Affordable Housing Renewal: Retrofits at Scale

Workshop Summary

January 10, 2018

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Outline

Workshop Background

Part 1: Context and Inspiration

Part 2: Retrofit Economics

Part 3: Strengths, Weaknesses, Opportunities, Threats

Part 4: Cultivating Opportunities

- A: The Housing Society Perspective
- B: The Industry Perspective
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Part 5: Barriers, Solutions and Next Steps

Key Contacts

Workshop Background

Who

- 40+ participants,
- 30 organizations
- Housing societies, government, academia and industry
- Primarily South Coast B.C.

Figure 2. Vintage of buildings in BC Housing and non-profit housing stock

Note: Data does not include buildings with no year of construction listed, single rooms, rent supplements, and other unique building types.

Potential for aggregation

Of the approximately 100,000 units of social housing in B.C., how many units could be pooled in a first contractual offering? Once a scalable product is developed, what potential market would be available to service providers? Table 1 presents a breakdown of the number of social housing units by building type. Based on data provided by BCNPHA and BC Housing, there are 25,000 to 30,000 units of social housing in low-rise wood-frame apartments built before the year 2000. This gives us a sense of the potential social housing market for a solution appropriate to that building archetype. Depending on the solutions developed, an additional 8,500 units of townhouses could also be reached.

The total private market potential (outside of the affordable housing sector) is much larger than any of the above categories, with an estimated pre-2000 stock of about 500,000 apartment units and 150,000 townhouse units.[10] The private market is shown broken down by vintage in Figure 3.

[10] Assuming an average size of 800 ft² for apartments and 1,200 ft² for townhomes. Natural Resources Canada, "Survey of Household Energy Use 2011." http://www.nrcan.gc.ca/energy/efficiency/17097

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Reference Materials

- Project kickoff blog
- Pre-read materials
- Concept video

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Goals

What: Net-zero carbon retrofits delivered at scale across Canada, driving toward a carbon neutral residential sector by 2050

How: Engage and coordinate the market to develop a complete, industrialized net-zero retrofit package

Objectives

Understand how *Energiesprong* brought retrofits to scale in the Netherlands, and envision how a structured market development approach could be used in B.C.

Clarify value proposition for housing societies, barriers to access, and conditions for success

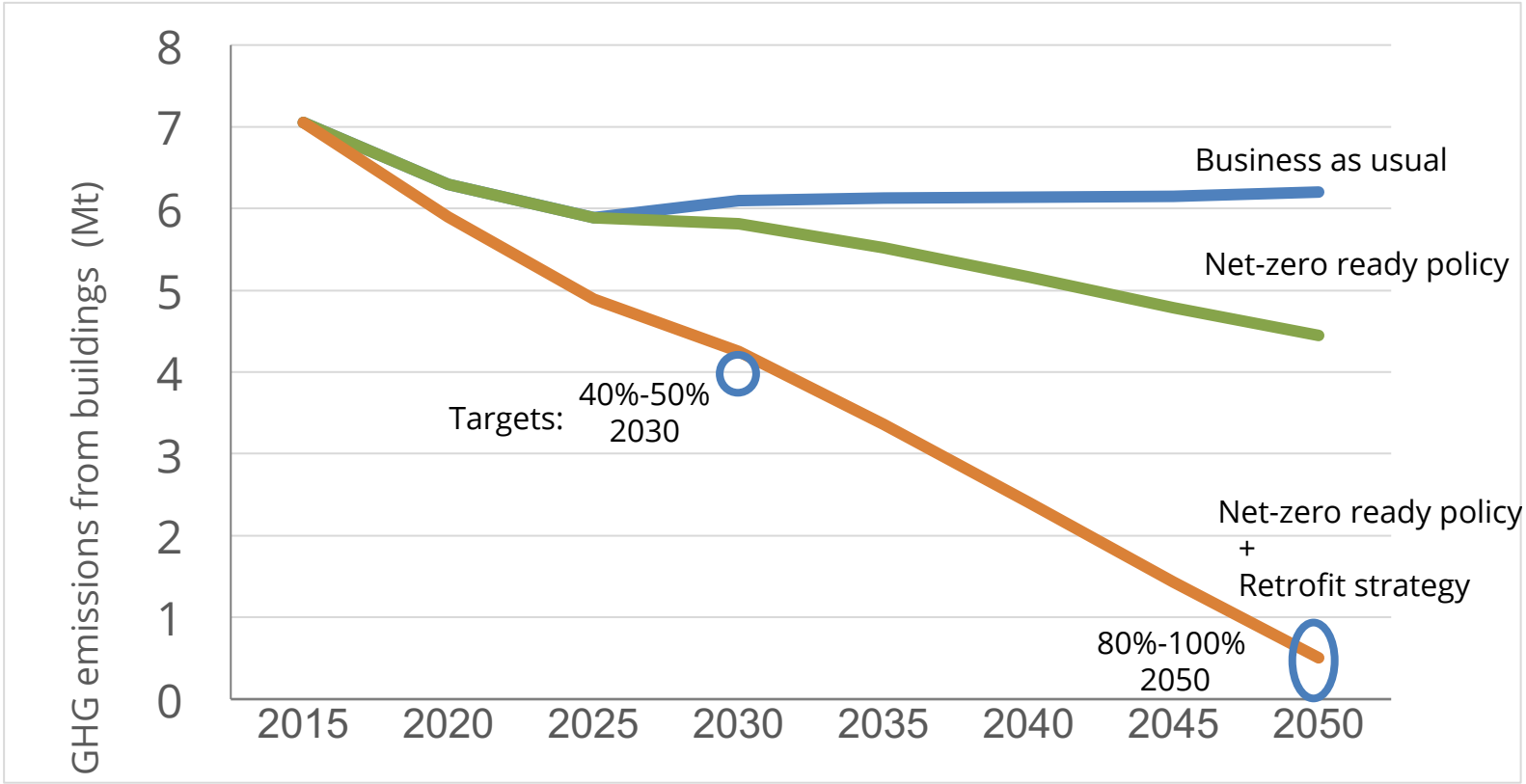
Assess state of readiness for service providers to provide industrialized retrofit solutions

Identify partners on pilot projects and the future roll-out of such an offering

Part 1: Context and Inspiration

Emissions from B.C. buildings

- To meet economy wide reductions of 80% by 2050, we estimate that building sector must decrease its emissions by half by 2030 and be decarbonized by 2050
- The “Net-zero ready policy” scenario below (green line) shows the savings expected from transitioning codes for new homes and buildings to a net-zero energy standard by 2032
- The orange line represent additional emissions reductions required to meet targets: these must be delivered by a provincial retrofit strategy



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What is needed from a retrofit strategy

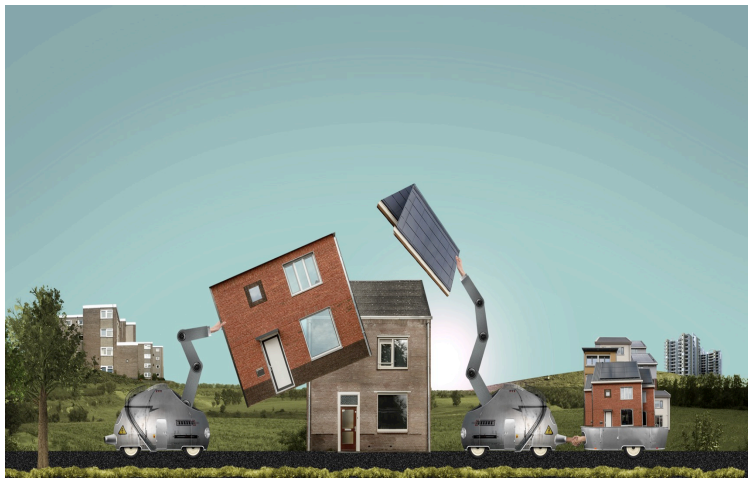
- 3% annual retrofit rate @ 60% average GHG reductions
- Can be achieved by electrifying 1 out of 2 buildings and achieving 25% GHG reductions in the rest

	Homes	MURBs	ICI
Current stock	1 million	25,000 (575,000 units)	60,000 (100 million m^2)
3%	30,000 per year	800 per year (17,000 units)	1,800 per year (3 million m^2)

Energiesprong

A successful model from the Netherlands which could deliver some of these savings. It features:

- Net-zero energy performance with a warranty up to 30 years
- Packages that are installed within one week
- Cost of living for tenants stays the same



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The Netherlands' learning curve

Roosendall 2010
2 weeks

Kirkrad 2011
10 days

Appeldoorn 2012
1 week

Arnhem 2014
1 day

130,000 euro

100,000 euro

80,000 euro

60,000 euro

40,000 euro
Target Price

50% energy savings

Net-zero

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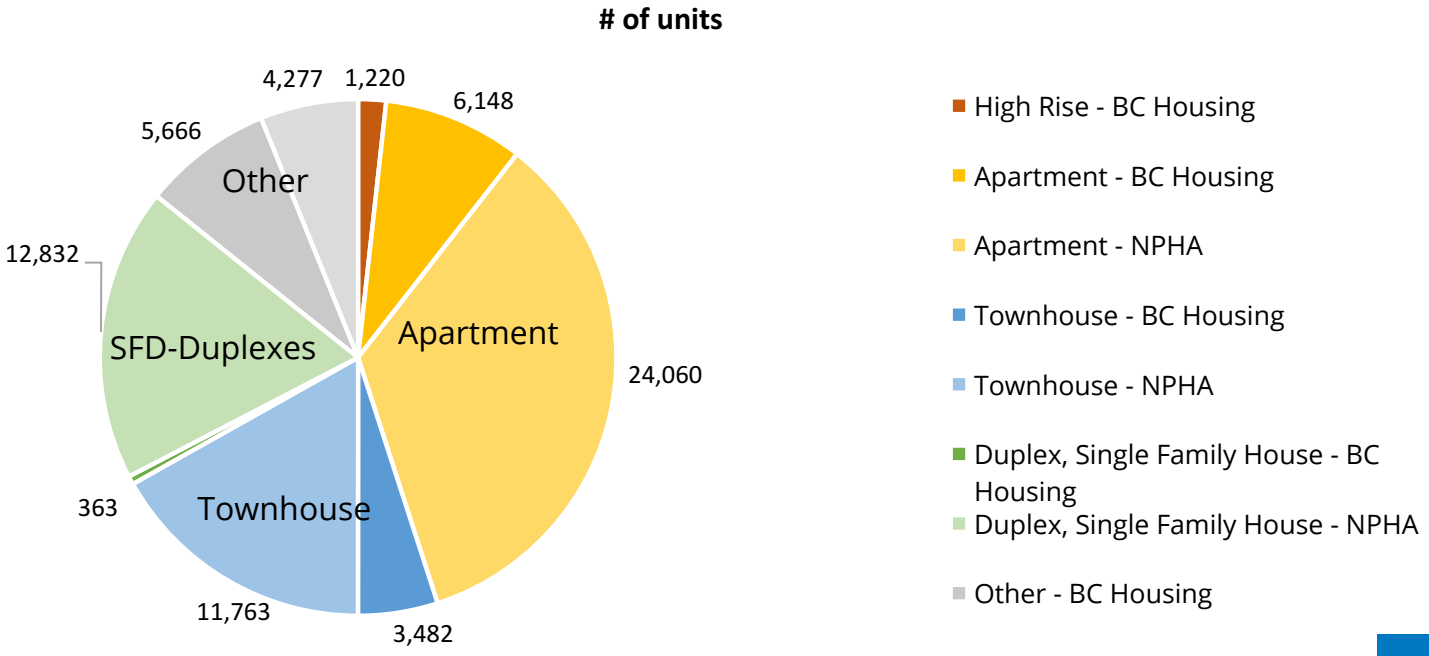
Social housing stock in B.C.

- ~ 100,000 units of social housing
- > 750 associations: 91% of which manage 5 or less buildings. The 10 largest societies manage on average 1000 units each, and together manage 10% of the stock
- Around 38,000 units of social housing apartments and townhouses were built before 2000, using 2,700 TJ of energy per year and emitting 50,000 to 70,000 tonnes of CO_2e per year
- There are also approximately 500,000 units of market rental apartments in B.C., which constitute a significant potential market for turnkey deep retrofit solutions
- Currently about 90% of the non-profit housing sector is subsidized by BC Housing. These subsides are distributed through operating agreements, 63% of which will expire by 2034



Data: BC Housing, BC-NPHA

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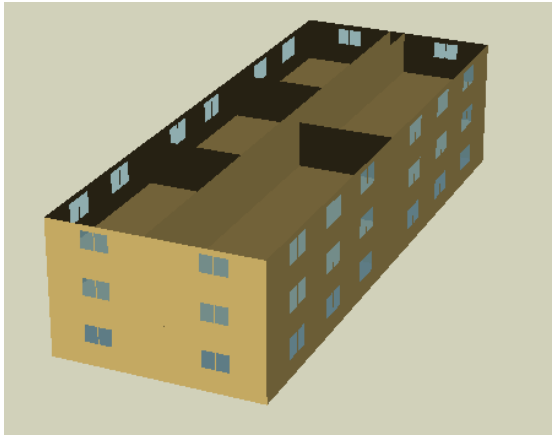
Part 2: Retrofit Economics

Key questions

- What do we expect the upfront costs to be?
- What factors influence cost?
- How and where can we capture savings?
- How does this compare to other options (i.e. redevelopment) and what is the added value?

Archetypes

- 3–4 storey, wood-frame apartment, likely built in the 70s or 80s
- There is a significant amount of this stock in B.C. social housing
- Example archetype model from U.S. Department of Energy: 15 units, ~1,000 m^2



Case study - Netherlands

Roosendall 2010
2 weeks,
$200k/unit

Arnhem 2014
1 day, $90k/unit

- $90–200k/unit total cost
- $750–1,500/m^2
- Exterior insulated panels
- Prefabricated
- All heating converted to electric
- Solar PV
- Exterior mechanical shed
- Net-zero energy

Case study - Surrey

- $100k/unit total cost, including complete envelope refurbishment ($700/m^2)
- $47k/unit real incremental cost ($320/m^2)
- Heat pumps
- Insulation
- Solar PV
- >90% GHG reduction

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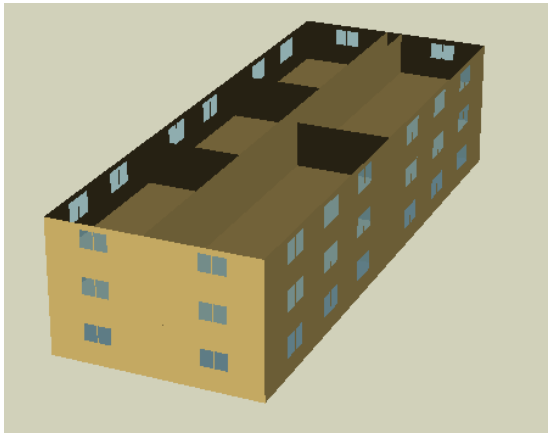
Modelled case study – San Francisco (RMI)



- $23k/unit projected incremental costs based on optimization ($320/m^2)
- Both envelope and heat pump-based solutions
- Cost excluding solar (net-zero ready)
- 60% energy reduction

Modelled case study – Vancouver (RDH)

- $7–13k/unit projected incremental costs ($170–330/m$^{2)}$
- Windows, HRVs, interior & roof insulation
- Some other tech considered (solar thermal, ground source heat pump)
- 75–80% heating energy reduction

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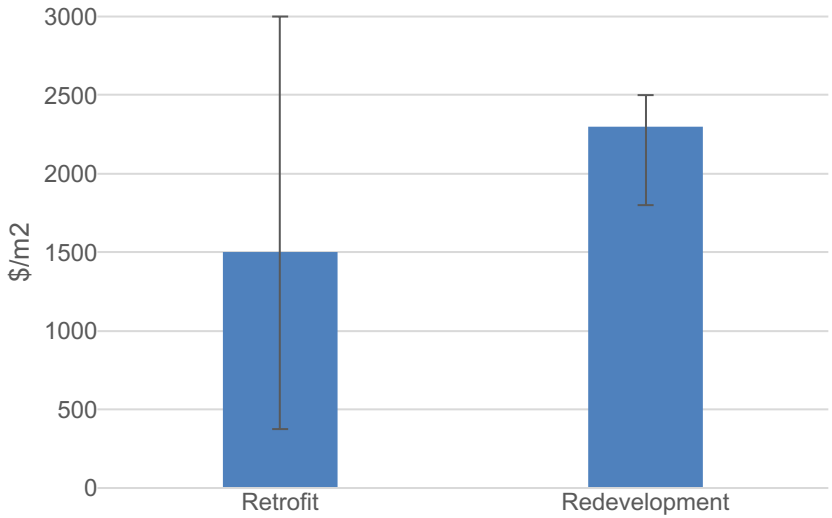
Capturing savings

Energy cost savings

- lLw range (Average for pre-2000 BC Housing low-rise apartments, over 25 years):
  $13,300/unit NPV, $170/m^2 NPV
- High range (Average for worst-performing quartile of pre-2000 BC Housing low-rise apartments, over 25 years):
  $29,600/unit NPV, $413/m^2 NPV

Maintenance cost savings

- Avoided lighting replacement, boiler calls, window calls, water ingress and mould remediation.
  One society estimates $4,700/unit, $50/m^2 NPV over 25 years



Possible proxy for cost of redevelopment

- Energy Step Code Step 4 equivalent MURB: $2,500/m^2

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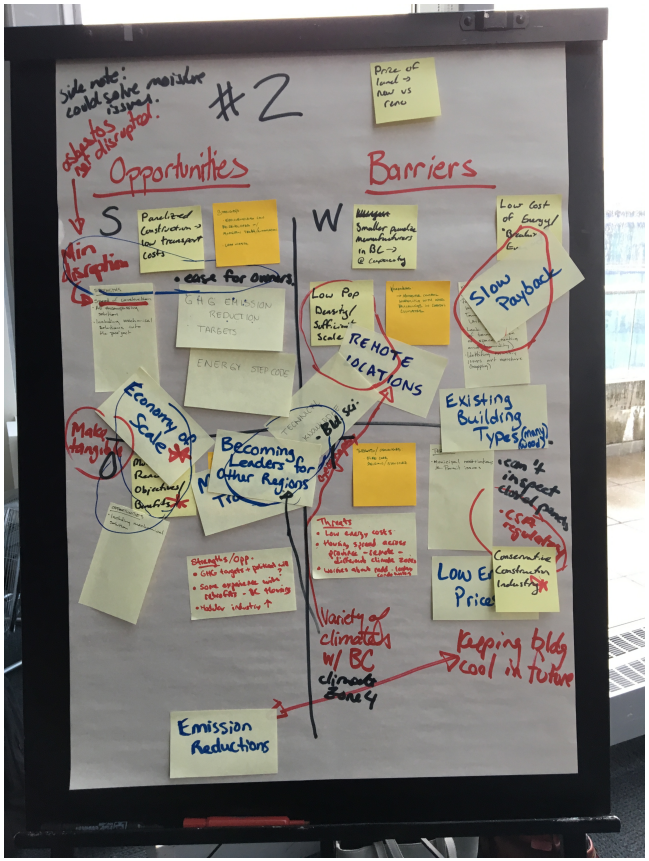
Part 3: Strengths, Weaknesses, Opportunities, Threats

Internal S/W of Energiesprong approach for B.C.



Strengths

- Holistic and comprehensive approach
- Modular and prefabricated construction
- Not just about energy and emissions, about quality of living as well
- Address existing issues and deferred maintenance

Weaknesses

- Not universally applicable
- Challenging business case
- Geographically and physically diverse building stock
- Risk of redevelopment

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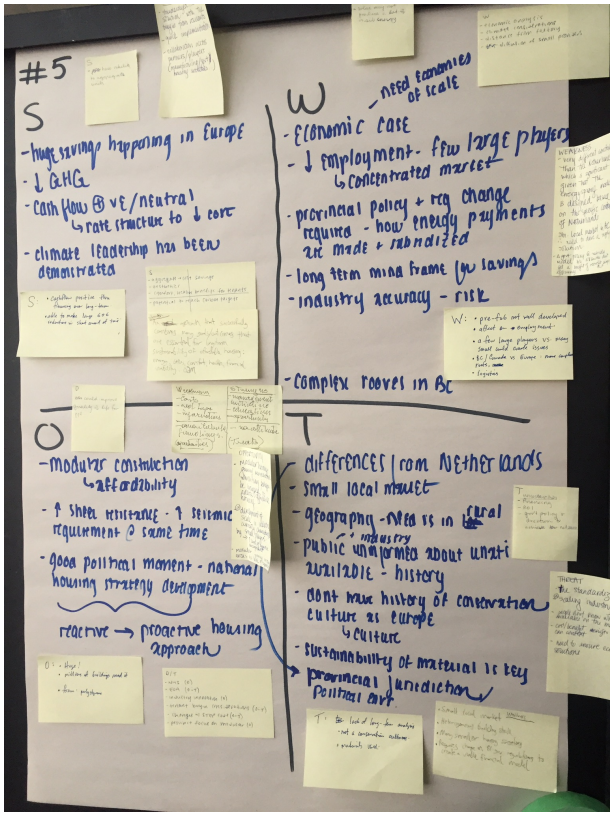
External O/T of Energiesprong approach for B.C.



Opportunities

- Can entice industry to innovate
- Visible “showcase” project to show what is possible
- Take advantage of political opportunity and renewed federal funding
- Create economies of scale

Threats

- Low energy prices
- Smaller market size
- Requires enabling changes to legislation
- Complex funding and payment structures

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Part 4: Cultivating Opportunities

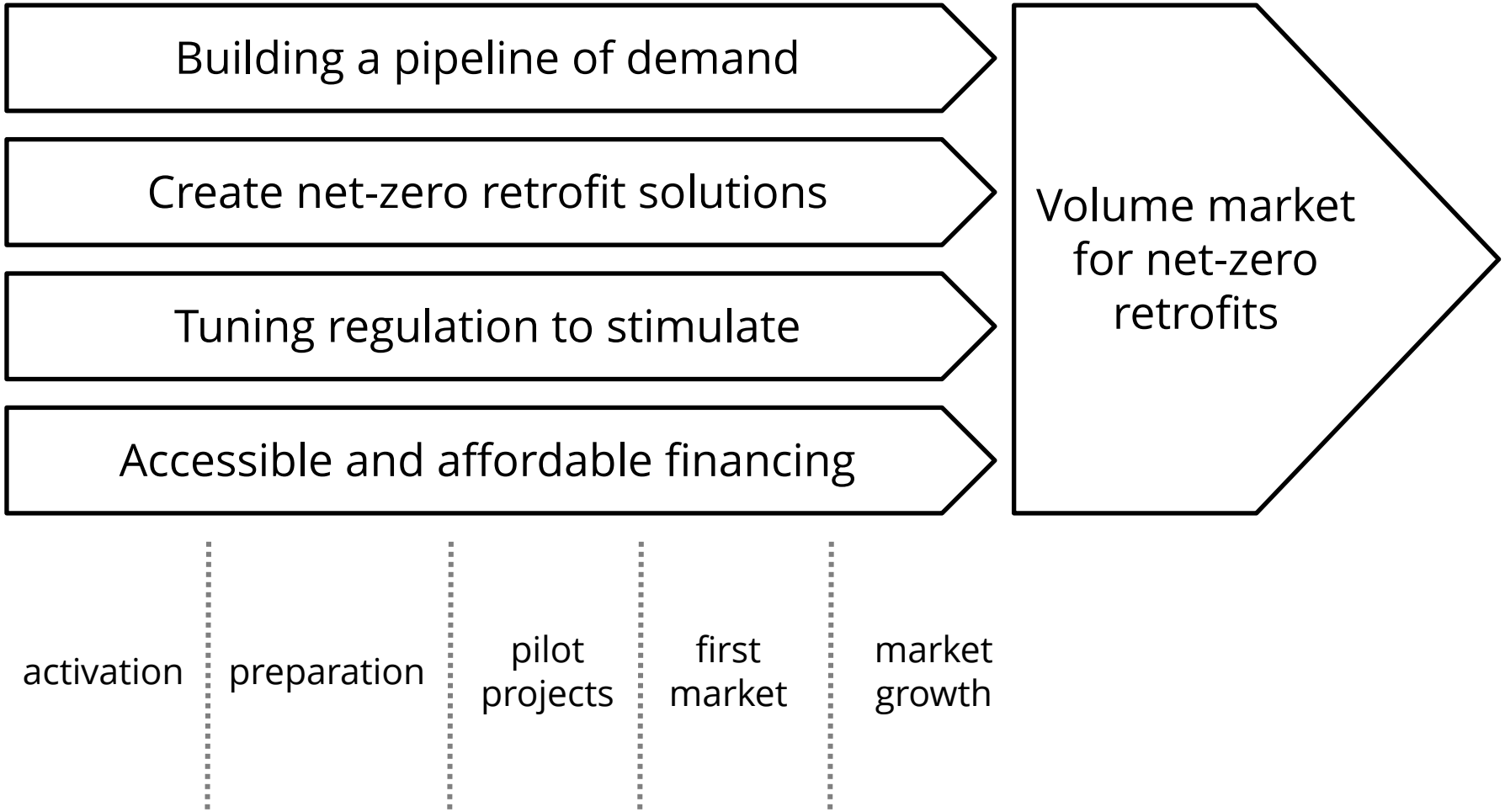
Primary objectives

- Healthy, abundant housing at accessible cost
- Climate protection and resilience
- Solutions transferable to market housing

Secondary objectives

- Accessibility and usability
- Deferred maintenance
- Seismic resilience
- Supporting renewables and smart grids

The Big Picture



Source: Energiesprong

A. The Housing Society Perspective

Housing providers in B.C. face a number of challenges in addressing deferred maintenance in their portfolios and implementing energy efficiency measures.

Issues facing housing societies range from expiring operating agreements, pressure to redevelop, and limited access to dedicated energy efficiency funding streams.

We asked housing stakeholders to identify pathways to improving the business case for retrofitting their stock, accessing capital and recovering savings, and engaging tenants around housing renewal and the aggregation model.

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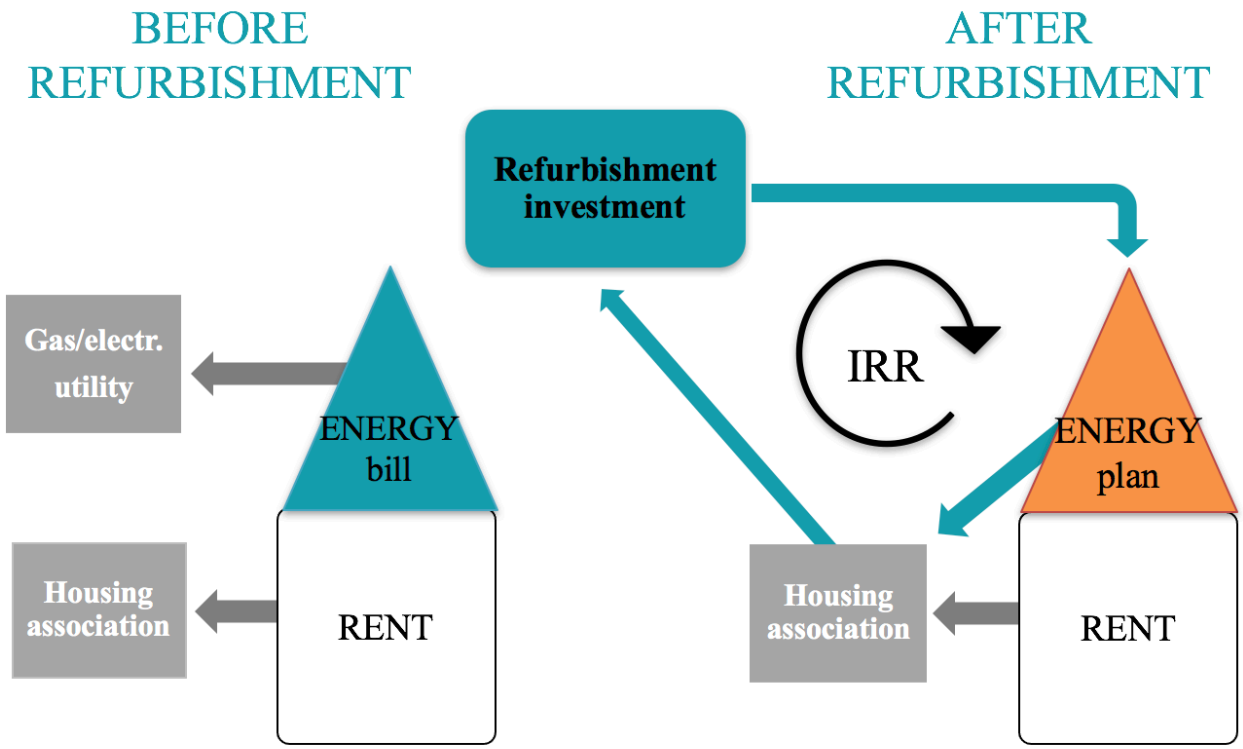
Q1. How can we recover energy cost savings accrued to tenants?

- Simplest solution: rent increase equivalent to the energy cost savings – no change in overall cost of living for tenants
  - This requires either permission from tenants, or a change to the Residential Tenancy Act
  - Similar approach to the "energy plan" introduced in the Netherlands *Energiesprong* projects:



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Other potential solutions:

- Socialize the cost of the retrofits and let the savings accrue to tenants
- Tenants could pay for a portion of the initial investment
  - It is not clear what mechanism could require tenants to pay for initial costs
  - Tenants may not be supportive
- Building operators could take over energy costs – an "energy as a service" model that results in energy being a fixed cost for the tenant
  - Decoupling energy usage from billing for tenants has the potential to raise consumption and reduce energy cost savings
- Tenants could be incentivized to sign up for sub-metering
  - This would likely lower energy use
  - Installing sub-metering infrastructure can be expensive
- Tie in with an education campaign and awareness
  - Incentivize tenants to reduce energy use through education

Q2. Improving the business case: What other value streams could be captured to make the case for financing by banks or subsidies by government / utilities?

- Tenant health and comfort is likely to be improved after the retrofit
  - Reduced mould + moisture and improved air quality
  - It is difficult to quantify/monetize these benefits
- Possible reduced maintenance costs
  - Includes avoided maintenance to mechanical systems, windows etc.
  - Avoided refurbishment costs due to mould or moisture ingress
- Retrofits have the potential to proactively avoid legal fees
  - Tenants may take legal action when building maintenance and condition is left unaddressed
  - Buildings with a great deal of deferred maintenance are a PR risk
- Economics of retrofit vs. redevelopment
  - There is a need to better understand the benefits and drawbacks of redevelopment to housing societies
- Pairing retrofit with redevelopment: adding other units on site, or on top of current buildings
- Fundraising and volunteerism
- Forgivable loan based on performance
- Municipal affordable housing funds
- Avoiding costs of relocating tenants

Q3. How could the program increase tenants' sense of ownership and pride?
How do we integrate it with social planning for the society or region?

- It is unclear what the current level of engagement/pride is within the social housing sector.
  - One perspective: a Victoria social housing site did an interior design project; after which tenants engaged with each other more and were more respectful of the space. Less destruction of property.
  - However, even in brand new buildings there is still neglect and property destruction.
- Communicating early and often is key
- Not having to displace tenants is helpful for getting buy-in
- In cases where tenants don't pay for energy costs, it is more challenging to engage tenants to lower energy consumption and buy into retrofits
- General need for education on building systems and infrastructure:
  - Some tenants do not know how to turn off/adjust the heat
  - Many windows left open during the heating season
- Health authorities set prescriptive requirements for building operation in care buildings: limited ability to change use patterns or reduce consumption
- In buildings with seniors or assisted care, changing the building can create significant stress to tenants

Q4. What is a fair way to introduce sub-metering and in-suite billing? How do we provide tenants feedback on their use to incent conservation?

- There needs to be a legal way to charge the tenants for energy
  - Likely requires changes to the Residential Tenancy Act
- Annual tests need to be done on the meter
- BC Housing can introduce sub-metering to show how much energy tenants are using, but cannot charge based on that
  - Energy is typically charged based on the square footage
  - This might be sufficient to change behavior if paired with a collective goal (i.e. save $ to invest in X)
- Getting BC Hydro to set up separate accounts and do maintenance is cost prohibitive
- New buildings can have sub-metering that can be used for billing, but no way to do this for existing buildings currently
- Potential opportunity to change current regulations so that sub-metering is allowed
  - There could not be an increased cost impact on tenants. Introducing energy charges would need to be compensated for through rent reductions
- Technology may have to play a role to play in changing behaviors - smart thermostats, window sensors, etc. that take human decisions out of the equation

Q5. What fraction of the 3-storey building stock is “at risk” of redevelopment?
What is the value proposition for refurbishment over redevelopment for this archetype?

- The value proposition for redevelopment depends heavily on location and zoning
  - More urban/central areas are are seeing the most redevelopment and have the greatest pressure to densify
- A Landlord BC study identified that by 2025, 20,000 units are going to need to be redeveloped or retrofit
- In Victoria - about 50% of the rental stock is due for significant restorative work, remediation or replacement by 2025
- Need to define how much a deep retrofit can extend the life of a building from the 60s or 70s
  - In BC Housing stock, even the worst units have had their life extended by an estimated 30 years - but at what cost?
- One society was quoted $20M to do the necessary retrofits on a building. Decided it made more sense to build new and make the existing 4 storey a 7 storey. In the new building there are more residents and more diversity

- BC Housing can build a new 80 unit building for approximately $20M
- If the cost of retrofits dropped by 50% it would be a very different conversation and decision
- Certain conditions must exist in order to support retrofit over redevelopment:
  - Structurally sound. Buildings with good bones, plumbing, electrical etc.
  - Concrete buildings are ideal candidate: long life and less problems
  - Good energy efficiency potential
  - Can't be on prime real estate where the potential to densify changes the equation
  - There is an opportunity for community land trusts to address the skewed economics of land value
- Need to have healthy reserves or some form of money for investment (currently it is easier getting money to redevelop than to retrofit)
- Low interest rates or financing that makes borrowing more affordable
- Societies could take out another mortgage on the building, but it's not desirable to be in more debt
- If only exterior and energy efficiency work is getting done and the interior issues aren't addressed, then there isn't the added value that a Board of Directors would want to see
- Re-locating residents temporarily is extremely expensive; needs to be low impact

B. The Industry Perspective

The retrofit industry in B.C. has some experience with the mechanized and prefabricated solutions that were used in the Netherlands.

However, a large potential market needs to be demonstrated to industry in order to encourage consortiums and research into new technologies and processes.

We asked industry to identify their key competencies and needs, and to help us refine the criteria for appropriate building sites and teams to include in an aggregated retrofit offering.

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Q1. Do we have the technical, industrial, and supply-chain capacity to deliver a prefabricated retrofit solution similar to the Netherlands' in B.C.?
What know-how, components, and industrial capacity is missing, and who could provide them?

- Consensus that industry capacity could exist relatively easily in B.C. to deliver the "Netherlands-style" solution, given sufficient demand
- Industry generally prefers the prefabricated approach, given that it is starting to be proven and simplifies the process significantly.
  - Some Canadian firms already doing closed panel projects for new construction
  - Improved ventilation is likely necessary
  - The solution can be made more mechanized
- Prefabricated panels/walls are done in B.C., roofs less often.
  - Prefab roof and solar are doable but not easy – this is a technology that builders have shown interest in
- There is an education gap and a need for capacity building.
- Balconies are a potential issue, much easier to deal with if they are not concrete (thermal bridging and complications in panelization)
- It may be more difficult to create economies of scale in B.C.
  - Easier in Netherlands because it is a small country
  - Panel shipping not a large barrier according to builders (small cost)

- Long supply chain means we can bring in panels and solutions from outside of BC
- Ontario challenges – historical societies had an issue with changed appearance of some buildings
  - Much of the affordable housing stock we are talking about in B.C. isn't a heritage concern – 70s-90s built
  - Some older buildings might be left as representative of the era but this is likely a minor factor
- If the envelope needs major work it is not clear whether a prefabricated exterior solutions will work
  - Prefabricated interior solution another option but causes more disruption, loss of floor space, not as much energy savings
  - Is there a way to use a prefabricated solution on a compromised building/envelope?
- Open source technology/design – doesn't exist yet but it's an opportunity
  - Lowers the barrier to other participants
- Before the exterior wall can be designed, the cladding needs to be considered – not just one type of wall that will adjust for the right moisture and heat depending on the existing cladding
  - This is why 3-5 designs in a competition is important, as well as narrowing the housing stock down to similar buildings
  - The process and knowledge in choosing buildings (selection criteria) is very important but challenging because we do not necessarily have all the information needed about each building and cladding without performing on-site assessments

- Gaps in skills – designers, architects, carpenters that know about panelized construction
- 3D scanning of the buildings is a valuable component of the Energiesprong model
- Energiesprong did not address the issue of concrete patios on buildings.
  - This is why we would want to go after the boxier buildings first
- In the Netherlands, the projects are typically low rise, up to about 8 stories, cranes would be the limiting factor to lift the panels up
  - Highest a crane can lift these panels is likely 18-19 stories without a much more expensive crane
  - You could design better equipment to do taller buildings if necessary
  - Would need a fire resistant panel material for noncombustible large buildings
- Applicability of these measures in non-social housing? How big is the potential total demand in BC?
  - Social housing the niche where this can be tried and then hopefully used in the broader stock of housing
  - Private sector markets – simple buildings from 1960 or so, poor performing envelopes – there are a lot of these across the country
  - War time bungalows for returning war vets are a promising market (about 750k built in Canada) – built from about 3 sets of plans so if you had a retrofit solution tuned for these then it could be widely applicable
  - Private residential side is challenging because the average home owner is adverse to using financing for renovations – about 70% finance with their own savings

Q2. What "B.C.–made" alternative to the "Netherlands-type" retrofit could be packaged into an easily replicable and scalable zero-carbon/zero-energy retrofit solution?

- Seismic intervention, is there potential overlap?
  - Detailed condition assessment necessary for every building
  - Analysis for seismic would have to be separate from the analysis of building structure for prefab
  - Panels might help address some seismic issues, but otherwise they are quite separate interventions
  - However, final solution could be combined (thermal envelope and seismic), just moisture analysis that has to be done separately
  - Long wait time to get either done if we try to do them separately
- Envelope shouldn't be brand new for first projects, but not so compromised that there is a structural/rot issue
- Social housing as a good catalyst market, but must demonstrate scalability to private market,
  - Some other archetypes other than 3-4 storey apartments that might demonstrate that include Vancouver Specials and light industrial

- Rather than an alternative, could a mechanical approach also be complimentary?
  - At the minimum you need provide insulation, ventilation and maybe a heat pump
  - Probably wont get to a place where it makes sense to electrify without putting in any other energy savings measures, so it will likely need to be a hybrid approach
- What about cooling loads?
  - Envelope-first approach helps for both heating and cooling – good incentive for the owner – restricting heat flow across the wall in both directions
  - This could be huge motivator for the private sector
  - Also could be a motivator to get government on board with climate changing around the buildings
- Which parts of a hybrid approach are still a challenge in B.C., specifically thinking about solar PV?
  - There are innovations such as solar cladding, solar windows, etc. that exist that could be brought together as B.C. solution
  - It may be possible to go to net-zero energy with good insulation and roof + wall + window solar on 3-4 storey walk-ups in B.C.
  - Energy storage within the cladding and outside for batteries etc.
  - Business case for solar PV isn't particularly strong

C. The Pilot

Q1. What would we need for the "Netherlands-type" solution, or a "B.C.-made" breakthrough, to emerge in a design competition? Who are the players we would want to attract?

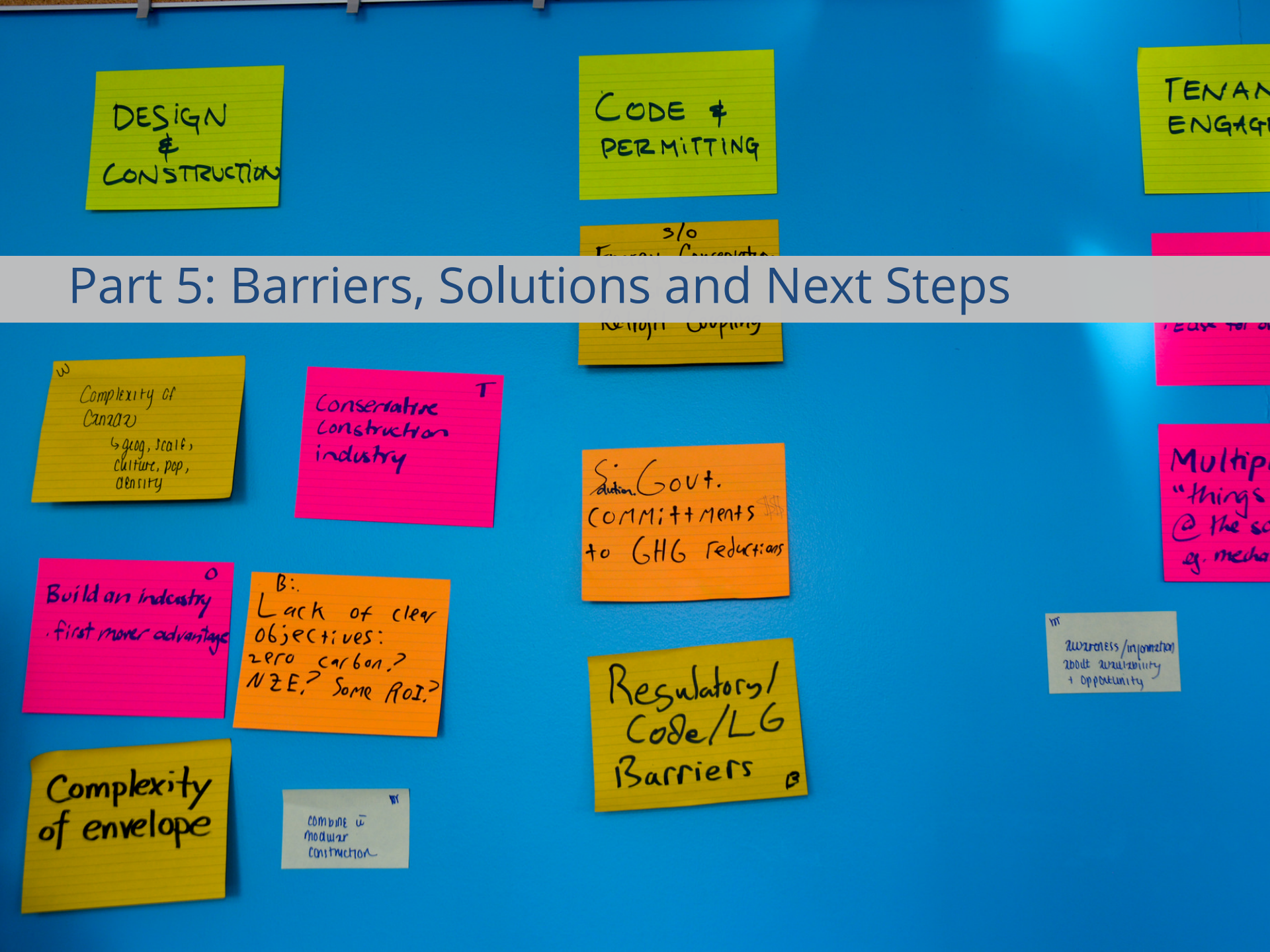
- BCIT and other institutions to deliver skills training
- New construction design team, prefab specific
- Contractors
  - Should be involved right from the beginning because they know what's possible, etc.
- Material suppliers – insulation, solar products
  - Suppliers may be able to alter their production process to fit the design
- Tenants
  - Understand what their goals are within their community and housing
- Governments
  - support to secure the loans (as done in the Netherlands) or provide financing
- Municipalities
- Code consultant – fire codes, seismic, liability
- Balcony consultant/contractor
- Solar consultant
- Utilities
- Financiers and insurers
- Housing societies
- Public health agencies

Q2. What factors should we consider in the selection of properties for the pilot?

- Owner-maintained and off-agreement (society owns the building)
- Financially stable society with experience in innovative projects
- Components close to end of life cycle but structurally sound
- Buildings that need work done – already in line for renovation/repair
- Not heritage
- Appropriate for current zoning (# of units/density) – low redevelopment risk
- Representative and replicable design and construction – high volume archetype
- Simple building features
  - Flat roof
  - No big balconies – only an issue for concrete construction
- Evaluate tenants – choose a building where tenants are more open to education and adjusting their behaviour
- Solar access/solar potential of the site
- Value of the land
- Balance between economizing in one spot and having the renovations showcased in many different locations
- Higher range of energy consumption / EUI
- Both tenant pays and society pays utilities (to evaluate the differences)

Q3. What are other success factors for a design competition?

- Savings are as anticipated/are guaranteed
- Tenants are satisfied with the proposed changes and see a benefit
- Everything works as promised and is easy to maintain
- Impact/$ invested is considered
- Skills and connections are built, local industry starts to be developed
- Benchmark performance against other buildings
- Society sees the value in replicating the model
- Confidence in the technical solution
- Confidence in the regulatory system
  - Ensure stable funding
  - Legal fees looked after
- Board buy in
- Tenant buy-in
- Showcased as a success story when completed
- Non-biased review (upfront and end)
- Long-term monitoring
  - Funding for monitoring is secured



Part 5: Barriers, Solutions and Next Steps

Barriers

Identified by industry

- Not very one-size-fits-all; tougher business case overall compared to other jurisdictions (e.g. Netherlands, U.S.)
- Applicability to the larger (private) market needs to be demonstrated

Identified by societies

- Lot of variation between societies and between buildings (e.g. different operating agreements)
- Currently less risky to invest in redevelopment as opposed to retrofit
- Diversity of the stock and landscape in Canada weighs against aggregating large numbers of units.
- Lack of clear objectives at this point, e.g. zero carbon, zero energy?
- Is there a maximum acceptable payback period?
- Procurement policy – need societies to not be required to choose lowest bid
- No clear way to recoup energy cost savings without changes to legislation

Solutions

Identified by industry

- Energiesprong approach does simplify the process and could be applied in BC.
- Industry capacity exists to deliver such a solution
- Industry preference for the prefabricated approach

Identified by societies

- Potential savings in legal costs – unhappy tenants produce legal costs so improvement of living conditions reduces these costs
- Sponsorship to recoup costs, forgivable loans from government
- Retrofit makes more sense if the building is durable and sound and has long life
- Basic tenant education – e.g. how to control heat
- Balance of redevelopment vs. retrofit – invest to extend the life of the building with a deep retrofit and refurbishment where zoning and land value make this appropriate
- Get many stakeholders engaged from the beginning – important to get different cities involved in the early stage in order to get permits etc. to get the process moving faster

Next Steps

- Continue to follow partner projects, sharing lessons learned and best practices (e.g. CanmetENERGY's PEER, RMI's REALIZE, RetrofitNY, Sustainable Buildings Canada, Energiesprong)
- Identify and work with partners to secure funding for market transformation team and integrated design competitions
- Refine business case and cash flow analysis – UBC project
- Determine the maximum reasonable cost vs. redevelopment
- Develop a deeper understanding of available reserve funds and asset management plans
- Design the terms for potential design competition and RFP for a first round of pilot projects

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