

Whatever happens will not affect me much s.22(1) .\~

But you should know s.22(1)
survey, to get a tree by-law in the 90's, when we lost up to 5,000 □ per annum in Vancouver.\~

With hope for a sustainable\~future,

Sincerely

s.22(1)



From: s.22(1)
To: "Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
"Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
"Dominated, Lisa" <Lisa.Dominated@vancouver.ca>
"Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
Date: 2/28/2022 10:51:38 AM
Subject: [EXT] Fw: Update: 1477 W Broadway (RBC Site)

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

A building of this size is absurd, excessive, and ludicrous!\~ I absolutely oppose the looks and size of it.

Why would anyone approve of such a monstrosity which will upset the neighbourhoods of Fairview South and South Granville?

I pray Council will reconsider this referral,

Yours truly,

s.22(1)

Vancouver

Can't see this message? [View in a browser \[shoutout.wix.com\]](#)

Referral Report Published for
1477 W Broadway (RBC
Site)\~\~

[shoutout.wix.com]

Dear Neighbours and Supporters,

\~

Action needed on this today!

\~

The Referral Report for 1477 W Broadway (RBC site) has been published and will be considered by Council on Tuesday, March 1st, 2022.

\~

We have reviewed the Referral Report in detail and have found **stunning errors, omissions and inconsistencies which speak to staff's apparent confidence that this rezoning is a fait accompli**. Following are some of the highlights, and you can read our full critique here (click here [shoutout.wix.com])

\~

- 7 times throughout the Report, **City staff state that the proposed height and density of the proposal aligns with the Broadway Plan Refined Directions, even though the Broadway Plan is not finished, nor has it been approved by Council.**\~
- The developer (PCI) has **applied for a Development Cost Levy waiver (saving \$3.3M) and will not have to make any financial Community Amenity Contributions.**\~
- Staff claim that no major public parks or plazas are shaded by the building however, **they didn't assess shadowing at the winter solstice, the darkest time of the year.**\~
- Per the Housing Vancouver Strategy, **this rental building is being planned for all family types and yet, the Report provides no details on the building's amenities, access to parks, nor space in nearby schools.** (Incidentally,\~catchment schools and other nearby schools have no capacity.)\~\~

\~

Your voice is needed TODAY! \~Write to Council and tell them to Oppose the referral of CD-1 Rezoning: 1477 West Broadway to Public Hearing, on the March 1st, 2022 Council Agenda:\~

\~

Copy and paste this list in the email "To:" field and send your message to Council:\~

\~

CLRbligh@vancouver.ca; CLRboyle@vancouver.ca; CLRcarr@vancouver.ca;
CLRdegenova@vancouver.ca; CLRfry@vancouver.ca; CLRhardwick@vancouver.ca;
CLRkirby-yung@vancouver.ca; CLRswanson@vancouver.ca; CLRwiebe@vancouver.ca;
CLRdominato@vancouver.ca; kennedy.stewart@vancouver.ca

\~

If Council refers the Report, a date will be set for the Public Hearing.\~ We will keep you apprised as more information becomes available.\~

\~

Please forward this to your neighbours, and thanks for your support,\~\~

\~

Fairview/South Granville Action Committee\~

\~

Follow Us

Visit www.fsgac.org \~ → [shoutout.wix.com]

You've received this email because you are a subscriber of [this site \[shoutout.wix.com\]](http://this.site.shoutout.wix.com).
If you feel you received it by mistake or wish to unsubscribe, please [click here \[wixapis.com\]](http://click.here.wixapis.com).

From: s.22(1)
To: "Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
"Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
"Dominator, Lisa" <Lisa.Dominator@vancouver.ca>
"Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
CC: s.22(1)
Date: 2/28/2022 1:25:18 PM
Subject: [EXT] Fwd: CD - 1 Rezoning: 1477 West Broadway

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

Dear Mayor & Council Members,

I am writing s.22(1) to oppose the Referral Report statements for the above captioned which will be heard by Council on March 1/22. \~The reasons for our opposition are as follows: \~

- 7 times throughout the Report,\~City staff state that the proposed height and density of the proposal aligns with the Broadway Plan Refined Directions, even though the Broadway Plan is not finished, nor has it been approved by Council.\~
- The developer (PCI) has\~applied for a Development Cost Levy waiver (saving \$3.3M) and will not have to make any financial Community Amenity Contributions.\~
- Staff claim that no major public parks or plazas are shaded by the building however,\~they didn't assess shadowing at the winter solstice, the darkest time of the year.\~
- Per the Housing Vancouver Strategy,\~this rental building is being planned for all family types and yet, the Report provides no details on the building's amenities, access to parks, nor space in nearby schools.\~(Incidentally,\~catchment schools and other nearby schools have no capacity.)\~

We have also on a previous occasion written to oppose the proposed height plan for the bldg on the former RBC site. No (!) action has been taken.

We constantly feel we are being unheard & that your proposals for this site are being forced

through with little or no consideration of local input (for which you were elected). We clearly understand the need for increased density but High Rises of the level proposed are EXCESSIVE.\~

We respectfully request that these views be given full hearing at the Council Mtg and appropriate action taken.

Sincerely,

s.22(1) [REDACTED]
(Local Fairview Residents)

From: s.22(1)
To: "Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
Date: 4/10/2022 11:19:29 AM
Subject: [EXT] Granville 40 Story Building

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

Fully support this building and we need more density and development to address housing needs
PLEASE and Thank you.

s.22(1)

Kitsilano

\~

Sent from [Mail \[go.microsoft.com\]](mailto:Mail [go.microsoft.com]) for Windows

\~

From: s.22(1)
To: ["Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>](mailto:Rebecca.Bligh@vancouver.ca)
["Boyle, Christine" <Christine.Boyle@vancouver.ca>](mailto:Christine.Boyle@vancouver.ca)
["Carr, Adriane" <Adriane.Carr@vancouver.ca>](mailto:Adriane.Carr@vancouver.ca)
["De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>](mailto:Melissa.DeGenova@vancouver.ca)
["Fry, Pete" <Pete.Fry@vancouver.ca>](mailto:Pete.Fry@vancouver.ca)
["Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>](mailto:Colleen.Hardwick@vancouver.ca)
["Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>](mailto:Sarah.Kirby-Yung@vancouver.ca)
["Swanson, Jean" <Jean.Swanson@vancouver.ca>](mailto:Jean.Swanson@vancouver.ca)
["Wiebe, Michael" <Michael.Wiebe@vancouver.ca>](mailto:Michael.Wiebe@vancouver.ca)
["Dominato, Lisa" <Lisa.Dominato@vancouver.ca>](mailto:Lisa.Dominato@vancouver.ca)
["Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>](mailto:Kennedy.Stewart@vancouver.ca)
Date: 4/4/2022 1:49:40 PM
Subject: [EXT] I am OPPOSED to the opposed CD-1 Rezoning: 1477 West Broadway

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

Hello, I understand the public comment period is open regarding the above captioned rezoning. I live in this neighbourhood and am opposed to this redevelopment, specifically as to the height of the tower. I am agreeable to 12 stories for redevelopment on that site.

\~

The Broadway Plan has not yet been approved so it cannot be possible to approve this proposed rezoning according to that Plan because that Plan is not yet approved and in place; accordingly any staff report references to being in accordance with the Plan are not accurate. It is not appropriate to approve this project and pre-empt the Broadway Plan development and approval process itself. There is no valid reason to allow 'exceptional circumstances' because there are in fact none in this situation.

\~

40 stories height is not appropriate for this strongly residential community with commercial /retail on the main arterials. The shadow studies were undertaken at a time of year that do not align with acquiring correct data.

\~

There are insufficient local amenities already in this neighbourhood (lack of parks, day care, schools, community centre) and I am opposed to the proposal to discharge the developer from the requirement of the amenity contributions. The City actually needs these contributions to finance its activities and should not be foregoing these – the developer can well afford to pay these contributions and should not be allowed to negotiate them away. The City should not give away so much and receive so little in return; it can and must require more from the developer.

\~

Engagement with the public appears to be for 'show' only as another development at Broadway + Hemlock was approved (old Esso site) for an overheight tower and a third is under consideration (Broadway + Hemlock) at the car dealership site, also for an overheight building. The Plan is apparently already in place and being used despite not actually yet receiving official approval. This is misrepresentation and dishonest. The building in question first applied for an excessive underground parkade as to the initial tower height, indicating the original idea for an overheight tower to be 'added' later or after the fact. Were it not the original concept there would be no reason or rationale for such extensive underground parking.

\~

The City is not treating this subway station site the same way it is treating all the others being developed along this line. Those others are for one story stations which would need further development approval at a separate time in the future. Excuses are made for why to treat this station differently now (passenger access) and that makes no sense because plenty of construction goes on at other existing stations and passenger access is managed and maintained all the same.

\~

Approval of this tower would trigger changes in value to other existing housing stock in this neighbourhood in a way that will raise property taxes on those properties, increase rents, and put the current building structures themselves at increased risk for demolition and redevelopment so that property owners can maximize value as BC Assessment uses "best use" to assess land values and this overheight tower would become the 'best use' for all other properties in the neighbourhood, displacing the renters in this neighbourhood. This is not acceptable, especially at a time of housing affordability cost issues as it stands.

\~

Lack of in person or virtual open house is discriminatory and excludes those citizens who are not able to access technology to learn about this rezoning or to provide their feedback. Online Q&A erodes citizen participation and limits acquisition provision of information by citizens to Mayor and Council.

\~

I am opposed to this redevelopment and opposed to using 'spot development approval' to redevelop an entire neighbourhood as this will be the second of three site in a one block area to be approved for overheight redevelopment. I consider height of 12 stories acceptable along Broadway in this neighbourhood.

\~

I note there is a civic election coming soon. I will be using the voting decisions to inform my choices when at the ballot box. Thank you.

\~

Kind regards, s.22(1) Vancouver, BC

\~

s.22(1)

From: s.22(1)

To: "Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
"Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
"Dominated, Lisa" <Lisa.Dominated@vancouver.ca>
"Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>

Date: 4/19/2022 5:15:32 PM

Subject: [EXT] I oppose the current building expansion along the Broadway Corridor.

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

I do not oppose new buildings. I do not oppose a greater height to new buildings but I do oppose buildings over 15 stories in this area. There is no need to go to 39 stories....it is so out of character for the neighborhood.

No no parks, no new schools or community centers. Where do you expect the projected 50,000 people along the corridor to relax, to feel like they are part of a community? It is ridiculous.

Reconsider your proposal. It is an awful inhuman plan. I will be horrified if it goes ahead.

s.22(1)

From: s.22(1)
To: "Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>
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"Fry, Pete" <Pete.Fry@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
Date: 4/14/2022 7:47:39 AM
Subject: [EXT] I oppose the proposed tower at 1477 West Broadway

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

Dear Mayor and Councillors, I oppose the proposed tower at 1477 West Broadway. It is out of scale and would set a terrible precedent. Thank you. s.22(1)

From: s.22(1)

To: "Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
"Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
"Dominated, Lisa" <Lisa.Dominated@vancouver.ca>
"Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>

Date: 2/28/2022 5:30:54 PM

Subject: [EXT] I oppose the referral of CD-1 Rezoning: 1477 West Broadway to Public Hearing, on the March 1st, 2022 Council Agenda

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

To Mayor Stewart and Council:

\~

I oppose the referral of the 1477 West Broadway project to public hearing. What is the point of a Broadway Plan if spot-zoning undermines it and neighbourhood concerns are brushed aside into the shadow of this monster tower?

Send it back to the drawing board.

\~

Yours truly,

\~

s.22(1)

Vancouver

From: s.22(1)

To: "Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
"Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
"Dominated, Lisa" <Lisa.Dominated@vancouver.ca>
"Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>

Date: 2/27/2022 4:22:45 PM

Subject: [EXT] I oppose the Referral report for the CD-1 Rezoning of 1477 West Broadway

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

All

It tickles me pink to read 61 pages of a referral report on a cloudy Vancouver Sunday afternoon!
I'm sure you enjoy spending your Sunday afternoons doing the same.

\~

I'd like to formally note my opposition to this report & encourage you to vote against it March 1st 2022.

I have many reasons why I oppose it but I hate to sound like a broken record, so, I'll stop writing now.

\~

Regards

s.22(1)

Vancouver, BC

\~

From: s.22(1)
To: "Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>
"Dominated, Lisa" <Lisa.Dominated@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
Date: 4/14/2022 5:12:19 PM
Subject: [EXT] Motion re 1477 W. Broadway at Granville St. zoning

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

I do not support this motion and agree with the statement below;

"It is a breach of process to be bringing this project forward for rezoning in advance of the Broadway Plan approval. This will set a major precedent for the entire Broadway corridor and has major implications for all station areas including at the Jericho Lands."

s.22(1)

Resident s.22(1)

From: "Fairview/South Granville Action Committee" <info@fsgac.org>
To: "Stewart, Kennedy"
Date: 2/28/2022 8:00:00 AM
Subject: [EXT] News Release: Flawed Referral Report Pushes 1477 W Broadway Development Ahead of Broadway Plan.
Attachments: FSGAC_ResearchReport_PressRelease_20220228_v3.pdf

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

NEWS RELEASE

FOR IMMEDIATE RELEASE
February 28, 2022

Contact: \~ Fairview/South Granville Action Committee
info@fsgac.org

Flawed Referral Report Pushes 1477 W Broadway Development Ahead of Broadway Plan.

The Referral Report for 1477 W Broadway (former RBC Site, Broadway & Granville) has been published and will be considered by Council on Tuesday, March 1st, 2022. The Fairview/South Granville Action Committee reviewed the Referral Report in detail and has found stunning errors, omissions, and inconsistencies. \~ These include:

1. \~ \~ \~ \~ \~ 7 times throughout the Report, City staff state that the proposed height and density align with the Broadway Plan Refined Directions, even though the Plan is not finished or approved by Council.

\~

2. \~ \~ \~ \~ \~ The developer (PCI) has applied for a Development Cost Levy waiver (saving \$3.3M) and will not have to make any financial Community Amenity Contributions.

\~

3. \~ \~ \~ \~ \~ Staff claim that no major public parks or plazas are shaded by the building however, they didn't assess shadowing at the winter solstice, the darkest time of the year. Vast portions of Fairview, False Creek & Burrard Slopes will be affected. \~

\~

4. \~ \~ \~ \~ \~ Per the Housing Vancouver Strategy, this rental building is being planned for all family types and yet, the Report provides no details on the building's amenities, access to parks, nor space in nearby schools. (Incidentally, catchment schools and other nearby schools have no capacity.)

\~

5. \~ \~ \~ \~ \~ The Referral Report is coming to Council, and if referred to a Public Hearing, this means Council will be considering yet another precedent-setting rezoning in advance of any review of the Broadway Plan.

\~

6.\~\~\~\~ This appears to be a case of bait and switch since blueprints for a 40-storey building with SkyTrain station at this address were found by Stanley Woodvine two years before the latest high-rise proposal was tabled.\~ The 5 storey “bait” would not have needed 6 floors of parking.

You can read the full, published article here: [1477 W BROADWAY REFERRAL REPORT CRITIQUE \[fsgac.org\]](#)

FAIRVIEW / SOUTH GRANVILLE ACTION COMMITTEE

NEWS RELEASE

FOR IMMEDIATE RELEASE

February 28, 2022

Contact: Fairview/South Granville
Action Committee

info@fsgac.org

Flawed Referral Report Pushes 1477 W Broadway Development Ahead of Broadway Plan.

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The Fairview/South Granville Action Committee reviewed the Referral Report in detail and has found stunning errors, omissions, and inconsistencies. These include:

1. 7 times throughout the Report, City staff state that the proposed height and density align with the Broadway Plan Refined Directions, even though the Plan is not finished or approved by Council.
2. The developer (PCI) has applied for a Development Cost Levy waiver (saving \$3.3M) and will not have to make any financial Community Amenity Contributions.
3. Staff claim that no major public parks or plazas are shaded by the building however, they didn't assess shadowing at the winter solstice, the darkest time of the year. Vast portions of Fairview, False Creek & Burrard Slopes will be affected.
4. Per the Housing Vancouver Strategy, this rental building is being planned for all family types and yet, the Report provides no details on the building's amenities, access to parks, nor space in nearby schools. (Incidentally, catchment schools and other nearby schools have no capacity.)
5. The Referral Report is coming to Council, and if referred to a Public Hearing, this means Council will be considering yet another precedent-setting rezoning in advance of any review of the Broadway Plan.
6. This appears to be a case of bait and switch since blueprints for a 40-storey building with SkyTrain station at this address were found by Stanley Woodvine two years before the latest high-rise proposal was tabled. The 5 storey "bait" would not have needed 6 floors of parking.

You can read the full, published article here: [1477 W BROADWAY REFERRAL REPORT CRITIQUE](#)

From: s.22(1)
To: "Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>
"Dominated, Lisa" <Lisa.Dominated@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
CC: "WPGRA Society" <wpgra.info@gmail.com>
Date: 4/14/2022 3:57:32 PM
Subject: [EXT] No to 39 storeys at 1477 West Broadway!

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

I am **strongly opposed** to the City approving a precedent-setting 39 storey tower with FSR of 12.16 along the Broadway corridor prior to finalization of the Broadway Plan, by use of Policy 3 which allows exceptions to leapfrog due process. I see no demonstrated need for such a tall tower when massing studies and year-round shadow studies for that area are not complete and public. The MIRHPP is not going to yield a meaningful contribution in numbers of truly affordable homes that accommodate families. I feel concerned that such a large tower will trigger massive demolitions of existing, affordable rental housing. Full, year-round shadow studies should be public prior to approval. The developer should contribute its fair share of amenity costs to the CAC, since the population inhabiting such a building will be placing additional demands on those amenities which create a good quality of life for our citizens. No to super tall towers! No to extreme precedents without due diligence!

s.22(1)



From: s.22(1)
To: "Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
"Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Dominated, Lisa" <Lisa.Dominated@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
"Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
Date: 2/28/2022 11:38:29 AM
Subject: [EXT] NO to 1477 West Broadway

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

Dear Mayor and Council,

I strongly oppose the rezoning proposed for 1477 West Broadway.

There are many crucial reasons to oppose it as indicated at the following links:

https://brianpalmquist.substack.com/p/feint-by-number-1477?utm_source=url
[brianpalmquist.substack.com]

<https://www.fsgac.org/1477-w-broadway-rezoning> [fsgac.org]

<https://www.fsgac.org/1477-referral-report-errors> [fsgac.org]

There are so many concerns and errors noted in these links that a responsible council has not choice but to vote against this egregious spot rezoning.

Sincerely,
s.22(1)
Vanoucouver, BC

From: s.22(1)
To: "Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>
"Dominated, Lisa" <Lisa.Dominated@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
CC: s.22(1)
Date: 4/14/2022 12:21:14 PM
Subject: [EXT] NO WEST BROADWAY REZONING

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

Dear Councillors,

I STRONGLY OPPOSE any rezoning along the Broadway corridor. These plans are destroying this city -- we want to reduce population density, not increase it.

We recognize that the activities that advance these plans are conducted in secrecy and undermine any confidence that citizens may have in your processes and your planning. WE IMPORE YOU TO OPEN UP AND BE TRANSPARENT with your plans and intentions.

We ask you to publicize the benefits that you are receiving that motivate you to support these agendas. Surely you cannot expect us to believe the secrecy of this planning is coincidental or accidental.

Thank you.

s.22(1)
Vancouver resident

From: s.22(1)
To: "Stewart, Kennedy"
Date: 4/20/2022 3:03:30 PM
Subject: [EXT] Office to Rent, 1477 W Broadway, V6H 1H6 - CBRE Commercial

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

The developers are ASSUMING that you will vote yes to the Development at 1477 Broadway!!

Look! This is appalling. They're already renting out space in the building before the DP is even approved.

Please Vote No!!

<https://www.cbre.ca/en/properties/search/office/details/CA-Plus-298160/1477-w-broadway-vancouver-v6h-1h6?view=isLetting> [cbre.ca]

s.22(1)

From: s.22(1)

To: "Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
"Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
"Dominated, Lisa" <Lisa.Dominated@vancouver.ca>
"Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>

Date: 2/27/2022 4:06:28 PM

Subject: [EXT] Oppose Rezoning: 1477 West Broadway

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

I Strongly Oppose the referral of CD-1 Rezoning: 1477 West Broadway to Public Hearing, on the March 1st, 2022 Council Agenda:

Sincerely

s.22(1)

~

From: s.22(1)
To: "Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
"Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
"Dominated, Lisa" <Lisa.Dominated@vancouver.ca>
"Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
Date: 4/12/2022 10:01:46 PM
Subject: [EXT] OPPOSE the CD-1 Rezoning: 1477 West Broadway

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

To Mayor and Councillors,

I am writing to **OPPOSE the CD-1 Rezoning at 1477 West Broadway.** I'm sure you agree that City Council must ensure that decisions are being made to benefit the citizens of Vancouver. However, as explained in the evidence below, this proposal does **not** benefit the citizens of Vancouver.

1. **Broadway Plan:** There are 7 times throughout the Report where **City staff state that the proposed height and density of the proposal aligns with the Broadway Plan Refined Directions, even though the Broadway Plan is not finished, nor has it been approved by Council.** This demonstrates that the City is only paying lip service to the public through the Broadway Plan consultation, thereby ignoring the input of the public, and not concerning itself with what is for the ***benefit of the citizens of Vancouver.***

2. **Sacrificing Millions of Dollars:** The developer (PCI) has applied for a **Development Cost Levy waiver (saving \$3.3M) and will not have to make any financial Community Amenity Contributions, the money used to pay for parks, childcare facilities, social housing, infrastructure, etc.** If, as the report suggests, there will be 43 MIRHPP units, that equates to a subsidy of more than \$77,000 per unit. Residents should not lose sight of the fact that this is revenue that the City will not be receiving – and will have to make this up elsewhere – meaning your property taxes. ***This does not benefit the citizens of Vancouver!***

3. \~\~\~\~\~\~ Not green: \~ Staff claims that this is a "green" building, but Brian Palmquist's recent analysis shows that \~ **the COV's Sustainability standards are, in some cases, non-existent, nor do they contemplate the full lifecycle GHG emissions of buildings, including construction and materials.** City staff remains stuck in the false narrative that bigger is better, yet tall towers such as this have been shown to have a greater negative impact on the climate than smaller buildings. The recommendation of this 39-storey building does not align with scientific and real-life evidence. Doesn't Vancouver claim to be a green City and have aspirations of continuing to do so? If so, this building cannot be part of Vancouver's future, because as a significant contributor to GHG, it **does not benefit the citizen of Vancouver!**

\~4. \~\~\~\~\~\~ Homes for Families: \~ **How much sense does it make to have family-oriented housing in a high-rise located at one of the busiest intersections in the City of Vancouver, and where the subway station will generate a very high volume of foot traffic?** \~ Has any thought been given to the possibility that this might not be the ideal location for children since, even if they want to go to Granville Park, it's 0.5km away and requires walking down busy streets and navigating through transit-related pedestrian traffic and queues? **This does not benefit the citizens of Vancouver, specifically the families that are suggested to live there.** \~

5. \~\~\~\~\~\~ Schools: \~ This rental building is being planned for all family types and yet \~ **the Report provides no details on the building's amenities, access to parks, nor space in nearby schools (catchment schools and other nearby schools have no capacity).** \~ Under the section headed "Council Authority/Previous Decisions" staff have cited the "High-Density Housing for Families with Children Guidelines" as part of the justification for this project. The guidelines stipulate that "sites selected for family housing development should be within 0.8 km walking distance of an elementary school". \~ False Creek Elementary School is 1.3km from Broadway and Granville. \~ Henry Hudson Elementary school is a distance of 1.6km. \~ **Not only are the closest schools further away than the Guidelines instruct, \~ these are both operating at full capacity!** \~ Building homes for families where there are no available neighbourhood schools for their children. **This does not benefit the citizens of Vancouver.** \~

6. \~\~\~\~\~\~ Through escalating property values, the rezoning will place immense pressure on the large number of older, affordable rentals in the neighbourhood, exacerbating our housing affordability crisis.

\~

Who does this plan benefit? The evidence shows that it certainly does not benefit the citizens of Vancouver. For these reasons, I oppose this development, and I urge you to vote against it. \~

Thank you.

s.22(1)

Resident of Fairview in Vancouver, BC

From: s.22(1)
To: "Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
Date: 2/28/2022 10:50:01 AM
Subject: [EXT] Oppose the referral of CD-1 Rezoning: 1

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

\~I feel it is obvious the height to extreme for this site, there are no the facilities to handle such densities along Broadway, eg. parks, school etc. Let's think outside the box and see what other solutions can also work.

-
-

Please Oppose the referral of CD-1 Rezoning: 1477 West Broadway to Public Hearing, on the March 1st, 2022 Council Agenda:\~

s.22(1)

A large rectangular area of the document has been redacted, appearing as a solid grey block. The redaction code 's.22(1)' is visible in the top-left corner of this area.

From: s.22(1)

To: "Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
"Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
"Dominated, Lisa" <Lisa.Dominated@vancouver.ca>
"Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>

Date: 3/1/2022 5:17:22 PM

Subject: [EXT] Oppose the referral of CD-1 Rezoning: 1477 West Broadway to Public Hearing, on the March 1st, 2022 Council Agenda:

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

I oppose the Rezoning at 1477 West Broadway.

This is a very walkable neighbourhood, with very few highrises, mostly only 3 storey walk ups. This will be a glaring structure in a very friendly neighbourhood. This will also then allow for more highrises in the neighbourhood. Meanwhile, an Interim Rezoning Policy, (effectively, a moratorium on rezonings) is suppose to be in place. Planning staff are engaging in extensive and detailed discussions with developers and moving blockbuster projects ahead seeking Council Approval.

Why are we even building a highrise, with more vacant storefronts don't we have enough.

I cannot afford to buy in Vancouver, but I can afford to rent at this time. With the addition of this building and more where will I be able to live. Our rents will skyrocket because of demand.

Where will all these extra people park, this neighbourhood is already congested enough.\~

I oppose the Rezoning of 1477 West Broadway.

s.22(1)

\~

From: s.22(1)
To: "Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
"Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
"Dominator, Lisa" <Lisa.Dominator@vancouver.ca>
"Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
Date: 2/28/2022 10:54:20 PM
Subject: [EXT] OPPOSED: City's Referral Report for 1477 W Broadway (former RBC site)

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OPPOSED to City's Referral Report for 1477 W Broadway (former RBC site)

I am OPPOSED to Council accepting/referring the City's Referral Report for 1477 W Broadway (former RBC site) for the following reasons:\~

- The Report repeatedly states the proposed height and density align with the Broadway Plan Refined Directions.\~\~That is impossible since the Broadway Plan is NOT finished NOR approved by Council.\~\~Other City Staff are still engaged in compiling public opinion regarding the Broadway Plan. \~It is not fait accomplish.
- PCI, the developer, has applied for a Development Cost Levy (DCL) waiver.\~\~If a DCL is granted Vancouver taxpayers will have to make up the \$3.3M PCI saves with its zero payment toward Community Amenity Contributions\~
- Shadowing studies included did NOT assess the shadow effects at winter solstice (the darkest time of the year).\~\~Instead, relying on shadow studies done of brighter days, the Report claims no major public parks or plazas are shaded by the building. Living downhill from the building site, the proposed 40 stories will loom large

- and shadow vast portions of Fairview, False Creek & Burrard Slopes. I will be personally affected.
- The Report provides no details on the building's amenities, access to parks, nor space in nearby schools (with no capacity). Despite these shortcomings this rental building is being planned for all family types.
- The City should have imposed a moratorium on developments while the Broadway Plan public input was going on. Instead Council has already approved an increase from 17 to 28-storeys (for [2538 Birch Street](#)) and is now considering this 40-storey tower. Both these buildings grossly over-height for the surrounding area. In addition they are set new rezoning precedents in advance of any review of the incomplete Broadway Plan.
- Rampant high rise developments have obliterated mountain views from many vantage points in the city. The visual delight of living in Vancouver, and seeing our mountains, is rapidly disappearing for all but a few.

I strenuously oppose the construction of the proposed 40-storey tower at Broadway and Granville on the old RBC site above the new Skytrain station.

s.22(1)

Fairview resident

Sent from my iPhone

From: "Coalition of Vancouver Neighbourhoods \\\(CVN\\)" <info@coalitionvan.org>
To: "Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
"Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Dominated, Lisa" <Lisa.Dominated@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
"Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
CC: "Mochrie, Paul" <Paul.Mochrie@vancouver.ca>
"Correspondence Group, City Clerk's Office" <ccclerk@vancouver.ca>
Date: 4/14/2022 8:38:26 AM
Subject: [EXT] Opposed "4. CD-1 Rezoning: 1477 West Broadway" (Public Hearing 14-Apr-2022)
Attachments: CVN Letter - 2022-03-14 public hearing 1477 Broadway - Granville-V2.pdf

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

City of Vancouver Council
Dear Mayor Kennedy Stewart and Councillors,
Re: Public Hearing 1477 W. Broadway at Granville St.
Agenda: <https://council.vancouver.ca/20220414/phea20220414ag.htm>
Report: <https://council.vancouver.ca/20220301/documents/rr5.pdf>

The Coalition of Vancouver Neighbourhoods (CVN) is opposed to this proposal since it is far too large for the area, has had a flawed process that is brought forward prematurely. The local community's concerns have not been addressed. Not only is the project far too large in scale for both height and density, but there has also been an enormous breach of process to get to this point.

City staff state that the proposed height of 40 storeys and density of 12.3 FSR aligns with the Broadway Plan, even though Council has not approved the Plan yet. This sets a huge precedent for the whole Broadway Corridor. There is no rationale why this project should be considered for approval now when the Broadway Plan is proposed to go to Council next

month.

Staff are recommending \$3.3M in development fees be waived. If you accept that, this project will increase demand for infrastructure and amenities, and you will instead force those costs to be subsidized by public funding through property taxes and capital debt financing. If you approve this project you will be setting a precedent for 40 storeys at other stations, resulting in large scale growth despite having no plans for funding for more schools, among many other growth related needs.

You must not ignore the many other issues involved in setting a precedent for this development in the Broadway corridor, such as massive shadowing, embodied carbon, as well as land value inflation that will lead to the loss of affordable rentals throughout the area. Please do not approve this proposal. See more here:

[https://urldefense.com/v3/__https://www.fsgac.org/1477-w-broadway-rezoning__;!!G4oVokrRG-Im!](https://urldefense.com/v3/__https://www.fsgac.org/1477-w-broadway-rezoning__;!!G4oVokrRG-Im!47sYr9ebVzgqDsJEoAgJbTQTMGmqBkLoEwRIWmySNavMIPKDqaw2E4S3Gr16uafys9dBafLhpQ$)

[47sYr9ebVzgqDsJEoAgJbTQTMGmqBkLoEwRIWmySNavMIPKDqaw2E4S3Gr16uafys9dBafLhpQ\\$](https://urldefense.com/v3/__https://www.fsgac.org/1477-w-broadway-rezoning__;!!G4oVokrRG-Im!47sYr9ebVzgqDsJEoAgJbTQTMGmqBkLoEwRIWmySNavMIPKDqaw2E4S3Gr16uafys9dBafLhpQ$)

Steering Committee,
Coalition of Vancouver Neighbourhoods

Member Groups of the Coalition of Vancouver Neighbourhoods

Arbutus Ridge Community Association
Arbutus Ridge/ Kerrisdale/ Shaughnessy Visions
Cedar Cottage Area Neighbours
Dunbar Residents Association
Fairview/South Granville Action Committee
False Creek Residents Association
Grandview Woodland Area Council
Granville-Burrard Residents & Business Assoc.
Greater Yaletown Community Association
Kitsilano-Arbutus Residents Association
Kits Point Residents Association
Marpole Residents Coalition
NW Point Grey Home Owners Association
Oakridge Langara Area Residents
Residents Association Mount Pleasant
Riley Park/South Cambie Visions
Shaughnessy Heights Property Owners Assoc.
Strathcona Residents Association
Upper Kitsilano Residents Association
West End Neighbours Society

West Kitsilano Residents Association
West Point Grey Residents Association
West Southland Residents Association

--

[https://urldefense.com/v3/__http://www.coalitionvan.org__;!!G4oVokrRG-Im!
47sYr9ebVzggDsJEoAgJbTQTMGmqBkLoEwRIWmySNavMIPKDqaw2E4S3Gr16uafy
s9ezd0QFOg\\$](https://urldefense.com/v3/__http://www.coalitionvan.org__;!!G4oVokrRG-Im!47sYr9ebVzggDsJEoAgJbTQTMGmqBkLoEwRIWmySNavMIPKDqaw2E4S3Gr16uafys9ezd0QFOg$)



COALITION OF VANCOUVER NEIGHBOURHOODS

<http://coalitionvan.org>

April 14, 2022

City of Vancouver Council

Dear Mayor Kennedy Stewart and Councillors,

Re: Public Hearing 1477 W. Broadway at Granville St.

Agenda: <https://council.vancouver.ca/20220414/phea20220414ag.htm>

Report: <https://council.vancouver.ca/20220301/documents/rr5.pdf>

The Coalition of Vancouver Neighbourhoods (CVN) is **opposed** to this proposal since it is far too large for the area, has had a flawed process that is brought forward prematurely. The local community's concerns have not been addressed. Not only is the project far too large in scale for both height and density, but there has also been an enormous breach of process to get to this point.

City staff state that the proposed height of 40 storeys and density of 12.3 FSR aligns with the Broadway Plan, even though Council has not approved the Plan yet. This sets a huge precedent for the whole Broadway Corridor. There is no rationale why this project should be considered for approval now when the Broadway Plan is proposed to go to Council next month.

Staff are recommending \$3.3M in development fees be waived. If you accept that, this project will increase demand for infrastructure and amenities, and you will instead force those costs to be subsidized by public funding through property taxes and capital debt financing. If you approve this project you will be setting a precedent for 40 storeys at other stations, resulting in large scale growth despite having no plans for funding for more schools, among many other growth related needs.

You must not ignore the many other issues involved in setting a precedent for this development in the Broadway corridor, such as massive shadowing, embodied carbon, as well as land value inflation that will lead to the loss of affordable rentals throughout the area. **Please do not approve this proposal.** See more here: <https://www.fsgac.org/1477-w-broadway-rezoning>

Steering Committee,

Coalition of Vancouver Neighbourhoods

Member Groups of the Coalition of Vancouver Neighbourhoods

Arbutus Ridge Community Association

Arbutus Ridge/ Kerrisdale/ Shaughnessy

Visions

Cedar Cottage Area Neighbours

Dunbar Residents Association

Fairview/South Granville Action Committee

False Creek Residents Association

Grandview Woodland Area Council

Granville-Burrard Residents & Business

Assoc.

Greater Yaletown Community Association

Kitsilano-Arbutus Residents Association

Kits Point Residents Association

Marpole Residents Coalition

NW Point Grey Home Owners Association

Oakridge Langara Area Residents

Residents Association Mount Pleasant

Riley Park/South Cambie Visions

Shaughnessy Heights Property Owners
Assoc.

Strathcona Residents Association

Upper Kitsilano Residents Association

West End Neighbours Society

West Kitsilano Residents Association

West Point Grey Residents Association

West Southland Residents Association

City of Vancouver - FOI 2022-226 - Page 104 of 396

From: s.22(1)
To: "Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
"Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
"Dominated, Lisa" <Lisa.Dominated@vancouver.ca>
"Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
Date: 2/27/2022 4:21:30 PM
Subject: [EXT] Opposed - CD-1 Rezoning 1477 W Broadway

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

Please reconsider the rezoning of 1477 Broadway. The additional height proposed jeopardizes one of Vancouver's greatest natural attributes (i.e. the views of the North Shore mountains), negatively impacts its immediate surroundings (e.g. shadow cast), does not add or contribute a reasonable amount of public amenities (i.e. waiver of CACs), does not add the type of affordable housing required for a diverse community (e.g. family units) and is in complete contrast with the current character of the neighbourhood.\~\~

Most important, from a legal standpoint, the COV has failed to provide the public with a meaningful opportunity to provide feedback. The process has been flawed for several reasons but most notably a lack of information (documented), a lack of reach (documented), skewed language suggesting a predetermined result (documented) and poor survey design (documented).

For the record, I am opposed to the rezoning of 1477 W Broadway and will be seeking intervention from the Courts for a lack of due process by the COV. Affordability and density are both desirable outcomes to any proposed development but neither outweigh the importance of meaningful community involvement and the COV has blatantly disregarded their obligation in this instance. Thanks\~for your consideration.

s.22(1)

From: s.22(1)
To: "Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
Date: 4/14/2022 2:39:17 PM
Subject: [EXT] OPPOSED to 1477 W. Broadway @ Granville rezoning

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

Dear Mayor Stewart:

I am opposed to the proposed rezoning at the above-referenced address that would permit the construction of a 40-odd storey building there.~ Towers such as the one proposed are the most carbon-intensive to build.~ Moreover, studies have shown that the taller a building is, the less energy efficient it is to operate over its life cycle.~\~

The City of Vancouver has an opportunity to become a world leader in facilitating environmentally responsible, livable development by prioritizing the creation of new green spaces and protecting and enhancing existing ones to maximize carbon sequestration, facilitating the development of low-rise buildings with a significantly lower embedded carbon footprint, and prohibiting the gratuitous development of high-rise towers such as this one.~\~At a time when vast swaths of the province are literally burning for several months over the course of the summer, and people are actually dying in Vancouver due to climate change-related heat waves, it strikes me as environmentally reckless that Council would even consider approving this proposed rezoning, particularly given that the entire corridor of West Broadway has already been ear-marked for massive development as part of the city's Broadway Plan.

In the interests of people who live in and love this city, please vote NO to this proposed rezoning.

Sent from my iPhone

From: s.22(1)
To: "Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>
"Dominated, Lisa" <Lisa.Dominated@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
CC: s.22(1)
Date: 4/14/2022 3:20:51 PM
Subject: [EXT] OPPOSED to 1477 West Broadway @ Granville rezoning

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

Dear Mayor and Councillors,

I am opposed to the proposed rezoning at the above-referenced address that would permit a 40-odd storey building there.\~

1) Let us decide upon the Broadway Plan before City Council embarks on spot-zoning this particular building site. One step at a time, and first steps first.

2) Towers such as the one proposed are the most carbon-intensive to build and energy inefficient to operate over their life cycle. Forget about the slogan "Vancouver - the greenest City" if we start building towers like this everywhere. Where is your concern about the climate emergency?

3) Rezoning this tower and all the other towers that might be permitted if the Broadway Plan is approved will result in some so-called affordable units that are not family-friendly and lots of units for well-off people. I favour gradual low- to mid-rise densification that has a much higher chance of being family-friendly and truly affordable (especially if the construction costs are lower by using mass timber construction).\~

4) I am opposed to the sprawl of downtown onto the westside. I don't want our city to become a vast concrete canyon. I am opposed to the vision for Vancouver, where we all have to live in and amidst these gigantic towers. I do not share the vision of Towers Everywhere! Why would anyone want to live in these high-rise towers?\~

Permitting rezoning this site at 1477 West Broadway & Granville would start your vision of Towers Everywhere! I oppose that vision. In the interests of people who live in and love this city, please vote NO to this proposed rezoning.

Thank you,

s.22(1)

From: s.22(1)

To: "Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>
"Dominated, Lisa" <Lisa.Dominated@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>

Date: 4/14/2022 8:37:24 AM

Subject: [EXT] Opposed to proposed 40-storey tower at Granville & Broadway

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

Dear Mayor Kennedy and members of the Vancouver City Council,

I want to voice the strongest possible opposition to the proposed 40-storey tower at Broadway and Granville.

I am a long-time resident of Vancouver and homeowner in Pt. Grey and I believe huge towers like this, and the precedent it will set for the Broadway corridor, will destroy much of what we have come to love about our city. 40 storeys is radically out of scale with all existing development in the area. It will completely change - and depersonalize - the feel of the upper-Granville area. It is way too much way too soon.

Yours sincerely,

s.22(1)

Vancouver, BC V6R 2A9

From: s.22(1)

To: "Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>
"Dominated, Lisa" <Lisa.Dominated@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>

Date: 4/14/2022 11:38:05 AM

Subject: [EXT] Opposed to proposed rezoning of 1477 West Broadway as 40 storey tower etc.

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

Dear Mayor Stewart and Councillors,

I support improving housing opportunities for lower income people, but Council, you seem determined to destroy piecemeal everything that is nicest about Vancouver. I voted for most of you in 2018 and also supported many financially, but I will consider very carefully before supporting any of you again.

For most of the year we have little sunlight ... and we have lost so many of our views over the last 50 years ... do you really want Vancouver to lose what made it such a wonderful place to live?

You will accelerate loss of older reasonably scaled buildings, just as your predecessors allowed in Kerrisdale (when I fought that as hard as I could in 1989-1991 as a local MLA). You look like you wish to be remembered as the people who helped finish off Vancouver's livability.

I think you need to slow things down a little. The pace of development exceeds the ability of citizens to remain engaged, and the loss of faith in democracy so prevalent elsewhere is spreading here. Developers are taking advantage of Covid19 which has virtually strangled any public engagement. Sane people are still worried about it, plus potential of a nuclear war arising from Ukraine.

You are still encouraging “more growth” including population growth and now another Olympics!

What is the matter with you? I am beginning to give up hope that democratically elected representatives still listen to their constituents. Are you also going to allow 38 story towers at Jericho, as the City plans from last fall show? Is more money for people who are already exceedingly wealthy really what drives Council, despite all the campaigning that you were going to be on the side of the “little people”???

s.22(1)



From: s.22(1)
To: "Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
"Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
"Dominated, Lisa" <Lisa.Dominated@vancouver.ca>
"Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
Date: 4/19/2022 12:24:31 PM
Subject: [EXT] OPPOSING the CD-1 Rezoning: 1477 West Broadway

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

Dear Counselors:

I am a concerned owner s.22(1) the proposed 1477 W Broadway. I strongly oppose the rezoning that will allow the construction of this building.\~

Its height (39 storeys) is totally unacceptable in an earthquake prone area.\~
Besides it will:\~

1. cast a long shadow
2. cut the north mountains view for many residents\~
3. be an eyesore in the neighborhood
4. open a\~precedent leading to more high rises approval in the future
5. not contribute to solving the existing housing crisis since it will be expensive to build (concrete and steel are more expensive than wood) and only a small percentage of its units will be available to low and medium income buyers /renters\~\~
6. be less efficient (using almost twice as much energy per square metre as a mid-rise) and less sustainable (BC Hydro has shown that steel and concrete produce ten times more greenhouse gases than wood)
7. be isolating and dehumanizing for people since its height will decrease people's participation in public spaces and contacts with other neighbors, thus\~increasing the level of alienation and isolation especially of children and seniors
8. contribute to gentrification and inequality since it will\~inflate the price of adjacent land and offer mostly\~luxury units eventually\~leading to the displacement of the

8. area's previous occupants
9. go against the goals of the Greenest City and the Climate Emergency Plans approved and under implementation by the City.

Please do not approve this rezoning!

Sincerely,

s.22(1)

~

From: s.22(1)
To: "Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
"Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
"Dominated, Lisa" <Lisa.Dominated@vancouver.ca>
"Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
Date: 4/17/2022 2:59:31 PM
Subject: [EXT] Opposition - CD-1 Rezoning: 1477 West Broadway

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

As a resident of s.22(1), I am writing to oppose the rezoning of 1477 West Broadway. I know that this matter is still being discussed in Council so I wish to have my opposition recorded.

- 1) The Broadway plan is not yet approved and yet high-rise properties are being approved in this area.
- 2) There is no definitive plan yet for services and amenities in this area, given the increase in residents that will occur with such a building being permitted. Since I moved into this area, services such as bakeries and independent grocery shops have been pushed out due to high rents - so how is it anticipated that there will be services provided for the increased number of residents?
- 3) It is argued that lower rise buildings are more environmentally sustainable
- 4) The City of Vancouver talks about the value of community but it is very hard to develop a community in a tower of 35-40 stories.
- 5) There are lots of other areas along the Broadway corridor that could take medium rise buildings that would mean there would not have to be such density in one area.
- 6) when I asked a staff member recently at an open house what kind of services and amenities would be in the building, they were unable to define it other than say "commercial space". Is this going to be the same commercial space that comes and goes on South Granville (fashion stores, restaurants and galleries) because of the high rents?

s.22(1) I have many friends who cannot afford to buy and their rents are increasing to an almost unaffordable level. We need more affordable accommodation (and different types of accommodation) rather than pandering to the developers.

I am very much against this rezoning until a full plan has been discussed in more detail.

Thank you
s.22(1)

s.22(1)



Vancouver, BC, Canada

Traditional territory of the Musqueam, Squamish and the Tsleil-Waututh people.

From: s.22(1)
To: "Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
"Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
"Dominated, Lisa" <Lisa.Dominated@vancouver.ca>
"Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
Date: 4/18/2022 10:52:52 PM
Subject: [EXT] Opposition of rezoning of 1477 Broadway

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

I OPPOSE the rezoning of 1477 West Broadway.

~

I've lived in the Granville Broadway s.22(1), it's walkable and livable. The new Broadway corridor build is already putting undue stress on parking, sidewalks, and access to retail. I'm very afraid that the 39-storey tower at 1477 Broadway, will make it impossible to stay here any longer. This building and plans for ones in the future will give landlords the incentive for demolition and renovation of numerous low rises to then make way for more of these towers along the Broadway Corridor.

This building will increase density, but it won't get people into their cars, those people in their upmarket condos won't be taking the train.

Do the people in favor of the rezoning of 1477 Broadway, actually live here? Or are they just happy it's not happening in their backyards. 20% of affordable rental stock that has been promised is not enough to even begin fixing the housing crisis. Rent in this area is already more than 2100 for a 1 bedroom, I know those units being built won't be anywhere near that price range. So how is that affordable?

How is this even almost approved when we are still waiting on the Broadway plan approval or am I missing something, have you already approved that too?

If I wanted to live downtown, I'd move there but it's not affordable, much like this area won't be if this tower at 1477 Broadway is approved.

I insist you scale back the rezoning of 1477 West Broadway to the original height of 10-storeys.

s.22(1)

From: s.22(1)
To: "Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Dominated, Lisa" <Lisa.Dominated@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
"Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
"Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
Date: 4/16/2022 12:09:44 PM
Subject: [EXT] Opposition to 40 story buildings in kitsilano

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

Mayor and Council.

This is to register my opposition to the proposed 40-story building proposed for Granville and Broadway.

s.22(1)

From: s.22(1)
To: "De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
"Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
"Dominated, Lisa" <Lisa.Dominated@vancouver.ca>
"Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
"Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
CC: "Fairview/South Granville Action Committee" <info@fsgac.org>
Date: 2/27/2022 4:36:46 PM
Subject: [EXT] Opposition to 1477 West Broadway rezoning

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

TO: Mayor and Vancouver City Council members

FROM: s.22(1)
s.22(1) Vancouver

DATE: February 27, 2022

RE: Opposition to referral of CD-1 Rezoning: 1477 West Broadway
Public Hearing March 1

CC: Fairview/South Granville Action Committee

I've been writing for more than two years to express my concern with errors, omissions, and failure of City staff to fully and fairly address the concerns of neighbourhood residents and citizens of Vancouver regarding the West Broadway subway extension and proposed apartment building expansions.

I've just review a summary report by the Fairview/South Granville Action Committee, and thank them for, yet again, drawing our attention to the myriad to mistakes and oversights by City planning.

The response of City planning and some City council members continues to be disheartening. Neighbourhood voice is not heard, only given lip service at best.

I felt optimistic when previous opposition to building a downtown casino was heard. Then, the opposite happened—a casino was built, and a myriad of downtown high rise buildings effectively destroyed the full view of BC place. Great cities like Paris don't engulf the special beauty and historical relevance with construction that distracts and obscures a city's beauty.

If a 39-story building is erected on the site of 1477 West Broadway, it will not stand as a mindful and meaningfully placed edifice to make Vancouver a great city. Instead, it will look like someone made a mistake, and no one stopped them.

s.22(1)



From: s.22(1)
To: "Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
"Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
"Dominated, Lisa" <Lisa.Dominated@vancouver.ca>
"Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
Date: 4/3/2022 10:06:02 AM
Subject: [EXT] Opposition to CD-1 Rezoning at 1477 West Broadway

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

I live in Vancouver and I oppose the CD-1 Rezoning at 1477 West Broadway.

The density of the city now, and this area in particular, is overwhelming, and whilst I appreciate the need for more housing, this is not the answer.\~ The air pollution will be horrifying in this area and very unhealthy.\~ This is a very nice neighbourhood; liked by many now and many more to come.\~ Other people should be able to enjoy it, but if you overload it, which the plan will do, the entire living\~conditions will be spoiled.\~\~

I also question whether or not the Council has given serious thought and planning to what else will be needed when increasing the population in an area like Broadway to the extent suggested.\~ Already, we are finding it difficult to find a doctor -- there just aren't enough; and hospitable space is already almost impossible to find; water, sewage, electricity will also be overwhelmed; and traffic will make life intolerable with so many more people driving on the road in one area -- so congested as well as making the air extremely unhealthy.

Please do consider this very carefully and do not pass the CD-q Rezoning at 1477 West Broadway; the area simply cannot take it and remain a good place to live for all.

Sincerely,

s.22(1)

V6H 4G5

s.22(1)

"Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
"Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
"Dominated, Lisa" <Lisa.Dominated@vancouver.ca>
"Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>

4/10/2022 2:09:20 PM

[EXT] Opposition to CD-1 Rezoning at 1477 West Broadway

Letter 1477 West Broadway.pdf

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

Dear Mayor Stewart and Councilors:

~|~|~| I have attached a letter to express my opposition to the CD-1 Rezoning at 1477 West Broadway.~ I appreciate your attention to my concerns.~ Thank you.

~ ~ ~ ~ ~ s.22(1)

April 10, 2022

Dear Mayor and City Council:

I live in Fairview s.22(1). I am writing to ask you to vote **NO** to the CD-1 rezoning application at 1477 West Broadway. My reasons for this request are as follow:

- ➔ I feel it isn't right that this vote is to take place before the proposed Broadway Plan is presented to Council on May 18, 2022. Approval of this project would ensure this huge building will be built regardless of the outcome of the Broadway Plan vote while at the same time priming the mindset for a yes vote to the Broadway Plan – e.g. oh well, we've already started with the 40 story buildings, so why not continue on? Why not demonstrate that you are transparent and genuine by waiting until after the decision regarding the Broadway Plan is actually made?
- ➔ Vancouver touts itself as wanting to be a groundbreaking Green City in this century and beyond. Many studies are concluding that high-rise aren't the way to go to reach that goal.
 - 2019 BC Hydro report says high rises use 4X the energy per unit than low-rise, even with improvements in energy efficiency.
 - USA and European studies show that the lifecycle CO2 emissions are lower for low-rise than high-rise with the same areas and density.
 - Vancouver's Net Zero Plan says low-rise is best for energy efficiency.
 - A Vancouver study by RDH states that high-rise energy use increased over 30 years despite supposed improvements in energy efficiency.We are all very concerned about climate change and the effect it will have on future generations. We expect our elected officials to be constantly mindful of how their decisions fit into a concerted effort to move towards net zero.

I feel so very disappointed in the lack of vision that the City of Vancouver is exhibiting in the wholesale high-rising along the Broadway corridor. The truly great cities of the world are innovative in their approach to densifying and steadfastly committed to fighting climate change and decreasing their carbon emissions. Vancouver is turning into a city of nothing but tall glass rectangles with no real style or character. This approach to densification hasn't alleviated the affordable housing crisis we are experiencing, and indeed seem to exacerbate it by driving up average rental rates in various neighbourhoods around the city.

I will be writing further regarding the proposed Broadway Plan, but for now, I ask that you vote No to the CD-1 rezoning application at 1477 West Broadway.
Thank you.

s.22(1)

From: s.22(1)
To: "Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Dominated, Lisa" <Lisa.Dominated@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
"Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
"Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
Date: 4/5/2022 9:06:36 PM
Subject: [EXT] Opposition to the CD-1 Rezoning: 1477 West Broadway

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

Good evening, I am writing to let you know as s.22(1) Vancouver resident, living in Fairview I am in opposition of the CD-1 Rezoning: 1477 West Broadway.\~

As a Vancouver resident in the Fairview neighbourhood I am opposed to the CD-1 Rezoning: 1477 West Broadway.\~

--
Cheers,

s.22(1)

From:

s.22(1)

To:

"Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>

Date:

4/6/2022 4:54:31 PM

Subject:

[EXT] Opposition to the CD-1 Rezoning Application at 1477 W. Broadway

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

April 6, 2022

\~

Dear Mayor and City Council:

\~

As a resident of Fairview Slopes, I am writing to you, the Mayor and the City Councillors of Vancouver, to vote "NO" to the CD-1 rezoning application at 1477 West Broadway.\~

I am opposed to this rezoning for the following reasons:

. \~\~\~\~\~\~\~\~\~\~ The height of this building at 40 storeys is far too high and it is not environmentally sustainable or healthy. Clearly this massive high-rise contradicts the City's objectives to improve energy efficiency and reducing greenhouse gases (GHGs) as\~\~\~\~\~\~\~\~ part of their Climate Plan.

\~. \~\~\~\~\~\~\~\~\~\~ The City says the height and density of this building is in line with the Broadway Plan but the plan hasn't even been approved yet.\~ Therefore, 1477 W. Broadway is pre-empting the Broadway Plan.

\~. \~\~\~\~\~\~\~\~\~\~ There needs to be greater scrutiny of the MIRHPP program. The details of the plan favour the developer.

\~. \~\~\~\~\~\~\~\~\~\~ The developer CPI has applied for a Development Cost Levy waiver that could equate to a subsidy of \$77,733 per unit. That \$3.3 million in funds would still be needed by the city and would likely be collected through property taxes.

\~. \~\~\~\~\~\~\~\~\~\~ There is no planning or budget to build new schools and parks. We currently don't even have enough school spaces for the current populations of these areas.

\~□□ □□ □□ □□ □□ □□ □ The proposed rezoning will drastically affect the livability and quality of life for residents.

\~□□ □□ □□ □□ □□ □□ □□ □ These large developments have been done in Vancouver in the past and has let to a lack of \~\~\~affordable housing, increased homelessness, and enriched developers.

I understand the need for increased supply of affordable housing and rental units, but this type of rezoning will not help and will continue to contribute to the ongoing problems Vancouver has.

\~

Yours Sincerely,

s.22(1)



\~

From: s.22(1)

To: "Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Dominato, Lisa" <Lisa.Dominato@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
"Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
"Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>

Date: 2/27/2022 8:02:36 PM

Subject: [EXT] Opposition to the Referral Report Published for 1477 W Broadway
(RBC Site)

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

Dear all,

I have some serious concerns with the referral report. \~

- 7 times throughout the Report, \~City staff state that the proposed height and density of the proposal aligns with the Broadway Plan Refined Directions, even though the Broadway Plan is not finished, nor has it been approved by Council. \~
- The developer (PCI) has \~applied for a Development Cost Levy waiver (saving \$3.3M) and will not have to make any financial Community Amenity Contributions. \~
- Staff claim that no major public parks or plazas are shaded by the building however, \~they didn't assess shadowing at the winter solstice, the darkest time of the year. \~
- Per the Housing Vancouver Strategy, \~this rental building is being planned for all family types and yet, the Report provides no details on the building's amenities, access to parks, nor space in nearby schools. \~(Incidentally, \~catchment schools and other nearby schools have no capacity.) \~

Please DO NOT approve a height like this and take the above issues into consideration!

Thank you,

s.22(1)

Fairview resident \~

From: s.22(1)
To: "Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>
"Dominato, Lisa" <Lisa.Dominato@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
Date: 4/14/2022 12:32:30 PM
Subject: [EXT] PLEASE, STOP the towers

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

Hello. I'm writing again to express my opposition to the City's plan to construct enormous towers along Broadway as part of its Broadway corridor plan. Perhaps you will say that you are not actually constructing the towers, someone else is, but the truth is that you have the authority to determine what contractors can do.

Tower of that height destroy a city. They block the sun. They block the sky. They cast enormous shadows. They block the view that gives joy to so many people in this city. They are inhuman in scale; in recent decades, researchers have found that high rise towers contribute to loneliness. People do not know their neighbours. The building is frequently designed so you can't move easily between floors (i.e. you need a pass). They contribute to a lack of fitness: many of us will walk up 3 or 4 or 5 flights of stairs, but not 10, 20, 30 or 40. s.22(1) died of a heart attack when he decided to walk down 12 stories to get to a medical appointment. The elevator in his building had been out of commission for 2 days. It was a long weekend, they couldn't get service people in. So this man, s.22(1) set out to walk down the stairs so that he could get to a doctor. He didn't make it.

PLEASE: look at models of cities which are successful. We definitely need more housing, but fancy high rises are not going to meet the need.~ Let us line our streets with human scale 4-5 story buildings, which do not block the sun or sky, and allow people a change to know and mingle with their neighbours.

I feel that our beautiful city is being run by people who are more interested in relationships with developers than in stewarding a healthy and vibrant city.~ I hope you will prove me wrong, and put an end to 40 story towers. Thank you.

s.22(1)

From: s.22(1)
To: "Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
"Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
"Dominator, Lisa" <Lisa.Dominator@vancouver.ca>
"Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
Date: 2/27/2022 10:06:25 AM
Subject: [EXT] Please consider this

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

Dear Council,
Please don't act too quickly.

The Referral Report for 1477 W Broadway (RBC site) has been published and will be considered by Council on Tuesday, March 1st, 2022.

\~

We have reviewed the Referral Report in detail and have found **\~stunning errors, omissions and inconsistencies which speak to staff's apparent confidence that this rezoning is a fait accompli. Following are some of the highlights, and you can read our full critique here ([click here \[shoutout.wix.com\]](https://shoutout.wix.com/))**

\~

- 7 times throughout the Report, **\~City staff state that the proposed height and density of the proposal aligns with the Broadway Plan Refined Directions, even though the Broadway Plan is not finished, nor has it been approved by Council.\~**
- The developer (PCI) has **\~applied for a Development Cost Levy waiver (saving \$3.3M) and will not have to make any financial Community Amenity Contributions.\~**
- Staff claim that no major public parks or plazas are shaded by the building however, **\~they didn't assess shadowing at the winter solstice, the darkest time of the year.\~**
- Per the Housing Vancouver Strategy, **\~this rental building is being planned for all family types and yet, the Report provides no details on the building's amenities, access to parks, nor space in nearby schools.\~(Incidentally, \~catchment schools and other nearby schools have no capacity.)\~\~**

s.22(1)

s.22(1)

Vancouver

From: s.22(1)
To: "Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
Date: 4/5/2022 6:16:17 PM
Subject: [EXT] Please Oppose CD-1 Rezoning: 1477 West Broadway
Attachments: 1477 W Broadway.pdf

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April 5, 2022

Mayor Kennedy Stewart
3rd Floor, City Hall
453 West 12th Avenue,
Vancouver, BC V5Y 1V4

Dear Mayor Stewart,

I am writing to you and city council as a resident in the Fairview Slopes area of Vancouver to ask you and council to vote NO to the CD-1 rezoning application at 1477 West Broadway.

I am opposed to the rezoning for the following reasons:

- The building height is far too high and it's not environmentally sustainable or healthy. It is not a green building even though it's being marketed that way.
- There is no planning or budget to build new schools and parks. We don't have enough school spots for the current populations of these areas as it is.
- The proposed rezoning will drastically affect the beauty, light and serenity of the existing Granville and False Creek neighbourhoods and the livability and quality of life for residents.
- Shadow studies are incomplete.
- There needs to be greater scrutiny of the MIRHPP program. The details of the plan favour the developer.
- The developer CPI has applied for a Development Cost Levy waiver that could equate to a subsidy of \$77,733 per unit. That \$3.3 million in funds would still be needed by the city and would likely be collected through property taxes.
- These large developments have been done in Vancouver and has led to a lack of affordable housing, increased homelessness, and enriched developers.

I understand the need for increased development and affordable housing and rental buildings, but this type of rezoning will not help and will continue to contribute to the ongoing problems Vancouver has.

Sincerely,

s.22(1)

Cc: Councillors R. Bligh, C. Boyle, A. Carr, M. De Genova, L. Dominato, P. Fry, C. Hardwick, S. Kirby-Yung, J. Swanson, M. Wiebe

From: s.22(1)
To: "Stewart, Kennedy"
Date: 4/20/2022 12:11:07 PM
Subject: [EXT] Please please vote no to the rezoning proposal for 1477 West Broadway!

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

I didn't sign up to speak at the hearing. I wasn't able to make the date(s), but I urge you to vote **NO** on the~

CD-1 Rezoning: 1477 West Broadway.

Let's work together to develop a beautiful and low-rise city where we can see the mountains and where housing is ground-oriented. Vancouver does not need towers to thrive. The only benefactors of tower-development are the developers and investors. Please vote no! Thank you.

s.22(1)

From: s.22(1)
To: "Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
Date: 4/14/2022 1:57:52 PM
Subject: [EXT] Please vote No to building high rises along Broadway corridor

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

Dear His Worship Kennedy Stewart,\~

I am writing about the plans for a high rise on the corner of Broadway and Granville, and moving east along Broadway, the proposal for many high rises along the Broadway corridor. \~

We were told approval of the Broadway train would decrease congestion. Now it is being used as a rationale for massive density.\~

s.22(1) in Vancouver, grew up in this area and still live here. s.22(1) I have never seen a more beautiful city in my travels. We have an obligation to preserve the quality of living in Vancouver for the future.\~ There would be no coming back from building gigantic high rises along Broadway. It will forever change the character of this special place.\~

Cities like Copenhagen and many others considered some of the best in design do not have huge highrises lining their streets, one block on either side from residential neighbourhoods.\~

Vancouver prides itself on being "green". BC Hydro reports high rises use four times more energy than low rises despite improvements in energy efficiency.\~

There are wait lists for schools in this area and no plans to address even the current problem.\~

Please consider quality of living for our special City.

There is already high density in this area.\~

Best,

s.22(1)

From: s.22(1)
To: "Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>
"Dominated, Lisa" <Lisa.Dominated@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
Date: 4/14/2022 2:56:54 PM
Subject: [EXT] Please vote OPPOSED to 1477 West Broadway at Granville rezoning

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

Downtown is for tall buildings.\~ Build as many as you like there. Go as high as you want.\~

Don't ruin the rest of the city.\~\~

From: s.22(1)
To: "Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
"Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
"Dominated, Lisa" <Lisa.Dominated@vancouver.ca>
"Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
Date: 4/10/2022 6:53:36 PM
Subject: [EXT] Please! -- OPPOSE the CD-1 Rezoning: 1477 West Broadway

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

To Mayor Stewart and all members of Vancouver City Council,

I live in Fairview Slopes and am seriously concerned about the CD-1 rezoning application at 1477 West Broadway. Please, vote "NO". I have stated some of my reasons for this request below. Thank you for reading them.

The staff report to you sounds to me as if\~staff are\~making policy; their language in the report sound as if the Broadway Plan rezoning is a done-deal. For instance, they state -- seven (7) times! -- \~that the application's proposed height & density align with the Broadway Plan. However, the Broadway Plan has not yet been finished or approved by Council.\~ Is the consultation process merely lip service?

Regarding the MIRHPP program. The details of the plan as stated favour the developer. For instance, the developer has applied for a waiver of the Development Cost Levy that would equal a subsidy of \$77,733 per unit, and that adds up to \$3.3 million that the City would still need to find somewhere. Such as property taxes, perhaps? What about building new schools and parks? At the moment there are not even enough school spaces for the existing residents of these areas.

The staff report claims that no major public parks or plazas are shaded by

the building, but their assessment took place only during the spring and summer months. What about winter when sundown occurs about 4 pm each day? What are the implications then for nearby parks and popular public areas?

There is no provision for additional parking, beyond the 285 vehicles spaces allocated for 223 homes and 6-storeys of commercial space.~ Where will people ~park in this already vehicle-challenged neighbourhood?

A large spot zoning like this will increase property values -- and hence property taxes -- of the fairly affordable rental buildings in the area. Will BC Assessment look to 1477 W Broadway as the "best use" to assess surrounding land values? If the existing rental buildings a few blocks away appreciate and property taxes go up, will not rents increase as landlords seek to recoup their additional cost?~The rents will quickly become affordable to many of the working and retired people in that area -- and many of the rest of us.

Even more, will landowners start to think about selling or rezoning their older rental buildings? When this happens, residents will be displaced, as has happened so often in other places. Statistics show that when existing, affordable rental buildings are replaced by huge, concrete towers, the previous tenants are unable to afford homes in the new building.

And what about the environment? At 40 storeys, building is not environmentally sustainable or healthy. Clearly this massive high-rise contradicts the City's objectives to improve energy efficiency and reduce greenhouse gases (GHGs) as part of their Climate Plan.

Finally, the Broadway/Granville intersection is one of the busiest in the City. To me it does not make sense to put family-oriented housing in such a densely populated high-rise as the developer has proposed.

We Vancouverites desperately need a lot more~affordable housing and rental units. Unfortunately, rezoning and developments of this sort will not lead us to an equitable solution. It will just~exacerbate our current~problems.

Sincerely yours,

s.22(1)

s.22(1)

Vancouver, BC V5Z 1C9

Stay safe. Stay well. Be kind.

s.22(1)

From: s.22(1)
To: "Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
"Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
"Dominated, Lisa" <Lisa.Dominated@vancouver.ca>
"Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
Date: 4/5/2022 11:25:15 PM
Subject: [EXT] Proposed re-zoning of 1477 West Broadway

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

Dear City Council Members,

\~

I live s.22(1) from the site of the proposed rezoning and development at 1477 West Broadway (near the corner of Granville).

\~

I am very much OPPOSED to the proposed rezoning of this property in the manner currently being recommended.

The 20% of secured rental housing at below-market rates is TOO LOW of a threshold.

The threshold should be double that, or much closer to 50% for below-market rates.

This is a general consideration for the entire city and not specific to this proposal, although it definitely does apply in this case.

\~

Apart from the proportion of below-market rental units, the proposed height and scale of the 39-storey building should be REDUCED fully by one-half, to something around 20 storeys.

While I agree that more sustainable density is achieved by "building up", literally, so taller structures in more places, this proposal is just too far off the scale of reasonableness and sound development policy for your approval.

\~

As a long-time resident of this neighbourhood my primary concern is for the incentive that this would give to the demolition and renovation of numerous low-rise, typically three-storey walk up rental buildings in this area.\~ Many of these would become targets of land assembly projects and result in the sale and eviction of low and middle-income tenants, s.22(1)

\~

Where would I go?\~ Many of my neighbours are seniors on a fixed income with a number of chronic medical conditions.\~ Currently, the proximity to VGH and other medical offices is VERY important.\~ A forced eviction from the land assembly coming after this development, would create a "domino effect" that would put me and numerous others much further away from important health care

clinics.\~ Our health, well-being and quality of life would suffer.

\~

So City Council's decision is not just about this one property, it is about a LIVEABLE neighbourhood that enables access to transit and important services that are NEARBY.\~ The proposal for 1477 West Broadway would be a tipping point for the degradation in the lives of people in this neighbourhood – and this in a city that is clearly already destroying living conditions for so many, because of its pattern of high-cost, out-of-reach condo developments.

\~

PLEASE REVISE this proposal.\~ Scale it down; way down.\~ Stop the pattern of land assembly that destroys liveable rental housing.

\~

LASTLY, any building, regardless of scale, should clearly demonstrate a LOW or VERY LOW carbon footprint, with regard to its construction and the materials used to build it.

As we see the damaging effects of climate change take over, this practice is one of many that is a MUST HAVE in all building projects.

\~

Sincerely,

s.22(1)



From: s.22(1)
To: "Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
Date: 4/14/2022 12:58:19 PM
Subject: [EXT] Public Hearing - 40-storey Tower - Precedent for Broadway Corridor & Jericho Lands

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

Dear Mayor of Vancouver Mr. Kennedy Stewart,

I know that the development of this lot is inevitable, but the density of the plan is not suitable for the area and I hope that urban planning can turn this huge development into a smaller one.

Thank you for your attention on this matter!!!

s.22(1)
Vancouver, BC, Canada
V6R 1W8

Sincerely,
s.22(1)

From: s.22(1)
To: "Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Dominated, Lisa" <Lisa.Dominated@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
"Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
"Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
Date: 4/21/2022 6:32:42 PM
Subject: [EXT] Public Hearing 1477 W. Broadway at Granville St.
Attachments: Urban Sustainability - decoupling tallness LCA.pdf
Applied Energy - climate change mitigation.pdf
Transportation Research - net GHG impact sheppard subway.pdf
Environmental Research Letters -- embodied emissions in rail infrastructure.pdf

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

Dear Mayor and Council,

Further to following prior communication, here's to point out that a recent article at The Tyee, by Patrick Condon and Scot Hein, provides a perfect and timely example of the possibility of increasing urban density without increasing urban height -- and, that (as per attached Urban Sustainability article) a major reduction in life cycle GHG emissions can be achieved while simultaneously delivering more affordable housing for an equivalent population.

Moreover, by incentivizing wood-frame and mass-timber construction, we can simultaneously strengthen BC's forest products industry and stem the flow of raw logs to foreign markets, thereby realizing further carbon emissions reductions associated with global freight transport.\~ \~

Please read the article at following link..

<https://thetyee.ca/Opinion/2022/04/06/Jericho-Lands-Need-Human-Scaled-Rethink/> [thetyee.ca]

And, re subject rezoning application, please also understand that the same net benefits are achievable on the Broadway Corridor.

Thus, in my view, if the aim is truly to make Vancouver more sustainable and affordable, it's essential that the City stop facilitating (i.e. rezoning for) high-rise forms of development that are predictably counterproductive in the face of both climate change and real estate speculation.\~

To do otherwise -- in the public interest -- makes no sense.

Respectfully,

s.22(1)

Vancouver

----- Forwarded Message -----

From: s.22(1)

Sent: Sunday, April 17, 2022, 5:36:49 PM GMT-8

Subject: Climate Emergency and sustainable transportation/development

Dear Mayor and Council,

I am writing to express general concern about the apparent contradiction between the City's declaration of a Climate Emergency in 2019, and an ever increasing focus on high-rise development through subsequent planning processes, including -- most recently -- for Broadway and Jericho.

In particular, I feel compelled to draw your attention to recent scientific research in the journal *Urban Sustainability* (see attached) which concludes that "taller" (high-rise) urban environments significantly increase life cycle GHG emissions (+154%), but that increasing urban density without increasing urban height reduces life cycle GHG emissions while maximizing population capacity.

Also, please be aware of attached recent research reported in the journal *Applied Energy*, making the case that while the GHG emissions of buildings are generally decreasing due to energy efficiency improvements, embodied GHG emissions are increasing and are now dominating life cycle GHGs. And, thus -- not surprisingly -- that new-building upfront (embodied) GHGs are the critical concern for climate change mitigation.

Furthermore, recent work by researchers at the University of Toronto and Cambridge University is raising serious concern about the life-cycle GHG performance of underground mass transit.

See attached findings reported in the journals *Transportation Research* and *Environmental Research Letters*. Notably, the authors conclude that underground transit projects produce 27 (± 5) times more embodied GHG per kilometre than at-grade alternatives.

~

Frankly, given proposed and already unfolding visions for Broadway and Jericho, it's not clear to me that the City's planning and transportation staff are keeping up with leading-edge research.

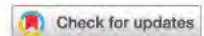
Consequently, as a scientist, I'm concerned about the sustainability of our city, and encourage you to look beyond Vancouver City Hall and the local development community for perspective.

Sincerely,

s.22(1)

Vancouver

ARTICLE OPEN



Decoupling density from tallness in analysing the life cycle greenhouse gas emissions of cities

Francesco Pomponi^{1,2✉}, Ruth Saint¹, Jay H. Arehart^{1,3}, Niaz Gharavi¹ and Bernardino D'Amico¹

The UN estimate 2.5 billion new urban residents by 2050, thus further increasing global greenhouse gases (GHG) emissions and energy demand, and the environmental impacts caused by the built environment. Achieving optimal use of space and maximal efficiency in buildings is therefore fundamental for sustainable urbanisation. There is a growing belief that building taller and denser is better. However, urban environmental design often neglects life cycle GHG emissions. Here we offer a method that decouples density and tallness in urban environments and allows each to be analysed individually. We test this method on case studies of real neighbourhoods and show that taller urban environments significantly increase life cycle GHG emissions (+154%) and low-density urban environments significantly increase land use (+142%). However, increasing urban density without increasing urban height reduces life cycle GHG emissions while maximising the population capacity. These results contend the claim that building taller is the most efficient way to meet growing demand for urban space and instead show that denser urban environments do not significantly increase life cycle GHG emissions and require less land.

npj Urban Sustainability (2021)1:33; <https://doi.org/10.1038/s42949-021-00034-w>

INTRODUCTION

Population and urbanisation are increasing with an estimated additional 2.5 billion people living in urban areas by 2050¹. The built environment is the greatest cause of carbon emissions, global energy demand, resource consumption and waste generation². In the European Union (EU), it accounts for 50% of all extracted materials, 42% of the final energy consumption, 35% of greenhouse gases (GHG) emissions and 32% of waste flows³. Therefore, achieving optimal use of space and maximal efficiency in buildings is fundamental for the transition to sustainable built environments and to progress towards national and international climate targets.

The design of urban environments has not rigorously considered life cycle GHG emissions (LCGE hereon), focusing instead on reducing the operational energy demand and the carbon emissions associated with the energy used to operate buildings. Operational energy use occurs while the building is in service, and includes heating and cooling, lighting, and other plug loads. The use of operational energy contributes to the LCGE of a system as the energy grid is not carbon free, thus conversion factors can be applied to convert between units of energy used and carbon dioxide equivalent (CO_{2e}), the metric of LCGE. LCGE includes these operational emissions as well as the embodied emissions of the entire system. Embodied energy and CO_{2e} emissions are the hidden, “behind-the-scenes” energy and emissions that are used or generated during the extraction and production of raw materials, the manufacture of the building components, the construction and deconstruction of the building, and the transportation between each phase⁴. As operational efficiency grows, so does the share of embodied impacts on the whole-life balance, thus reinforcing the need for sustainability analyses of buildings and cities to be underpinned by a life-cycle-based approach^{5,6}. In other words, operational energy and carbon savings should not be made at the expense of the embodied

impacts, and a holistic approach focused on reducing LCGE should be the primary aim.

Apart from a few studies focusing on urban morphology and energy demand^{7,8} in the built environment, there has been a growing belief that building taller and denser is better, under the idea that tall buildings make optimal use of space⁹, reduce operational energy use and energy for transportation^{10,11}, and enable more people to be accommodated per square metre of land¹². However, this is only partly true. As buildings grow taller they need to be built further apart; for structural reasons, urban policies and regulations, and to preserve reasonable standards of daylight, privacy and natural ventilation¹³. Furthermore, for a fixed amount of internal volume (e.g. expressed in terms of floor area times the inter-storey height) an increase in the building's tallness corresponds to an increase of the building slenderness and hence to a reduction of its compactness which is detrimental to space optimality¹⁴. Urban density is commonly defined as the ratio of built land area (i.e. building footprints) to total land area yet this metric does not capture building height.

Height has been captured in urban density metrics by summing the total floor space of an urban environment and dividing by the total land area¹⁵. To date, however, no method exists to (i) analyse density and tallness of urban environments independently of each other or (ii) evaluate their influence on the LCGE of urban environments. These are the two main objectives of this paper. To decouple the two (i.e. density and height) we propose an additional metric for describing urban environments through a ‘tallness’ factor, or the average height of an urban area. This informs a method that includes a model to generate synthetic, yet realistic, parametric urban environments based on a number of input variables, as detailed in the Methods section. To embed such realism, we collected primary data on real urban environments since building regulations vary greatly across any one country, due to the devolved powers of local authorities in matters of urban planning. Therefore, picking any single value for building

¹Resource Efficient Built Environment Lab (REBEL), Edinburgh Napier University, Edinburgh, UK. ²Cambridge Institute for Sustainability Leadership (CISL), University of Cambridge, Edinburgh, UK. ³Department of Civil, Environmental, and Architectural Engineering, University of Colorado Boulder, Edinburgh, UK. ✉email: fpomponi@napier.ac.uk

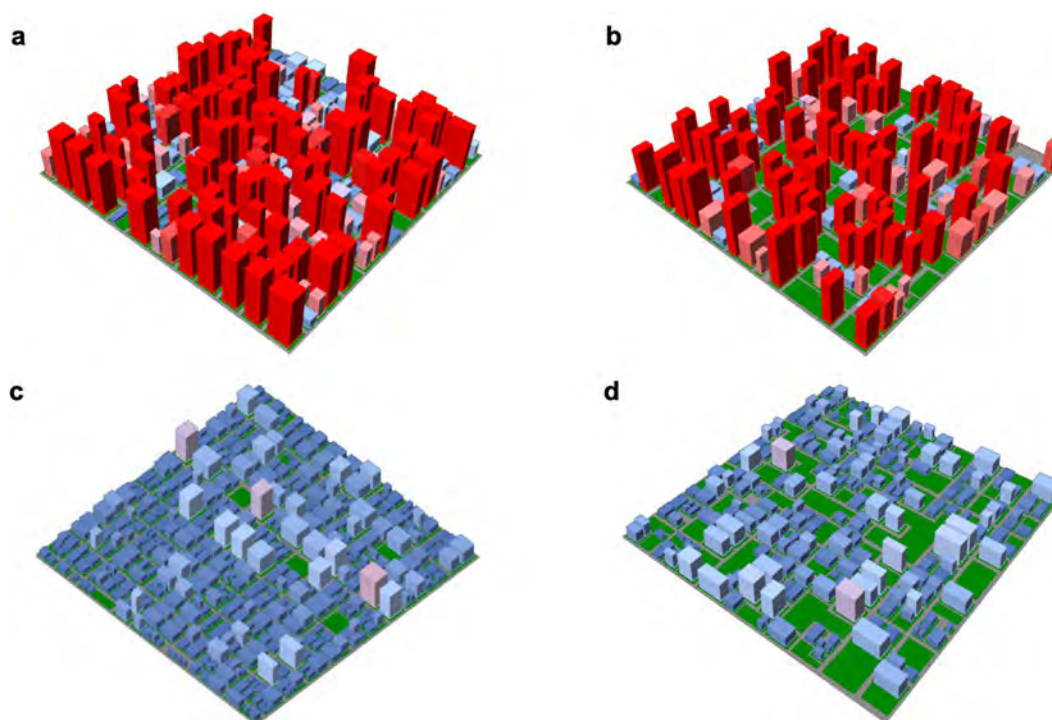


Fig. 1 Illustration of the different of urban typologies classified in the present analysis. **a** HDHR, **b** LDHR, **c** HDLR, **d** LDLR. The height of each building is mapped to the colour with blue as low heights and red as high heights.

footprint, sizes, number of storeys, distance with adjacent buildings, etc. could bias our results. As an alternative, we surveyed 25 addresses in the UK (in the cities of London, Edinburgh, Glasgow, Manchester, Leeds, Sheffield and Birmingham) to measure these key building characteristics and neighbourhood constraints. The choice of the addresses we surveyed was due to proximity to the authors to ensure a good coverage of the key inputs to our analysis and the possibility of site visits where needed. In the attempt to avoid a sole UK focus of our study, we verified these primary collected data against spot checks in the European cities of Berlin, Oslo, Stockholm and Vienna, obtaining good agreement.

For each of the 25 addresses we surveyed, we extended our analysis to 1 km², with each building at the centre, and collected the following data: number of blocks, number of green spaces, average block perimeter, average block area, average green space perimeter, average green space area, average street width, average main road width, average distance to surrounding buildings, and width and depth of the building plot (including gardens, driveways, etc.). These inputs ensure the synthetic urban environments stem from real-world observations. For each urban environment we assess, at the building level, both embodied and operational emissions to inform a whole-life set of results. While our model and method are applicable irrespective of the geographical context of analysis, the results of their application—while aimed at a broad European context—remain rooted in UK primary data. The results for such context are shown in the next section.

RESULTS

Density and tallness of urban spaces

Urban environments are diverse, arguably unique, and the product of many factors such as the landscape, culture, economy and history. Yet, a common theme throughout urban environments is the types of buildings that comprise them. These can be categorised as non-domestic low-rise (NDLR); non-domestic

high-rise (NDHR); domestic low-rise (DLR); domestic high-rise (DHR); and terraced or semi-detached houses (House)^{16,17}. Full details are given in the Supplementary Information (specifically Supplementary Methods 1, Supplementary Table 1 and Supplementary Methods 3). The layout and combination of these different building types contribute to both the density and height of an urban space^{13,18–20}.

In this study, we offer a LCGE analysis of urban environments by decoupling and analysing both tallness and density. Through our method, we parametrically simulate 5000 urban environments under two scenarios and perform a cradle-to-grave process-based life cycle assessment on each to evaluate the LCGE. Scenario 1 considers fixed populations of 20, 30, 40 and 50 thousand people with varying land area, while Scenario 2 considers a fixed land area of 1 km² with varying populations potentially supported. We compare the LCGE of each urban environment to evaluate if taller and denser environments yield greater efficiency in terms of accommodated population, land use, energy demand and GHG emissions. This multi-criteria approach provides a more holistic picture of the LCGE of urban environments and can inform better policies and practice related to urban design and planning.

While a large variety of urban typologies could be defined with respect to density and height, we define four typologies for discussion herein: high density, high-rise (HDHR); low density, high-rise (LDHR); high density, low-rise (HDLR); and low density, low-rise (LDLR). Examples of these urban environments are visualised in Fig. 1. An area of midtown Manhattan in New York City, USA, is an example of a HDHR urban typology with a density factor of approximately 54.5 and a tallness factor of 54.2. Central Paris is an example of a HDLR urban typology with a maximum density factor of 62.6 and tallness factor of 7.5. LDLR urban typologies are commonplace in suburban metropolitan areas, or urban “sprawl,” while LDHR environments have been envisioned by many urban planners, notably by Le Corbusier’s design of the “Radiant City”²¹. Details around the determination of the cut-offs for each urban typology (Supplementary Discussion and Supplementary Methods 1) as well as the procedural flowchart of the

algorithm behind our model are given in the Supplementary Information (Supplementary Methods 2).

For each of the five types of building considered herein, the LCGE results are presented in Table 1, separated by life cycle stage as defined by BS EN 15978:2011⁴. As expected, the structural system of each building contributes significantly to the cradle-to-gate emissions. With a 60-year lifespan assumed for all buildings²², the operational impacts represent between 77–83% of the LCGE. Non-domestic buildings typically have higher LCGE than domestic buildings, while high-rise buildings have greater LCGE than low-rise buildings which is consistent with findings from other studies^{5,23,24}. These LCGE results for different building types feed into the 5000 parametrically simulated urban environments which are explored under the two previously defined scenarios.

Scenario 1: fixed population

Figure 2a illustrates the LCGE of all simulated urban environments for the four population scenarios: 20, 30, 40 and 50 thousand people, while Table 2 shows key results for LCGE and land area (averages and standard deviations) for each population cluster. Across all four populations, the LCGE increases as tallness increases, independent of the amount of land required to house the population. In contrast, the density of buildings has little impact on LCGE; for each population, low- and high-density typologies result in similar LCGE results. If the simulated environments are separated into their height-density typologies, we find that between the LDLR and HDLR typologies, there is a decrease in the average LCGE as population increases: 10% decrease for a 20k population, 16% for 30k, 19% for 40k and 15% for 50k. A key difference between LDLR and HDLR typologies is the built land area required to accommodate the same number of people. HDLR typologies require 49–56% less land than LDLR, resulting in lower LCGE impacts and less demand for land. Percentages in the discussion of the results always refer to comparison across the averages reported in Tables 2 and 3.

High-rise buildings have much higher LCGE than low-rise buildings, as shown by the large bubbles in Fig. 2. Thus, building taller has a significant impact on the LCGE of an urban environment when the number of people is kept constant. For a 20k population, moving from a HDLR (small purple bubbles) to a HDHR (large purple bubbles) typology results in a 140% increase in LCGE; for 30k, 40k and 50k populations, the difference is 154, 143 and 132%, respectively. Compared with the difference between LDLR and HDLR typologies presented above, this shows the much greater impact of building taller over building denser.

From Table 2 it is possible to see that, for all the fixed populations, HDLR buildings minimise LCGE. HDHR is the worst-case scenario for all populations, ranging from a 27 to 77% increase in LCGE when moving from a 20k to a 30k and 50k population, respectively. However, the impact on LCGE with increasing populations is higher for the other urban typologies, despite absolute LCGE being much higher. For a LDLR scenario, doubling the population, i.e. from 20k to 40k, results in an 81% increase in LCGE; moving from 20k to 50k gives a 94% increase. In terms of increasing impacts with greater populations, LDHR shows the highest differences; 112% LCGE increase moving from 20k to 40k and 145% moving from 20k to 50k. This suggests that the land required, and thus the land use change emissions factor, to accommodate higher populations plays a role in LCGE. This is reflected in the larger land areas required when building low-density typologies for higher populations; in a LDHR scenario, moving from 20k to 30k results in a 53% increase in land area and from 30k to 40k and 50k populations, the difference is 115 and 152%, respectively. However, the small absolute LCGE increase does not reflect the large increase in land required suggesting the relatively insignificant impact land use change has on LCGE.

Table 1. Embodied carbon coefficients (ECC) and operational carbon coefficients (OCC) used to determine a LCGE coefficient for each building type, normalised per square metre of floor area.

	ECC (A1–A3 Structure) ²⁵ kgCO ₂ e m ⁻² FA	ECC (A1–A3 Façade) ²⁶ kgCO ₂ e m ⁻² EA	ECC (A1–A3 Roof) ²⁷ kgCO ₂ e m ⁻² BF	ECC (Stage A4) ⁶ kgCO ₂ t ⁻¹ km ⁻¹	ECC (Stage A5&C) ⁶ kgCO ₂ e m ⁻² FA	OCC (over 60 years) ^a kgCO ₂ e m ⁻² FA	LCGE kgCO ₂ e m ⁻² FA
Non-domestic low-rise	180	72	21	0.19	221	2460	2953
Non-domestic high-rise	250	168	21	0.19	221	2460	3120
Domestic low-rise	180	76	33	0.19	221	1898	2426
Domestic high-rise	250	61	33	0.19	221	1898	2462
Terraced/house	90	84	36	0.19	221	1491	1925

^aDerived from operational energy estimates for non-domestic buildings²⁸ and domestic buildings²⁹. Units are given below each element considered: structure, façade and roof ECCs refer to Stage A1–A3 (i.e. from raw material extraction to manufacturing, general use, referred to as cradle-to-gate). A4 refers to transportation to site and A5 to construction activities in line with the EN 15978 terminology on a building's life cycle stages. FA floor area, EA envelope area, BF building footprint.

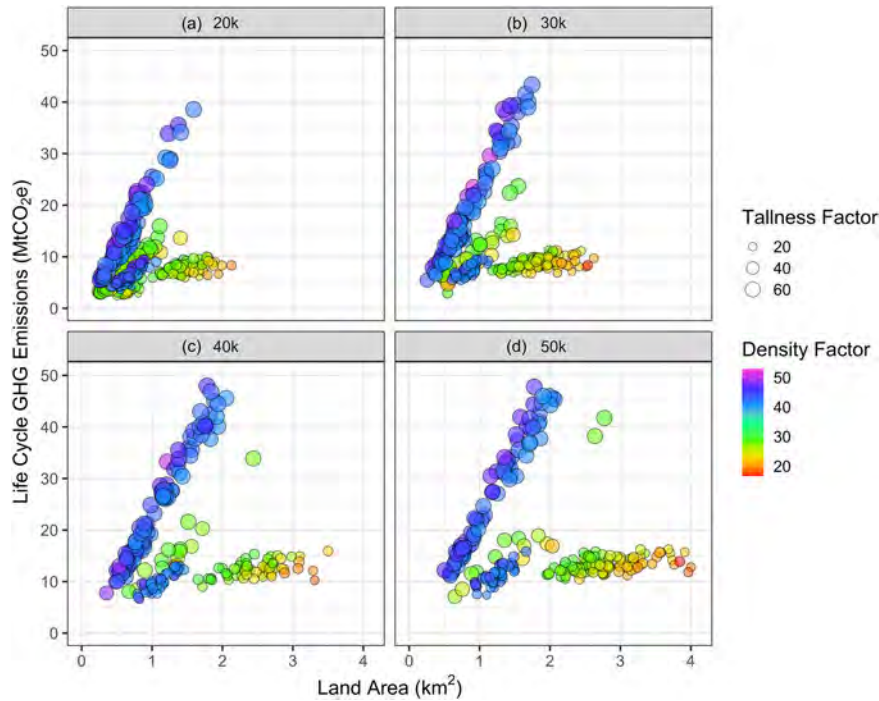


Fig. 2 LCGE versus built land area for fixed populations. Results presented for 20 (a), 30 (b), 40 (c), and 50 (d) thousand people.

		LDLR		LDHR		HDLR		HDHR	
		Average	Std. dev.	Average	Std. dev.	Average	Std. dev.	Average	Std. dev.
20k	LCGE (MtCO ₂ e)	6.82	2.08	7.44	3.46	6.12	1.52	14.68	7.07
	Land area (km ²)	1.32	0.41	0.62	0.29	0.67	0.14	0.65	0.26
30k	LCGE (MtCO ₂ e)	8.69	1.21	11.20	4.75	7.32	1.18	18.60	9.79
	Land area (km ²)	1.82	0.34	0.95	0.35	0.84	0.12	0.81	0.36
40k	LCGE (MtCO ₂ e)	12.37	1.49	15.8	6.20	9.98	1.83	24.25	10.88
	Land area (km ²)	2.48	0.41	1.33	0.42	1.11	0.19	1.07	0.44
50k	LCGE (MtCO ₂ e)	13.2	1.38	18.2	9.94	11.2	1.83	26.01	11.4
	Land area (km ²)	2.81	0.49	1.56	0.65	1.24	0.17	1.16	0.46

The distribution of building types across the four population models is shown in Fig. 3. For the higher populations (40k and 50k), proportionally more domestic buildings are selected in order to accommodate the need for more residences. This need is particularly illustrated through the 50k population model in which domestic low-rise buildings dominate any other building type across all simulations.

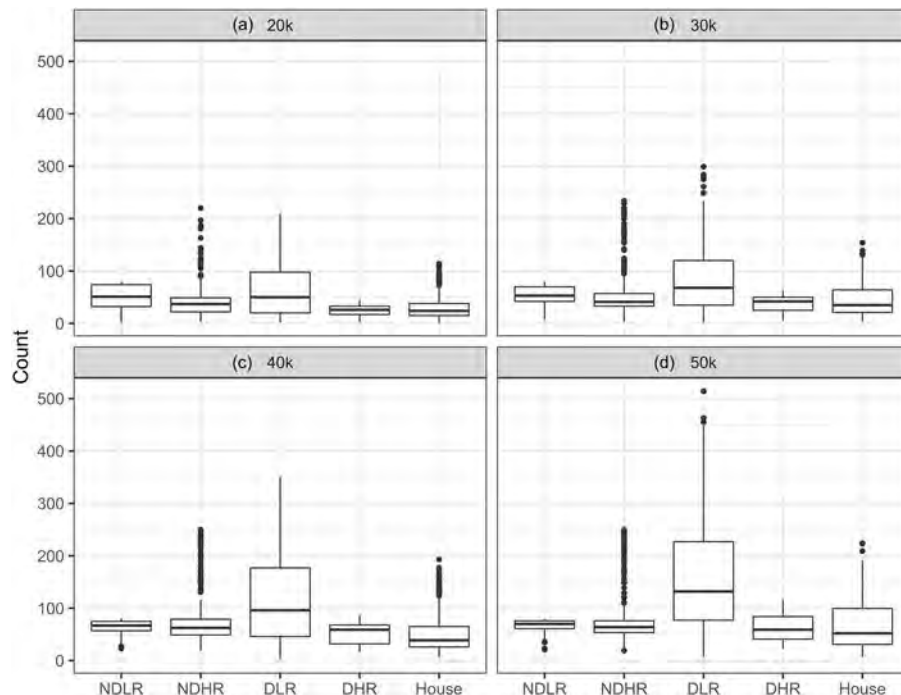
When LCGE is normalised per building type, non-domestic buildings have the highest share of the impact at 75% (62% for non-domestic high-rise and 13% for non-domestic low-rise), so their inclusion in the urban scenario inherently increases LCGE. Domestic buildings account for the remaining 25% with the following split: 17% for domestic high-rise and 4% for both domestic low-rise and terraced/house. This split in LCGE impact aligns with the results presented in Table 1. As expected, non-domestic buildings are responsible for the largest portion of LCGE due to having higher operational emission intensities. This value will become less significant as a driver for higher non-domestic impact in future years due to the decarbonisation of the grid and reduced reliance on fossil fuels²⁵. Therefore, the next hotspot to address from a LCGE perspective is the structural system of buildings, which is largest in high-rise buildings, both domestic

and non-domestic. Beyond that, the largest difference is seen in the façade; non-domestic high-rise buildings have at least twice the impact of the other four building types, due to the heavy material intensity of steel and glass^{26,27}.

In terms of land area, the difference between LDHR and HDHR urban typologies is not as stark as the low-rise scenarios. The LDHR scenario requires between 17–34% more land for a 30k population and 50k population, respectively. Essentially, more people require more space, but high-rise buildings require a similar land area compared to low-rise buildings with varying density. This is due to the space required when building taller; buildings must be further apart for structural reasons, urban policies and occupant comfort. Therefore, building taller to accommodate a growing population not only does not save space but also significantly increases LCGE. A note here might be on whether the additional empty space between high-rise buildings is transformed into urban greenery that can sequester carbon. Evidence in support of this can be found in the work of Zirkle and colleagues²⁸, who modelled carbon sequestration in home lawns in the US finding a technical sequestration potential ranging from 25.4 to 204.3 g C m⁻² year⁻¹. Their work covers different US zones with their own climates, ranging from cases

Table 3. Summary of the LCGE and population accommodated with a fixed land area for the four urban typologies.

	LDLR		LDHR		HDLR		HDHR	
	Average	Std. dev.	Average	Std. dev.	Average	Std. dev.	Average	Std. dev.
LCGE (MtCO ₂ e)	7.11	0.60	15.10	3.02	8.79	1.16	24.98	2.69
Population (thousands)	21.04	5.19	42.69	12.70	46.66	12.65	57.80	18.98
LCGE per capita	0.34	0.12	0.35	0.24	0.19	0.09	0.43	0.14

**Fig. 3** Count of building types for each simulated urban environment across the four population models. Results presented for 20 (a), 30 (b), 40 (c) and 50 (d) thousand people. Quantitative comparison between the typologies in our synthetic environments and those observed in real urban environments showing good agreement is offered in the SI (Supplementary Fig. 3).

(arid southwest) where the lawn management (energy, irrigation, fertilisers, etc.) can offset the net carbon sequestration to others (northeast) where best practices for lawn management show a significant and promising net carbon sequestration potential. We are therefore unable to immediately translate such values into inputs to our model to capture carbon sequestration of urban greenery, but this undoubtedly is an important point for future work.

Figure 4 presents the LCGE as a function of the tallness and density factor for each fixed population. This visual representation shows that LCGE increases with increasing height and that high-rise buildings are more commonly paired with high density typologies. Furthermore, this representation illustrates that the LCGE of different densities is less stratified than for building height, reinforcing the finding that building height has a significant impact on LCGE, while density does not.

Scenario 2: fixed land area

Figure 5 illustrates the LCGE for different combinations of density and height for a fixed land area of 1 km². This plot is more variable and does not show the same trends that were identified in Fig. 2. There is a pattern whereby LDLR (small red bubbles) exhibit the lowest LCGE and HDHR (large purple bubbles) have the highest. Therefore, in this scenario, LDLR is the best-case in terms of minimising LCGE and HDHR is the worst. However, LDHR can

accommodate 103% more people than a LDLR scenario and HDLR and HDHR scenarios can accommodate 122–175% more, respectively. On average, more than twice as many people can be accommodated in a HDLR scenario for a similar LCGE, with 21k people at 7.11 MtCO₂e for LDLR and 47k people at 8.79 MtCO₂e for HDLR. Thus, HDLR would offer a better solution; invest 24% more carbon to accommodate 122% more people. With high-rise scenarios, LCGE significantly increases compared to LDLR; 112 and 251% more LCGE in LDHR and HDHR scenarios, respectively. Therefore, the carbon investment does not seem justified. Changing the density from low to high has little impact on the LCGE in low-rise scenarios, as shown in Table 3. However, moving to high-rise structures results in a significant impact on LCGE with a 184% increase moving from HDLR to HDHR.

DISCUSSION

With an aim to evaluate the widespread belief that building dense and tall is the only way to accommodate a growing urban population, we developed and employed a method to separate density from tallness in urban environments and establish the extent to which each influences the LCGE of cities. Indeed, the difference between varying urban scenarios and across varying populations had yet to be quantified from a LCGE perspective. We found that while tallness does significantly increase the LCGE, density does not, and we here suggest that there is an alternative

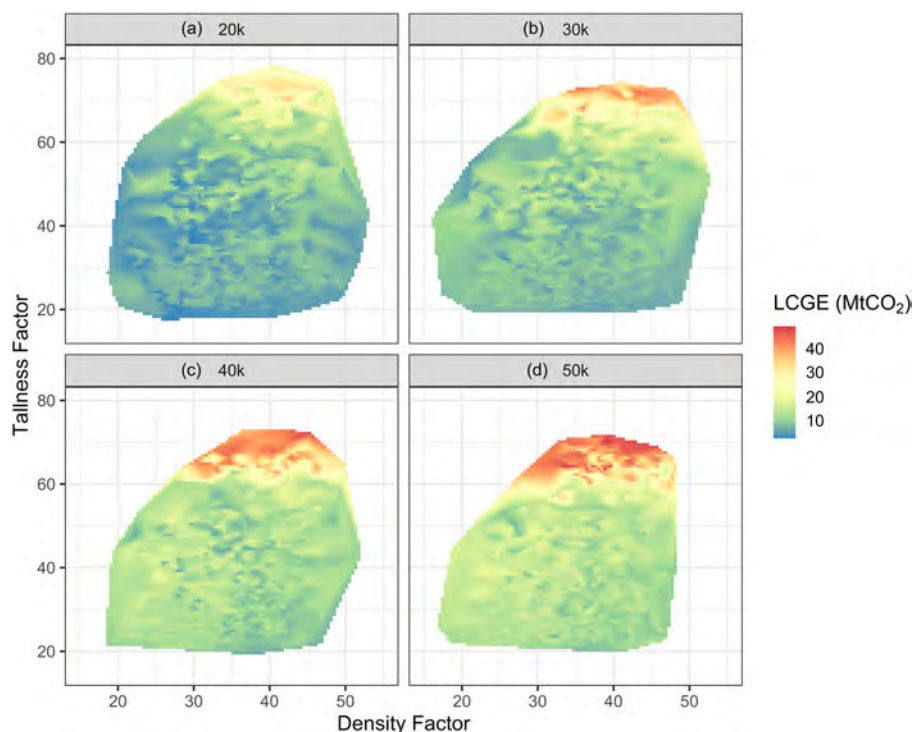


Fig. 4 Colour maps for the fixed population conditions under investigation. Results presented for 20 (a), 30 (b), 40 (c), and 50 (d) thousand people. A spline interpolation is used to interpolate between each simulated urban environment.

low-rise pathway for urban development that can meet the growing demand for urban floor area. While not explored in detail, it is worth considering that low-rise urban environments also allow to choose from more construction materials than the handful of elite materials that govern and dominate our high-rise built environments (i.e. steel, reinforced concrete, aluminium and glass).

Specifically, in terms of LCGE impacts, HDLR urban typologies are the best-case scenario for a fixed population. This can even be argued to be the case for a fixed land area, despite a higher absolute LCGE output than the LDLR typology, due to the much greater number of people that can be accommodated. For the case of fixed populations, it may be surprising that LDLR typologies do not have the lowest impact. However, due to the larger land areas required to accommodate the same population, the land use change factor pushed the impact past that of HDLR though there is only a relatively small difference between them (10–19%). Given the growing pressure and competing demands on land as a resource it is however only reasonable to assume it is used as efficiently as possible, and this is what HDLR urban typologies do. The worst-case scenario for a fixed land area is the HDHR typology, as population does not constrain the number of buildings or type that can fit within the 1 km² boundary. For the fixed population conditions, the worst-case scenario is also HDHR (followed by LDHR) suggesting that there seems to be no supporting evidence behind the necessity for high-rise urban environments.

While simulation based, our synesthetic urban environments (i) stem from primary data collected in real-world neighbourhoods (Supplementary Methods 2 and 3 and Supplementary Note) and (ii) match well with the features revealed by analysis of today's cities (Supplementary Method 1 and Supplementary Fig. 3). As such they can effectively support both better urban policies and more environmentally sustainable urban design and planning. For instance, when new mixed-use neighbourhoods are being developed or redeveloped, our method and model can offer important insights to inform policies in order to meet the desired

targets (e.g., population to be housed and/or non-domestic floor area to be achieved) while reducing LCGE. Similarly, in parts of the world where new cities are being built from scratch (e.g. China) or where this could happen in the near future (e.g. Africa) our research could support urban planning and design. Significantly, the EU/UK geographical context of our work only affects the underlying data and not the model and method which could feed off machine-readable data representative of any country in the world.

Future potential applications of the model and method could investigate 'optimal' values for urban density and tallness given specific constraints or support the development of a dynamic modelling element that interacts with the analysis of density and tallness. In addition, the results of this study suggest that there is no merit to the claim that building denser and taller is more sustainable. By building dense, low-rise urban environments, the same populations can be accommodated for drastically lower carbon costs and without having to significantly increase land use.

Limitations and recommendations

The model limitations are covered in detail in the accompanying Methods section. To capture the stochastic nature of urban areas, a simulation-based methodology is used. A limitation of this approach is that the model selects building types based on the plot size and desired height. Although we checked that, overall, our share of domestic vs. non-domestic building types match that of real urban environments, a fully simulation-based approach could present simulation bias. Further, while we based our input variables selection on extensive data collection of real urban environments (e.g. distance between neighbouring buildings), these input variables could all be subjected to sensitivity analysis to further unravel the extent of the role they play in determining the LCGE of urban environments. An element where this would become particularly useful is to adopt a continuous distribution of buildings' heights to choose from. This would remove the simplification between low-rise and high-rise that we introduce in this research to be able to

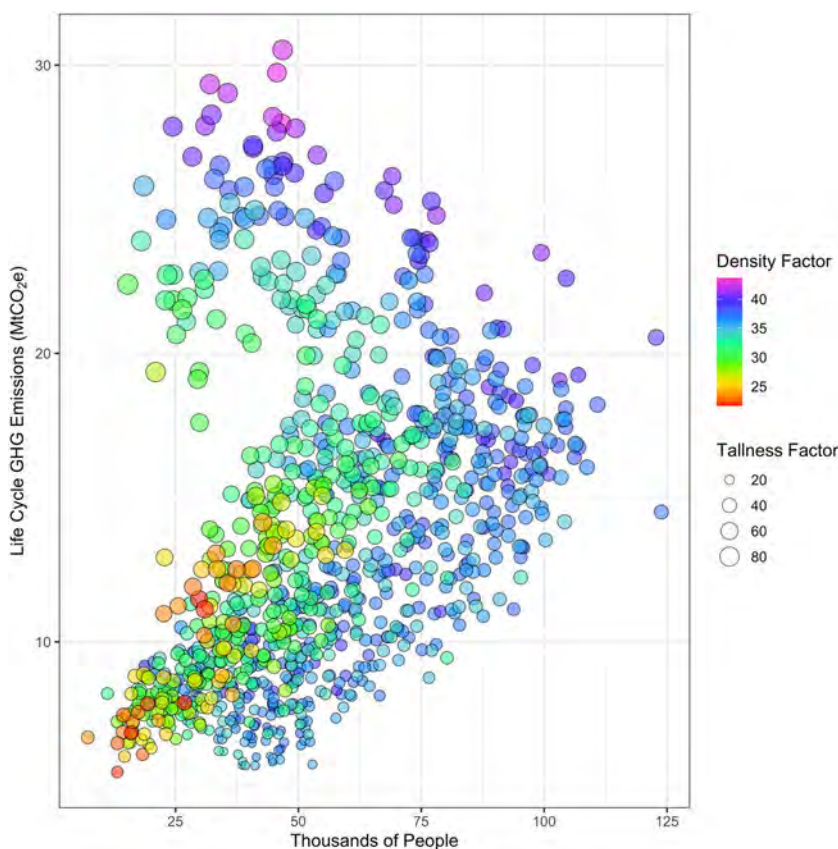


Fig. 5 Density, tallness, and life cycle GHG emissions. LCGE versus number of people accommodated for a fixed land area.

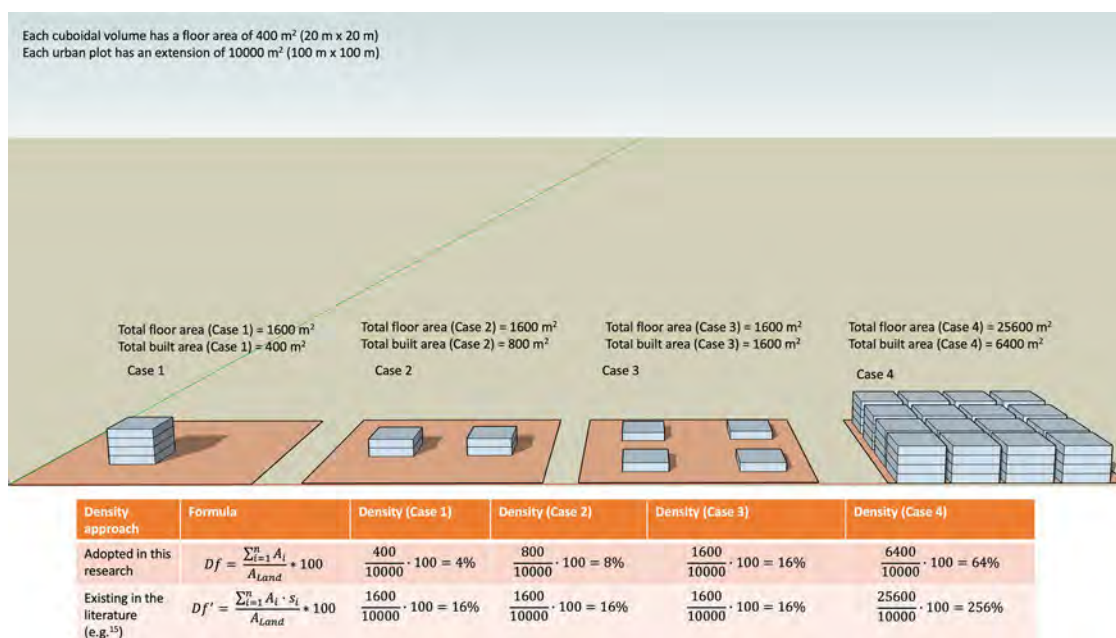


Fig. 6 Metrics of urban density. Comparison between floor-area-based metric of urban density and land-occupation based metric (adopted by the authors).

compare the two. Furthermore, to aggregate the embodied GHG emissions values for the substructure and roof, generalisations were made based on average values obtained from literature. Additionally, for land use, land-use change and forestry (LULUCF) we adopt

conventionally agreed factors from the leading database ecoinvent. The land use change method adopted and the assumptions of the previous use of land also warrants further research to increase the understanding of the importance of this variable.

These limiting assumptions were necessary based upon the urban scale scope of this study. Providing additional levels of detail at the building scale would greatly improve the accuracy of the analysis and can be refined in future works. Employing a cradle-to-cradle approach to consider resource reuse, the impact of retrofitting existing building stock over rebuilding; the inclusion of transportation impacts; adding a dynamic time component to investigate material inflows and outflows; and including a detailed time-related analysis of carbon sequestration potential offered by urban greenery in the simulated environments—are all valuable and important avenues for future work to build on this study and expand its relevance while reducing its limitations. This study therefore acts as a stepping-stone to provide a strong foundation from which extensive future work can be born.

When considering LCGE, which encompasses both embodied and operational GHG emissions, the results provide further insight to dispel the growing belief that taller and denser is better. These findings support the growing claim to resolve the unnecessary opposition between embodied versus operational and re-unite them both into the physical unity of a built asset. For example, it has been argued that the environmental impact of the operational phase of cities can be alleviated by green plant coverage, i.e. vegetation façades²⁹. However, to support such an additional load there needs to be more materials in the building structure thus increasing the embodied impact. Additionally, vegetation covering the façade may offset carbon emissions, but it also shades the entire façade increasing the need for mechanical means of ventilation, daylighting and heating.

Sustainability is a three-legged stool comprising the economy, the environment and society: to be truly sustainable all three must be in equilibrium. Therefore, interdisciplinary considerations that need to be addressed when progressing this work include, for instance: occupant comfort; the urban heat island effect; competing land use; the carbon sequestration effect of green spaces; urban policies; resource consumption; how the urban environment affects crime; etc. Cities are the central hub of modern society and to address these multi-faceted issues a highly multidisciplinary approach seems the only appropriate way forward.

METHODS

Life cycle assessment methodology

To determine LCGE, carbon coefficients for the different life cycle stages and building components were found from existing literature. Table 1 outlines these results and the embodied and operational carbon coefficients for the five building types considered. A cradle to grave life cycle assessment was conducted for this study, accounting for the 100 year global warming potential (GWP100) measured in kilograms of carbon dioxide equivalent (kgCO_2e). Here, carbon impact and LCGE are used as shorthand for GWP100. Resource reuse or recycling was excluded since it is beyond the scope of the study. With respect to building components, the core structure, building façade and roof were included while the foundations for all building types were excluded. The lifespan for each building type was assumed to be 60 years, after which the buildings are assumed to be demolished and materials sent to landfill. To accommodate for a decarbonising energy mix, a steady decarbonisation rate of 6.4% per year was applied as this is the rate required to limit global warming to 2°C ³⁰. For the models with fixed populations, a land use change factor, $0.08 \text{ kgCO}_2\text{e per m}^2$, was added to account for the changing land area. This factor was taken from ecoinvent³¹ and is specific to construction processes. The focus of this analysis is limited to a UK and European context to reflect the regional variations of lifecycle inventories, which are highly dependent upon the region in which the data is collected³².

Twenty five case studies were used to generate primary data on the building parameters which were utilised as inputs to the parametric model. Buildings in the UK were chosen to collect primary data due to physical proximity and possibility of accurate measurements and site visits when needed. These collected data were then used to cross check other buildings in Berlin, Oslo, Stockholm and Vienna to make our analysis

relevant to the broader Europe (full details in Supplementary Methods 1 and Supplementary Note). To determine the LCGE of the built forms, in $\text{kgCO}_2\text{e per m}^2$, embodied carbon coefficients (ECCs) for different construction materials and the different life cycle stages were found from existing research and emissions databases^{5,31,33–35}. These values were then multiplied by the normalised material intensities found during primary data collection to arrive at the LCGE impact of each building type. Full details are available in Supplementary Methods 3.

The embodied carbon of the façade was calculated from the envelope area and the roof from the building footprint; the ECC of each buildings' structure was taken directly from the literature³⁶. The life cycle was considered from Stages A C, cradle to grave, and the operational carbon coefficients were derived from operational energy estimates provided by DECC and DBEIS^{37,38}.

Parametric model

A bespoke parametric model was developed for this work that allowed the density and height of building plots to be stochastically selected from predefined ranges (Supplementary Methods 2). The ranges were informed by the case studies for the five building types considered in this work. The benefit of this randomisation lies in the variety of realistic built forms that can be developed, computed and assessed. Likewise, block size and street sizes were captured from the case studies. Existing buildings in urban environments were surveyed and data were collected for a number of building characteristics (e.g. population density, storey height, perimeter, building footprint, etc.) and neighbouring constraints (e.g. blocks and green spaces in 1 km^2 , road widths, distance from neighbouring buildings, etc.). Full information on the buildings surveyed and data collected for each neighbourhood is given in the supplementary information (Supplementary Methods 3 and Supplementary Note). Two street sizes were included, main and secondary streets. To calculate the potential population supported by each simulation (for the fixed area case), the floor area per person for each type of building was used. These values are based on the average floor area per person for owner occupied and social housing domestic dwellings (46 m^2 and 36 m^2 , respectively)³⁹ and office space required per person (8 m^2)⁴⁰.

To simulate the fixed area urban typologies (Scenario 2), 1000 buildings were simulated with random sizes based upon the representative case study buildings for each of the five building types. Next, the land area is divided into blocks with varying dimensions. Main streets were generated between blocks with widths randomly selected from 13, 14 or 16 m, based on the case studies. Each main block is then divided into smaller lots of land based upon the specified density factor which determines the density of the model. Plots that do not have access to streets are turned into green space. Each plot is then iterated over to place a random building with the target tallness factor of the model into each plot. The criteria for placement are that (i) each building has an area of free space surrounding it, (ii) the height of the building is the closest (typically within a five metre range) to the target height factor of the model, and (iii) the space between adjacent buildings is 10 m if high rise whereas low rise buildings can attach to each other. Plots where no representative buildings could fit were turned into green space. Once an urban typology is simulated based on the specified tallness and density factor, the LCGE is computed for that typology. A flowchart to further support the understanding of the logic behind the model is offered in the supplementary material (Supplementary Methods 2).

To simulate the fixed population urban typologies (Scenario 1), 1000 buildings were simulated for each population as described by Scenario 2. A large land area ($4 \times 4 \text{ km}$, based on analysis of large urban environments such as London, New York City and Shanghai) was generated and divided into blocks of varying dimensions. Blocks, streets and green spaces are generated in the same manner as Scenario 2, for a $400 \times 400 \text{ m}$ grid. The number of possible inhabitants was calculated based on the floor area of the residential buildings divided by the floor area per person required for each building type. Using a recursive algorithm, the initial grid ($400 \times 400 \text{ m}$) is increased by 50 m on each side if the number of people is less than the target number of people for the simulation. Buildings are again sampled, and the total population supported recalculated. Once a tolerance of 50 people is achieved, the model calculates the LCGE of the urban typology. The code used to generate this simulation can be accessed through a GitHub repository linked in the Data Availability section.

The carbon impact of green spaces and transport infrastructure were not included as it is beyond the scope of this study. However, a one way

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ANOVA was conducted to determine the impact of increasing density on road area. A one way ANOVA was also carried out to determine the impact of building height and density on LCGE, to reduce any uncertainty in the interpretation of the findings. Three hypotheses were tested: (1) Impact of building height on LCGE: H_0 increasing height does not impact LCGE; H_1 increasing height does impact LCGE. (2) Impact of density on LCGE: H_0 increasing density does not impact LCGE; H_1 increasing density does impact LCGE. (3) Impact of density on road area: H_0 increasing density does not impact road area; H_1 increasing density does impact road area. The null hypothesis is rejected for the case of building height; increasing height does significantly impact LCGE. For the case of density and LCGE, the null hypothesis is not rejected; increasing density does not impact LCGE significantly. Likewise, the null hypothesis is not rejected for the impact of road area. The output of each urban typology is the overall density, average height and total LCGE of the stochastic simulation.

Urban density metrics

Urban density is usually referred to as number of people per unit land area inhabiting a given urbanised location. When dealing with urban forms, different approaches exist such as dwellings per hectare or a height centred approach (e.g., floor area divided by land area¹⁵). The latter can be mathematically represented as follows:

$$Df = \frac{\sum_{i=1}^n A_i s_i}{A_{Land}} \quad (1)$$

with the numerator in Eq. (1) above representing total floor space as a sum of products between the building footprint area, A , and number of floors, s , for the generic i^{th} building. The main limitation of such a metric is that it does not allow to differentiate between the separate effects resulting from horizontal and vertical densifications. This is graphically illustrated in Fig. 6 where three urban configurations (Cases 1, 2 and 3) score the same urban density (16% as per Eq. (1)); however, they are significantly different if we look at them in terms of land occupation and vertical development. Two separate metrics are therefore required in order to estimate the effect of these two parameters independently. Specifically, we developed two distinct factors for density and height, a “density factor” (Df) and a “tallness factor” (Tf), as defined in equations (2) and (3), where A_i is the building footprint of the generic building i , A_{Land} is the useable land area, H_i is the building height of the generic building i and n is the number of all buildings.

$$Df = \frac{\sum_{i=1}^n A_i}{A_{Land}} \quad (2)$$

$$Tf = \frac{\sum_{i=1}^n H_i}{n} \quad (3)$$

Using the two density factors in Eqs. (2) and (3) above allow for an independent evaluation of the effects that horizontal densification (occupying more of the available land) and vertical densification (building taller) have on urban environments. When density and height are combined, for example expressing density as a function of floor area (e.g. Eq. (1)), two scenarios can have identical urban densities but completely different typologies, thus masking the impact of building type.

Additionally, the density factor we developed always ranges between 0 and 1 (or 100%), thus enabling meaningful comparisons within strict and defined boundaries. The existing metric instead allows density values to exceed 100% (Case 4 in Fig. 6) and potentially has no theoretical upper bound thus limiting further its practical use in comparing the density of different urban typologies.

DATA AVAILABILITY

The data generated and analysed during this study are described in the following data record: <https://doi.org/10.6084/m9.figshare.14663313>⁴¹. All code and supporting data can be accessed via GitHub at <https://github.com/jayarehart/DenserTaller>. Static versions of the two data files included in the GitHub repository have also been included with the figshare data record⁴¹ (downloaded from GitHub on 24/05/2021). Additional supplementary data and notes are available in the files ‘supplementary methods.xlsx’ (Excel spreadsheet with multiple tabs) and ‘supplementary notes.pdf’, which are publicly available in the Mendeley Data repository at <https://doi.org/10.17632/kj3zn5nx6b.1>⁴², as well as together with this figshare data record⁴¹.

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AUTHOR CONTRIBUTIONS

F.P. and B.D. conceptualised the research. R.S. conducted the primary data collection and N.G. developed the parametric model. R.S., N.G. and J.A. developed the methods and performed the analysis. All authors contributed to the discussion and

interpretation of the results. F.P., R.S. and J.A. wrote the manuscript and S.L. All authors reviewed and edited the manuscript and approved the final version.

COMPETING INTERESTS

The authors declare no competing interests.

ADDITIONAL INFORMATION

Supplementary information The online version contains supplementary material available at <https://doi.org/10.1038/s42949-021-00034-w>.

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Embodied GHG emissions of buildings – The hidden challenge for effective climate change mitigation[☆]

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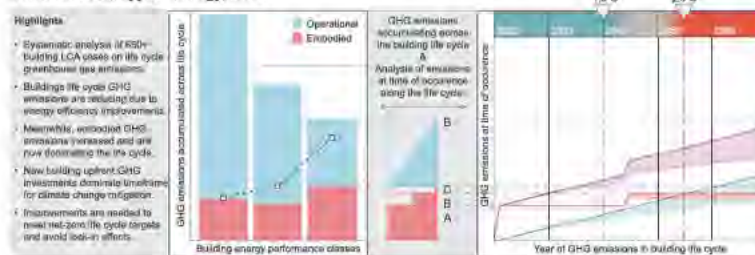
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HIGHLIGHTS

- Systematic analysis of 650+ building LCA cases on life cycle greenhouse gas emissions.
- Buildings life cycle GHG emissions are reducing due to energy efficiency improvements.
- Meanwhile, embodied GHG emissions increased and are now dominating the life cycle.
- New building upfront GHG investments dominate timeframe for climate change mitigation.
- Improvements are needed to meet net-zero life cycle targets and avoid lock-in effects.

GRAPHICAL ABSTRACT

Embodied GHG emissions of buildings – the hidden challenge for effective climate change mitigation. M. Röck et al., Applied Energy, 2019.



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ABSTRACT

Buildings are major sources of greenhouse gas (GHG) emissions and contributors to the climate crisis. To meet climate-change mitigation needs, one must go beyond operational energy consumption and related GHG emissions of buildings and address their full life cycle. This study investigates the global trends of GHG emissions arising across the life cycle of buildings by systematically compiling and analysing more than 650 life cycle assessment (LCA) case studies. The results, presented for different energy performance classes based on a final sample of 238 cases, show a clear reduction trend in life cycle GHG emissions due to improved operational energy performance. However, the analysis reveals an increase in relative and absolute contributions of so-called 'embodied' GHG emissions, i.e., emissions arising from manufacturing and processing of building materials. While the average share of embodied GHG emissions from buildings following current energy performance regulations is approximately 20–25% of life cycle GHG emissions, this figure escalates to 45–50% for highly energy-efficient buildings and surpasses 90% in extreme cases. Furthermore, this study analyses GHG emissions

[☆] This research is related to IEA EBC Annex 72 - Assessing Life Cycle Related Environmental Impacts Caused by Buildings - <http://annex72.iea-ebc.org>.

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at time of occurrence, highlighting the ‘carbon spike’ from building production. Relating the results to existing benchmarks for buildings’ GHG emissions in the Swiss SIA energy efficiency path shows that most cases exceed the target of 11.0 kgCO₂eq/m²a. Considering global GHG reduction targets, these results emphasize the urgent need to reduce GHG emissions of buildings by optimizing both operational and embodied impacts. The analysis further confirmed a need for improving transparency and comparability of LCA studies.

1. Introduction

1.1. The role of buildings in responding to the climate crisis

The potential consequences of the climate crisis and the effects it has already triggered are prompting an intensive examination of the necessity of and possibilities for reducing anthropogenic greenhouse gas (GHG) emissions. The relevance and pressing nature of this topic is highlighted by the integration of climate change mitigation measures into the globally recognized Sustainable Development Goals (SDGs) [1], the alarming reports of the Intergovernmental Panel on Climate Change (IPCC) [2] and the commitments to national GHG emission reduction measures within the framework of the United Nations Climate Change Conference of the Parties (COP) [3].

The relevance of ‘buildings’ and the ‘construction industry’ in this context is highlighted, for example, in the yearly status reports published by UN Environment, the International Energy Agency (IEA) and the Global Alliance for Buildings and Construction (GABC). These reports make it clear that “building construction and operations [account for] 36% of global final energy use and 39% of energy related carbon dioxide (CO₂) [emissions]” [4].

In recent reports [2,5], the IPCC identified ‘buildings’ as an essential field of action for a number of reasons. First, building operations worldwide account for 28% of energy related GHG emissions [4]. These emissions from building operation arise from the energy used for heating and/or cooling, hot water supply, ventilation and air conditioning, lighting, and process related climate relevant GHG emissions, i.e., the release of refrigerants and blowing agents (HFC and PFC gases). Second, because ‘buildings’ are responsible for a massive amount of current GHG emissions, they also have significant potential to reduce GHG emissions through improved operational energy efficiency. In this context, the IPCC states that “1.5 °C consistent pathways require building [GHG] emissions to be reduced by 80–90% by 2050, new construction to be fossil free and near zero energy by 2020”, and the need for “an increased rate of energy refurbishment of existing buildings to 5% per annum in OECD countries” [5].

Thus far, efforts to improve building related GHG emissions focus

mainly on increasing energy efficiency to reduce operational energy demand and on increasing the use of renewable energy carriers. Eventually, the aim is a net zero energy and emissions balance in the use phase of buildings. In addition to conserving non renewable energy sources, pursuing these goals should support the reduction of GHG emissions across the life cycle of buildings. The tightening of legal requirements regarding energy efficiency in building operation has led to, e.g., growing awareness among actors in the construction and real estate industry, increased development of related construction products and systems, and the establishment and improvement of various information and design support tools. Altogether, these measures have successfully contributed to a decline in the energy demands of building operation, thus shifting the environmental hotspots to other stages in the life cycle of buildings [6].

1.2. Shifting focus from efficiency in operation towards a full life cycle perspective

Currently, a large part of the scientific community in the field of buildings and energy research focuses on optimizing the so called ‘operational’ energy use of buildings and, more recently, on the associated GHG emissions. However, given the full life cycle of buildings, energy use and GHG emissions occur for reasons that extend beyond building operation. Energy is required for the manufacturing of construction products; it is ‘invested’ in the construction of new buildings and in modernization and replacement measures; and it is consumed by transport and construction processes as well as during the dismantling and disposal of buildings and materials. The field of buildings and energy research can build on previous work on embodied energy from the twenties and eighties of the last century [7–10]. In particular, the publicly available results of IEA ECBCS Annex 31 *Energy related environmental impacts of buildings* [11] and IEA EBC Annex 57 *Evaluation of Embodied Energy and CO₂eq for Building Construction* [12] are highly relevant.

The life cycle assessment (LCA) methodology, internationally standardized in the 1990s, aims at quantifying the environmental impacts of products and processes throughout their entire life cycle, i.e., from

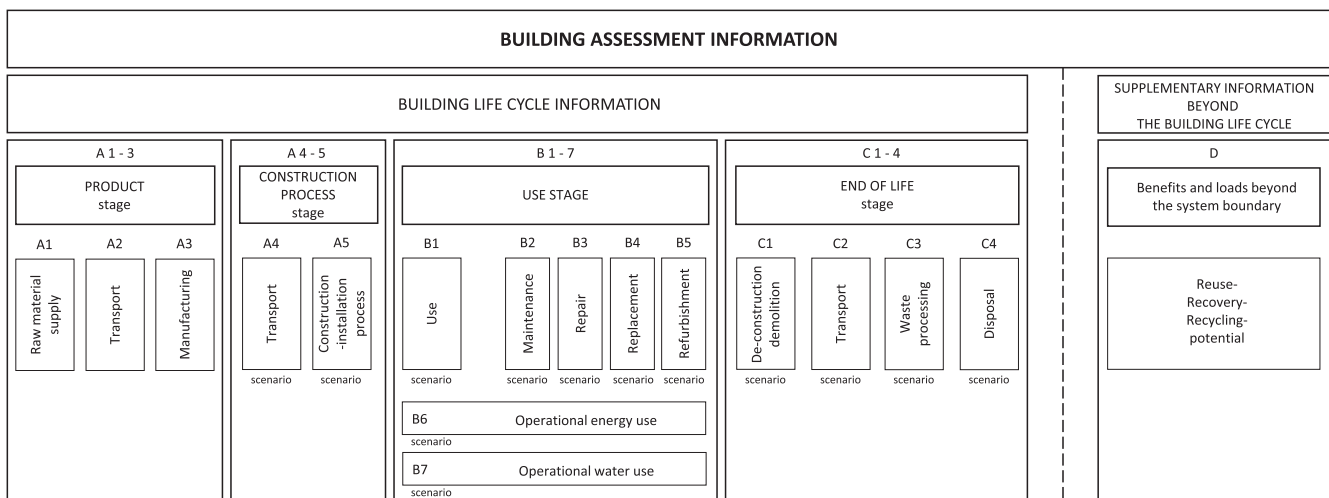


Fig. 1. Display of modular information for the different stages of building assessment (acc. EN 15978).

'cradle to grave' [13–16]. This approach provides a sound methodological basis for calculating energy consumption and assessing resource depletion, GHG emissions and other environmental indicators over the full life cycle of buildings [17–20].

Due to methodological developments in recent years, the application of LCA has been successfully facilitated in the construction industry. Increasingly, manufacturers of construction products publish LCA data for their products using Environmental Product Declarations (EPD) [21–23] and other formats, the establishment of which follows international standards such as ISO 14040/14044 [24]. In a European context, the related standards for the sustainability of construction works are EN 15978 ('Assessment of environmental performance of buildings') and EN 15804 (stating the core rules of establishing EPDs). Fig. 1 presents the general structure and definition of stages in the life cycle of buildings according to the European standard for the sustainability of construction works, assessment of the environmental performance of buildings (EN 15978).

1.3. Challenges and misconceptions regarding life cycle related GHG emissions

There are systemic reasons for the lack of attention paid to embodied impacts in building related energy research thus far. The energy consumption and GHG emissions that arise in the life cycle of buildings are cross sectoral issues. Top down statistics and environmental considerations are typically broken down by economic sectors. The 'buildings' sector includes all activities related to the operation of buildings, whereas the construction of these very same buildings is attributed to the 'industry' sector. Today, the production of construction products used for new buildings and for the refurbishment of existing ones represents 11% of global overall energy and process related GHG emissions, with more than half of these emissions related to the manufacturing of steel and cement [25]. The most recent IPCC report aimed to overcome this division by including a short discussion of embodied energy in buildings [5].

One of the reasons embodied impacts have seldom been considered in policy making is the misconception that factors other than operational energy demands and GHG emissions are negligible aspects of a building's environmental performance. Now considered outdated, earlier studies showed that for typical buildings, the ratio of embodied to operational impacts was approximately 1:10. Therefore, the embodied contribution to life cycle energy was within the uncertainty range of the energy demand forecast for building use and thus not considered relevant [26]. However, this situation has changed dramatically. In recent years, several studies have demonstrated the growing importance of embodied impacts, both relative to their contribution to life cycle based performance and in absolute terms [27–30]. Among the topics investigated and discussed are the relative and absolute values of the embodied impacts as well as how to identify related benchmarks [31–33]. In some countries, there are initial standards that identify benchmarks for embodied and operational GHG emissions, e.g., the

Swiss SIA [34,35]. Studies often use only one or a few buildings to examine how individual building and site characteristics affect the magnitude of the embodied GHG emissions or their contribution to life cycle GHG emissions; few studies have investigated a larger number of buildings [32]. Examples of the parameters commonly analysed are (i) the type of building and its use [36,37]; (ii) site specific properties (e.g., country, climatic zone, seismic zone) [38,39]; (iii) the energy performance standard [40,41]; (iv) construction method (choice of main building materials (e.g., for structural system, envelope, internal walls) [36,42–44]; and (v) the size and shape of the building (e.g., floor area, number of stories, general shape) [32,36].

However, as shown in Table 1, studies investigating the matter have thus far been limited regarding the number and variety of studies compared; they are often limited to one building type and are limited in scope with regard to temporal and spatial representativeness. To date, no studies have systematically investigated recent trends in the contribution of embodied and operational impacts across the life cycle of buildings. The present paper aims to analyse the relative and absolute relevance of operational and embodied GHG emissions across different geographical locations, building types and energy performance standards.

1.4. Research questions

Building on the state of the art as described above, the following research questions are investigated:

- I. What is the historical trend and current state of the art with regard to the contribution of embodied versus operational GHG emissions in the life cycle of buildings?
- II. Is there a clear and causal trade off between operational and embodied GHG emissions, or can buildings have both below average operational and below average embodied GHG emissions?
- III. How does a consideration of the temporal distribution, i.e., time of occurrence of GHG emissions in the life cycle of buildings, influence conclusions in the context of the climate crisis?

2. Material and methods

2.1. Systematic compilation of scientific literature

The collection of published information and subsequent analysis of the documents were performed following the structured protocol for Systematic Literature Review (SLR) and the 'snowball' approach [45,46], a complementary strategy to assure relevant sources are not left out which consists of checking the reference lists of papers and reports collected via the initial protocol. Based on the previously defined research questions, the authors systematically searched the publicly available literature using the following keyword string: [(LCA OR life cycle assessment) AND buil* AND embodied]. The search was performed on 'Scopus', checking for the presence of selected terms in

Table 1

Overview of previous studies documenting embodied GHG emissions and the parameters that affect them.

Paper(s)	Number of buildings	Analysed parameter(s) affecting embodied GHG
De Wolf, Iuorio and Ochsendorf, 2014	3	Construction method (choice of main building materials)
De Wolf et al., 2015	200	Construction method (choice of main building materials)
Chastas, Theodosiou and Bikas, 2016	90	Energy performance standard
Cobîrzan et al., 2017	2	Site-specific properties
Hossain and Ng, 2018	37	Type of building and use
Koezjakov et al., 2018	25	Energy performance standard
Ng et al., 2016	1	Site-specific properties
Passer, Kreiner and Maydl, 2012	5	Construction method (choice of main building materials)
Säynäjoki, Heinonen, Junnila, et al., 2017	116	Construction method (choice of main building materials); Size and shape of building
Simonen, X Rodriguez and De Wolf, 2017	1007	Size and shape of building

the paper's abstract, title or keywords, limiting results to English written papers only. The search criteria further predicted the exclusion of grey literature (e.g., conference proceedings, master's and/or doctoral theses, books/chapters), and no time boundaries were set. In addition, the authors used the snowball approach to identify publications that are relevant but may have not shown up in the systematic search. This approach was executed by (i) checking the reference list of each sampled paper, (ii) assessing case studies listed in European technical reports, and (iii) consulting experts in the field for additional input regarding relevant LCA studies. The database search was finalized in July 2018, but additions via the snowball method continued through March 2019.

The scientific papers that matched the initial search criteria were then transferred to a reference management software, where, following the SLR method, they went through three filtering phases: (i) a title analysis, (ii) an abstract analysis and (iii) a full paper in depth analysis and data extraction. Filtering was carried out conservatively, i.e., by retaining up until the final screening phase papers for which it was uncertain whether they could contribute to answering the research questions (iii). Fig. 2 illustrates the phases of database search and filtering, showing the number of studies remaining after each phase.

A total of 369 papers matched the initial search. After the first filtering round (title based), 20 papers were excluded. The abstract analysis led to the elimination of 168 papers. Finally, after a full paper investigation, the final paper sample was composed of 94 files, encompassing 325 case studies. The snowball approach added 331 case studies to the review, documented in 43 scientific papers, 9 reports, 2 master theses and one book. An overview of all studies compiled for this analysis, and the studies contained in the final sample, can be found in the [supplementary information \(Table S1\)](#).

To extract information from the studies in the final sample, a data extraction table was established to systematically collect relevant metadata, building related and method related information, as well as energy and GHG emissions from sampled papers and technical reports (Fig. 2). The information collected in the data extraction table fed the meta analysis, which allowed for a joint discussion of the findings, as well as an in depth analysis of GHG emissions across buildings' life

cycles as reported in the identified studies.

2.2. Data transformation and classification

2.2.1. Harmonization procedure

For the analysis of absolute embodied GHG emission (EGHG) values, all results collected in this study have been harmonized to the common reference unit $\text{kgCO}_2\text{eq}/\text{m}^2\text{a}$, which expresses GHG emissions in kg CO_2 equivalent per square metre (m^2) of gross floor area (GFA) normalized across a 50 year Reference Study Period (RSP).

Due to the aim of applying a harmonization procedure towards a common floor area based reference unit, the sample of LCA results was limited to studies reporting the GHG emissions either per m^2 GFA or m^2 NFA (net floor area) or, at least, providing the information necessary to calculate any of these two areas (e.g., building plans). In other words, studies that only vaguely defined the functional equivalent were excluded from the final sample. In the case of the studies that only reported the m^2 NFA, the results were converted to m^2 GFA using a net to gross adjustment factor, as described in the following. The definitions 'usable floor area' and 'gross internal floor area' were considered to be equivalent to the NFA definition. As a general rule, GFA indicates the total constructed area, while NFA refers to the area inside the building and excludes the area covered by the outer walls of a building (ISO 6707 1).

All values of the sample were transformed to the common reference unit $\text{kgCO}_2\text{eq}/\text{m}^2\text{a}$ by dividing, where necessary, with the reference study period and square metres stated in each study. As previous studies have showed, differences in the building life span as well as in the reference study period could lead to significant variations in the results [47,48]. Hence, following this initial harmonization, a two step procedure was employed. First, the total sample of annualised EGHG values was normalised for a 50 year reference study period using Formula (1).

$$EGHG_{\text{norm}} = EGHG \left(\frac{RSP}{50} \right) \quad (1)$$

where

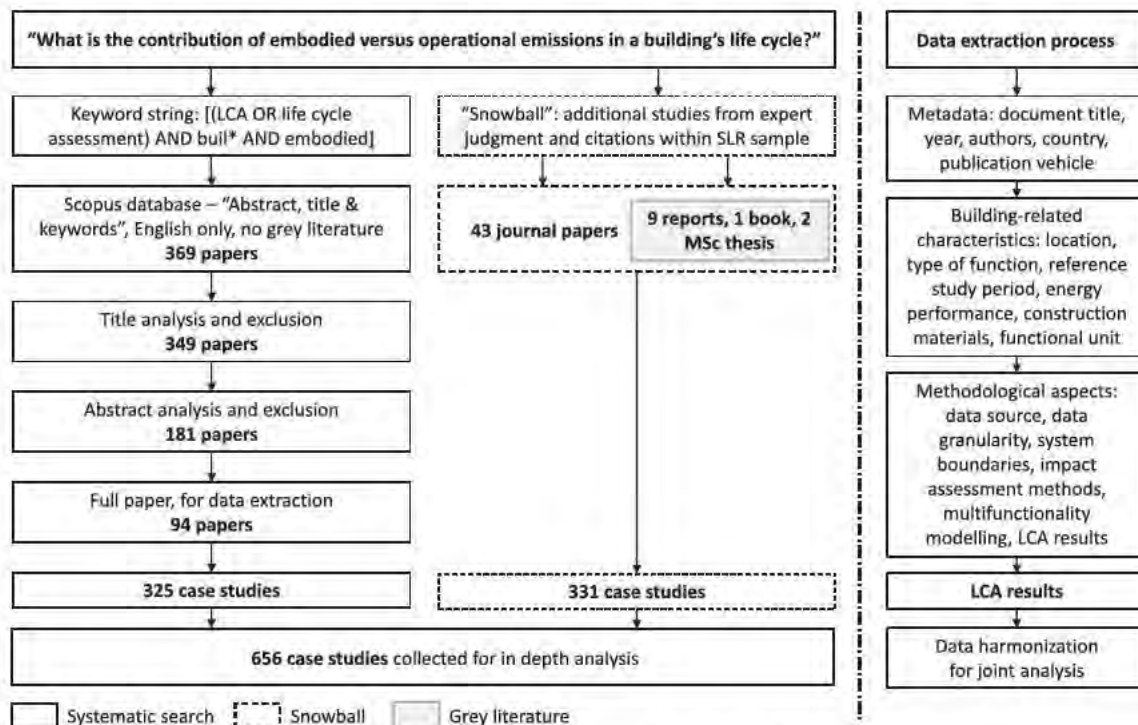


Fig. 2. Overview of systematic search and data analysis.

$EGHG_{norm1}$ = Annualized EGHG value after the 50 year normalization ($\text{kgCO}_2\text{eq/m}^2\text{a}_{50}$)
RSP = Reference study period considered in the investigated study

Second, using Formula (2) for building cases where only the NFA was known, the $EGHG_{norm1}$ values were converted into GFAs by applying a constant of 0.8 m^2 NFA per m^2 GFA (in line with [49]). However, the specific net to gross floor area conversion factor may differ across countries and building types due to differences in building codes and architectural practices [36].

$$EGHG_{norm2} = 0.8EGHG_{norm1} \quad (2)$$

The relative figures (i.e., share of embodied GHG emissions) were obtained by converting $EGHG_{norm1}$ values from step 1 into percentages.

2.2.2. Data classification

The final sample dataset was analysed with regard to the building type, energy performance standard and location. For building types, a two category division into residential and office buildings was employed. For the energy performance classification, the building cases were categorized into three different types of energy performance:

- (a) 'New advanced' buildings (i.e., studies assessing passive houses, low energy buildings or near/net zero energy or emission (NZEB) buildings);
- (b) 'New standard' practices (i.e., buildings following current standards regarding operational energy performance, which are in place as legal requirements in most of the countries investigated), or
- (c) 'Existing standard' buildings, i.e., constructed before the tightening of legal requirements for building operation (these 'existing standard' buildings make up the majority of the building stock).

For the latter two types, a point in time was defined before which buildings were considered to have a different level of energy performance. This time point was defined following a 'rule of thumb' regional approach and giving the label 'existing standard' to the following:

- All existing building cases built prior to 2005 for Europe and Australia. This date was chosen as critical for these two regions because a few years earlier, stricter energy standards began to be introduced, i.e., the first version of the Energy Performance of Buildings Directive (EPBD) in Europe in 2002 (updated in 2010) [50] and a '4 star' requirement in the Building Code of Australia in 2003 [51]
- All office buildings built prior to 2007 and residential buildings built prior to 2009 for the USA. The selection of these two dates is also based on the introduction of tighter energy standards in the US around that period of time, i.e., ASHRAE 90.1:2007 [52] and the 2009 International Energy Conservation Code (IECC)

Although each country has a different history with respect to enforcing stricter energy efficiency regulations and standards, defining a different point in time for each country included in the review was not

feasible. For the classification of location based climate zones, the widely applied Köppen Geiger climate classification (1980–2016) [53] was applied, focusing on its five main zones: (A) Tropical; (B) Arid; (C) Temperate; (D) Continental; (E) Polar.

2.2.3. Exclusion criteria and data quality requirements

One challenge identified in the screened literature was that a significant share of the published papers, surprisingly, either do not report their data sets in sufficient detail to allow an analysis of their scope or, in some cases, report implausible results. This limitation reduced the number of eligible results that could be included in the analysis to 583 cases. The systematic analysis focuses on studies investigating 'New buildings' (calculated GHG emissions of new building models and archetypes) and 'Existing buildings' (impacts of buildings already in operation) and was limited to residential and office buildings. All papers dealing with 'refurbishment' cases were excluded because, from a methodological point of view, they do not allow comparison with the results of new construction cases. This restriction reduced the dataset to 401 cases. Therein, studies reporting only embodied energy (EE) but no embodied GHG emissions (EGHG) were excluded because a 'general' conversion factor from primary energy to GHG emissions does not exist and a regional conversion based on the various differences in construction material use, fuel type or year was not feasible. The final dataset for the analysis of global trends was composed of 238 building cases based on 54 studies.

It is important to note that in many papers, the results were not provided in numerical terms but only given in graphs and charts. Although the extracted values from these papers are thus only visual approximations, they are accurate enough for the purposes of the present study and therefore were considered in the analysis if all other inclusion criteria were met.

Although the harmonization of the reference unit and reference study period of the results analysed in this study enables general comparison, the results are still influenced by the studies' diversity regarding building type, climate, scope in relation to the included life cycle stages, type of LCI data, etc. As these parameters could not be fully harmonized, they indicate a source of systematic uncertainty.

2.3. Final sample meta analysis

The meta data analysis of the studies contained in the final sample, as presented in Table 2, shows that the majority of case studies within the final sample come from European countries (74%), followed distantly by Asian countries (15%) and Oceania (6%). Cases from North America, South America and other regions make up only a minor fraction in this sample (sum of 5%). This distribution explains why the majority of case studies were located in either a Temperate (C) (64%) or Continental (D) climate (25%). The analysis thus revealed a clear research gap regarding studies from the Americas as well as from tropical countries more generally. This gap in the analysis is notable considering how outside temperature can affect heating and cooling energy demand during a building's use phase. In terms of building type and energy performance, the final sample is hence composed of office (52) and residential buildings (186), mostly adopting current standards in

Table 2

Number of cases in the final sample (and total of initially eligible but excluded cases) sub-divided based on, e.g., building's type of function, energy performance class, world region and climate zones (acc. Köppen-Geiger definition).

Type of function		Energy performance		World region		Climate zone	
Residential	186 (416)	Existing Standard	67 (89)	Europe	175 (388)	Tropical (A)	10 (27)
Office	52 (83)	New standard	111 (274)	Asia	35 (77)	Arid (B)	12 (18)
other	- (84)	New advanced	60 (159)	Oceania	15 (60)	Temperate (C)	153 (393)
		n/a	- (61)	North America	4 (21)	Continental (D)	59 (138)
				South America	7 (24)	Polar (E)	1 (1)
				other	2 (13)	n/a	3 (6)

energy performance, i.e., 'New standard' and 'New advanced' buildings.

For the reference study period (RSP) applied throughout the different studies, an RSP of 50 years was the predominant choice (approximately 60% of the sample). The preference for this specific estimation is consistent with the depreciation principles for construction investments [54].

3. Results and discussion

3.1. The increasing importance of embodied GHG emissions

The analysis of life cycle GHG emissions in the collected building

cases makes clear that with increasing energy efficiency in buildings, the relevance of embodied GHG emissions is increasing in both relative and absolute terms as shown in Fig. 3.

Fig. 3a presents the outcome of the analysis of the average of GHG emissions across the life cycle of the buildings investigated in absolute terms (i.e., $\text{kgCO}_2\text{eq}/\text{m}^2\text{a}$), distinguishing between embodied and operational GHG emissions (stacked bar graph). Furthermore, Fig. 3a shows the relative contribution (percentage) of embodied GHG emissions in buildings' life cycle GHG emissions (line graph). The figure presents these values for both residential and office buildings combined as well as separately for each of these building types. The results are further distinguished into three 'energy performance classes', ranging

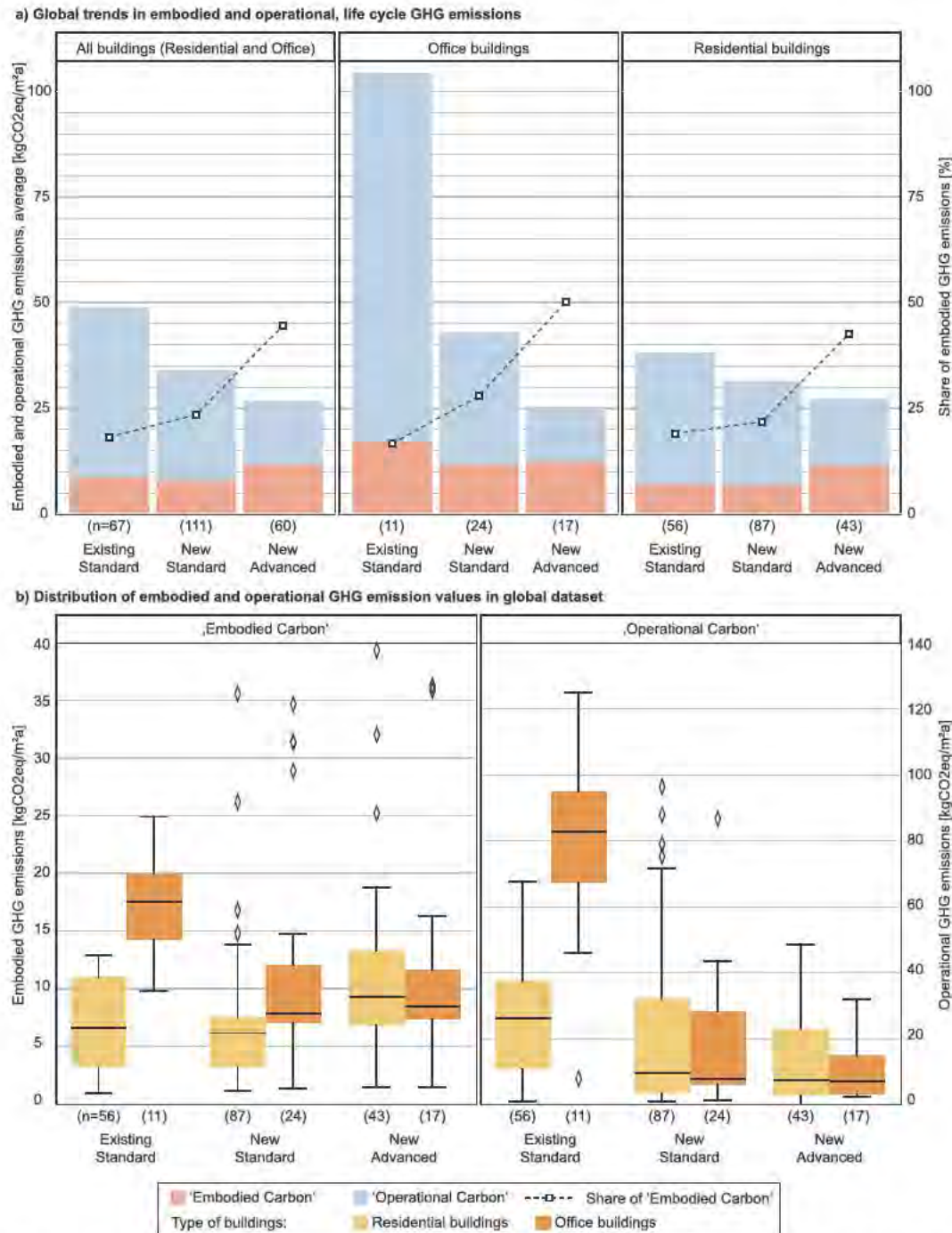


Fig. 3. Global trends in buildings' life cycle GHG emissions (a), and distribution of GHG emission values (b) for residential and office buildings by energy performance class.

from 'existing standard' buildings to 'new standard' and 'new advanced' buildings', as defined in the section 2.2. Focusing on this embodied GHG emissions share, there has been a global escalation of the contribution of embodied GHG emissions in both residential and office buildings from ~20% to ~50% in new advanced buildings, surpassing 90% in extreme cases. This relative increase in embodied GHG emissions is mainly because operational GHG emissions have dropped in the transition from existing buildings to buildings with new and advanced standards. These trends can be observed for both building types, i.e., in office and residential buildings. These results are consistent across different locations, i.e., there are similar trends in studies from Europe or Asia as well as in the full set of globally distributed LCA studies.

At the same time, embodied GHG emissions have, in absolute terms, either not declined or have even increased. Our analysis shows that this increase in embodied GHG emissions in absolute terms can be observed as an overall trend for residential buildings, where embodied GHG emissions have been increased on average, from approximately 6.7 kgCO₂eq/m²a for existing buildings to 6.7 and 11.2 kgCO₂eq/m²a in new and advanced residential buildings. The same trend is not found for the investigated office buildings, where in absolute terms, a decrease and levelling of embodied GHG emissions can be observed, from approximately 17.3 kgCO₂eq/m²a for existing buildings to 11.6 or 12.0 kgCO₂eq/m²a for new or advanced office buildings.

Investigating the distribution of data in more detail, as shown in Fig. 3b, values of both operational and embodied emissions are found to vary widely even for buildings of the same type and energy performance class. The absolute values for GHG emissions embodied in new buildings with standard and advanced energy performance, ranges from approximately 3.3–13.3 kgCO₂eq/m²a for residential buildings and 7.1–11.6 kgCO₂eq/m²a for office buildings (1st to 3rd quartile).

Complete descriptive statistics and related values can be found in Table S2 of the supplementary information. Furthermore, the distribution of embodied and operational GHG emissions is presented for cases from Europe and Asia in Figures S1 and S2, respectively. Potential aspects driving these differences are discussed in the section 3.5.

A critical investigation of these results reveals that the GHG emission peak for existing office buildings globally is mainly driven by results obtained from Input Output (IO) based LCA studies of office buildings in Japan [55] and the United States [56]. These two studies provide more than ninety percent of the 'existing' office building cases in the sample, while most of the other building cases use the Ecoinvent database (i.e., a generic database containing average environmental datasets about construction materials) either exclusively or in combination with regional data sources. An overview of the wide variety of data sources used by the studies contained in the final sample is provided in the supplementary information (Table S3). IO based LCA studies, in general, are known to yield impact results at a higher level than process based studies [36,57], which could explain why these studies report higher GHG emissions. The methodological differences between following a bottom up (process based) or a top down (IO based) approach arise at the very beginning of an LCA study, defining early modelling choices and paths to be taken by the LCA practitioner.

3.2. Life cycle GHG emission metrics of individual building cases

The life cycle performance of a building in terms of its environmental impact depends on various factors, as laid out earlier. Furthermore, the building function, related requirements for thermal comfort, and its occupational patterns during use, including user behaviour, influence life cycle impacts and, for that matter, GHG emissions.

Fig. 4 gives an overview of the individual results from the investigated studies by showing the total life cycle GHG emissions over the share of embodied GHG emissions. Coloured areas provide an approximation of clusters representing the energy performance classes. Note that to provide a clearer picture of the situation, we have limited

the y axis to 100 kgCO₂eq/m²a, hence omitting a small number of extreme results (occurring for reasons discussed in the methodology section). We observe a spread of life cycle related GHG emissions ranging from below 10 kgCO₂eq/m²a up to more than 90 kgCO₂eq/m²a. However, we can also clearly see a trend in which the energy efficient buildings, where operational energy consumption has been reduced (indicated by a higher share of embodied GHG emissions), have overall lower emissions across the life cycle. This result confirms the previous observation arguing that the improvement of energy efficiency in buildings did reduce overall GHG emissions (Fig. 3). Moreover, when zooming in on buildings with low life cycle GHG emissions in the reference study period (lower than 20 kgCO₂eq/m²a), it becomes evident that the share of embodied GHG emissions tends to increase from existing standard buildings to new standard and new advanced buildings.

This result is striking because it shows that it was and is possible to design low life cycle emissions buildings with all types of standards. However, buildings built with existing standards relied on smaller embodied GHG emissions and a higher contribution of operational energy and related GHG emissions. In contrast, for similar total GHG emissions, the buildings with newly advanced standards show a substantially higher share of embodied GHG emissions, which means that most of the GHG emissions saved through energy efficiency measures have been lost or even outweighed through extra emissions from building materials and technical systems.

Fig. 4 clearly shows a shift in the origin and therefore the timing of occurrence of GHG emissions from existing to advanced buildings. The results confirm that there is a general tendency towards a higher share of embodied GHG emissions, which, in the current analysis, correlate with lower total GHG emissions in the building's life cycle. At the same time, the results show that it is possible to achieve low total emissions without necessarily increasing the share of embodied GHG emissions.

As will be discussed in more detail, the results of LCA studies of individual building cases are influenced by a variety of parameters and methodological choices. However, across all these varieties, which are in part due to the large number of studies analysed, we see clear trends and consistent results in the average values shown in Fig. 3 and when investigating the clusters of individual studies' results as shown in Fig. 4. The results are therefore considered robust because they show consistent trends across studies from different geographical contexts, climate zones and building types.

3.3. European residential buildings and benchmark comparison

To improve the understanding of individual buildings' performance, we investigate the relation of the best practice examples in this analysis and existing benchmarks for buildings' GHG emissions.

As described in the meta analysis, most of the data collected in the systematic review are from buildings in Europe. Within this dataset, we observe a more homogenous situation regarding differences in geographical aspects as well as overall technical building standards. In this sense, an analysis is presented below focusing on how the residential buildings in Europe contained in the dataset perform in relation to existing benchmarks for buildings' life cycle performance as well as benchmarks for embodied GHG emissions. The benchmark used for comparison is the Swiss SIA 2040 [35]. The SIA 2040 provides well established benchmarks for buildings based on the '2000 Watt society' concept. The benchmark provides a life cycle based target value for buildings, including embodied impacts, operational impacts, and impacts due to so called building related mobility. These benchmarks were established following a top down approach based on a global GHG budget, which was transferred to a budget per capita. According to the Swiss 2000 Watt society principles [58], and according to the German Environment Agency [59], reaching a goal of reducing GHG emissions to 1 t CO₂eq per capita and year by the year 2050 puts us on track to achieve 'climate neutrality'.¹ SIA 2040 further splits this per capita budget into different sectors, such as housing, mobility or private and

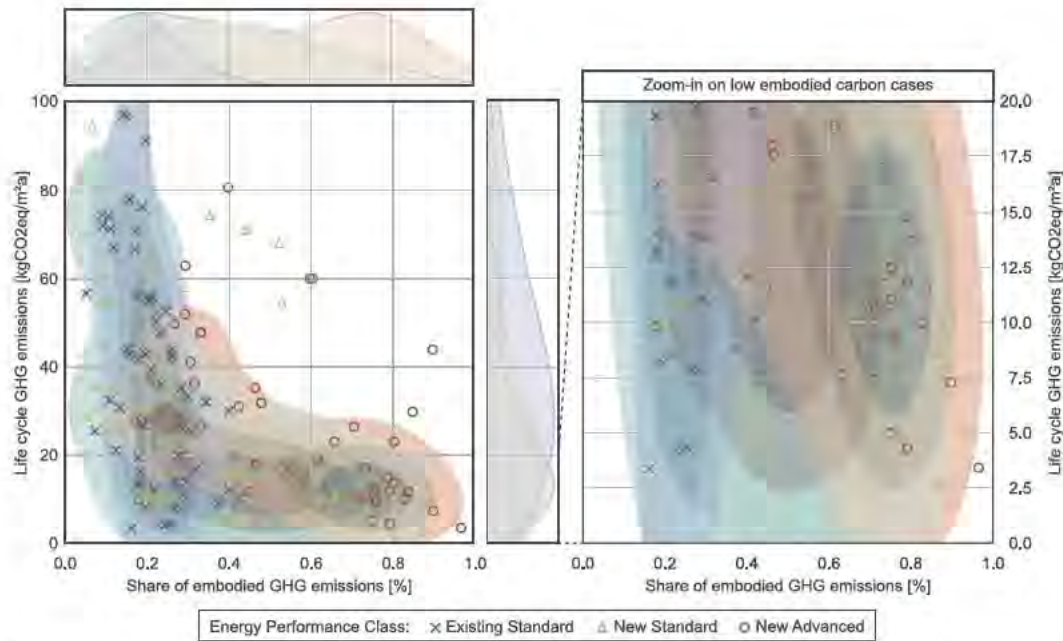


Fig. 4. Overview of individual results regarding GHG emissions across the life cycle and share of embodied impacts, incl. zooming in on the low life-cycle-emissions examples.

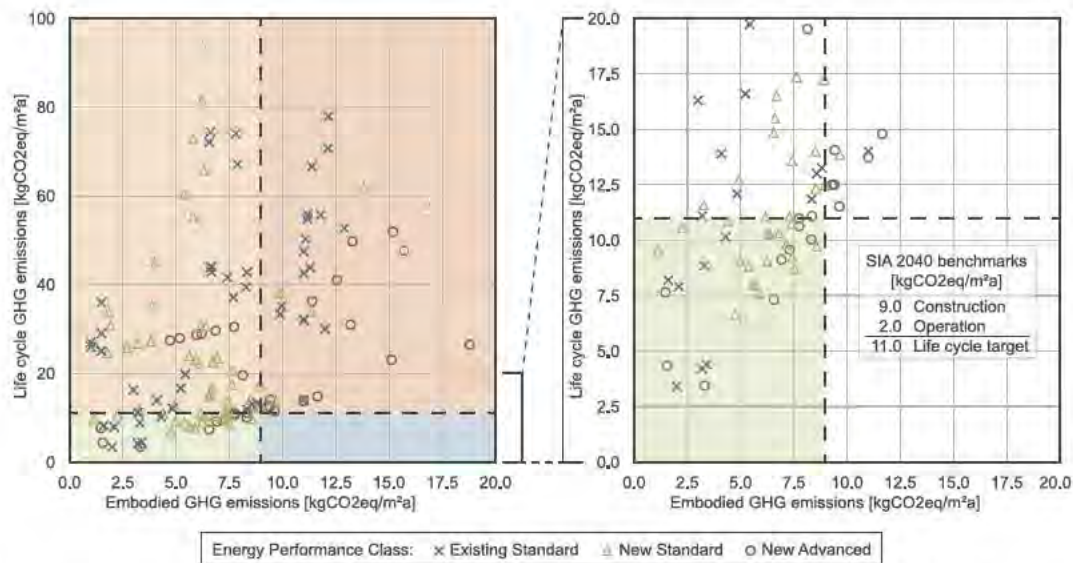


Fig. 5. European residential buildings' GHG emissions across the life cycle and absolute embodied GHG in relation to Swiss SIA 2040 benchmarks.

public consumption. Thirty six percent of GHG emissions are attributed to housing. Other countries currently have, or are planning to introduce, benchmarks for the GHG emissions of buildings (see [60]), but the 2000 W society benchmark is at this point considered one of the clearer approaches and has already been used by many studies in investigating the environmental impacts of buildings [61,62].

Fig. 5 shows the total life cycle GHG emissions of European residential buildings over the amount of embodied GHG emissions and the related benchmarks according to SIA 2040. The figure clearly shows that most of the buildings do not meet the target values. For the vast majority of cases, total life cycle GHG emissions are higher than 11.0 kgCO₂/m²a. This is the case independent of the buildings' energy

standard. For all energy performance categories, i.e., existing standards for new standard and new advanced buildings, only a few cases meet the benchmarks. Considering the buildings that do meet the targets, it can be observed that it is not necessarily the buildings with new standards that have a better chance of meeting the targets. This raises the question of the adequacy of building standards, focusing on operational energy efficiency, compared to the targets that need to be achieved to stay at a global temperature increase of 'well below 2 °C'. If new building standards do not necessarily meet the targets, which kind of building requirements, policies and directives have to be implemented to bend the GHG emission curve of buildings? The analysis shows that target values related exclusively to the operational phase are not sufficient for reducing life cycle GHG emissions. It is therefore necessary to develop and implement benchmarks addressing embodied GHG emissions and overall environmental life cycle performance to put buildings on track for ambitious and effective climate mitigation scenarios.

¹ At the time of writing, the 2000 W society benchmarks are under revision. Most likely, the benchmarks will be substantially lowered to comply with the scientific findings of the IPCC 1.5 °C special reports [76].

3.4. Temporal distribution: the 'carbon spike' from initial GHG 'investments'

The importance of addressing embodied GHG emissions is further emphasized when considering the temporal distribution of life cycle GHG emissions due to the 'carbon spike' resulting from building production. In the context of the Paris climate goals and limited GHG emission budgets for achieving net zero GHG emissions globally, as emphasized in the IPCC 1.5°C special reports [2], emissions across the life cycle of buildings have to be lowered to 'net zero' eventually. Hence, the GHG emissions invested in erecting and modernizing buildings and other infrastructure must be 'cost effective', i.e., their GHG 'investment' has to contribute to eventually reducing the level of GHG emissions from a whole life cycle perspective. The previous sections showed that investing more in embodied GHG emissions does not necessarily reduce life cycle GHG emissions and that 'advanced' building concepts are not necessarily the most effective way to achieve low life cycle GHG emissions.

To further explore the issue of GHG investment, Fig. 6 illustrates the temporal occurrence of GHG emissions across the building life cycle. The figure draws on the average values for embodied and operational GHG emissions as shown in Fig. 3, partly reversing the normalization and transforming the values to the accumulated sum of embodied and operational GHG emissions across the years of the life cycle. Embodied GHG emissions therein are distributed by allocating GHG emissions across different life cycle stages based on shares from the literature [63]; i.e., the production and construction process stage (64%); the use stage (maintenance and replacement) (22%); and the end of life stage (14%).

Fig. 6 conceptually shows the accumulation of GHG emissions plotted at the time of occurrence on a year by year basis for 'New Standard' and 'New Advanced' buildings. In this exercise, all GHG emissions associated with the replacement of construction elements during the use stage are modelled as taking place in one single year, i.e., in year 25 after construction. In reality, both replacement activities and the related GHG emissions would occur at different discrete points in time during the use stage.

The embodied 'carbon spike' occurring in the year of construction (plotted in year 1) relates to emissions from the production of building

materials and the construction of the building. Following the findings presented earlier in Fig. 3, on average, this initial GHG investment for 'New Standard' buildings is 253 kgCO₂eq/m². For 'New Advanced' buildings, the initial investment is 377 kgCO₂eq/m² on average. Investigating the dataset in detail, the variety of this initial GHG investment for new standard or advanced buildings ranges from 103–423 kgCO₂eq/m² (1st to 3rd quartile) and surpasses 1250 kgCO₂eq/m² in extreme cases. The replacement of materials, when summed as one occurrence, generates an additional spike of GHG emissions during the use stage, in the magnitude of on average 87 kgCO₂eq/m² for 'New Standard' buildings and 132 kgCO₂eq/m² for 'New Advanced' buildings (based on today's GHG emissions of materials manufacture).

In contrast, operational GHG emissions occur throughout the building life cycle and are plotted on an annual basis, with amounts of 26 kg kgCO₂eq/m²a for 'New Standard' buildings and 15 kgCO₂eq/m²a for 'New Advanced' buildings. Assuming constant GHG emission values and plotting over the reference study period (50 years), the accumulating operational GHG emissions exceed the amount of embodied GHG emissions of 'New Standard' buildings after approximately 10 years of operation. For 'New Advanced' buildings, this break even occurs only in year 35, i.e., after all GHG emissions from replacements have been taken into account. This 'static' approach towards modelling operational impacts can be considered the default procedure in building LCA. However, due to ambitions to increase renewable energy production, the annual GHG emissions related to the energy demand of buildings are expected to decrease. According to the International Energy Agency (IEA), global GHG intensity of energy production fell an average of 2.0% in the period 2014–2018 (International Energy Agency, 2019). Projecting that trend of emission intensity reduction, the actual relevance of GHG emissions from operational energy use will further decrease with time. This trend towards increased GHG emissions efficiency in production is expected to also lower the embodied impacts associated with the future replacement of building materials and the end of life treatment of construction materials. However, the figure shows that improvements to material production and end of life treatment are less relevant to the accumulated GHG emissions than is the reduction in operational GHG emissions.

When considering the expected GHG emission reduction of the

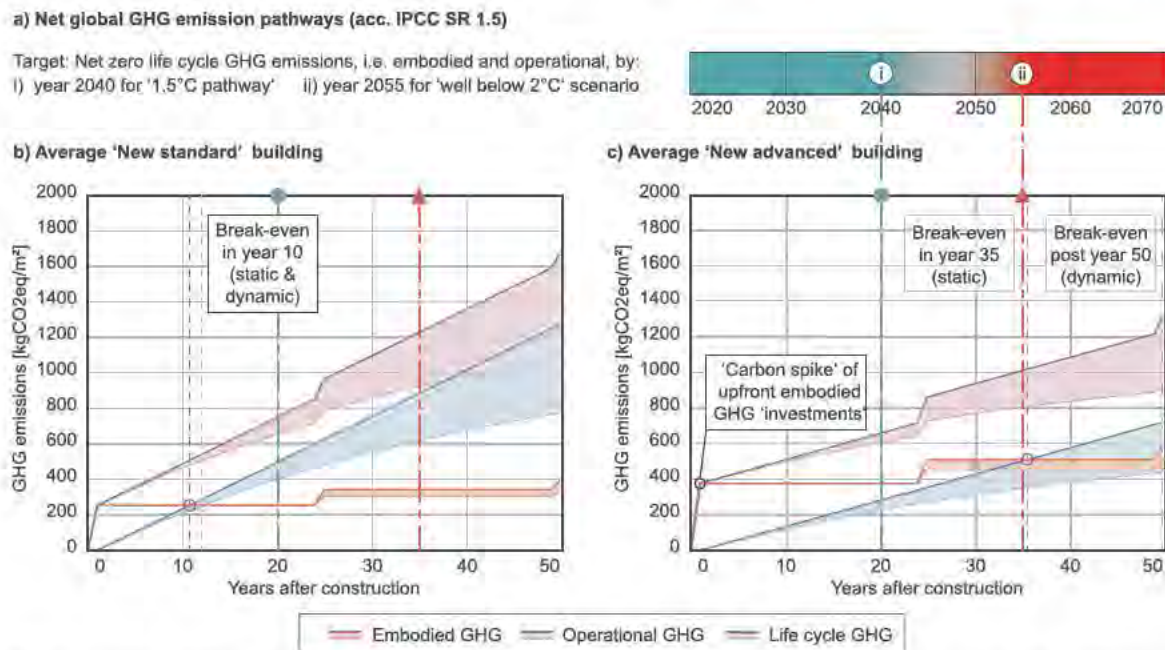


Fig. 6. (a) IPCC GHG emission reduction pathways (acc. [2]) in relation to the temporal distribution of GHG emissions (embodied and operational) across the life cycle of (b) 'New Standard' buildings and (c) 'New Advanced' buildings. Projections for future reduction of emission intensity (hatched areas) are based on a yearly improvement of 2% (acc. IEA [4]).

energy mix in the future, the ‘investment’ of embodied GHG emissions due to building production is becoming the single most influential source of GHG emissions in the life cycle of buildings (as shown in Fig. 6). In this case, the comparison of embodied versus operational GHG emissions in the life cycle of ‘New Advanced’ buildings reveals a ratio of approximately 1:1 on average, with embodied GHG emissions dominating the timeframe available for effective climate change mitigation measures.

Furthermore, this analysis also showed that a 2% annual decrease in the GHG emissions intensity of grid energy [4] will only bring about half the emission reductions needed for the net zero target of 2050. Hence, this demands that the energy sector further accelerate the decarbonisation of energy provision to reach that target. Simultaneously, decarbonisation efforts related to building operation need to further reduce energy demand and GHG emissions from building operation in the future, down to ‘near zero’. The potential strategies for improving energy systems on different scales and through different technologies (e.g., district heating or combined heat and power (CHP) vs. electrification and use of heat pumps on a building level) have to be assessed on a case by case basis with regard to their economic and technical feasibility as well as their effectiveness in reducing GHG emissions and other environmental impacts [64–66]. In line with IPCC recommendations, this requires “*new construction to be fossil free and near zero energy by 2020*”, and “*an increased rate of energy refurbishment of existing buildings to 5% per annum in OECD countries*” [5]. To achieve the required ‘near zero’ energy performance for both new and existing buildings, additional embodied GHG investments in building materials and systems are necessary.

As these embodied GHG emissions are occurring upfront, i.e., at (or prior to) the time of construction, they are exceptionally relevant considering the need to decarbonize the global economy while respecting limited GHG emissions budgets. This situation emphasizes the urgent need to assess and optimize the effectiveness of embodied GHG emissions invested in buildings.

In this paper, the term ‘decarbonisation’ is used to describe the process of reducing emissions of carbon dioxide (CO₂) and other greenhouse gases (GHG), which is consistent with the wording used by, e.g., the IPCC. Because the GHG emissions reduction is achieved mainly through reduction of fossil fuel based energy provision, the term ‘defossilisation’ is found more and more in contemporary discourse.

3.5. Limitations and methodological considerations

LCA results are heavily dependent on the methodological choices made by practitioners. Moreover, when applying the method to a complex and long living system, i.e., an entire building, the number of crucial aspects and scenarios to be considered increases. In these cases, practitioners’ preferences and idiosyncrasies, coupled with the peculiarities of the systems that compose a building and their interactions, play a significant role in the LCA’s modelling design.

To collectively assess the findings of whole building LCAs, one must identify certain archetypes that allow the case studies to be compartmentalized into groups. Here, as previously mentioned, the results were divided among others based on the type of function (office or residential), energy efficiency performance, building location and climate zone. Nevertheless, harmonizing the results within those groups was sometimes challenging. The obstacles faced were twofold, related either to varying building and use characteristics or to how the LCA was modelled. The former involves various specificities within a case study, including certain outstanding aspects: (i) the size of the building (number of stories and built area), (ii) the construction materials used (mainly those in the building’s structure and envelope), (iii) the location of the building (due to related differences in, e.g., building requirements, climatic context, cultural norms), (iv) the various technical systems used to provide cooling or heating, as well as (v) socio-economic aspects and their influence on, e.g., operational energy

consumption, as shown by [67–70]. Even within one category, these factors affect lifecycle impacts and can lead to divergent results.

Regarding methodological choices in LCA, a number of differences can arise and affect comparability. First, the scope of the assessment in terms of the life cycle stages considered greatly affects the outcome regarding environmental impacts. Although all the assessed papers covered (at least) the product stage (A1–A3 according to EN 15978) and the operational energy use (B6), papers that included additional stages were kept in the sample, and the level of data granularity within similar stages might have differed. Furthermore, the differences in the scope of the assessment (i.e., including building components and life cycle stages covered) are critical for comparison. Hence, the extracted LCA results could have been influenced by the varying scopes of the LCA studies performed, which are seldom reported in detail (e.g., by publishing the Life Cycle Inventory (LCI)). Even in cases of similar assessment scopes, it is still likely to have variations in LCA results due to the application of different data sources [71,72]. There is a diverse range of sources (and providers) of LCI data for common building products and processes, and these sources might not always use the same cut off rules, allocation principles and other underlying assumptions. This diversity results in different emission factors for the same category of building material, product and component. As some authors suggest, data quality indicators can be helpful in this case [73]. In any case, these differences were documented, and the related results went through the same harmonization process as explained in the methodology section.

Another limitation and important aspect of the analysis of published LCA studies is their general lack of transparency. In many cases, basic methodological assumptions were omitted and at times impossible to trace within the publications. The obscurity of key aspects of the LCA leads to superficial results, preventing aggregated analyses that can eventually feed decision making [74]. Thus, comparability was hindered, and for that reason, several papers had to be excluded from the review. LCA studies, even while allowing diverging scopes and some freedom for interpretation, are robust enough to set benchmarks and scientifically grounded public policies regarding the required performance of the built environment if certain key requirements are followed. To properly implement this approach, however, the global scientific community needs harmonized and clear guidelines on how to perform and document whole building LCAs; such guidelines are long overdue. Proposals for harmonizing the LCA of buildings on an international level can be based on existing standards, e.g., the ISO 14000 series or European EN 15978, and are also being developed, for example, within the ongoing activities of IEA EBC Annex 72 [75].

4. Conclusions and outlook

The study presented in this paper applied a systematic approach to identifying and analysing GHG emissions in the building life cycle. The analysis was based on the systematic review of more than 650 in individual building LCA studies, with a final sample of 238 cases fit for evaluation.

The results show that the reduction in life cycle related GHG emissions is a global trend for buildings that have adopted new energy performance standards for building operation. At the same time, the contribution of embodied GHG emissions increases up to and beyond a ratio of 1:1 (embodied:operational) when we consider a 50 year period. The relevance of embodied GHG emissions further increases when anticipating future reductions in GHG emissions from building operations. This projection assumes current policies, i.e., ‘net zero’ GHG emissions from operational energy use due to renewable energy carriers and no (substantial) reduction in embodied GHG emissions (i.e., in construction material manufacture).

The investigation of the temporal distribution of GHG emissions revealed the importance of the initial, upfront ‘carbon spike’ from the production of building materials and systems. This initial investment of GHG emissions embodied in the investigated ‘New advanced’ buildings

dominates the GHG emissions released in the timeframe relevant for decarbonisation. This result highlights the need to address and reduce operational as well as embodied impacts in the context of limited GHG budgets.

It was further shown that existing life cycle related benchmarks (for example, the Swiss SIA 2040) can be achieved with different strategies, i.e., high or low embodied GHG emissions, opening the discussion of the effectiveness of 'GHG investments'.

In conclusion, the results of this study highlight the need to address and further reduce the life cycle related GHG emissions of buildings by optimizing embodied emission investments for new construction and promoting 'carbon effective' investments for the refurbishment of existing buildings.

Considering the IPCC backed call for action towards a global net zero GHG emissions economy by 2040, profound changes are needed in the construction and use of buildings. First, as an integrated part of the transition in the energy sector, energy systems and technologies implemented for new and refurbished buildings today have to support fossil free, zero emission building operation by 2040. Second, attention must be paid to reducing the embodied GHG emissions invested in buildings to net zero emissions, i.e., industries that produce construction materials need to offer net zero GHG emission materials by 2040. To support effective climate change mitigation, embodied GHG emissions invested until then must be 'carbon effective' and respect limited carbon budgets. In this context, aspects of sufficiency and optimization of occupational density as well as other potential strategies for reducing the demands of new construction activity deserve further attention after all, reducing the area of square metres built is still the most effective way to reduce both embodied and operational GHG emissions.

This crucial transition of the building and construction sector demands a notable and cross sectoral effort. It requires implementation by building design professionals, and the relevant (construction) industries to decarbonize their production to achieve net zero embodied emissions for future building construction. Furthermore, building owners and users are urgently challenged to implement activities and practices that further reduce GHG emissions for building operation and to move towards net zero emissions.

To support this transition in building construction and operation, a clear policy narrative (e.g., introduction of a roadmap and/or regulations) is an important lever with which to enable the concerted action of all industries and actors who influence GHG emissions in the life cycle of buildings.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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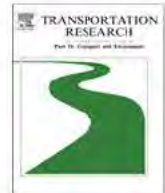
Appendix A. Supplementary material

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.apenergy.2019.114107>.

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The net greenhouse gas impact of the Sheppard Subway Line



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ABSTRACT

As cities work to reduce their total greenhouse gas (GHG) emissions, the transportation sector is lagging, accounting for a growing percentage of total emissions in many cities. The provision of public transit, and specifically urban rail transit, is widely seen as a useful tool for reducing urban transportation GHG emissions. There is, however, limited understanding of the net impact of new metro rail infrastructure on urban emissions. This paper examines the net GHG emission of the Sheppard Subway Line in Toronto, Canada. The GHG emissions associated with construction, operation, ridership and changes in residential density associated with the provision of the new metro rail infrastructure are assessed. These components are then combined and compared to calculate the net GHG impact across the study period, which extends from opening in 2002 through 2011. The GHG pay back period is calculated. After nine years of operation, the Sheppard Subway Line is found to have nearly paid back its initial GHG investment in the optimistic case. The payback was due to the calculated mode shift from automobiles, changes in residential density and associated energy savings in the station pedestrian catchment areas. The payback period is very sensitive to the potential for induced demand to backfill the mode shifted automobile kilometres.

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1. Introduction

The negative impact of greenhouse gas (GHG) emissions on climate change has been prominently discussed in the academic literature, in the press and by governments. International bodies, governments and citizens groups have called for a reduction in GHG emissions to avoid the most catastrophic impacts of climate change. To this end, many countries and cities have declared ambitious greenhouse gas reduction targets. In cities around the world, transportation emissions are an increasing percentage of all GHG emissions. While urban GHG emissions in other sectors have begun to decrease, the emissions due to transportation have largely held steady and make up an increasing fraction of total GHG emissions (Banister, 2011). The total transportation emissions and emissions per capita vary from city to city and are tied to urban form and the provision of public transport (Kennedy et al., 2009). The majority of urban transport emissions are due to road based transport, particularly in cities and neighbourhoods that lack public transportation alternatives. This is due to the high number of trips that are made by automobile and the average GHG intensity of automobile travel, which is generally higher than other modes. The development of a robust public transportation system is often proposed to reduce urban transportation

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emissions. The provision of mass transit has been identified as a key opportunity in the reduction of global GHG emissions with the potential to save 25 GtC over 50 years (Pacala, 2004).

Globally, cities are expanding their urban rail networks (Newman et al., 2013). There are many reasons to expand rail transport, such as congestion relief, expanding access to public transport, attracting development, and environmental stewardship. It is generally accepted that the development of urban rail reduces urban GHG emissions by reducing road based transport emissions and encouraging density. In general, the literature supports this perception; studies have repeatedly shown that, per kilometre travelled, moving by public transport is 'cleaner' than driving a private vehicle (Newman, 2000). However, these studies often exclusively assess transport during operation, ignoring the GHG emissions associated with infrastructure construction, the uptake of new metro infrastructure by users of other modes, the potential for induced demand onto roads and the potential of transportation infrastructure to affect urban form.

This limitation in scope can mask the real GHG impact of new metro rail and hide the need for supporting policies and interventions to maximize the GHG benefit of rail infrastructure. As cities take action to reduce their GHG emissions, they need to understand the quantifiable effectiveness of proposed interventions of new metro rail infrastructure and under what conditions the GHG benefit will be maximized. For new transportation infrastructure projects, this evaluation should include an assessment of life cycle impacts of the infrastructure, actual mode shift and mode share patterns, and the ripple effects on urban form.

Life cycle thinking and consideration of GHG payback periods are emerging considerations in thinking about transportation infrastructure (Gallivan et al., 2014). However, to date, few studies have looked at the GHG payback of metro rail infrastructure. Of the studies that have been published, the majority have focused on the lifecycle GHG impacts; less work has been done to assess the GHG savings associated with opening the line or the length of time and the behaviours/policies needed to payback the initial GHG investment. In particular, the impact on urban form is under explored in the literature, though the GHG impacts of the connection between transport infrastructure developments and transport land use interaction is starting to be made (Nahlik and Chester, 2014).

Chester and colleagues have found that the GHG emissions associated with rail systems increased by a factor of 1.6–2.5 when taking a lifecycle approach (Chester and Horvath, 2009). In contrast to some other work in the area, Chester considered the lifetime of construction through individual structure types or materials rather than assigning a lifetime to the rail system as a whole: This ranges from substations with a lifetime of 20 years to concrete at 50 years (Chester, 2008). In other rail examples, construction emissions are predicted to account for 15% of the lifecycle emissions for Crossrail, a new rail line under construction in London (Paris and de Silva, 2010); the Hong Kong MTR attributes 11% of total life cycle emissions for their railway to civil infrastructure embodied GHG (MTR, 2013). Crossrail and the MTR find much lower impacts from infrastructure in large part because they assess the projects over a much longer 120 year lifespan.

Calculating the GHG investment required to construct the rail infrastructure in theory facilitates assessment of the GHG payback period for the project. In practice, however, the GHG payback period of rail transport infrastructure has rarely been assessed. Of the available case studies, the first cases date from the 1970s oil crisis. In this period, Lave assessed the energy intensity of the BART System in San Francisco. The work does not address GHGs but is relevant as energy use and GHG emissions are highly correlated. Given the energy input in construction and the operational savings of ridership on the metro at the time, a payback period of 535 years was required (Lave, 1978). The long payback period was due primarily to the relative operational energy intensity of buses and metro at the time, buses required less energy per PKT and much of BART's early ridership had shifted from the bus network. Rail vehicles are heavy, requiring more energy to move than a bus; for per capita energy impact to advantage rail more riders are needed per vehicle.

The contemporary challenge of GHG emissions and associated climate change has prompted a re-emergence of life cycle thinking in infrastructure. Assessments of the GHG benefit of rail infrastructure are starting to be compared to the life cycle GHG cost, in order to assess the net GHG impact. In general, the assessed benefits and the GHG payback period have been based on ridership impacts, namely the reduction in automobile use. In assessing the GHG payback period for the Gold Line Rail Line in Los Angeles California, Chester et al. (2012) found that a minimum mode shift from automobiles of 35% was required to payback the GHG investment of constructing the line (Chester et al., 2012). Travel surveys indicated that 67% of Gold Line users were previously driving leading to payback within the first decade of operation (Chester et al., 2012, 2013b). Similarly, the predictions for Crossrail are that it will most likely payback the initial carbon investment in 9–13 years (Paris and de Silva, 2010). This payback period is based on a calculation of 530 million fewer vehicle kilometres (VKT) travelled in London after opening of Crossrail (Paris and de Silva, 2010). The calculated GHG paybacks in both of these examples are heavily dependent on reductions in private automobile use. The potential for releasing unmet travel demand onto the roads is not discussed. In addition, the urban form impacts of new metro rail were not included in either of these assessments. New automobile users induced onto the road would mitigate the GHG savings associated with mode shift. Changes in urban form, specifically densification around transit nodes, have the potential to lead to meaningful GHG savings. A full assessment of the GHG impact should consider these two factors.

Researchers are now exploring the opportunities for combining urban development policies and transit infrastructure to reduce GHG emissions (Nahlik and Chester, 2014; Kimball et al., 2013). The existing work mostly evaluates future potential GHG savings and is based on projections of what might happen, rather than measurements of observed changes around an existing rail system as assessed in this paper. These predictions show that, through a coupling of transportation and land use planning, there is a large potential for GHG savings. Looking at the Phoenix LRT, Kimball et al. (2013) found a potential GHG saving of 36% by combining densification planning with public transport deploy

ment compared to business as usual (Kimball et al., 2013). The yearly potential saving in GHG is calculated to be 1700 230,000 MgCO₂e, ranging with the achieved residential density (Chester et al., 2013a). Similar results were found in LA, where up to 40% of GHG emissions could be avoided through combined transit and land use planning (Nahlik and Chester, 2014).

As cities increasingly turn to rail transit to meet their mobility requirements, a greater understanding of the net GHG impact of new rail infrastructure is needed. The existing literature has looked at the lifecycle GHG impact of rail infrastructure in only a few cities. The published work is focused on surface rail rather than underground systems and has only started to include urban form effects in calculating the life cycle benefit. This research expands understanding of the lifecycle GHG impact of rail infrastructure by assessing underground rail through measured rather than predicted outcomes. Detailed assessments of the GHG impact of the Sheppard Subway on ridership and land use can be found in Saxe et al. (2015, 2016b). This paper investigates the combined GHG impact of construction, operation, ridership patterns and changes in urban form associated with the Sheppard Subway Line in Toronto. The GHG payback period is calculated and sensitivity tested.

1.1. The Sheppard Subway Line

The Toronto Sheppard Subway Line opened in 2002 bringing subway access to a new part of Toronto. It is 5.5 km long running between Sheppard-Yonge and Don Mills Stations. Fig. 1 illustrates the Sheppard Line within metro public transit in Toronto.

2. Methods

The GHG from construction is estimated from available construction data and correlations to the literature. The operational GHG is calculated from operational energy requirements provided by the operating transit authority and published GHG energy intensity conversion factors. The impacts of changes in ridership behaviour are assessed through an analysis of ridership counts and on board surveys. Longitudinal changes in mode share are assessed using transit survey data. For further details on calculation of the operational GHG cost and savings through ridership behaviour refer to Saxe et al. (2015, 2016a). The relationship between new metro and changes in residential density is investigated by comparing the change in accessibility provided by the case study metro lines and the subsequent observed changes in residential density and by a quasi experimental analysis of the changes in residential density compared to controls, refer to Saxe et al. (2016b). The GHG impact of changes in residential density is calculated from the relationship between residential density and energy expenditure reported in the 2006 Canadian long form census (Statistics Canada, 2006c).

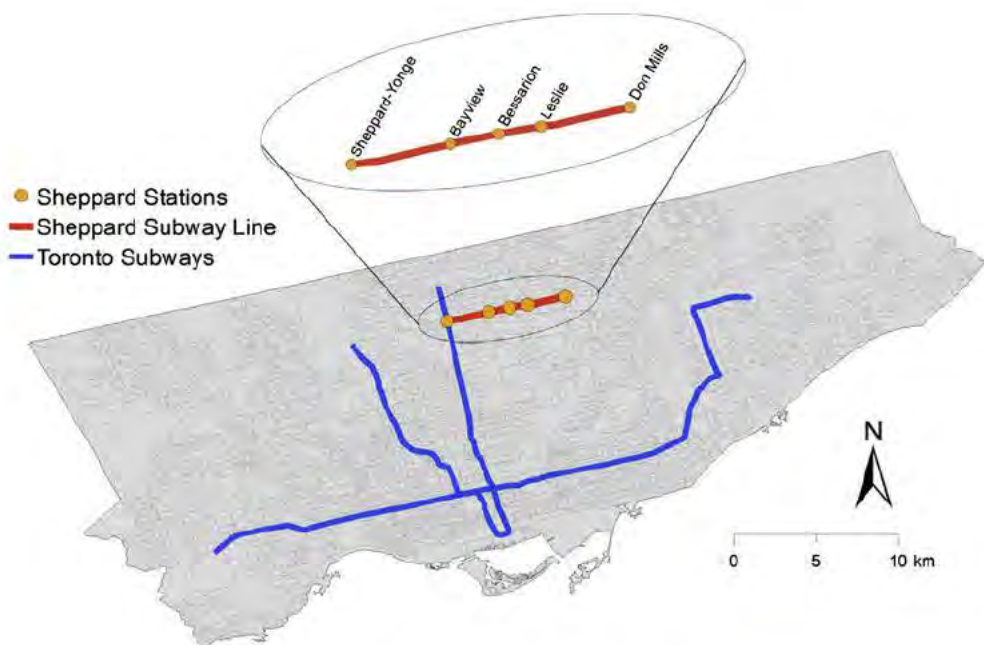


Fig. 1. Toronto Transit Commission Subway Route Map (Saxe et al., 2015).

2.1. Study boundaries

Saxe et al. (2016a) propose a holistic assessment of the GHG impacts of new rail infrastructure (Saxe et al., 2016a) shown in Fig. 2. Another framework for assessing the GHG impacts is provided by the American Public Transportation Association (APTA) (APTA climate change standards working group, 2009). However, with its focus on calculating yearly emissions, the APTA recommendations do not consider construction emissions as central to the GHG impact (as they are the emissions of others i.e. Steel manufacturers) or provide much discussion on the impact of induced demand. Similarly as this research deals with a specific infrastructure project, the land use multitier approach proposed by APTA which is meant for regional scale assessments is not appropriate at this scale.

While efforts were made to analyse all of the identified factors in the GHG impact of new rail infrastructure, due to data limitations some elements are excluded. Fig. 2 highlights the elements included in this research. Elements highlighted in **bold** are analysed in detail using case study specific data; those in *italic* are touched on or assessed through the literature. Those left in standard type are outside the scope of this work. The construction of new transportation infrastructure will have many ripples on the development of a city, its urban form and travel mode share breakdown. This study focuses on the local effects within 3.2 km (2 miles) of the new subway and the marginal impact of adding the case studies to the existing local transit network.

Key exclusions include:

- (1) Other infrastructure not built: Enough provision of one type of transport infrastructure has the potential to reduce the need for other types of transportation infrastructure, eventually resulting in less construction and a reduction in GHG emissions.
- (2) The assessment of GHG has been limited to the civil infrastructure. The impacts of constructing, maintaining and replacing the mechanical vehicles required are excluded. For urban rail, the GHG impact of the vehicles is between 2% and 4% of the total (Chester, 2008).
- (3) The impact of changes in urban form on commercial and industrial energy use is excluded from this research. Data on commercial and industrial energy use was not available in Toronto; further, data on the location of employment in the study area was not available at a sufficient resolution to separate the station catchment area from the surrounding land uses. In addition, there is a risk that intensified land use displaces more energy intensive jobs such as manufacturing. This requires more research.

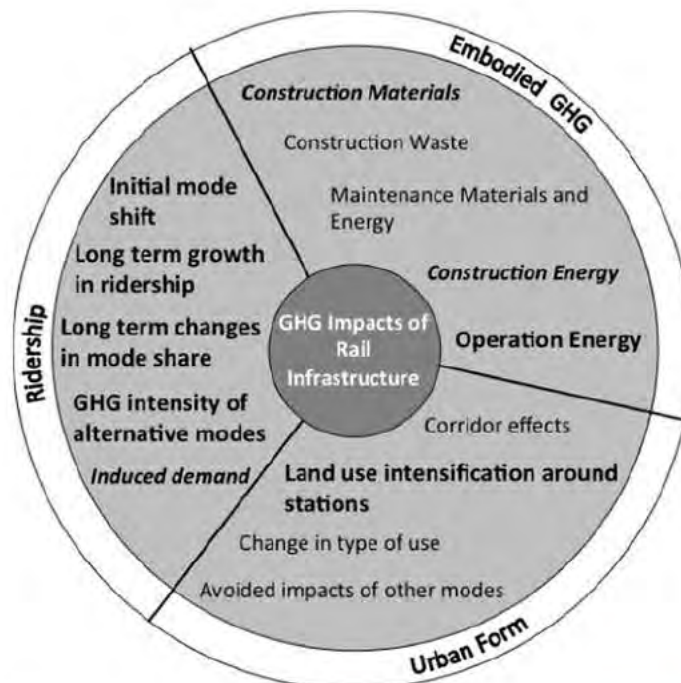


Fig. 2. Elements of holistic assessment included in current research (After Saxe et al., 2016a).

3. Calculations

3.1. The greenhouse gas impact of construction

The construction of new metro infrastructure necessitates the use of significant amounts of materials and energy. GHG emissions associated with construction activities are due to:

- (1) Manufacturing of construction materials, including mineral extraction by mining, logging, and processing of raw materials;
- (2) Direct construction energy consumed onsite; and
- (3) Transportation energy used in movement of people, materials and machinery to and from site (Soga et al., 2011).

The construction industry consumes a massive amount of new and recycled materials, from concrete and steel to wood and plastics. Before it can be used for construction, each material must be extracted, processed and transported to site. This process is very energy and resource intensive. Significant environmental impacts are embodied in the use of any material for construction. In Canada in 2012, the construction industry consumed 92 PJ of energy (Nyboer and Bennett, 2015). The world wide impacts of construction materials on global GHG emissions are significant. For example, annually, 1.45 giga Tonnes of cement is produced worldwide accounting for 5% of global anthropogenic CO₂ emissions. In Toronto, the GHG intensity of 20 MPA concrete is 0.084 kgCO_{2e}/kg (assuming a concrete density of 2400 kg/m³) (Athena Sustainable Materials Institute, 2005) and the GHG intensity of steel rebar is 0.602 kgCO_{2e}/kg (Athena Sustainable Materials Institute, 2002). For scale, the annual average Canadian GHG emission are 20.6 metric tonnes per person (Environment and Climate Change Canada, 2016).

Construction of the Sheppard subway line required 6.2 km of new twin tunnels, 4 new stations and the expansion of the existing Sheppard Station on the Yonge University Spadina Line into the interchange station Sheppard Yonge.

3.1.1. Tunnels

The Sheppard Subway Line was constructed using a combination of cut and cover excavation and bored tunnels. The running tunnels range from 15 to 18 m below ground and are 13 m apart. Reinforced segmental concrete lining was used to support the tunnels (Transit Toronto, 2012) which have an internal diameter of 5.2 m (Canadian Consulting Engineer, 2002). The Toronto Transit Commission provided key quantities of concrete and rebar used in the construction of the Sheppard Subway. For each metre of tunnel, 11 m³ of concrete and 8.8 tonnes of rebar was used (Toronto Transit Commission, 2013).

3.1.2. Stations

The stations were built using cut and cover bottom up construction. Soldier pile and lagging support was the most commonly used retaining wall system. Interlocking secant pile walls were also used at headwalls and at Sheppard Yonge Station. Both anchors and props were used for lateral support (Anchor Shoring, 2013b, 2013a). Table 1 lists the concrete and rebar quantities used in construction of the Sheppard Subway Line stations. At Sheppard Yonge Station, Bayview Station and Don Mills Station the adjacent cut and cover excavated sections are included (e.g. wye structures and crossover tracks).

3.1.3. Estimate of capital GHG

Overall, the construction of the Sheppard Subway Line required 358,851 m³ of concrete and 40,000 tonnes of rebar (Toronto Transit Commission, 2013). These equate to GHG emissions of 96,482 tCO_{2e} for the concrete and rebar use alone. The concrete and steel rebar assessed here is assumed to contribute the bulk of the construction material GHGs. Materials, however, are not the only contributors to construction GHG. In an assessment of Crossrail in London, the material use accounts for 57.6% of the total GHG emissions (Paris and de Silva, 2010). Assuming this relationship holds for the Sheppard Subway, the total GHG emissions for the Sheppard Subway Line are 167,503 tCO_{2e}. The Sheppard Subway took eight years to construct equating to an annual average GHG impact of 20,938 tCO_{2e}/year.

3.2. Operation of the Sheppard Subway Line

In 2012, operation of the Sheppard Subway Line consumed 22,940,200 kWh. The majority of the energy, 83%, is used for traction energy with the remaining for station operation and routine maintenance. Since 2002, operation of the line has con

Table 1
Concrete and rebar use for Sheppard Stations (Toronto Transit Commission, 2013).

Station Name	Total concrete (m ³)	Total rebar (tonnes)
Sheppard-Yonge Station, Cross-over & Wye Structures	82,500	14,362
Bayview Station & Cross-over Structures	39,975	5400
Bessarion Station	20,856	3420
Leslie Station	37,130	3548
Don Mills Station, Cross-Over, Tail Track Structures & Parking Deck	55,000	6026

sumed a steady amount of energy plus or minus 10% (Wood, P, personal communication). For the purposes of this research the yearly energy use is assumed constant (Saxe et al., 2015).

The Sheppard Subway Line has run at a consistent service interval of 5 min 30 s since opening; this schedule is maintained Monday to Saturday from approximately 5:45 to 1:20 am, on Sundays trains start at 8 am. Over the course of a year, 73,855 trains run along the 11 km Sheppard Subway route (Toronto Transit Commission, 2011, 2014b). The effect of passenger weight on traction energy is ignored. The GHG intensity of travel on the Sheppard Subway is calculated from the PKT travelled per year, the traction energy used and publically available GHG intensity factors for electricity in Toronto (City of Toronto, 2014; Saxe et al., 2015). During the study period the operational GHG intensity of PKT on the line has reduced by 70%, this is due mainly to changes in the local electricity mix and increases in ridership. Fig. 3 illustrates the relative GHG intensity of the travel modes compared.

3.3. GHG savings from ridership

Calculation of the GHG saving from changes in travel patterns associated with the Sheppard Subway Line is detailed in Saxe et al. (2015). In 2003, 152,884 PKT were travelled on the new Sheppard Subway. Forty one percent of the initial ridership had previously been using buses along Sheppard Ave. The remaining ridership is assumed shifted from automobile users, though road counts do not observe a reduction in traffic on Sheppard. This could be due to many factors including long periods between road counts and high amount of through traffic. Through 2011, the number of PKT travelled on the subway increased by 44%, some came from a further reduction in bus use but most would otherwise have been automobile drivers (Saxe et al., 2015). The relative GHG intensity of travel per mode is shown in Fig. 3. Prior to opening of the Sheppard Subway, buses along Sheppard Ave were packed, much of this ridership then shifted to the subway. This resulted in a large increase in GHG per PKT for the remaining bus users. The GHG savings of PKT shifted from the bus to the Sheppard Subway are calculated based on the pre subway bus use intensity.

The upper bound GHG savings from the Sheppard Subway Line ridership is calculated at 55.7 ktCO₂e between 2003 and 2011. Fig. 4 illustrates the relative contribution of the reduction in bus and car use due to the initial mode shift and the long term impacts of the growth in metro mode share, at the expense of the automobile, over time. This assessment includes the assumption that all PKT not shifted from Sheppard Ave buses would have been travelled by automobile. Little evidence was found of new trips induced because of the subway. Potentially critical to the overall GHG impact of the Sheppard Line, no reduction in traffic was observed. Fig. 4 includes the increase in GHG emissions associated with the initial mode shift from bus, is this due to two factors, (1) until 2009 the GHG intensity of PKT on the subway was higher than on the pre subway bus and (2) buses that ran parallel to the Sheppard Subway became emptier after opening producing more GHG/PKT than the pre subway bus.

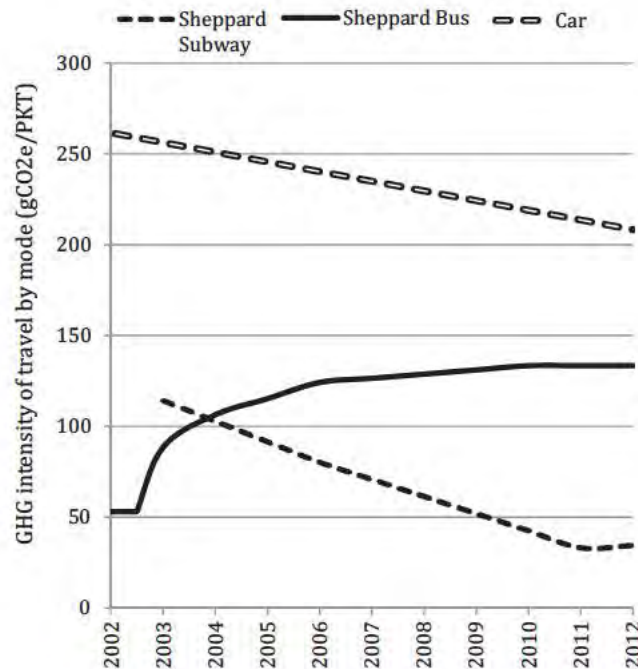


Fig. 3. The GHG intensity of studied travel (VandeWeghe and Kennedy, 2007; Toronto Transit Commission, 2014a, 2002, 2006, 2011, 2014c; City of Toronto, 2014).

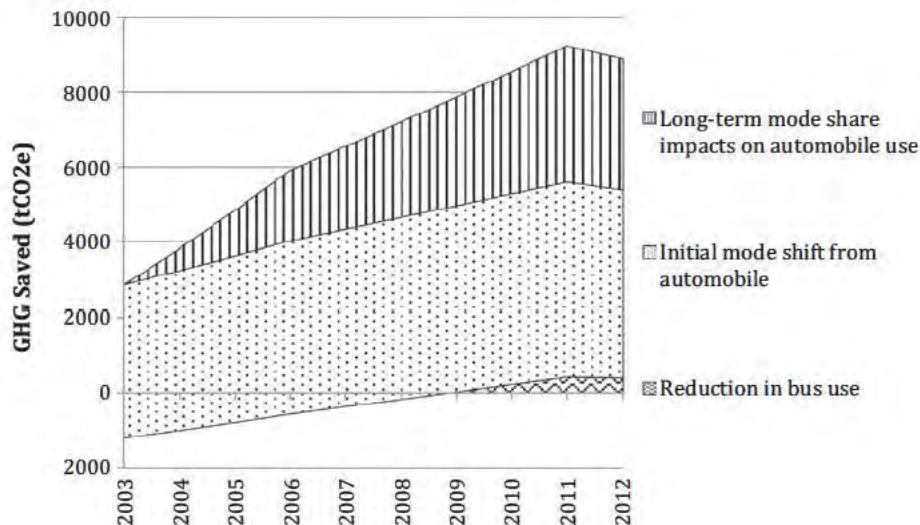


Fig. 4. Net GHG saved through Sheppard ridership (Data Management Group, 2001, 2006, 2011; Statistics Canada, 2001, 2006a, 2011a; Toronto Transit Commission, 2014a, 2014c; Traffic Data Centre and Safety Bureau, 2014c, 2014a, 2014b).

Induced demand may have significantly reduced the actual impact of any shifted travel. If 100% of the shifted automobiles were replaced by induced demand the net impact of the metro would have been a GHG increase of 29.4 ktCO₂e. The literature indicates that an induced demand of 30% is common (Graham and Glaister, 2004). Assuming a 30% rebound in automobile traffic, the net GHG impact of ridership on the Sheppard Subway Line produces a savings of 30.2 ktCO₂e from 2003 to 2011.

3.4. GHG savings from residential density

3.4.1. Impact of the Subway on residential density

In addition to influencing travel mode choice and public transit ridership, the construction of new rail transit is often expected to influence land use by concentrating residences and employment around the stations (Cervero and Landis, 1997; Kahn, 2007; Roukouni et al., 2012; Newman and Kenworthy 2006). This concentration has been shown to materialize in the presence of other critical mitigating factors, such as, demand for new homes and offices, supportive public policy and available land (Knight and Trygg, 1977). The literature reports mixed outcomes; some projects have seen large changes in land use around new metro stations while others have not, often the land use impact varies from station to station within the same project (Knight and Trygg, 1977; Cervero and Landis, 1997).

Saxe and colleagues assess the relationship between the accessibility provided by the Sheppard Subway and changes in residential land use intensity from 2001 to 2011 (Saxe et al., 2016b). The results of a quantitative comparison of changes in accessibility to changes in residential land use as well as a quasi experimental analysis comparing the station pedestrian catchment area (PCA) to controls found a relationship between the opening of the Sheppard Line and increases in residential density. Fig. 5 illustrates the results of the quasi experimental analysis. Two types of controls were used: (1) the outer ring, a nearby control formed of a ½ mile thick annulus around the PCA and (2) a matched pair controls based on 2001 residential density, job density and a measure of local deprivation. Deprivation is calculated using a method after Foth et al. (2013) and is calculated from median household income, the unemployment rate, percentage of population that has immigrated to Canada in the 5 years before the census and the percentage of households that spend 30% or more of their income on rent. In 8 out of 10 comparisons the Sheppard Subway Station PCA saw faster residential growth than the controls.

The availability of land and zoning are known to have important impacts on the realization of land use intensity around new metro stations. This appears to have been the case along Sheppard where existing land uses varied from station to station and the zoning is prescriptive.

The area was already widely developed, primarily with single family homes, before the construction of the Sheppard Subway Line. Around Sheppard Yonge Station there were many high rise towers but interspersed between them were large surface parking lots, prime land for redevelopment. Bayview Station's PCA consisted of single family homes, some schools with outdoor green space and Northeast of the station a commercial/industrial area with a large parking lot. Bessarion Station's PCA included a large commercial/industrial area to the Southeast and an area of residential apartment buildings to the west. A significant percentage of the Leslie Station PCA was parkland, through to the North there were high rise residential buildings and to the South multi storey hospital buildings. The Don Mills Station PCA was divided into four quadrants by two major roads, Sheppard Ave. and Don Mills Rd. The northeast quadrant was used for commercial purposes, the northwest

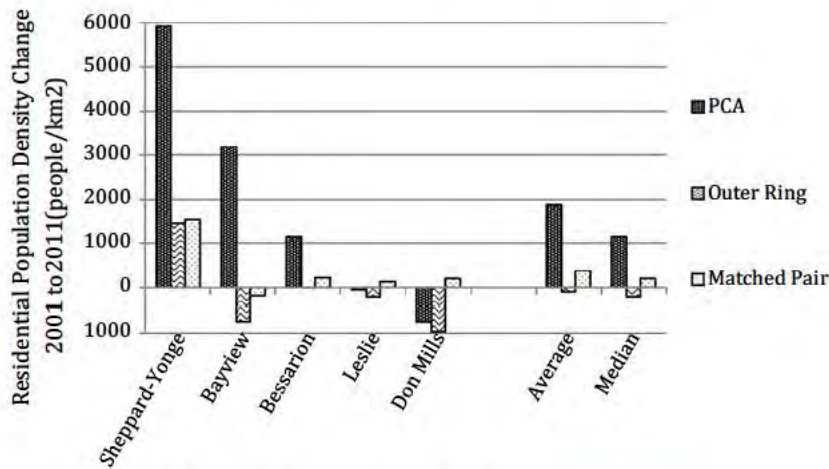


Fig. 5. Changes in residential density 2001–2011 (Saxe et al., 2016b).

and southeast were predominantly high rise residential, and the southwest was low rise residential. Undeveloped green space surrounded the high rise residential (Triathlon Inc., 1999). Sheppard Yonge, where the greatest increase of land use intensity was observed, had available land in the form of parking lots. These lots, located next to existing tall buildings provided an ideal location for high rise construction. Leslie Station, which saw nearly no change in residential density, had significant land limitations; much of the land in the Leslie catchment area consisted of parkland and hospital land, strong locked in uses. Don Mills Station had available land in the form of parks between existing high rises but saw little development and lost population. The Tower in a Park paradigm is common across the city of Toronto which is now working to infill this type of land (City of Toronto, 2012).

Zoning was a barrier to development around the stations. Parts of each station's catchment are zoned mixed use, areas where strong new development could be expected. In addition, at Bayview and Don Mills stations, sections of the catchment areas are zoned for residential apartments. At Leslie station, however, a large swath is held for open space and a hospital. The dominant zoning across the station PCAs, and the study area as a whole, is low rise residential. This zoning is a significant barrier to intensified land use and limits the ability of the Sheppard Stations to influence residential and employment growth (© OpenStreetMap contributors, 2015; Statistics Canada, 2011a; Toronto City Planning, 2013).

The impact on industrial and commercial land use has been excluded from this analysis. Sufficiently detailed spatial data showing the location of employment was unavailable for the study area. In addition, energy use for business, necessary to calculate their GHG impact is not available in Toronto. This would be an important area for future research should the data become available.

3.4.2. Relationship between residential density and energy use/greenhouse gases

Increasing land use intensity through higher concentration of residences is a path to reducing energy use and associated GHG emissions (Clark, 2013). Bigger houses tend to use more energy. This is due to many factors, including the increased conditioning loads associated with larger volumes and the greater exposed skin to volume ratio associated with freestanding homes (Ewing and Rong, 2008; Ko, 2013; Steemers, 2003). With land use intensification, interior building volumes tend to decline and the incidence of shared walls increases driving associated conditioning loads to decrease (Clark, 2013). Smaller spaces can also require less lighting and have less room for appliances and electronics that use energy (Senbel et al., 2010). A neighbourhood's density is strongly related to housing type and size, important factors that affect energy use (Ko, 2013). Detached, single family homes are the most energy intensive housing type and are most likely to be found in low density neighbourhoods (Kellett et al., 2013). Ewing and Rong (2008) found that compact development leads to approximately 20% reduction in residential energy use and GHG emissions compared to sprawl (Ewing and Rong, 2008).

As part of the 2006 long form census, Statistics Canada collected data on the electricity and fuel expenditure for 20% of the population (Statistics Canada, 2012). Fuel refers to oil, gas, coal, wood or other fuels (Statistics Canada, 2006c) and is used primarily for space heating and cooking. Electricity is primarily used for appliances and lighting. Included in this analysis were people who reported their electricity and/or fuel payments separately from their rent or mortgage payments. Those who reported zero expenditure for electricity and fuel or whose energy costs are included in their rent or mortgage were excluded.

Figs. 6 and 7 illustrate the annual energy expenditure decrease in a household with increasing residential density. The relationship between fuel expenditure and density is expressed by:

EQUATION 1: Toronto – Residential energy, electricity expenditure

$$Expense_{Electricity} = 1438 - 0.01243(Density) \quad (1)$$

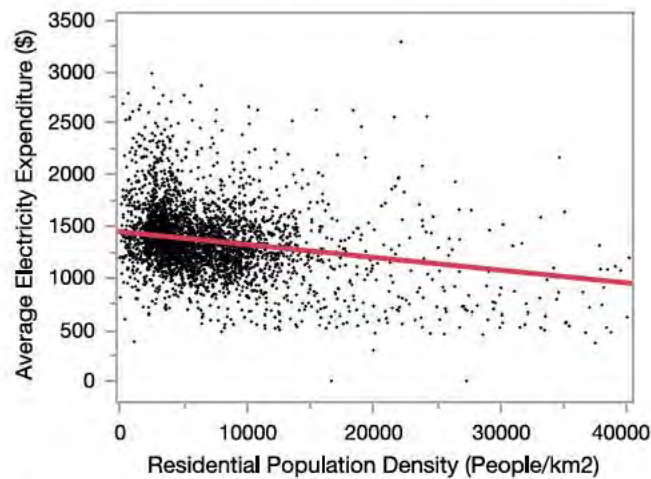


Fig. 6. Residential density compared to annual residential electricity expenditure for the City of Toronto in 2006, $r^2 = 0.08$ (Author's own graphic based on data from Statistics Canada, 2006a, 2006b).

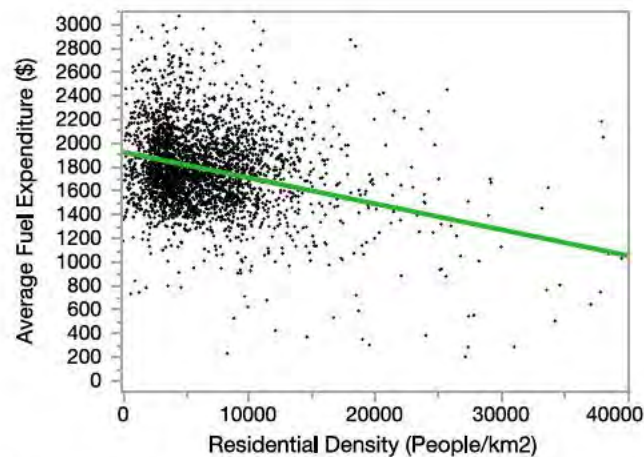


Fig. 7. Residential density compare to annual fuel expenditure for the City of Toronto in 2006, $r^2 = 0.18$ (Author's own graphic based on data from Statistics Canada, 2006a, 2006b).

EQUATION 2: Toronto – Residential energy, fuel expenditure

$$Expense_{Fuel} = 1921 - 0.02175(Density) \quad (2)$$

where $Expense_{Electricity}$ and $Expense_{Fuel}$ are the annual average expenditure on electricity and fuel expressed in dollars and density is the residential population density expressed in people/km² calculated at Canadian 2011 Census Dissemination Area agglomeration. Density explained 8% of the variation in electricity cost and 18% of the variation in fuel cost. Both relationships have $p < 0.0001$.

Energy expenditure is converted to GHG emissions using a method established by VandeWeghe and Kennedy (2007) (VandeWeghe and Kennedy, 2007). Table 2 summarizes the conversion factors used to calculate the GHG emissions. Since

Table 2
Summary of residential building energy conversion factors.

Energy source	Service and regulatory charge	Cost per unit	GHG intensity
Electricity	\$23.68/month (1)	6.122 ¢/kWh (1,2)	203.5 gCO ₂ e/kWh (5)
Natural gas	–	31.3223 ¢/m ³ (3)	1890 gCO ₂ e/m ³ (6)
Heating oil	–	82.62 ¢/L (4)	2793.6 gCO ₂ e/L (6)

(1) (Toronto Hydro, 2006), (2) (Ontario Energy Board, 2015a), (3) (Ontario Energy Board, 2015b), (4) (Statistica, 2015), (5) (City of Toronto, 2014), (6) (VandeWeghe and Kennedy, 2007).

bills are per household the average household size for each geographic unit was calculated and used to convert the expenditure to per capita. For illustration, the average household size for the City of Toronto in 2006 was 2.8 people (Statistics Canada, 2010).

Converting the energy expenditure data to GHG emissions and comparing to density gives the relationship:

EQUATION 3: Toronto – Residential density and GHG emissions

$$GHG_{Residential} = 5.434 + 6.496 \times 10^{-5} (Density) \quad (3)$$

where $GHG_{Residential}$ is the combined emissions from electricity and fuel use expressed in $tCO_2e/capita$ and density is the residential population density expressed in $people/km^2$. Density explains 10% of the variance in calculated GHG emission and $p < 0.0001$.

While the relationship is statistically significant, the rate of change in GHG emissions based on density is slow meaning large changes in density are needed to achieve significant GHG savings. To further investigate the relationship between the Sheppard Subway and energy use the quasi experimental method is revisited.

A direct assessment of the station PCAs compared to their controls supports the finding of energy savings associated with the Sheppard Subway. The PCAs emitted lower GHG per capita than their controls in 7/10 comparisons. Bayview Station performed the poorest and had emissions 2% larger than its outer ring and 27% larger than its matched pair. Don Mills Station had the best results outperforming its matched pair by 86%. As shown in Fig. 8, the PCAs had 10% lower GHG emissions per capita (mean and median) than the outer ring and 1.5% (median) to 7.4% (mean) less GHG than the matched pair. The calculated savings in GHG ranged from 1.5% to 10%. For the 47,482 residents on the PCAs in 2006, this equates to a GHG saving from 3.2 $ktCO_2e/year$ to 21.7 $ktCO_2e/year$. Given the moderate finding for the relationship between accessibility and density for the Sheppard Subway Line PCAs and the small but consistent impact on energy emissions, the average of the mean and median density savings is assumed in the optimistic case (12.45 $ktCO_2e/year$). The impact of changes in urban form is assumed zero in 2003, the first year of operation, ramping up to the calculated 12.45 $ktCO_2e$ in 2006 and held constant through 2011. This takes a conservative approach to any savings due to residential development in anticipation of the line and since 2006. For the less optimistic case the lower bound of the saving between the PCA and control is assumed at 3.2 $ktCO_2e/year$ with the same ramp up pattern.

4. Results

Fig. 9 illustrates the annual and net GHG impact of the Sheppard Subway Line for the optimistic case. During the construction period the yearly impact has been taken as the annual average GHG emissions. In actuality, the emissions will vary year on year with changes in construction activity but such data was not available for this research. The GHG impacts of urban form are assumed to ramp up linearly over the first three years of operation and then hold steady, a conservative assumption. After a build up of GHG emissions during construction, the impacts of the new metro started to payback in its first year. In 2011, at the end of the study period the net GHG emission were 26.7 $ktCO_2e$. Projecting into the future, applying the same trends observed through 2011, the Sheppard Subway Line was on track to payback its GHG investment in 2013, 11 years after opening. The reduction in automobile ridership associated with opening on the Sheppard Line and the associated changes in residential density were both critical to nearly achieving GHG payback during the study period.

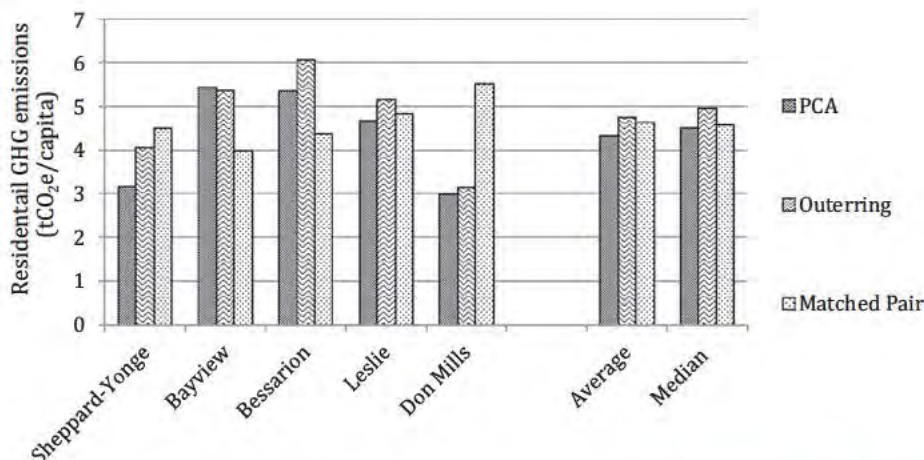


Fig. 8. Annual residential GHG emissions, 2006 (Author's own graphic based on data from Statistics Canada (2006c, 2006a) and © OpenStreetMap contributors (2015)).

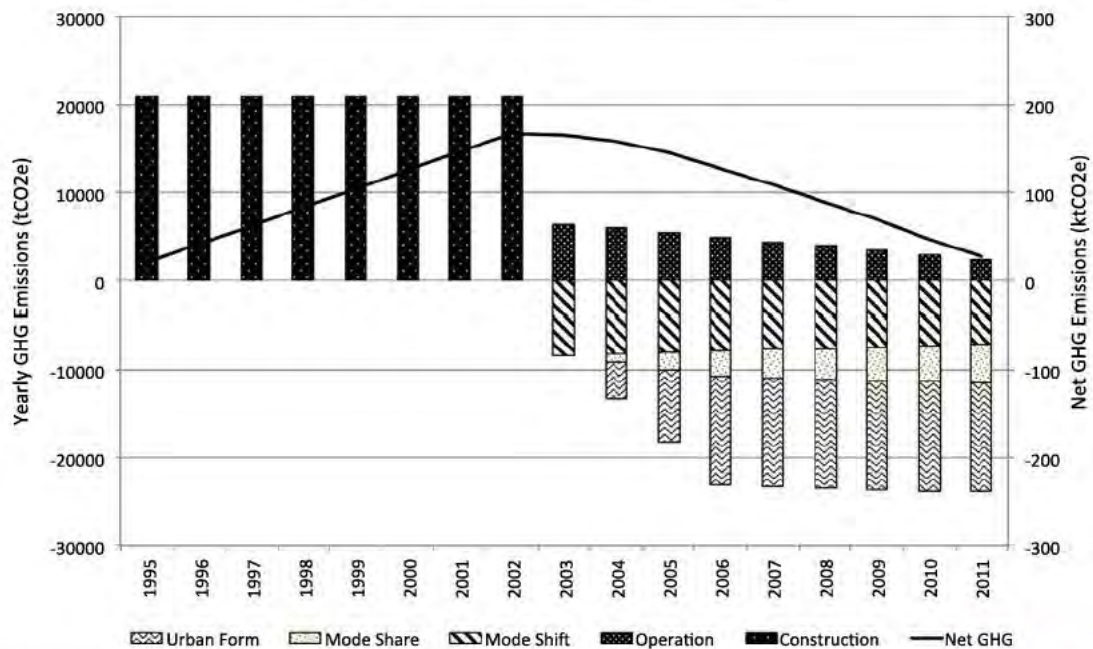


Fig. 9. Annual and net GHG impact of the Sheppard Subway Line, optimistic case (Author's own graphic based on data from Data ManagementGroup (2001, 2006, 2011), © OpenStreetMap contributors (2015), Statistics Canada (2011b), Toronto Transit Commission (2013), and Paris and de Silva (2010)).

In the optimistic case, above, no effect of induced demand on new automobile trips is assumed. Given experience from the literature and the observed traffic counts since opening of the Sheppard Subway this is likely very optimistic. The urban form impact value used was based on the average of the calculated savings compared to the nearby and matched pair controls as discussed in Section 3.4.

Fig. 10 illustrates a less optimistic assessment of the GHG impact of the Sheppard Subway Line. In this less optimistic case, at the end of 2011 the net GHG impact is 105 ktCO₂e, four times larger than in the optimistic case discussed above. To calculate this case, the lower bound of the GHG savings associated with changes in land use intensity around the stations is

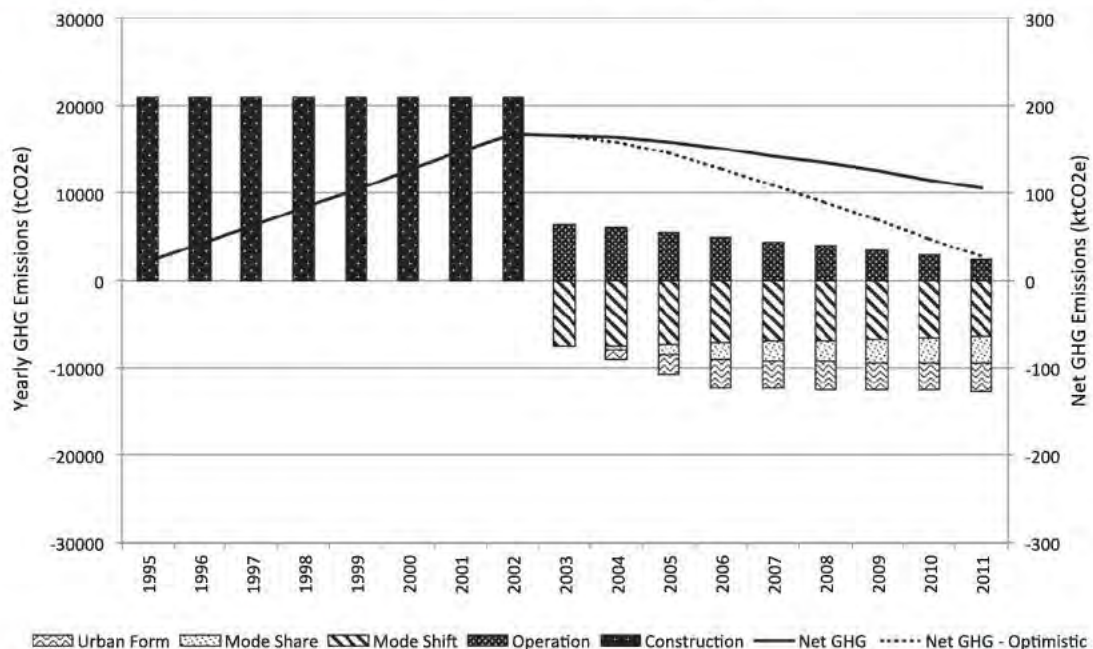


Fig. 10. Annual and net GHG impact of the Sheppard Subway Line, less optimistic case (Author's own graphic based on data from Data ManagementGroup (2001, 2006, 2011), © OpenStreetMap contributors (2015), Statistics Canada (2011b), Toronto Transit Commission (2013), and Paris and de Silva (2010)).

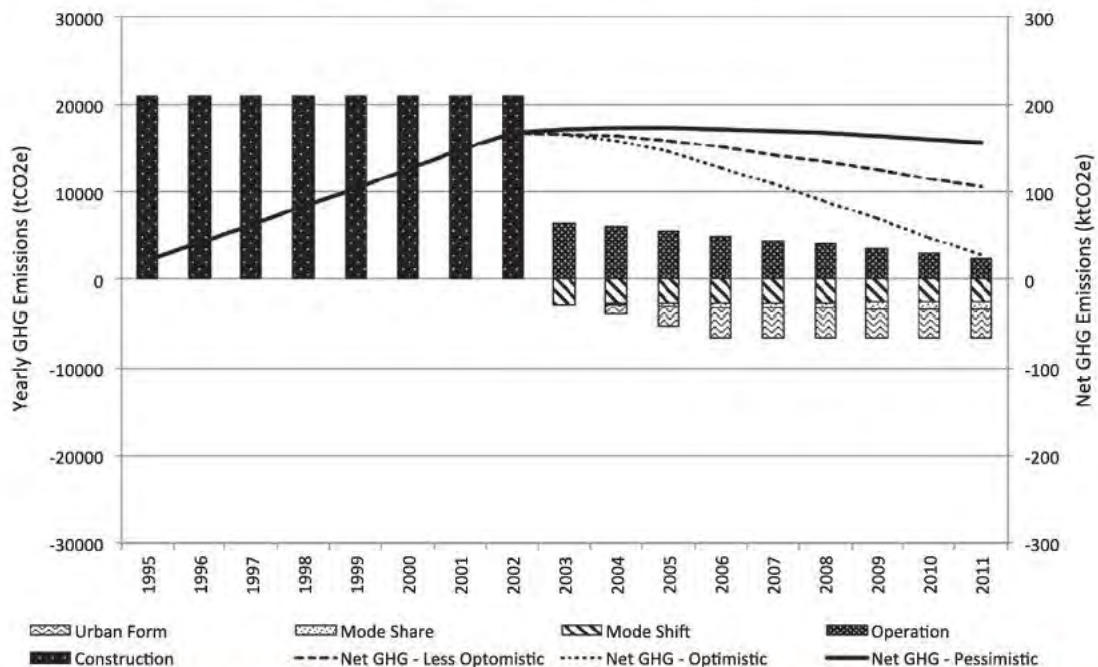


Fig. 11. Annual and net GHG impact of the Sheppard Subway Line, pessimistic case (Author's own graphic based on data from Data ManagementGroup (2001, 2006, 2011), © OpenStreetMap contributors (2015), Statistics Canada (2011b), Toronto Transit Commission (2013), and Paris and de Silva (2010)).

applied and induced demand of 30% is assumed to have offset some of the benefits of the mode shift and mode share changes from automobile travel. Based on this approach, and assuming the trends observed during the study period continue, the Sheppard Subway Line would be on track to payback the initial GHG investment by 2020.

Taking a more aggressive approach to the induced demand to reflect the steady road counts along Sheppard Ave, leads to the pessimistic case illustrated in Fig. 11. Here an 80% induced demand is assumed significantly reducing the GHG savings applied from ridership behaviour. In this scenario the Sheppard Subway Line only achieves GHG payback in 2035, 33 years after opening.

5. Discussion

The GHG payback of the Sheppard Subway line is dependent on PKT shifted from automobile travel and savings in energy use associated with increased density.

This calculation has assumed that all PKT not shifted from the Sheppard Ave Bus to the Subway come from automobiles, this assumption leads to a large number of automobile kilometres avoided. Large GHG savings materialize from these avoided PKT due to the relative GHG intensity of travel by automobile and by metro shown in Fig. 3. Metro travel in Toronto benefits from the very low GHG intensity of electricity in the city, this proves to be critical for achieving GHG payback. This has been particularly important for PKT shifted from the buses. The low ridership on the Sheppard Subway in its early years for a subway compared to the high ridership of the Sheppard Bus for a bus combined with the GHG intensity of power for each mode, meant that for 6 years each PKT shifted from buses led to a GHG increase rather than savings. As the Toronto electricity network became less GHG intensive the Sheppard Subway gained an advantage on the bus it replaced. With few savings realized from PKT shifted from buses the ridership impacts are very sensitive to induced demand. Assuming varying levels of induced demand changes the calculated GHG payback period by decades. This is an area that needs further research in Toronto.

Quantitative and quasi experimental analysis indicates that the Sheppard Subway did find some concentration of development around its stations and an associated reduction in residential energy use. An assessment of the relationship between energy and density in Toronto found that while it was statistically significant the strength of the relationship and its slope were both small.

6. Conclusion

This paper finds that Sheppard Subway GHG payback has taken/will take between 11 and 35 years depending on optimistic to pessimistic approaches taken to automobile induced demand and changes in residential intensity. Payback would

be easier to achieve and faster if the GHG cost were lower. All three of these elements could be influenced through careful policy and design guidelines to (1) limit the use of unnecessary materials (2) limit automobile use rebound through induced demand and (3) encourage densification around metros.

A number of policies should be considered during the planning of new metro to facilitate rapid GHG payback and maximize long term savings.

(1) Reducing the capital GHG of new infrastructure:

Concrete and steel, two major components of metro construction, are both GHG intensive materials. Leaner structures and/or smaller, simpler stations would reduce the capital GHG. At grade, track and stations require capital GHG investment an order of magnitude smaller than that required for tunnels and underground stations. Where possible, at grade track and stations should be considered. However, the land use impacts of surface tracks create an impassable barrier (not considered in this work) and could result in comparatively less service, which will impact the GHG benefit of the line. This should be considered against the savings of constructing at grade.

(2) Push policies in coordination with expanded metro to reduce automobile use

GHG savings from mode shift will be limited, unless induced demand onto the roads is prevented. For shifts from other transit modes, the transit agency can control supply through altering, cancelling or changing the service schedule of bus routes and similar. The choice to use automobiles is more in the hands of the traveller. Push as well as pull incentives are needed to avoid nullification of GHG savings through mode shift and share impacts on automobile use. As the GHG intensity of all modes of travel continues to reduce, the magnitude of the gap between PKT travelled by metro and by automobile will likely get smaller and require larger mode shifts to achieve the same GHG savings through metro projects. Push policies can include efforts to make driving more expensive (fees) and/or to make it slower (reductions in speed limits or traffic lanes).

(3) Encourage densification around new metro stations

There is a large potential for GHG savings associated with increased land use intensity and associated reduction in residential energy use. Specific policies to support densification around the new stations were missing at most stations. Incentives for densification can include appropriate zoning to facilitate development and/or tax incentives. Toronto has fairly strict land use rules around the Sheppard Subway Stations but much of the station PCAs are excluded from the high land use intensity zoning.

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Embodied emissions in rail infrastructure: a critical literature review

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Abstract

This paper investigates the state of knowledge in quantifying the embodied greenhouse gas (GHG) emissions in rail infrastructure and develops a sketch model for estimating the GHG impact of rail infrastructure based on the literature. A literature review identified 22 publications, containing 57 case studies, at least touching on the embodied GHG for different types of rail infrastructure. The case studies include high speed rail, intercity rail, light rail, commuter rail, heavy rail, freight, and metro rail. The paper examines the GHG impact per kilometre of rail infrastructure reported across the case studies and compares the boundaries, functional units, methods, and data used. Most studies employed process-based LCA for an attributional analysis. The embodied emissions associated with the case studies range from 0.5 to 12 700 tCO₂ km⁻¹; much of the variation is dependent on the proportion of the rail line at-grade, elevated, or in a tunnel. However, large ranges in GHG per kilometre remain after controlling for elevated and tunneled distance. Comparing the embodied emissions across the rail types was challenging, due to the large variations in system boundaries, study goals, and inventory methods adopted in the publications. This review highlights the need for standardization across the reporting of embodied GHG for rail infrastructure to better facilitate hot spot detection, engineering design and GHG policy decision making. The statistical model finds that overall $\sim 941(\pm 168)$ tCO₂e are embodied per kilometre of rail at-grade, and tunneling has 27 (± 5) times more embodied GHG per kilometre than at-grade construction. The statistical model is based on the findings of published literature and does not explicitly consider function, geometry, specifications, emphasis on whole lifecycle, legislative constraints, socio-economic factors, or the physical and environmental conditions of the construction site.

1. Introduction

This paper investigates the state of knowledge in quantifying the embodied greenhouse gas (GHG) emissions in rail infrastructure and develops a sketch model for estimating the GHG impact of rail infrastructure based on the literature. The embodied GHG emissions in the construction sector are defined as the emissions generated by ‘the energy consumed in the acquisition of raw materials, their processing, manufacturing, transportation to site, and construction’ and ‘the emissions incurred to maintain, repair, restore, refurbish or replace materials, components or systems during the effective life of the’ structure (Ibn-Mohammed *et al* 2013). In this paper we focus on embodied emissions from initial construction. A growing body of literature highlights the need to

understand the embodied GHG emissions of transport infrastructure provision (Chester and Horvath 2009, Morita *et al* 2013). Rail infrastructure can provide an important environmental service by reducing the need for automobile-based travel, but significant embodied GHG emissions are associated with the introduction of new rail transit infrastructure through the use of large quantities of materials (e.g. steel and concrete) and fuel (e.g. transportation, on-site energy use) during construction (Chester and Horvath 2010, Westin and Kågeson 2012, Saxe *et al* 2017). To maximize the life cycle environmental benefit of rail infrastructure, the up-front embodied emissions must be minimized where possible. As global rail infrastructure investments grow, a baseline numerical understanding of the embodied GHG emissions is needed to inform policy makers, engineers and contractors and facilitate reductions in

embodied GHG emissions for future rail projects, particularly at the early planning stage when project scoping is completed.

The planning and scoping phases of a construction project have the largest impact on the final overall performance of the project, as decisions at this stage largely lock in the type of project and its location (Häkkinen *et al* 2013). This scoping phase occurs prior to design and construction and is when the broad objectives and the requirements (e.g. route planning) of the project are established (Ainger and Fenner 2014). The planning phase is the purview of politicians and planners. By definition, this stage does not include sufficient detailed design to allow for a case-specific assessment of material and energy needs which are necessary for case-specific detailed GHG assessment.

For rail lines, the scoping process and route selection have the largest potential to influence overall GHG emissions, as they dictate the length of rail to be constructed and the type (at-grade, elevated, tunneled) of construction needed. Further, to explore the GHG benefit ratio or GHG payback period of a given project, the quantity of emissions associated with construction is needed but details of construction are unavailable at the key decision-making early stages. The synthesis of published work in this paper facilitates approximate early stage estimates of embodied GHG emissions. The aim of the present study is to identify and partition the embodied GHG findings from published research papers into classes of track (at-grade, tunneling, elevated) and establish a first step towards a generalized state-of-the-knowledge model of rail infrastructure embodied GHG emissions based on existing literature. This cannot and should not replace detailed case-specific GHG assessment as design progresses.

Life cycle assessment (LCA) is a holistic approach to quantify the environmental impacts of products through assessing the impact of each process in the manufacturing, operation, use and disposal of the product. The overall LCA impact is the cumulative environmental impact across all the life stages (The International Standards Organisation 2006b). Embodied GHG assessment is a subset of LCA focusing on the production of the product, in this case the rail infrastructure, and is often called cradle to gate LCA. An assessment of embodied GHG in rail infrastructure requires two main inputs, (1) detailed accounting of material and energy used and (2) the GHG intensity of materials and energy, usually reported as GHG intensity factors.

Over the last decade plus, an increase in academic and policy interests has produced a body of knowledge on the embodied GHG in rail infrastructure. This paper reviews and compares that knowledge for the range of GHG impact per kilometre of rail reported across the case studies and compares the boundaries, functional units, methods and data used. Further, this research compares different categorization criteria of

rail infrastructure, working towards a general estimate of the embodied GHG emissions in rail per km. In section 6, to facilitate comparison between different rail systems with different percentages of at-grade, elevated and tunneled segments, we convert the embodied GHG emissions to equivalent at-grade kilometres. This facilitated the development of a linear model of GHG emissions per at-grade kilometre and an assessment of the relative GHG intensity of elevated, tunneled and at-grade rail infrastructure.

This research provides baseline formulas for preliminary assessment of embodied GHG emissions at the project scoping stage to inform the project planning process of rail infrastructure and allow for rough estimates of GHG per kilometre.

Section 2 discusses the criteria used to select the literature reviewed in this study; section 3 provides a description of the dataset; section 4 discusses the parameters influencing embodied GHG emissions in the published literature; section 5 details the findings of embodied GHG from the literature review. Section 6 develops and reports on a generalized model of GHG emissions using a conversion to equivalent at-grade kilometres to adjust for the varying distances of tunneled, elevated and at-grade track between different case studies. Section 7 presents conclusions and goals for future research.

2. Selection of reviewed papers

In this research, we set out to identify and review a census of the last decade (post 2009) of literature quantifying the embodied GHG emissions in case study rail projects. All rail types are included in the literature review, including intercity rail, commuter rail, light rail, metro rail and freight. The papers were reviewed with a view to the following questions:

- Where in the world has embodied GHG in rail been investigated?
- What are the factors influencing the embodied GHG results in published papers?
- What are the published GHG payback periods—the operation period of rail infrastructure required to offset the embodied GHG emissions from construction?
- Does the literature provide a baseline of embodied GHG emissions in rail infrastructure that can be used to inform projects during planning?

The study started with a keyword search for rail, embodied and GHG in scientific research databases, primarily Scopus and Science Direct. Keywords were also searched on Google Scholar and OneSearch, the University of Toronto's Library journal search platform. Additional publications were gathered through cross-referencing. Our search on Scopus identified 133 research articles from 2009 to 2018. A search for

similar keywords in Science Direct found 451 research articles between 1994 and 2018. Publishing on this topic has increased significantly since 2009 and the seminal work by Chester and Horvath (2009). An abstract review was carried out on these initially identified publications. Publications that did not deal with rail and embodied emissions were eliminated (e.g. papers dealing with transportation fuels); publications pre-2009 (with the exception of Lave (1978) which is a key early payback analysis paper) were excluded. After initial review, 100 publications dealing with environmental life cycle assessment, embodied GHG and/or reducing the GHG of rail infrastructure were selected for full paper review. Throughout, a spreadsheet of considered papers was maintained and updated by the authors. These 100 papers were further reduced based on whether the paper (1) deals with embodied impacts, (2) contains real world data from at least one specific case study, and (3) communicates the results with sufficient detail to allow review (e.g. scope, functional unit, and methods are communicated or at a minimum implied).

This study did not consider studies where it was not possible for a reader to calculate the embodied GHG emissions separately from operational emissions (Åkerman 2011, Pan *et al* 2013, Tarnoczi 2013, Warren and Ieromonachou 2013, Timmermann and Dibdikova 2014, Matan *et al* 2015, Steffen *et al* 2015, Krezo *et al* 2016, Dalkic *et al* 2017) or studies which did not consider non-operational emissions (Cárdenas *et al* 2016, Dalkic *et al* 2017, Sarigiannis *et al* 2017, Prussi *et al* 2019). Studies which were not project-based, but either country-based and/or sector-based (Yang *et al* 2009, McCollum and Yang 2009, Nelldal and Andersson 2012, Pan *et al* 2013, Warren and Ieromonachou 2013, To 2015, Cheng *et al* 2016, De Andrade and D'Agosto 2016, Mulley *et al* 2017, Spears *et al* 2017, Toledo and Rovere 2018) were similarly not considered. This study focused on post 2009 papers, so older papers (von Rozycki *et al* 2003) were excluded.

The final body of literature consisted of 22 publications, including 57 unique infrastructure cases, which were used to develop a database reporting the key elements of published embodied GHG assessment in rail infrastructure. Since the data were collected by the authors of the respective publications, they are considered as secondary data (Irwin 2013). By its nature, the quality of the secondary data cannot be verified and the data are dependent on the assumptions and preconceptions of the authors who generated them (Irwin 2013). The reviewed publications are listed in table 1.

3. Description of dataset

The 57 reviewed case studies represent 7 types of rail infrastructure, as identified by the original authors, including High Speed Rail (HSR), Commuter Rail,

Heavy Rail Transit (HRT), Light Rail Transit, Intercity, Metro Rail and Freight Rail from 3 continents and 19 cities. High speed rail (HSR) is a form of mass transit that operates significantly faster than traditional rail traffic; trains that run consistently faster than 200 km h⁻¹ are called high speed (Agarwal 2011). Commuter rail is 'a passenger rail transport service operating between a city center to outer suburbs' (MDOT—Michigan Department of Transportation 2014, Credit 2019). Light rail transit system is a form of mass transit with a smaller passenger capacity compared to other rail systems and uses electric powered trains (Durand *et al* 2016). Heavy-rail transit has larger passenger capacities than light rail and usually runs in its own right of way (Hunter-Zaworski 2017, Credit 2019). Intercity rail is a passenger rail service between cities or metropolitan areas (Federal Railroad Administration 2017). Metro rail is a passenger rail system, mostly operated with electric trains and grade separated from other traffic, either underground (in tunnels) or above ground (elevated) (Sharma *et al* 2013). Finally, freight rail is a cargo rail service, usually intercity, and generally does not carry human passengers (Zunder *et al* 2016).

Six of the considered papers (National Rail 2009, Chester and Horvath 2010, Chester *et al* 2012, 2013, Yue *et al* 2015, Chester and Cano 2016) presented a scenario analysis of the same rail line changing infrastructure approaches (e.g. light rail, metro rail, tunneled, at-grade) and/or other non-infrastructure factors (e.g. train type). From these papers, only the infrastructure scenarios have been included in our case study database. Forty-four percent of the cases were HSR, nineteen percent intercity rail, twelve percent light rail, eleven percent commuter rail. The remaining case studies were heavy rail transit (HRT—7%), Metro rail (5%) and freight rail (2%) infrastructure. Twenty-eight (46%) of the case studies are from Europe (20 from the UK), nineteen (33%) of the case studies are from the North America (18 from the US and 1 from Canada), and the remaining 10 (18%) are from Asia as illustrated in figure 1.

The length of the case studies ranges from 0.3 to 1318 km; the average length of the rail infrastructure studied is 476 km and the median length is 401 km. The analysis period adopted in the case studies ranges between 20 and 100 years. There is large heterogeneity of analysis approaches, analysis periods, rail types and methodologies within the dataset, including within case studies from the same country. By focusing on embodied GHG emissions, this paper is focused on initial construction of the studied rail lines and is less subject to the wide ranges in temporal assumptions in the papers. However, the amount of time the initial construction would last, e.g. the durability of the rail line, is an important consideration of life time GHG emissions, affecting how much maintenance and replacement will be needed. A detailed consideration of long-term durability is outside the scope of this

Table 1. Reviewed literature: publication title; publication authors, rail types, functional unit, length and amortization period of case study.

Author (Ab)	Publication Title	Country/Region	Type of Rail	Rail length (km)	Functional units	Adopted infrastructure life time (Years)
Lave (1978)	Transportation and energy: some current myths	USA/San Francisco	HRT	180	1 PMT	N/A
National Rail (2009)	Comparing environmental impact of conventional and high-speed rail	UK	9* Intercity 9* HSR	185–764	1 PKT	N/A
Chester and Horvath (2010)	Life cycle assessment of high-speed rail: the case of California	USA/California	3* HSR	1100	1 VKT/1 PKT.	100
Chester and Horvath (2010)	Life cycle assessment of high-speed rail: the case of California	USA/California	3* HRT	710	1 VKT/1 PKT.	100
Chang and Kendall (2011)	Life cycle greenhouse gas assessment of Infrastructure construction for California's high-speed rail system	USA/California	HSR	725	1 PKT	60–100
Paris and de Silva (2010)	CROSSRAIL, Carbon footprint study—methodology and results	UK/Tottenham	Metro	118	1 PKT	120
Westin and Kägeson (2012)	Can high speed rail offset its embedded emissions?	(Europe)	HSR	500	1 PKT	50
Chester <i>et al</i> (2012)	Environmental Life-cycle Assessment of Los Angeles Metro's Orange Bus Rapid Transit and Gold Light Rail Transit Lines	USA/LA	2* Light	31.7	1 PMT	30
Chester <i>et al</i> (2013)	Infrastructure and automobile shifts: Positioning transit to reduce life-cycle environmental impacts for urban sustainability goals	USA/LA	2* Light	20.8	1 PMT	100
Morita <i>et al</i> (2013)	A Study on the Methodology for Evaluating the Environmental Load of Rail Infrastructure Construction	Japan/Tokyo	Light	33	1 RIS	50
Hanson <i>et al</i> (2016)	Greenhouse gas emissions associated with materials used in commuter rail lines	USA/New Jersey	5* Commuter	6–196	1 TMT	50
Lederer <i>et al</i> (2016)	The life cycle energy demand and greenhouse gas emissions of high capacity urban transport systems: A case study from Vienna's subway line U2	Austria/Vienna	Light	14.8	1 PKT	N/A
Miyoshi and Givoni (2014)	The Environmental Case for the High-Speed Train in the UK: Examining the London-Manchester Route	UK/London	HSR	351.7	1 PKT	30–100
Yue <i>et al</i> (2015)	Life Cycle Assessment of High Speed Rail in China	China/Beijing	6* HSR	1318	1 PKT	20
Infraestructuras (2015)	Environmental Product Declaration of 'Arroyo Valchano' railway bridge	Spain/Madrid	HSR	0.3	1 MOB	60
Jones <i>et al</i> (2017)	Life Cycle Assessment of High-Speed Rail: A case study in Portugal	Portugal/Lisbon	HSR	297	1 PKT	35
Li <i>et al</i> (2016)	Calculation of life-cycle greenhouse gas emissions of urban rail transit systems: A case study of Shanghai Metro	China/Shanghai	Metro	528	1 OCL	50
Chester and Cano (2016)	Time-based life-cycle assessment for environmental policymaking: Greenhouse gas reduction goals and public transit	USA/LA	Light	24.4	1 PKT	28
International Union of Railways (2016)	Carbon footprint of Railway Infrastructure. Comparing existing methodologies on typical corridors	Japan	HSR	554	1 PKT	60
International Union of Railways (2016)	Carbon footprint of Railway Infrastructure. Comparing existing methodologies on typical corridors	Netherlands	Intercity	30	1 PKT	55
International Union of Railways (2016)	Carbon footprint of Railway Infrastructure. Comparing existing methodologies on typical corridors	Sweden/Bothnia	Freight	209	1 PKT	40
Dimoula <i>et al</i> (2016)	Carbon footprint of Railway Infrastructure. Comparing existing methodologies on typical corridors	Greece/Thessaloniki	Intercity	442	1 RIS	N/A

Table 1. (Continued.)

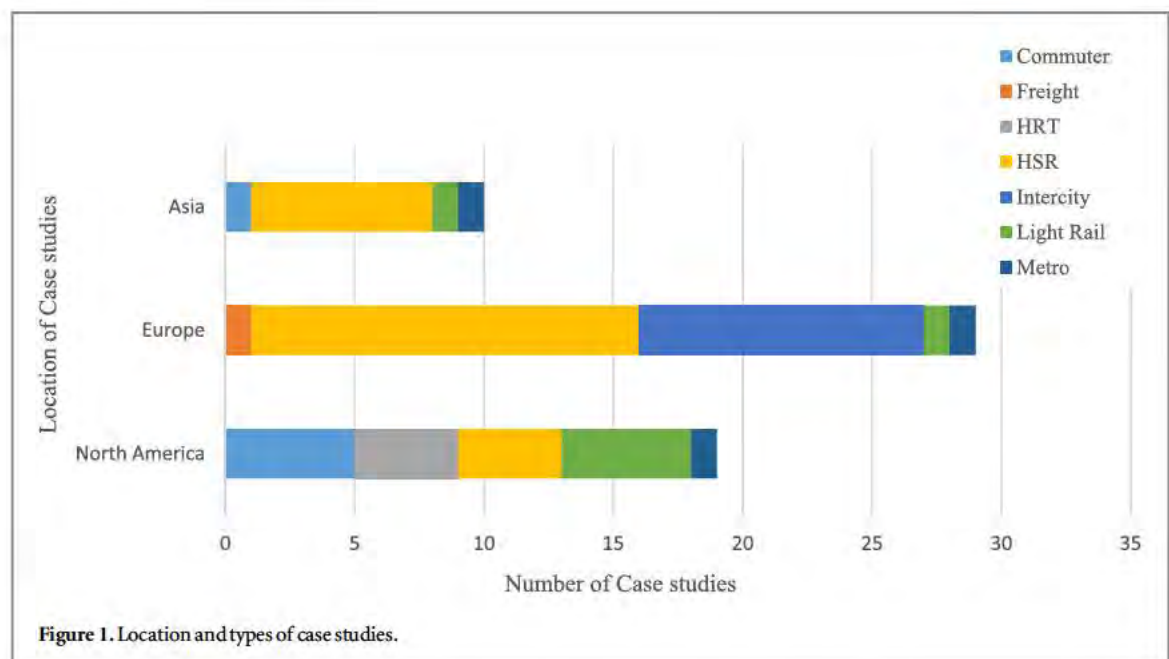
Author (Ab)	Publication Title	Country/Region	Type of Rail	Rail length (km)	Functional units	Adopted infrastructure life time (Years)
Bueno <i>et al</i> (2017)	A Holistic Approach for Estimating Carbon Emissions of Road and Rail Transport Systems Evaluating the environmental performance of the high-speed rail project in the Basque Country, Spain	Spain/Basque	HSR	180	1 PKT	60
Saxe <i>et al</i> (2017)	The net greenhouse gas impact of the Sheppard Subway Line	Canada/Toronto	Metro	5.5	1 SS	N/A
Shinde <i>et al</i> (2018)	Life Cycle Analysis based Comprehensive Environmental Performance Evaluation of Mumbai Suburban Railway, India	India/Mumbai	Commuter	983.8	1 PKT	25

2** means two case studies were present in the publication.

3** means two case studies were present in the publication.

PKT (Passenger kilometre travelled); PMT (Passenger mile travelled); VKT (Vehicle kilometre travelled); TMT.

(Track mile travelled), RIS (Rail Infrastructure system), MOB (Metre of bridge); CL (Kilometre of construction length), SS (Subway system); HSR (High Speed Rail).



review, as it is generally not explored in detail in the reviewed papers.

The examined papers completed embodied GHG/LCA assessments based on data collected at different points during the case study planning and construction. Twenty-three percent of the case studies were carried out during the proposed phase, before final designs were selected or construction started. Nine percent were in construction when they were studied. The remaining sixty-eight percent of the case studies were analyzed after they were completed. Assuming perfect data access, the completed projects have the potential to have the highest accuracy and least uncertainty, given details of construction were set and could be measured. During the planning stage, a large uncertainty would be expected as the final details of construction and material use are not yet fully determined. However, in practice, many of the authors note that access to the data for their case studies and details of material and fuel use were challenging, irrespectively of the project stage.

4. Comparison of published case studies

The case studies are compared along key characteristics of an LCA study (e.g. scope, functional unit) and were analysed quantitatively and qualitatively in order to facilitate comparison. Where possible, published supplementary data or personal communication with the authors were referenced to collect more detailed information not available in the main body of the paper (Chester and Horvath 2009, 2010, Chester *et al* 2012, Kimball *et al* 2013, Jones *et al* 2017). The scope, functional unit and type of rail studied are reported throughout this review as defined in the original papers.

Across the case studies, the rail infrastructure dimensions were obtained from Google Earth, Google Maps, Construction documents, and Preliminary bid documents available to the researchers (Infraestructuras 2015, Dimoula *et al* 2016, Shinde *et al* 2018). Embodied GHG emissions from the different case studies are converted to per kilometre for comparison below using the length of infrastructure reported in the paper or collected from publicly available data. The proportion of at-grade, elevated and /or tunneled length was gathered from publicly available data for built and planned infrastructure when not specifically stated in the original paper.

A range of rail infrastructure types was reviewed, from light rail to high speed intercity rail. The infrastructure types considered in the 57 case studies are shown in table 3. The reviewed papers generally reported what type of rail they investigated (e.g. metro, HSR, light rail). While rail type is often a proxy for construction type (subways are often underground, light rail is often at-grade), many of the case studies had exceptions to these rules (Chester and Horvath 2010, Morita *et al* 2013, Jones *et al* 2017). Perhaps unsurprisingly, our review indicates that more than being determined by the type of rail, the embodied GHG is driven by the type of construction (at-grade, underground, elevated); this is discussed further in section 6. The different papers communicated the type of rail infrastructure in different ways, some reported a fraction of the infrastructure as tunnels, bridges, or at-grade (Morita *et al* 2013, International Union of Railways 2016). Others reported detailed infrastructure information extracted from construction documents (Chang and Kendall 2011, Lederer *et al* 2016).

In line with this review topic most of the papers focused on GHG emissions. The considered GHG

Table 2. Main goals of reviewed literature.

Research goals	Publication
Identify environmental impact of the construction of the rail infrastructure	(von Rozycki <i>et al</i> 2003, Åkerman 2011, Chang and Kendall 2011, Infraestructuras 2015, Yue <i>et al</i> 2015, Hanson <i>et al</i> 2016)
Identify the relative environmental impact of the different life stages of transport infrastructure	(Morita <i>et al</i> 2013, Miyoshi and Givoni 2014, Chester and Cano 2016, Bueno <i>et al</i> 2017, Jones <i>et al</i> 2017, Saxe <i>et al</i> 2017, Shinde <i>et al</i> 2018)
Compare rail infrastructure with other transport infrastructure.	(Chester and Horvath 2010, Åkerman 2011, Chester <i>et al</i> 2012, Westin and Kågeson 2012, Morita <i>et al</i> 2013, Chester and Cano 2016, Dimoula <i>et al</i> 2016, International Union of Railways 2016, Lederer <i>et al</i> 2016, Li <i>et al</i> 2016)
Understand the environmental payback period of rail transport infrastructure	(Lave 1978, Chester and Horvath 2010, Chang and Kendall 2011, Chester <i>et al</i> 2012, 2013, International Union of Railways 2016, Saxe <i>et al</i> 2017)

emissions are commonly CO₂, N₂O and CH₄ (Chester 2008).

4.1. Research goals

In the reviewed papers the degree of focus on embodied GHG assessment and reporting varied. For some papers it was the main focus; for others an aside or a step towards the main goal. Reported detail and space dedicated to the embodied GHG assessment in the paper followed the main purpose of the papers.

Overall, the reviewed papers pursued four main research goals:

- To understand the environmental impact from the construction of rail infrastructure.
- To identify the relative environmental impact of the different life stages of transport infrastructure (e.g. construction versus operation).
- To compare the relative environmental impact of different types of transport infrastructure (e.g. rail versus road).
- To understand the environmental payback period of rail transport infrastructure.

Table 2 lists the main goal of the reviewed literature. Some papers had multiple stated goals and are listed more than once.

The goals of each study influenced the analysis methods chosen, the scope of data gathered, and the attention given to embodied emissions in the publications. This, in turn, affects the comparability of the case studies. Publications whose main goal was to examine the embodied GHG of the infrastructure included more detail on infrastructure construction and embodied GHG emissions (Chang and Kendall 2011, Infraestructuras 2015, Yue *et al* 2015, Hanson *et al* 2016). Publications where embodied GHG was only a part of the focus expectedly included less detail. For example, in their papers, Miyoshi and Givoni (2014) and Bueno *et al* (2017), who focuses on the relative environmental impact of the different life stages of transport infrastructure, focus more on communicating the method of analysis than the origin of the data. Westin and Kågeson (2012) and Dimoula

et al (2016), whose papers compared rail infrastructure with other transport infrastructure, focused their comparison on life stages where data were available for all the compared infrastructures. Chang and Kendall (2011), whose paper focuses on the payback period, presented a detailed model of the global warming effect using cumulative radiative forcing to calculate the payback period and mostly discuss payback related data.

While 22 papers at least touch on embodied GHG for rail, only 4 papers have made it the main focus. It was not practical to limit the review to this small number of papers. The limited number of embodied-GHG focused papers is likely due, in part, to the challenges of gathering detailed design or construction data for rail infrastructure projects. This challenge is reported in many of the reviewed papers and is an impediment to further research and development in this field.

4.2. Functional unit

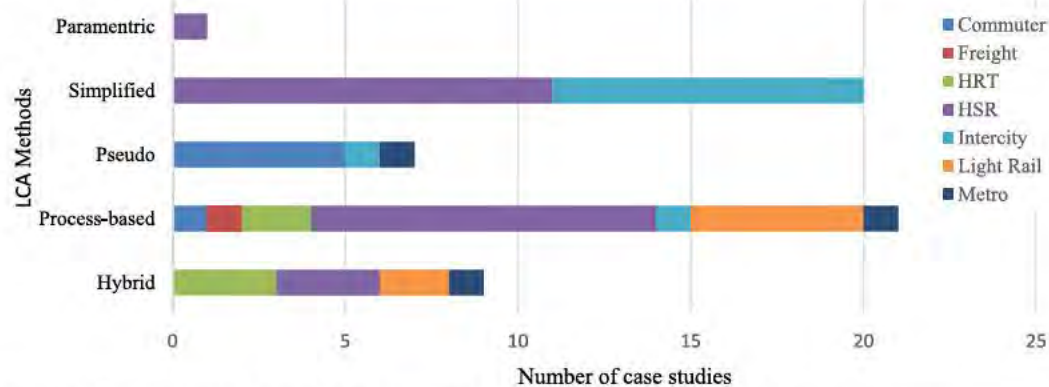
The definition of a functional unit is a central requirement of LCA (The International Standards Organisation 2006a, 2006b). The functional unit defines the purpose of the product and facilitates comparisons between different products that provide similar functions. A range of functional units was used across the reviewed studies. The most common functional units employed were passenger kilometre/mile travelled (PKT/PMT), particularly for papers comparing different types of transport infrastructure. Others include track kilometre/mile travelled, overall construction length, vehicle kilometre travelled (VKT), track mile travelled (TMT), the rail infrastructure system (RIS), the meter of bridge (MOB), the kilometre of construction length (CL) and the subway system (SS) as shown in figure 2. In cases where the functional unit was not explicitly stated, the implied unit of analysis is reported (e.g. one subway line) (Dimoula *et al* 2016, Saxe *et al* 2017).

The functional unit is critically used for normalization of GHG impacts and comparison to competing products. However, in the case of rail infrastructure which can be built in many different ways in many different conditions (e.g. soil types, elevation changes), it is challenging to clearly define and capture a well

Functional Units	1PMT	1PKT	1 VKT	1 RIS	1 TMT	1 MOB	1 CL	1 SS
Number of Publications	3	16	2	2	1	1	1	1
Number of Case Studies	5	42	6	2	5	1	1	1

PKT (Passenger kilometre travelled); PMT (Passenger mile travelled); VKT (Vehicle kilometre travelled); TMT (Track mile travelled), RIS (Rail Infrastructure system), MOB (Metre of bridge); CL (Kilometre of construction length), SS (Subway system)

Figure 2. Different functional unit in papers and case studies.



Parametric LCA: a method that specific system parameters are statistically modelled to calculate emissions
 Simplified LCA: compares the environmental impact of the rail infrastructure and no rail infrastructure condition
 Pseudo LCA: a methodology based on a mix of primary data and data from literature to calculate the GHG emissions
 Process-based LCA: a methodology performed by characterizing "all processes associated with all life cycle phases of the project"
 Hybrid LCA: incorporating both economic input-output analysis and process-based

Figure 3. LCA Methods used in case studies.

defined and complete function. For example, is the function of a metro line to move people 5 km, 5 km underground or 5 km underground through rock?

In the adoption and use of functional units across the reviewed papers, there was a significant heterogeneity in the ways infrastructure construction types (at-grade, elevated, tunneled) are represented in the functional unit. In case studies looking at shorter sections of rail infrastructure the challenge of using one functional unit across different types of construction was avoided as these case studies had, for example, exclusively tunneling (Saxe *et al* 2017), or exclusively elevated sections (Infraestructuras 2015). For longer case studies, the differences in function provided by different types of construction were universally not discussed. Similarly, the differences in external factors like ground conditions and elevation changes were not included in functional unit definitions.

The challenge in identifying the functional units for rail infrastructure complicates comparison of

embodied GHG emissions. For instance, a tunnel through competent rock will require different quantities of construction materials than one through clay, a nuance that is lost if a PKT or similar functional unit is adopted. Further, one PKT (or VKT) often used to compare between lines and modes is sensitive to the route travelled; a more direct route would have fewer PKT, a meandering one more PKT. Focusing on PKT could therefore mask important implications of construction route choice. For example, a tunnel would reduce the total length of the rail infrastructure but potentially increase the overall need for materials. The PKT would be lower in the tunnel scenario but the overall function of the rail line little changed. PKT is dependent on ridership often more than infrastructure, a challenge when the goal is embodied GHG assessment which is infrastructure focused. The GHG emissions generation of infrastructure life-cycle components, such as station construction, track/power construction, station lighting, station escalators, station train controls, station parking lighting, station

miscellaneous, are not dependent on ridership since they need to operate regardless of the use (International Union of Railways 2016). Additionally, the use of project scale functional units—like one subway line—are hard to compare as projects vary in length, specification and long-term carrying capacity. In this paper, we normalize to kilometre of rail (or equivalent at-grade kilometre which accounts for differences between elevated, tunneled and at-grade construction) given that embodied GHG emissions are strongly dependant on material and construction energy use, which are highly correlated to construction length. For embodied GHG emissions, the use of construction length (measured in kilometre or equivalent kilometre) is a reasonable generalizable function unit. Differences in geology and associated material needs, however, remain outside this functional unit. Given available details on ground conditions for the published case studies, controlling for differences in ground conditions was not within the scope of this review. Specific communication of ground conditions is something to be added to future work in this field.

4.3. Scope and boundaries

System boundary definitions are also a foundational aspect of LCA (The International Standards Organisation 2006a, 2006b). Equivalent system boundaries are important for comparison, and for the usefulness of past models to future predictions. This review focuses on the GHG emissions produced throughout the manufacturing of materials and construction of rail infrastructure—the GHG embodied in the infrastructure after construction. All reviewed studies deal with embodied GHG, while many also included other life stages (e.g. operation). Table 3 illustrates the life stages examined in each paper. As mentioned above, four papers were focused on embodied GHG emissions and included no other life stage. Sixteen papers include the operation and maintenance phases. Two papers include the disposal phase. Within the embodied GHG assessment, the papers varied in the details of infrastructure included. A full operational rail system includes trackbeds, stations, bridges, and tunnels. In addition, different ways of reporting the system boundaries were adopted across publications. In some cases, the boundary was unclear or unspecified, for example if bridges along the rail line were included in the assessment (Jones *et al* 2017) or the number of the stations taken into consideration (Li *et al* 2016). In some cases it was unclear if pre-existing infrastructure (e.g. the Figueroa Tunnel in California (Chester and Cano 2016)) was included in the analysis of embodied GHG.

The emissions considered were associated with a range of types of infrastructure, such as trackbeds, stations, bridges and tunnels, but not all the case studies considered the same type of infrastructure (see table 3). The review is based on the embodied GHG

emissions reported by the authors and as such is subject to the variation in boundaries. The embodied GHG emissions were not reported in enough detail in most papers to allow standardization of boundaries between papers. This is a key limitation of the publishing in this field.

4.4. Life cycle assessment methods

There are a variety of accepted LCA approaches, ranging from bottom up assessments like process based LCA, to top down assessments like input-output LCA. The choice of LCA method has implications for data requirements and assessment boundaries as well as for the final results. Different LCA methods were used in the different case studies (see figure 3). Thirty-four percent of the case studies used process-based LCA, a bottom up methodology performed by mapping and characterizing ‘all processes associated with all life cycle phases of the project’ (Jones *et al* 2017). Hybrid LCA method were used in sixteen percent of the case studies incorporating both top down economic input-output analysis-based (sector-by-sector wider analysis) and process-based LCA (Chester and Horvath 2010) in an effort to recover the lack of data when data were available only for a part of the whole process or to expand the boundaries of analysis (Jones *et al* 2017). Thirteen percent of the case studies were analyzed using pseudo LCA methods based on a mix of primary data and data from literature to calculate the GHG emissions. Where system data were not readily available, simplified and parametric LCA approaches were adopted (Westin and Kågeson 2012, Bueno *et al* 2017). Simplified LCA was carried out by comparing the environmental impact of the rail infrastructure and no rail infrastructure condition within a given area (Bueno *et al* 2017). In parametric LCA, specific system parameters were statistically modelled to calculate emissions associated with the system. In one case study, energy per seat kilometres required to move passengers was adopted in the parametric method used to study a 500 km HSR line (Westin and Kågeson 2012). Figure 1 illustrates the LCA methods used in the case studies by rail type.

The LCA method influences the uncertainty associated with the embodied emissions result recorded in publications. Hybrid LCA method incorporates economic and system data in a bid to analyzed the environmental impact of a system (Chester and Horvath 2010, Paris and de Silva 2010, Chester *et al* 2013), and is applied when there is lack of primary data at the process based level or to expand boundaries beyond where process based level detail is available (Jones *et al* 2017). Process-based LCA incorporates emissions from system information with less uncertainty than hybrid since process-based LCA allows a detailed analysis (Jones *et al* 2017) but often deals with a more limited scope to facilitate data collection. Hybrid and process-based LCA require a large amount

Table 3. Case study construction phase, Infrastructure types, and system boundaries.

Author (Ab)	Type	Construction phase			Infrastructure analyzed				System boundaries			
		Proposed	Under-construction	Constructed	Trackbeds	Stations	Bridges	Tunnels	Construction	Operation	Maintenance	Disposal
Lave (1978)	HRT								x	x	x	
National Rail (2009)	Intercity	x			x	x		x	x	x	x	x
Chester and Horvath (2010)	3*HSR, 3*HRT	x			x	x			x	x	x	
Chang and Kendall (2011)	HSR	x			x			x	x			
Paris and de Silva (2010)	Metro			x	x	x		x	x	x	x	
Westin and Kageson (2012)	HSR	x			x	x		x	x	x	x	
Chester <i>et al</i> (2012)	2*Light			x	x	x			x	x	x	
Chester <i>et al</i> (2013)	2*Light			x	x	x			x	x	x	
Morita <i>et al</i> (2013)	Light		x		x	x		x	x	x	x	
Hanson <i>et al</i> (2016)	5*Commuter			x	x		x	x	x			
Lederer <i>et al</i> (2016)	Light			x	x	x			x	x	x	
Miyoshi and Givoni (2014)	HSR	x			x	x		x	x	x	x	
Yue <i>et al</i> (2015)	HSR			x	x	x	x	x	x			
Infraestructuras (2015)	HSR			x	x	x	x		x			
Jones <i>et al</i> (2017)	HSR	x			x	x			x	x	x	
Li <i>et al</i> (2016)	Metro			x	x	x		x	x	x	x	x
Chester and Cano (2016)	Light			x	x	x			x	x	x	
International Union of Railways (2016)	HSR,			x	x	x	x		x	x	x	
International Union of Railways (2016)	Intercity			x	x	x	x		x	x	x	
International Union of Railways (2016)	Freight			x	x	x	x	x	x	x	x	
Dimoula <i>et al</i> (2016)	Commuter			x	x	x	x		x	x	x	
Bueno <i>et al</i> (2017)	HSR		x		x	x		x	x	x	x	
Saxe <i>et al</i> (2017)	Metro			x	x	x		x	x	x	x	
Shinde <i>et al</i> (2018)	Commuter			x	x	x			x	x	x	

of primary system data. Pseudo LCA uses cross-referencing to estimate emissions with the associated uncertainty of applying factors developed on one case study to another, often in different conditions, for example, in a different county, or different ground conditions (Hanson *et al* 2016). Parametric requires modelling one or two system specific data to approximately determine the emissions associated with the system (Westin and Kågeson 2012). As the methods move from parametric to process-based, the amount of data included increases, which, in theory, decreases the uncertainty in the results. Generally, bottom up methods like process based LCA are associated with lower bound assessments and top down approaches like input-output LCA are associated with upper bound assessments.

The majority of the papers took an attributional approach to examining the GHG impact of the infrastructure; those that dove into consequential analysis focused on the consequences for travel behavior and/or land use intensification. Despite the differences between the methods, they all use emission intensities (e.g. the GHG intensity of concrete per unit) for the processes or data of interest. All the emission intensities used come from existing databases or other publications by third parties, meaning that the factors may be interrelated as they come from the same pool.

4.5. Data collection

Two main types of data were used for the studied embodied GHG assessments: (1) quantities of materials and energy used in construction, and (2) characterization factors for the GHG intensity of materials and energy used. Table 4 lists data sources and type used in the reviewed papers. For the quantity data, seven of the case studies were based on primary data from a given rail project. Primary project data collection included bills of quantity (Infraestructuras 2015, Li *et al* 2016, Saxe *et al* 2017), bidding documents of the construction project (Lederer *et al* 2016) and activities schedule (Miyoshi and Givoni 2014, Infraestructuras 2015, Yue *et al* 2015, Lederer *et al* 2016, Saxe *et al* 2017, Shinde *et al* 2018). Many of the papers used secondary data for estimates of material or energy use in construction relying on published relationships from other projects. A number of the papers cross referenced other papers in this study for estimates of material and fuel use required for rail infrastructure construction. Some of the researchers interviewed construction personnel and visited construction sites to obtain relevant data that helped them in their study (Miyoshi and Givoni 2014, Lederer *et al* 2016, Shinde *et al* 2018).

The material and energy characterization factors were collected from environmental LCA databases such as EcoInvent (National Rail 2009, Chester and Horvath 2010, Yue *et al* 2015, Jones *et al* 2017), GEMIS, Chinese Core Life Cycle Database, and PE Database integrated with GaBi LCA analysis tools

(Infraestructuras 2015, Yue *et al* 2015, Lederer *et al* 2016). Electricity GHG characterization data and area data were obtained from government publications and local authorities, for example for the environmental life-cycle assessment of Los Angeles Metro's Orange Bus Rapid Transit and Gold Light Rail Transit Lines energy data were obtained by Los Angeles Department of Water and Power (Chester *et al* 2012). Rail projects exhibit a wide range of length and size scales. The traditional databases focus on elements with a much smaller magnitude than infrastructure projects and as such do not account for the scale of variability present in a large-scale project (e.g. the impact of year of manufacture on concrete GHG intensity). Calculating the emissions at scales larger than the ones presented in traditional databases is subject to uncertainty due to scale-up of LCA properties compounded with the influence of heterogeneity on materials and energy.

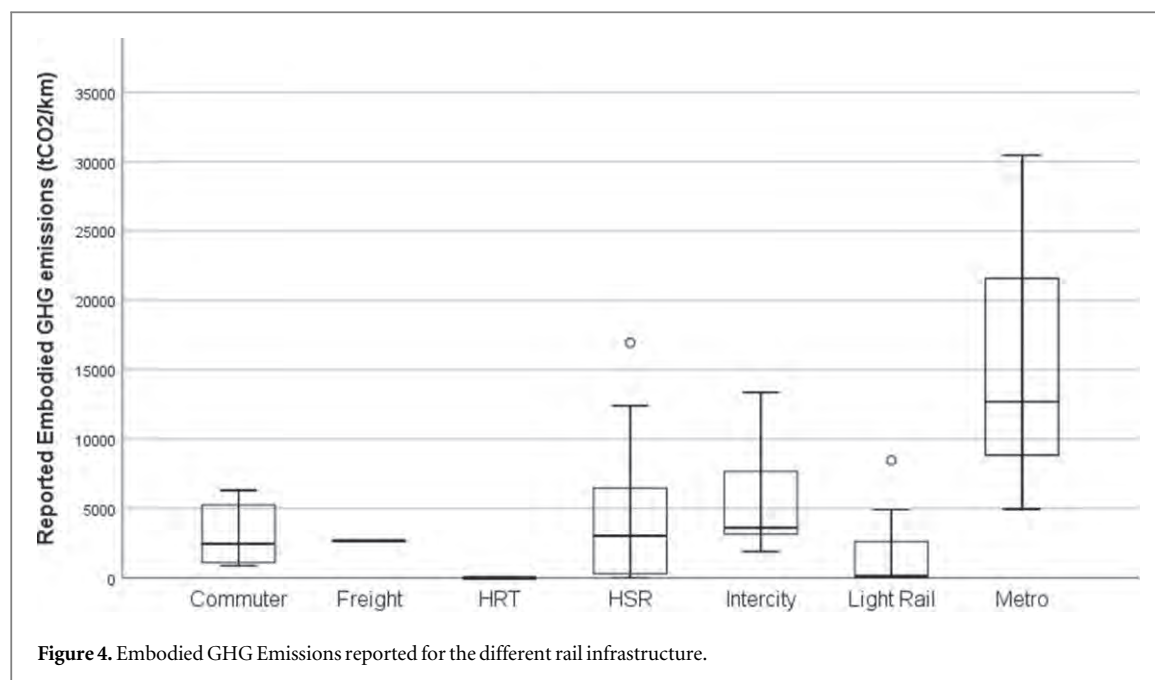
In most of the cases, the GHG intensity factors share a common starting point, using the EcoInvent database (National Rail 2009, Chester and Horvath 2010, Paris and de Silva 2010, Chester *et al* 2012, 2013, Kimball *et al* 2013, Yue *et al* 2015, Chester and Cano 2016, International Union of Railways 2016). Although the GHG intensity factors are always drawn from a database, the unique characteristics of each case study influences the way data are treated in terms of normalization and weighting, affecting not only the final results but the LCA process as well. Some papers had a much broader conception of the whole LCA process, by outlining the material manufacturing information and taking into consideration the construction documents, while other papers limited their scope of analysis to available data. For example, Westin and Kågeson (2012) assumed that all parameters were triangle distributed with a lowest, a highest and a central or most likely value for each parameter needed based on data from previously published papers. In National rail (2009), where data for specific materials was not available, proxy data have been used when possible based on the closest equivalents. Dimoula *et al* (2016) calculated the GHG emissions based on available data—mostly operational data—from Greece.

The range in data sources and approaches introduces irreducible heterogeneity to the case studies, as they are based on different background systems with different GHG intensities. The mix of primary and secondary data within the case studies is particularly telling as it reduces the independence of the individual data points. We have not removed the studies with secondary data from this review due to the small number of overall case studies. The use of proxy data is also common, indicating that the field would benefit by more specific data on both material and fuel use in construction and specific GHG intensity factors for material and fuel use in rail projects. These challenges stem from the nature of trying to capture detailed information about large fast-moving projects. Modelling the generation of embodied GHG emissions of

Table 4. LCA analysis tools and data source.

Author (Ab)	LCA analysis tools					Data sources			
	SimaPro	GaBi	Others ^a	Database ^b	Construction documents	Government publications	Material manufacturing information	Peer reviewed publications	Others data sources ^c
Lave (1978)	x			x		x			
National Rail (2009)	x			x		x	x	x	x
Chester and Horvath (2010)	x			x	x	x		x	
Chang and Kendall (2011)			x			x	x	x	
Paris and de Silva (2010)		x	x	x	x	x		x	x
Westin and Kageson (2012)			x			x		x	
Chester <i>et al</i> (2012)	x			x		x	x	x	x
Chester <i>et al</i> (2013)	x		x	x	x	x	x	x	x
Morita <i>et al</i> (2013)			x			x		x	
Hanson <i>et al</i> (2016)			x	x		x	x	x	x
Lederer <i>et al</i> 2016			x		x		x	x	x
Miyoshi and Givoni (2014)			x		x	x	x	x	x
Yue <i>et al</i> (2015)	x			x	x		x		
Infraestructuras (2015)		x		x	x		x	x	x
Jones <i>et al</i> (2017)	x			x		x		x	
Li <i>et al</i> (2016)					x	x	x	x	x
Chester and Cano (2016)	x		x	x	x	x	x	x	x
International Union of Railways (2016)			x	x		x		x	
International Union of Railways (2016)			x	x		x		x	
International Union of Railways (2016)			x	x		x		x	
Dimoula <i>et al</i> (2016)			x				x	x	x
Bueno <i>et al</i> (2017)			x	x		x		x	
Saxe <i>et al</i> (2017)			x		x	x		x	x
Shinde <i>et al</i> (2018)			x		x	x	x	x	x

^a Other Software includes Spreadsheet, PALATE, GREET, AggRain CO₂ Tools, Statistical Simulations.^b Databases includes EcoInvent, GEMIS, Chinese Core Life Cycle Database, PE Database.^c Other Data Sources Includes Google Map, Google Earth, Interviews, Email.



large scale rail infrastructure requires proper representation of multi-scale heterogeneity taking into account its interaction with underlying data sources.

4.6. The use of linearity assumptions

A fundamental assumption used across all the referenced literature is that assessed representative relationships (e.g. for material use, construction approaches, GHG intensity) can be scaled up linearly from a sub sample of the assessed infrastructure to the full project. In many cases, this has been done to adjust for the challenges inherent to detailed material accounting for large projects where data is often difficult to collect. For example, in Chester (2008) the steel intensity of elevated structures is calculated using a linear relationship for steel per foot based on the steel need from a typical drawing from 1915. The steel shown in this drawing of 2250 lbs of per linear foot is scaled over a full project. Given the foundational nature of Chester (2008) this relationship has been either explicitly or through reference used in other papers (Chester and Horvath 2010, Chester *et al* 2012, Kimball *et al* 2013, Chester and Cano 2016, Saxe *et al* 2017). Similar linear assumptions are made to assess the use of materials in most of the reviewed papers. For example, concrete (Chester 2008, National Rail 2009, Chang and Kendall 2011, Hanson and Noland 2015, International Union of Railways 2016, Jones *et al* 2017), steel (Chester 2008, National Rail 2009, Chang and Kendall 2011, Hanson and Noland 2015, International Union of Railways 2016, Jones *et al* 2017), copper (Hanson and Noland 2015), aluminum (Hanson and Noland 2015), salt for snow melting (Chester 2008), and/or the application of parts of the rail infrastructure such as track construction (Chester 2008, Hanson and Noland 2015, Jones *et al* 2017), lighting (Chester 2008), parking space (Chester 2008, Hanson and Noland 2015,

International Union of Railways 2016). The linearity assumption has a number of limitations, for example, different parts of a studied project use materials differently, particularly if the project is large or long. The design of one station does not necessarily accurately predict the material use of all other stations. The heterogeneity of the materials applied within the same project is also not taken into consideration. Similar concerns apply to construction energy use like fuel consumption. This introduces an uncategorized element of uncertainty to all the reviewed papers.

In future work, efforts should be made to capture a wider sample of large projects to reflect heterogeneity as, for example, ground conditions, construction approaches, design, materials and fuel use vary across projects. Researchers should explicitly consider the appropriateness and implications of linear assumptions. Rail authorities and contractors have an important data sharing role to play here as the challenge in collecting data is noted by multiple authors as a driver for using a subset of data and linear assumptions.

5. Reported embodied GHG

Figure 4 illustrates the embodied emissions reported in the reviewed literature categorized by rail infrastructure type. In this first instance, we present the embodied GHG as reported in the original papers without partitioning for construction type. HSR has the highest number (25 out of 57) of published case studies with published embodied emissions ranging from 13 tCO₂e km⁻¹ to 16 940 tCO₂e km⁻¹. The extrema (maximum) in the HSR boxplot diagram (see figure 4) is the Japan HSR system which primarily consists of tunnels and bridges. The large variation in HSR embodied GHG emissions were due to different

assumptions across the case studies and the different need for supporting infrastructure (e.g. bridges, tunnels) in the rail system. Emissions associated with the HSR tunnel equipment (signalling, energy, wired arteries; routes, catenary, works base; buildings; telecommunications; traction power; electrical substations; equipment signals and Hot Box Detector HBD) is twice that of the equipment used for the aerial infrastructure (Chang and Kendall 2011). Japan HSR, which requires a large amount of tunneling and elevated rail given the topography of Japan, has the highest GHG emissions with a calculated value of 17 000 tCO₂e km⁻¹ (International Union of Railways 2016).

The five US commuter rail were studied in one publication, and their embodied emissions range from 1104 to 6308 tCO₂e km⁻¹ (Hanson *et al* 2016). The eleven intercity rail lines were analyzed all located in Europe (one in Netherlands, one in Greece and nine in the UK). Embodied emissions from these systems range between 1902 and 13 378 tCO₂e km⁻¹ (National Rail 2009, International Union of Railways 2016). The UK intercity rail with the highest number of emissions contains 10% tunnel (National Rail 2009), while the case studies in Greece and The Netherlands had no tunnels (International Union of Railways 2016). The UK Bothnia freight rail was the only freight rail case study with a reported 2671 tCO₂e km⁻¹ embodied emissions (International Union of Railways 2016). Seven light rail case studies were reviewed and their emissions range from 47 to 8475 tCO₂e km⁻¹ (Chester *et al* 2012, 2013, Lederer *et al* 2016). The Tokyo light rail line is the extrema (maximum) in the light rail boxplot diagram (see figure 4) with 11% tunnels. Three Metro rail case studies were reviewed in this study and they were in the UK (12 712 tCO₂e km⁻¹), Canada (30 445 tCO₂e km⁻¹) and Asia (4984 tCO₂e km⁻¹). The Metro rail embodied GHG emissions had the largest variation. The LCA method adopted in studying the emissions associated with the case studies are different. While the Sheppard subway line was studied with pseudo LCA method, Shanghai Metro was analyzed with a process based LCA method (Li *et al* 2016, Saxe *et al* 2017) and Crossrail with the hybrid LCA method (Paris and de Silva 2010). Embodied emissions associated with the HRT range from 0.5 to 6 tCO₂e km⁻¹ (Chester and Horvath 2010).

The published GHG intensity of rail infrastructure varies significantly across the literature, leaving a question as to how these numbers can be used to help estimate the GHG of future projects. In general metro rail has the highest emissions, and light rail systems the lowest (of the types with multiple studies), however the quantity of case studies per rail type is highly uneven, making it hard to draw conclusions or comparisons. Section 5.1 below converts the GHG emission per kilometre to an equivalent at-grade construction to account for variation in material need

Table 5. Payback period of case studies.

Author	Payback period (Years)
Lave (1978)	535 ^a
Chester and Horvath (2010)	6 8 at high occupancy, 28 71 at mid level occupancy ^b
Paris and de Silva (2010)	5 32
Chang and Kendall (2011)	13
Chester <i>et al</i> (2012)	10 years after operation
Chester <i>et al</i> (2013)	30 60 years after operation
International Union of Rail ways (2016)	9
International Union of Rail ways (2016)	12
Chester and Cano (2016)	14 years after operation
International Union of Rail ways (2016)	15
Saxe <i>et al</i> (2017)	9 35 years after operation

^a Outlier base on energy use for mobility in a different era.

^b Different scenarios based on occupancy.

between at-grade, elevated and tunneled rail infrastructure.

5.1. Payback period

Payback period, the time required to save—through travel behaviour and land use change—as much GHG as were invested in construction, is measured in decades across the case studies. Nine out of 22 publications included payback periods in their study as summarized in table 5. The payback periods are influenced by the total emissions associated with the rail system including its embodied emissions, operating and maintenance needs, travel behavior and land use outcomes (Chester and Horvath 2010, Saxe *et al* 2017). Published payback periods range from 5 to 535 years with Lave (1978) the extreme outlier and base on energy use for mobility in a different era. While outside the post 2009 window of analysis, we include Lave as the first paper to analyze payback period. Three payback scenarios were analyzed by calculating the mean of the observation and using the average, the minimum, and the maximum values of the payback years for typical, optimistic, and pessimistic scenarios, respectively. The typical payback period (with Lave excluded) is 20 years, the optimistic scenario is 15 years, and the payback period for the pessimistic scenario is 27 years.

The decades long reported payback periods and the impetus to reduce GHG emissions in the short term indicate the significant efforts are needed to carefully reduce the embodied GHG of new rail infrastructure (while simultaneously fully taking advantage of the infrastructure for travel behavior and land use change).

When considering the payback period of these 10 cases, there is an uncertainty up to 75%. The contribution of the embodied emissions to this uncertainty is up to 30%; the rest, 45%, is due to operational

emissions and assumptions such as the estimation of the ridership. The estimation of the embodied emissions is based on the construction period and therefore static in time and not affected by dynamic factors which change over the years such as travel behaviour or railcar technology. As such the uncertainty in the upfront embodied emissions should be reducible with more detailed data collection and reporting.

With increasing pressure and urgency to reduce global GHG emissions and the associated impacts of climate change, GHG payback periods measured in decades may become unacceptable. As the cost half of the equation, the embodied emission of rail infrastructure will need to reduce to facilitate faster payback periods.

6. A generalized model of GHG emissions per kilometre of rail infrastructure

The wide heterogeneity in rail projects, type, location, design, soil characteristics leads to a large range of embodied GHG in assessed projects. This is amplified by the variations in scope, boundaries, approaches and goals in the published research. This heterogeneity is the key challenge in developing a generalized model for estimating the embodied GHG emissions in rail infrastructure projects.

To develop a sketch model of embodied GHG in rail, the first step was to track the relationship between the embodied GHG emissions and the length of the rail infrastructure. To examine this relationship, a linear modeling approach has been adopted. The reason for choosing this approach is that 'at heart, LCA is a tool based on linear modeling' (Guinée *et al* 2001). Linear regression is adopted for testing the impact of at-grade, elevated and tunneled construction on embodied GHG emissions in line with past findings that type of construction in a major driver of overall embodied GHG (Chester 2008, National Rail 2009, Chang and Kendall 2011).

Any model has some limitations which increases its uncertainty. Uncertainty in statistical analyses arises from random factors and is quantified based on the standard deviation of the measured quantities (Field 2013). In this framework, the statistical analysis of this study scopes out the effect of the detailed design factors affecting the embodied emissions of rail infrastructure including its function, geometry, specifications, emphasis on whole lifecycle, legislative constraints and socio-economic factors. This comes as a result of approaching the subject macroscopically, due to missing data and construction details. The embodied emissions are affected by the aforementioned factors which are not explicitly examined in the statistical analysis used in this paper.

Using the reviewed case studies, we developed a sketch model of the GHG emissions per kilometre of rail infrastructure. This analysis was performed using

inferential statistics. Analyses were conducted with IBM SPSS software. It is common practice to normalize the GHG emissions per infrastructure length in kilometre as discussed above (and done above in figure 4); this obscures the large differences in material and energy needs to construct at-grade, elevated or tunneled rail infrastructure. Previous research has identified tunneling as 3–89 times more GHG intensive than at-grade (National Rail 2009, Chang and Kendall 2011, Westin and Kågeson 2012, Miyoshi and Givoni 2014, Dimoula *et al* 2016, Hanson *et al* 2016, International Union of Railways 2016, Li *et al* 2016, Bueno *et al* 2017). Below we convert the GHG findings in the reviewed paper to at-grade kilometre equivalents, meaning we apply a scale factor to the case studies to convert to equivalent at-grade distances based on the ratio of GHG emissions between at-grade, elevated and tunneled construction in the reviewed papers. Most of the papers (National Rail 2009, Chang and Kendall 2011, Westin and Kågeson 2012, Miyoshi and Givoni 2014, Dimoula *et al* 2016, Hanson *et al* 2016, International Union of Railways 2016, Li *et al* 2016, Bueno *et al* 2017) clearly identify the tunneling percentage of the total rail line constructed. Some (Infraestructuras 2015, Yue *et al* 2015, Chester and Cano 2016, Dimoula *et al* 2016, Hanson *et al* 2016, International Union of Railways 2016) provided information about the bridges/elevated sections. With two exceptions (except (Hanson *et al* 2016) Chang and Kendall 2011), the papers consider stations but generally without providing detailed design and dimension data. As such, the stations could not be considered as separated variables during this process. Accordingly, stations were assumed to be at-grade, elevated or underground in parallel to the construction type for the attached section of rail line. More specifically, we assume that the embodied GHG of stations is proportional to the length and type of constructed rail. A similar approach was adopted in previous efforts to assess the GHG impact of different types of rail infrastructure by National Rail (2009). This assumption ignores differences in stations spacing and station design and with more detailed data in future publications it would be better to model stations separately. Some of the cases were excluded as they did not provide details on the tunneled/elevated/at-grade portions (Lave 1978, International Union of Railways 2016). From a total of 57 case studies, 44 were used in this part of the analysis. In publications with more than one scenarios for the same case (National Rail 2009, Yue *et al* 2015), the most GHG intensive scenario was used. A multivariate analysis was applied. The analysis showed that the length of tunneling (p -value = 0.000) and the length of at-grade (p -value = 0.000) affected the embodied GHG emissions to a significant level. The length of elevated section was not found to affect embodied GHG to a statistically significant level (p -value = 0.764). Linear regression was used to identify the relative GHG intensity of

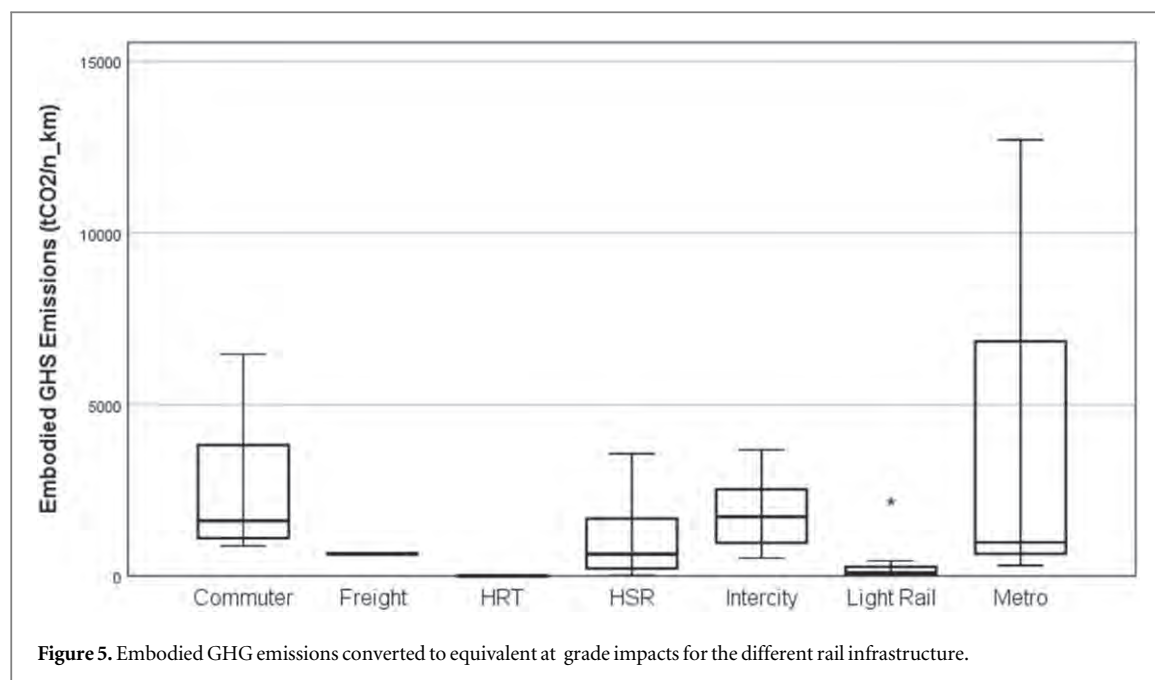


Figure 5. Embodied GHG emissions converted to equivalent at grade impacts for the different rail infrastructure.

tunneled length compared to at-grade construction. The linear regression lead to the following:

$$y = (18759 \pm 3169)x_1 + (685 \pm 469)x_2 + (233997 \pm 35561)$$

y is the tonnes of embodied GHG emissions
 x_1 is the kilometres of tunneling
 x_2 is the kilometres of at-grade.

The embodied emission generation of tunneling is 27 ± 5 times more than at-grade construction, and explains 46.8% of the variance in GHG emissions between case studies. We converted the data by adjusting values measured on different scales, at-grade and tunneling construction, to a notionally common scale, that is at-grade equivalents. The factor that was applied to convert tunneled lengths to at-grade was 27.

For elevated sections, we reran the regression including only the eight case studies that had more than 10% elevated length (Infraestructuras 2015, Yue *et al* 2015, International Union of Railways 2016), finding that elevated structures had embodied GHG 6 ± 1 times more than at-grade, explaining 16.7% of the variance. The linear regression analysis for the elevated sections was applied for comparison reasons but not for further use, since the length of elevated section was not found to affect embodied GHG to a statistically significant level (p -value = 0.764), and given the low number of case studies with relevant data is not included in the transformed to at-grade equivalents in figure 5 below.

An analysis of variance (ANOVA) demonstrated that the embodied GHG emission generation is differentiated depending on the types of rail infrastructure. In other words, there is a significant difference in the results between the different types of rail. Thus, a linear regression analysis was applied within each type of

rail infrastructure that had a sufficient number of cases for the analysis to be conducted (HSR, light rail, commuter rail, intercity rail). The number of publications per rail type is provided to illustrate the bias of the results. For commuter rail based on two publications and 6 case studies, tunneling affects the embodied emission generation 89 times more than at-grade, explaining 99.8% of the data variance. For HSR rail based on 11 publications and 25 case studies, tunneling affects the embodied emission generation 37 times more than at-grade, explaining 48.7% of the data variance. For intercity rail based on three publications and 11 case studies, tunneling affects the embodied emission generation 8 times more than at-grade construction, explaining 54.6% of the variance. For light rail based on five publications and 7 case studies, tunneling affects the embodied emission generation 3 times more than at-grade construction, explaining 54.2% of the data variance. The range of tunneling impact may be an artifact of the quality of the data, since every case was unique. So, to facilitate comparison between rail types and case studies, the average tunneling effect ratio equal to 27 was used to convert the reported GHG emissions in the reviewed papers to equivalent at-grade impacts. Figure 5 illustrates the at-grade adjusted embodied emissions reported in the reviewed literature, categorized by rail infrastructure type. The converted equivalent at-grade kilometre is denoted as 'n km'.

There is significant unreduced heterogeneity in the results. Details of methodology, assumptions, system boundaries and data collection techniques should be taken into consideration when interpreting the outcome of these analyses.

Overall, the adjusted boxplot shows a reduced range for embodied GHG emissions categorized per

Table 6. Initial model summary and parameter estimates.

Equation	Dependent variable: GHG emission in kg					
	Model summary		Parameter estimates			
	R Square	Significance (<i>p</i> value)	Constant <i>b</i> ₀	<i>b</i> ₁	<i>b</i> ₂	<i>b</i> ₃
Linear	0.454	0.000	3.034×10^8	6.697×10^5		
Logarithmic	0.267	0.000	2.194×10^9	5.503×10^8		
Inverse	0.058	0.105	1.388×10^9	1.617×10^{10}		
Quadratic	0.454	0.000	2.669×10^8	7.232×10^5	6.433	
Cubic	0.550	0.000	2.562×10^8	2.37×10^6	7.356×10^2	0.061
Compound	0.233	0.001	7.6×10^7	1.001		
Power	0.379	0.000	6.365×10^5	0.923		
S	0.134	0.012	19.458	34.435		
Growth	0.233	0.001	18.146	0.001		
Exponential	0.233	0.001	7.6×10^7	0.001		
Logistic	0.233	0.001	1.316×10^{-8}	0.999		

Dependent variable (*y*): GHG emission in kg; independent variable (*x*): at grade distance SPSS (IBM 2019) considers the following models to interpret the results: (1) linear mode $y = b_0 + b_1 \cdot x$; (2) logarithmic model $Y = b_0 + b_1 \cdot \ln(x)$; (3) inverse mode $Y = b_0 + \frac{b_1}{x}$; (4) quadratic model $y = b_0 + b_1 \cdot x + b_2 \cdot x^2$; (5) cubic model $y = b_0 + b_1 \cdot x + b_2 \cdot x^2 + b_3 \cdot x^3$; (6) compound model $Y = b_0 \cdot (b_1^x)$; (7) power model $Y = b_0 \cdot x^{b_1}$; (8) S curve model $Y = e^{b_0 + \frac{b_1}{x}}$; (9) growth model $Y = e^{b_0 + b_1 \cdot x}$; (10) exponential model $Y = b_0 \cdot e^{b_1 \cdot x}$; (11) logistic model $Y = \frac{1}{\frac{1}{u} + b_0 \cdot b_1^x}$, where *u* is the upper boundary value.

type of rail, however significant variation remains. The large variation in the embodied GHG emissions is partly a result of different demands of supporting infrastructures (bridges) in the rail system not controlled for in the adjustment. The Tokyo light rail line, with the highest embodied emissions, is 11% tunnels (Morita *et al* 2013) and is the only extrema in the box-plot diagram.

The data reviewed demonstrated a significant level of irreducible uncertainty in the body of knowledge given wide variations in approach, data quality and boundaries. Taking as a starting point the linear normalization process, it is possible to develop a model by using the length of tunneling and of at-grade construction as input (independent variables) and the GHG emissions as output (dependant variable). We explored which of the models provided by IBM SPSS software best described the relationship between the converted at-length length of rail infrastructure and the generated embodied GHG emissions. The models considered for the interpretation of the results are presented in table 6.

The larger the R^2 value, the larger the data variance explained by the model. As illustrated in the table 6, the model that best describes the relationship is the cubic model followed by the linear and the quadratic model. The rest of the models with high significance ($p = 0.000$) have a smaller R^2 . Nevertheless, the cubic model is prone to adjusting to non-homogenous samples like the present one. As a result, the cubic model was not monotonically increasing. It demonstrated that at some points in the curve the embodied GHG emissions were decreasing as the length of the rail infrastructure was increasing, something that does not occur in reality. Therefore, the linear function was

considered to be the most appropriate for the development of a sketch model in line with the linear nature of the LCA method. The sensitivity of the model suggests its revision with more case studies as more are published in the future.

The choice of using the distance data (length of rail) for developing a model was based on the significant effect (p -value = 0.000) of the at-grade and tunneled distance. This generates a model that can be used in cases where other data are missing or are limited. For example, as discussed above, during the scoping process for a rail project, detailed design data on material type, use and quantity are unavailable. In cases where detailed data are available, project specific GHG assessment should be carried out based on the physical design of the project to be analyzed. In future research, it will be valuable to create a model based on more specific rail design parameters (e.g. soil type, construction approach, local construction traditions). Given the detail and quality available in the reviewed papers, this was outside the scope of this paper.

The next step was to calibrate the model in order to adjust to the reviewed data. Since this paper targets a sketch model appropriate for most projects, the case studies which were proportionally far from the linear model were removed as outliers: Li *et al* (2016), National Rail (2009) NLP-SBC Total case, Westin and Kågeson (2012), Yue *et al* (2015) A5 case, Chang and Kendall (2011), Bueno *et al* (2017). The inclusion of these outliers would artificially move the mean to a less representative point (Field 2013). After removing the outlier cases, the IBM SPSS software generated an updated model which explained the 77% of the data variance, compared to the 45.4% the data variance explained by the initial model. The linear model is:

Table 7. Mean of the embodied GHG emissions (tCO₂) per kilometre of at grade with their standard error.

Type of rail	Number of cases	Mean of the embodied GHG emissions (tCO ₂)	Standard error
Commuter	6	2585	896
Freight	1	650	
HRT	4	2	1
HSR	25	1018	224
Intercity	11	1929	320
Light Rail	7	422	296
Metro	3	4670	4026
Total	57	1400	268

$y' = 935 \cdot x + 23205$ (where y' : GHG emissions in tCO₂e and x : the equivalent at-grade kilometre of rail lines). However, following the reasoning of the characterization factors that multiplies the subject of interest to a coefficient without adding a constant, a linear model was developed without the constant (23205). The resulting model is $y = 941 \cdot x$ and explains the 77.23% of the data variance. The resulting model suggests that 941 tCO₂e are generated per at-grade kilometre. A closer look to the numbers reveals that the coefficient of the resulting model is actually the mean of the cases considered. This suggests that the calculation of the means of the case studies is a sufficient indicator for linear modelling development. For comparison reasons, the mean of all the 57 cases, which includes the outlier cases, is 1400 ± 268 tCO₂e km⁻¹ of at-grade built. The means of the different types of rail infrastructure are provided in table 7.

Given the small number of case studies per rail type (e.g. HSR, Metro rail) all the 57 cases were considered as one category in the initial model. We additionally tested the predictive power of case study location, LCA methods and construction stage. An ANOVA showed that the specific location of the case study did not play a significant role on the embodied GHG emission calculation. However, in general, the case studies from Europe employed more tunneling and have a higher calculated embodied GHG emission per kilometre. The impact of LCA approach was also tested. Prior to exploring the methodology effect, the hybrid method was excluded from the analysis due its high uncertainty (1444 ± 1409 tCO₂e per at-grade kilometre). The parametric method was also removed as it was used in only one publication. Methodology was found to have a significant effect on the number of embodied GHG emissions reported with process-based LCA reporting generally lower embodied GHG emissions (582 ± 155 per at-grade built kilometre) when compared to both the pseudo (2709 ± 759 per at-grade built kilometre) and the simplified methods (1678 ± 240 per at-grade built kilometre). This is in line with bottom up LCA processes generally producing lower bound assessments.

Table 8. Mean of the embodied GHG emissions (tCO₂) per kilometre with their standard error portioned by construction type.

Construction type	Mean of the embodied GHG emissions (tCO ₂)	Standard error
At grade	1400	268
Tunneled	20695	2854

Finally, the impact of construction stage revealed that the reported GHG emission from the proposed projects (1928 ± 487 per at-grade kilometre) are higher than the constructed projects (941 ± 270 per at-grade kilometre). Since one objective of this paper is to summarize the published literature in tables of values that could support preliminary planning estimates of embodied emissions, table 8 summarizes estimates for emissions for the different infrastructure categories.

There is a lack of information on three significant features of the LCA: reliable data, characterization factors and LCA modelling methods (Passer *et al* 2015). Recovering this shortage of reliable data and characterization factors is beyond the scope of the present study. However, the authors explored the development of a modelling method using the existing data. This process was challenging as LCA is, by nature, a multi-model multi-paradigm approach (Guinée *et al* 2018, Yang and Heijungs 2018) and the necessary assumptions (e.g. GHG intensity of materials, accuracy of construction documents as predictive of material use) are very difficult to confirm (Guinée *et al* 2018).

7. Conclusions

A literature review of published papers dealing with the embodied GHG impacts of rail infrastructure identified 22 relevant papers with 57 case studies. The publications were classified based on their research goals, LCA methods, system boundaries, functional units, embodied GHG emissions, and GHG payback periods. While there has been an increasing body of literature that includes assessment of the GHG intensity of rail infrastructure, most have completed embodied GHG assessment as a step towards another goal rather than the main focus of the paper. Overall, the range of approaches, boundaries, functional units and methods are wide with unreducible heterogeneity in the reviewed case studies.

Large variation in scope, functional unit, boundaries and inventory methods make it challenging to compare the case studies directly. All the case studies include analysis of the GHG impact of construction but to varying degrees and with different boundaries. Data sources similarly vary across case studies. An ANOVA demonstrated that the embodied GHG emission generation is differentiated depending on the types of rail infrastructure. In other words, there is a

significant difference in the results between the different types of rail. In general, metro rail had the largest embodied GHG emissions, followed by intercity rail, high speed rail and light rail. However, this must be considered in context of the varying number of case studies per rail type and the general importance of infrastructure type (e.g. tunneled or elevated) to embodied GHG across rail types. Embodied GHG emissions normalization per distance highlights the influence of tunnels and bridges on embodied GHG emissions.

The papers dealing with embodied GHG emissions have originated in 11 countries, 10 of which are in the global north, future research from the global south would benefit the robustness of the field. Process based attributional LCA is the most common analysis approach, though some researchers have employed pseudo LCA, hybrid LCA and parametric approaches. The published payback period varied, ranging between 5 and 535 years, with 20 years as a typical average payback period. The biggest challenges to comparing and combining the findings were (1) inconsistent boundary selection between papers and (2) limited communication of the infrastructure details and embodied GHG calculations in many papers. As such, the papers make a start towards a baseline of embodied GHG emission for rail infrastructure but more standardization and detailed communication of construction material and fuel use is needed. A key contribution of this paper is identification of the need for future standardization in embodied GHG assessment and agreement on standards for communicating background data. Future research in this area should provide clear descriptions of (1) the kilometres of tunnelled, elevated, and at-grade construction included in the case study, (2) the range of ground conditions and elevations, (3) boundaries of assessment (specific communication of the embodied emission in each studied element (track beds, tunnels, elevated sections/bridges and stations) to allow for comparability between studies), (4) a description of all stations. The field will further benefit from a consideration of appropriate functional units for rail infrastructure. The current common functional units, PKT and kilometre, have limitations in regard to the heterogeneity of ground conditions, construction types, and passenger capacity of otherwise similar rail lines. A consideration of the linearity assumption is also needed.

Despite the heterogeneity in reviewed papers, it was possible to develop a range of findings. An ANOVA showed that the specific regional location of the case study did not play a significant role in the embodied GHG emissions calculation, however areas that required more tunnelling or more elevated structures due to topography led to more GHG emissions. LCA methodology was found to have a significant effect on the quantity of embodied GHG emissions

reported, with process-based LCA reporting generally lower embodied GHG emissions, this is in line with bottom up approaches generally providing lower bound assessments. Finally, the stage of project development at which the GHG assessment was carried out was found to have a significant effect on the quantity of assessed embodied GHG emissions, with the reported GHG emissions from proposed projects higher than constructed projects. This finding requires more investigation. We hypothesize that this could be a function of data quality and access. The size effect of these methodological effects should be taken into consideration when comparing case studies within this review or in the rail infrastructure embodied GHG literature more broadly.

The present paper introduced a novel conversion methodology, transforming the assessed embodied GHG emissions to equivalent and at-grade kilometres. This conversion permitted the development of a linear model for estimating GHG emissions. The statistical model finds that overall $941 \pm 168 \text{ tCO}_2\text{e}$ are embodied per kilometre of rail at-grade, while tunneling has 27 ± 5 times more embodied GHG per kilometre than at-grade construction. This simple distance-based statistical model can be used in cases where other data are missing or are limited as a rough estimate of potential embodied GHG. This model provides a first step towards a generalized approach to rail infrastructure embodied GHG assessment based on existing literature for project scoping. This cannot and should not replace detailed case-specific GHG assessment as design progresses and project specific details become available.

The statistical model is based on the findings of published literature and does not explicitly consider function, geometry, specifications, emphasis on whole lifecycle, legislative constraints, socio-economic factors, or the physical and environmental conditions of the construction site. More research is needed to create robust formulas for generalized embodied GHG assessment of rail projects. As more papers are published in the field, the data summarized here, and the approach to at-grade conversion, can be used to update the sketch model for embodied GHG per kilometre in this paper. As the field moves forward, clear communication of boundaries and data will be necessary to advance beyond the limitations identified in this paper.

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CC: info@wpgra.ca
Date: 4/11/2022 10:39:06 AM
Subject: [EXT] Public Hearing April 14,2022 - Re Item on CD1 Rezoning at 1477 Broadway

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

Dear Mayor Stewart and Councillors,

\~

40 Storey Tower at Broadway and Granville

\~

I do not support this proposal.

\~

- 1.\~\~\~ Such a tower is totally inappropriate for this sight. Apart from the developer, I doubt that any citizen wants to see the

profile of this area scarred by such a dominating structure.

2.\-\\- By approving such a tower, a precedent will be established that will proliferate throughout the Broadway Corridor and beyond.\~ It has the potential of establishing a rational that all Subway stations need to be ungainly tall. \~This is not true.

3.\-\\- The additional housing that may be provided does not justified the many horrors of imposing such a building in this area.

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Date: 4/19/2022 12:07:10 PM
Subject: [EXT] Re: Current Application for Rezoning of 1477 Broadway

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

Dear Mayor and Members of Council.

I am opposed to the proposed rezoning of 1477 Broadway. I am scheduled to speak on the matter at the hearing this evening, and I will explain my opposition more fully at that time. I write now to address a broader concern. After the initial hearing on April 14, I am very concerned about the integrity of the process to develop the Broadway Plan.

In any community the shadows to be cast by a building far higher than those around it is a matter of concern. City Staff, in their presentation, gave a very limited statement of what shadow the proposed new tower would create. The last speaker on April 14, Mr. Steven Boas gave a very detailed analysis of the shadow that the proposed development would create at various times of the year. It showed that the shadows to be cast by this development are substantially greater and more offensive than City staff advised. Mr. Boas stated that he had provided all of his research evidence to the City Staff. Unsurprisingly, he was disappointed that his research was ignored. He said City Staff did not respond.

The Broadway Plan is, so far as I am aware, the largest single development plan in the history of our City. If the rezoning for 1477 Broadway is approved, it will set a strong precedent for the Broadway Plan and will have a significant impact on the future of our Community. It is clear and obvious that this speaker's evidence should have been disclosed to the residents of the area. It is their quality of life that will be affected. It should also have been disclosed by Staff to you, the Mayor, and Members of the Council. As our elected representatives you are charged with reviewing this rezoning proposal and approving it or denying it. You need objective evidence to do that. In this instance, it appears you did not get this evidence from

Staff.\~ I don't know what other information may for whatever reason have not been provided to you.\~ I submit, however, that this application should be denied, and the Broadway Plan tabled, until you can satisfy the citizens of Vancouver that the information you are receiving from Staff is complete and accurate.

Yours truly,

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"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
"Dominated, Lisa" <Lisa.Dominated@vancouver.ca>
"Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
Date: 4/17/2022 11:47:54 PM
Subject: [EXT] Re: CD-1 Rezoning: 1477 West Broadway

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

Dear Mayor and Councillors,

I am a resident of Vancouver's Fairview neighbourhood. As my elected representatives, I ask you to please vote NO, OPPOSE the CD-1 Rezoning of 1477 West Broadway.\~

We've been through this before with the increased height problem at 2538 Birch Street. In that case you almost did the right thing and voted against it, but one of you changed his mind for some reason and it passed.\~

I could reiterate all the reasons that this zoning proposal is a really bad idea, but you've heard them before and they are the same arguments I and many others put forward against the rezoning of 2538 Birch. Your planning department is well aware of all the problems too, but they choose to ignore those issues.\~

I realize that you are advised by the planning department regarding these matters, but they seem determined to destroy our neighbourhood.

Please, please start listening to us, the people who elected you, instead of the planners *who we did not elect* and who are ignoring the wishes of Vancouverites. And by Vancouverites, I do not mean the developers or realtors, who are the only ones who will benefit from turning our neighbourhood into another Yaletown.\~

I am truly saddened to see the direction that our city is going. It is definitely not "green"; towers such as are proposed for 1477 West Broadway have been proven to be most un-environmentally friendly, un-human friendly.

Instead your planners should be looking at increasing medium-rise apartment buildings throughout the city, and other milder density-increasing ideas recently proposed by the Mayor.

In case you haven't seen it, you may find this article about the future of Fairview (and the Broadway Plan in general) enlightening:\~\~[https://brianpalmquist.substack.com/p/feint-by-numbers-1477the-beginning?s=r\[brianpalmquist.substack.com\]](https://brianpalmquist.substack.com/p/feint-by-numbers-1477the-beginning?s=r[brianpalmquist.substack.com])

I recommend you read it to be better informed.

Again, I ask you to listen to us, the people who live here in Fairview. Please vote NO on the CD-1 Rezoning of 1477 West Broadway.

Thank you for your attention,
s.22(1)

Vancouver, BC\~ V6H 1K5\~

From: s.22(1)
To: "Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>
"Dominated, Lisa" <Lisa.Dominated@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
"Fry, Pete" <Pete.Fry@vancouver.ca>
"Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>
"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
Date: 4/13/2022 9:56:25 PM
Subject: [EXT] Re. Item 4. OPPOSE 1477 W BROADWAY REZONING
(GRANVILLE & BROADWAY)

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

Dear Mayor and Council Members,

I oppose this rezoning application for these reasons.

City staff state that the application's proposed height of 40 storeys & density of 12.3 FSR aligns with the Broadway Plan, **~even though Council hasn't approved the Plan yet and it sets a huge precedent for the whole Broadway Corridor.**

The developer is attempting to sidestep **~\$3.3M in fees~** and will not make any financial Community Amenity Contributions, the money used for childcare facilities, social housing, and parks.

Staff say that no public parks or plazas are shaded by the building, but **they didn't assess shadowing at the winter solstice, the darkest time of the year.**

City resources should be allocated to building social and truly affordable housing, not providing uplift profit for people who develop for private profit.

Thanks you,
s.22(1)

From: s.22(1)

To: ["Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>](mailto:Rebecca.Bligh@vancouver.ca)
["Boyle, Christine" <Christine.Boyle@vancouver.ca>](mailto:Christine.Boyle@vancouver.ca)
["Carr, Adriane" <Adriane.Carr@vancouver.ca>](mailto:Adriane.Carr@vancouver.ca)
["De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>](mailto:Melissa.DeGenova@vancouver.ca)
["Fry, Pete" <Pete.Fry@vancouver.ca>](mailto:Pete.Fry@vancouver.ca)
["Hardwick, Colleen" <Colleen.Hardwick@vancouver.ca>](mailto:Colleen.Hardwick@vancouver.ca)
["Kirby-Yung, Sarah" <Sarah.Kirby-Yung@vancouver.ca>](mailto:Sarah.Kirby-Yung@vancouver.ca)
["Swanson, Jean" <Jean.Swanson@vancouver.ca>](mailto:Jean.Swanson@vancouver.ca)
["Wiebe, Michael" <Michael.Wiebe@vancouver.ca>](mailto:Michael.Wiebe@vancouver.ca)
["Dominato, Lisa" <Lisa.Dominato@vancouver.ca>](mailto:Lisa.Dominato@vancouver.ca)
["Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>](mailto:Kennedy.Stewart@vancouver.ca)

Date: 2/27/2022 10:44:13 AM

Subject: [EXT] re: referral of CD-1 Rezoning for 1477 West Broadway to Public Hearing

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

I oppose the referral of CD-1 Rezoning for 1477 West Broadway to Public Hearing.

I've reviewed the Referral Report in detail and have found stunning errors, omissions and inconsistencies which speak to staff's lack of impartial diligence in considering this rezoning.

Seven times throughout the Report, City staff state that the proposed height and density of the proposal aligns with the Broadway Plan Refined Directions, even though the Broadway Plan is not finished, nor has it been approved by Council.

The developer (PCI) has applied for a Development Cost Levy waiver (saving \$3.3M) and will not have to make any financial Community Amenity Contributions.

Staff claim that no major public parks or plazas are shaded by the building however, they didn't assess shadowing at the winter solstice, the darkest time of the year.

Per the Housing Vancouver Strategy, this rental building is being planned for all family types and yet, the Report provides no details on the building's amenities, access to parks, nor space in nearby schools. (Incidentally, catchment schools and other nearby

schools have no capacity.)

I urge you NOT to rubberstamp yet another ill-conceived staff/developer proposal.

From: s.22(1)
To: "Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
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"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
"Dominated, Lisa" <Lisa.Dominated@vancouver.ca>
"Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
Date: 2/27/2022 11:49:10 PM
Subject: [EXT] Re: Referral Report for 1477 W Broadway (RBC site)

City of Vancouver security warning: Do not click on links or open attachments unless you were expecting the email and know the content is safe.

Dear mayor and council members,

I am writing to ask you to **oppose the referral of CD-1 Rezoning: 1477 West Broadway to Public Hearing.**

Following are just some of the errors and inconsistencies in the proposal:

#1 - City staff state that the proposed height and density of the proposal "aligns with the Broadway Plan Refined Directions", even though the Broadway Plan is not finished, nor has it been approved by Council.

#2 - The developer (PCI) has **applied for a Development Cost Levy waiver (saving \$3.3M) and will not have to make any financial Community Amenity Contributions.** Yet again, the developers are being handed a gift - here, make lots of money and don't bother contributing to the community!

#3 - Per the Housing Vancouver Strategy, **this rental building is being planned for all family types and yet, the Report provides no details on the building's amenities, access to parks, nor space in nearby schools.** (Incidentally, catchment schools and other nearby schools have no capacity.) Where are all these lucky families going to send their kids to school? Where will the children play? There are no parks anywhere nearby.

#4 - Staff claim that no major public parks or plazas are shaded by the building however, **they didn't assess shadowing at the winter solstice, the darkest time**

of the year. \~And what about existing homes? Doesn't it matter that many nearby homes to the northwest, north and northeast will be shaded by this tower for at least half the year?\~

I ask you again, please\~oppose\~the referral of CD-1 Rezoning: 1477 West Broadway to Public Hearing.\~

Thank you,

s.22(1)

From: s.22(1)
To: "Bligh, Rebecca" <Rebecca.Bligh@vancouver.ca>
"Boyle, Christine" <Christine.Boyle@vancouver.ca>
"Carr, Adriane" <Adriane.Carr@vancouver.ca>
"De Genova, Melissa" <Melissa.DeGenova@vancouver.ca>
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"Swanson, Jean" <Jean.Swanson@vancouver.ca>
"Wiebe, Michael" <Michael.Wiebe@vancouver.ca>
"Dominator, Lisa" <Lisa.Dominator@vancouver.ca>
"Stewart, Kennedy" <Kennedy.Stewart@vancouver.ca>
Date: 3/1/2022 8:38:59 AM
Subject: [EXT] Re: Update: 1477 W Broadway (RBC Site)

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s.22(1)



On Sunday, February 27, 2022, 07:00:15 a.m. PST, Fairview/South Granville Action Committee <info@fsgac.org> wrote:

Dear Neighbours and Supporters,

~

Action needed on this today!

~

The Referral Report for 1477 W Broadway (RBC site) has been published and will be considered by Council on Tuesday, March 1st, 2022.

~

We have reviewed the Referral Report in detail and have found ~stunning errors, omissions and inconsistencies which speak to staff's apparent confidence that this rezoning is a fait accompli. Following are some of the highlights, and you can read our full critique here