Building capacity for mass deep energy retrofit in Quebec: A systems perspective

PhiusCon 2023

Michael Jemtrud, Thomas King
The decarbonization challenge

- We have **30 years and 300 GtCO2** left to make the global building stock carbon neutral.
- More than **80%** of buildings that will be in use in 2050 are already built.

![Scenarios of building-related CO2 emissions until 2050](image)

- **Business as usual**
  - 1% retrofit rate
  - New construction
  - OE neutral by 2050

- **Net-zero operational**
  - 5% retrofit rate
  - New construction
  - OE neutral by 2040

- **Net-zero embodied and operational**
  - 5% retrofit rate
  - New construction
  - OE and EE neutral by 2040
Presentation Outline

1. Introduction

2. Sociotechnical analysis of the deep retrofit market
   a. Key concepts for system change
   b. Market development challenges and opportunities
   c. Quebec’s sociotechnical context

3. Strategies for market development
   a. Creating niches through pilot projects and pipelines
   b. Transforming the DER workflow: value-case to turn-key
   c. Canadian Deep Retrofit Accelerator Network
1. Introduction

What are deep energy retrofits (DERs)?

- Significant airtightness, thermal performance, and HVAC upgrades.
- **Up to 80%** operational energy reductions.
- **Prefab panelized** exterior envelope solutions (over-cladding solution).
What are deep energy retrofits (DERs)?

- Moving beyond operational energy to account for **embodied carbon and climate resilience**.
1. Introduction

Benefits of deep energy retrofits

- Adaptation
- Resilience
- Building as Carbon sinks
- Indoor air quality (health)
- Comfort (productivity, well-being)
- Energy security/grid resilience
- Aesthetic upgrade (community pride)
- Affordable housing
- Job creation
- New supply chain opportunities
Market uptake is slow

- Only 0.07% of the US housing stock was retrofitted in 2018 with additional insulation.¹
- Need to increase rate to at least 2.5% (IEA).²
- Recent studies have suggested 5.6% retrofit rate to meet net-zero targets.³

Current rate (US): 0.07%

Required rate: Up to 5.6%
1. Introduction

**Construction sector challenge**

- Canada has more than 14.5 million residential/commercial buildings—**must retrofit 1 building every minute** by 2050.
- Productivity of the construction industry has increased by **only ~5%** in the last 20 years.

Challenges facing the decarbonization of the construction sector

1. **Lacking tools, products, services, and capacity** to address carbon impact of construction industry.
2. **Not equipped to rapidly respond** to need for mass retrofit, while reducing cost and time for new low-carbon construction.
3. **Chronic low productivity, weak innovation, long construction times** from inefficient practices, labor shortages, lack of automation.
The need for system-wide transformation

- Scaling DER requires coordinating:
  - diffusion of existing technologies;
  - coordinating systemic innovations and cross-sectoral inputs;
  - mobilizing key stakeholders.
- Goal is to build capacity for mass DER implementation.
Understanding system change

- Literature on sustainability transitions provides theoretical frameworks for addressing **sociotechnical systems**.
- ‘Sociotechnical’ implies that technology developments are entangled with social structures and norms.
The ‘multi-level perspective’

- Depicts sustainable transitions through three levels:
  - Niches
  - Regimes
  - Landscape
- MLP’s primary stance is that transitions occur through the **strategic alignment** of processes across these three levels.

2. Sociotechnical Analysis

**Niches**

- Spaces where new technologies emerge and develop that can replace established practices.
- Sociotechnical transitions gain momentum when multiple innovations are linked together.

Examples of niche innovations

• For DER, niche innovations can include novel processes, tools, workflows, technical solutions, financing mechanisms, legislation and business models.

**Products, technologies**
- Wood fiber insulation

**Practices, processes**
- Passive House design principles

**Tools, mechanisms, workflows**
- Laser scanning
Regimes

- Regimes refer to the dominant systems and actors at play that are stabilized in networks and often resist change.

Regimes

- For DER, regimes can include regulations and policies, building experts and service providers, labor and supply chains, market practices, financing, and political, cultural, and economic values.
Landscape

- Landscape represents the **broad context** in which niches emerge and regimes adapt.
- Includes societal values, cultural norms, market conditions, policy frameworks, and global trends.
- Accelerating transitions involves increasing momentum of niche innovations, weakening existing systems, and strengthening exogenous pressures to create windows of opportunity.

2. Sociotechnical Analysis

‘Strategic niche management’

• Focuses on creating protective spaces to cultivate niche innovations through real-life experiments.

• Two stages:
  • Execution of projects in isolation.
  • Execution of progressive interrelated projects over time.

2. Sociotechnical Analysis

Intermediaries

• Actors who create spaces and opportunities for emerging technologies or systems.
• Broker niche innovations between across key stakeholders to alter system regimes.
• Public or private organization, or otherwise.

The ‘Energiesprong’ intermediary approach

- €45 million to address barriers to capacity for mass DER in the Netherlands.
- Implemented an innovative business model of net-zero energy performance contracts, integrated supply chains, and a singular customer interface.
- Market development team composed of key stakeholders across value chain.
- Highlighted need for regional market development teams.
2. Sociotechnical Analysis

Market development challenges

- Array of studies has been conducted to understand deep retrofit market development barriers in Canada.

**Regulations and policies**
- Risk-averse
- Lack of market transformation initiatives
- Zoning by-laws are restrictive

**Labor and supply chains**
- Shortage of skilled tradespeople
- High labor costs
- Information mismatch for products

**Building experts and service providers**
- Lack of coordination between individual firms and levels of government
- Disconnect between retrofit industry and public
- Insufficient data-collection and sharing

**Approval, procurement**
- Procurement and delivery process for public projects are restrictive
- Trades are disjointed

**Financing, subsidies, incentives**
- High capital costs
- High risk
- Long return-on-investment periods
- Disjointed financing programs

**Political, cultural, economic values**
- Unwillingness to outsource certification standards, manufacturing, labor, and materials from overseas
- Reluctance due to a lack of predictability for a return-on-investment
2. Sociotechnical Analysis

Quebec’s market opportunities

- **Building stock**
  - Oldest building stock in Canada
  - Relatively low home ownership rates
  - Consistency of building type and construction across residential buildings, schools, and institutional facilities
  - Substantial amount of publicly owned social housing

- **Political, cultural, economic values**
  - Culture of cooperative management of civic assets and funds
  - Social solidarity economy among public and private enterprises

- **Energy providers and infrastructure**
  - Hydro-Québec, a crown corporation, operates the province’s entire electricity production, transmission, and distribution systems, primarily powered by hydroelectricity (94%)

- **Labor and supply chains**
  - Mature prefabricated manufacturing industry, supply chain, and training infrastructure
  - Relationships between local manufacturers and social enterprises can be leveraged towards job creation and supply chain and factory development for retrofit solutions

- **Need for a regional market development strategy.**
- **Quebec provides an exemplary case study for mass DER.**
- **Low electricity costs**
- **Incentive to reduce local demand as Hydro-Québec sells energy to other provinces and states at higher rates (net exports of 35.6 TWh in 2021)**
- **High need for improved grid resilience, peak shaving, and load management**

Quebec Climate and Resilience Retrofit Agency

- Intermediary is critical to building mass retrofit capacity.
- Focuses on creating strategic niches.
- Aims to facilitate the implementation of novel DER processes and products within niches.
Creating niches through strategic pilot projects—pipelines
Creating niches through strategic pilot projects—pipelines

- **Proactive mandate** to facilitate pilot projects and create pipelines of projects of high societal value and environmental impact that expedite innovation and build capacity.

### Strategic criteria for pilot/pipeline selection

1. **Structural and tectonic consistency** conducive for repeatable over-cladding solutions
2. **Substantial volume** of buildings across the province to establish a pipeline
3. **Ripe vintage and type** for high number of “anyways” renovation scenarios
4. **Societal and public sector importance**
5. **Stable public sector investment opportunities**
900 COMMUNITY CENTERS
Prefabricated steel superstructures

300 PRIMARY AND SECONDARY SCHOOLS
Masonry superstructures

400 SOCIAL HOUSING MULTI-UNIT RESIDENTIAL BUILDINGS
Light-framed and masonry superstructures
Pilot Project #1

Île-Bizard Community Centre

- Prefab steel “Butler barn”-style buildings exist in the thousands across Québec and Canada
- High social, cultural, community value
- Important for building adaptive capacity (emergency shelter in face of climate and other disasters)
- Major building deficiencies, in need of renovation “anyways”
3. Strategies for Market Development

The normative retrofit workflow

- Programs such as Renoclimat in Quebec and Greener Affordable Housing aim to simplify and subsidize the retrofit process by providing energy efficiency evaluations and recommendations for renovation measures.
- Renoclimat’s funding structures typically promote piecemeal retrofits of shallow to medium ECMs.
The normative retrofit workflow

3. Strategies for Market Development
3. Strategies for Market Development

The normative retrofit workflow

- Clients are only eligible to receive rebates after post-work evaluations have been assessed.
- Construction is carried out primarily on-site, leading to slow, costly, bespoke project delivery and material waste.
- Uptake is inhibited by reliance on building owners to initiate retrofits.
- Existing pre-retrofit services are not suitable for DER or overcladding solutions.
- The normative procurement and project delivery process is highly segmented, inefficient, and risk-averse.

Burden to coordinate and finance the retrofit on the front-end leads to dropouts in the retrofit process, or piecemeal renovations.
Niche development: *wholistic value proposition*

Making tailored cases for ‘co-benefits’ beyond simplistic ROI will help *cultivate buy-in* among building owners.
3. Strategies for Market Development

**Niche development: pre-retrofit services**

Additional pre-retrofit services are subsidized to produce comprehensive building retrofit passports capable of achieving deep energy reductions.
3. Strategies for Market Development

Niche development: transforming the DER workflow

The Agency **proactively identifies** early adopter projects that will build large-scale capacity.
3. Strategies for Market Development

**Niche development: Refurbishment Solution Provider Network**

The Agency will develop, operationalize, and provide third-party oversight of a Refurbishment Solution Provider Network (RSP): integrated groups of product manufacturers, prefab industry, and building professionals.
3. Strategies for Market Development

**Niche development: Refurbishment Solution Provider Network**

The RSP will be formed of industry stakeholders to create a “one-stop-shop” where a client deals with one certified contractor as the single point of contact throughout the retrofit process.
3. Strategies for Market Development

**Niche development:**
*Turnkey product, integrated design process*

Over-cladding solutions must be seen as a turnkey product; must get away from normative design, procure, construct bidding process. **Pre-approved envelope and active system solutions.**
Niche development: *last-mile funding*

Last-mile funding is provided based on **performance criteria** including during and for construction results and after a year of measurement.
To manage the market transition, develop regionally specific niches, and ensure performance metrics, a consistent data feedback loop of multicriteria KPIs is critical.
3. Strategies for Market Development

Key takeaways

- Overarching objective of niche developments together is to build **technical and implementation capacity** for mass retrofit.

- **Theoretical frameworks** provide methods for understanding regional contexts and making interventions and investments specifically and strategically.

6 P’s of capacity-building

1. **Proactive** mandate to facilitate projects to build capacity for mass retrofit across sectors.

2. **Proposition (value)** that illustrates DER’s wholistic benefits beyond energy savings to induce mass adoption.

3. **Pilot** projects that present scalable traits, high societal value, volume, and need for renovation.

4. **Pipelines** of projects that can nurture industry buy-in, efficiencies, supply chains, and expertise necessary to lower cost for mass retrofit.

5. **Product (turnkey)** that aligns supply chains physically and legislatively as an industrialized process.

6. **Procurement** (IDP) to streamline the DER process, mitigate risk, and reduce costs for industry actors which will accompany turn-key solutions.
3. Strategies for Market Development

Canadian Deep Retrofit Accelerator Network

- Deep Retrofit Accelerator Initiative (DRAI) has earmarked CAD $200 million to support intermediaries that will assist building owners in adopting DER across commercial, institutional, and multi-unit residential buildings.

- The network intends to foster a self-sustaining retrofit market through capacity-building activities and retrofit support services.
3. Strategies for Market Development

Canadian Deep Retrofit Accelerator Network

As the R&D collective for the network, ReCONstruct is supporting the network by developing shared tools and strategies for harmonizing capacity building efforts:

• Pilot project to pipeline identification, design, procurement
• Novel low-carbon envelope solutions
• Decision-making toolkit and digital platform
• Case Study & Technical Repository
• Protocol for Monitoring & Verification
• Equity, Diversity and Inclusion (EDI) policies and resources
Thank you.