Energiesprong Summary Report

Background Research, Design Workshop Results and Recommendations

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ACKNOWLDEGEMENTS

Since 2016, SBC has been supported in this endeavour by a large number of dedicated individuals and organizations who gave their time, insights and expertise to help us develop this initiative. This includes SBC staff and Board Members, student volunteers from Ryerson University, subject matter experts and energy modellers engaged in the Savings by Design program, staff from the various housing providers and ONPHA, and staff from Posterity Group Consulting, Arborus Consulting, Enbridge Gas, the Pembina Institute and Natural Resources Canada. More than 100 people attended the 2 workshops in Toronto and Ottawa, gave freely of their time and contributed immensely to the process. On behalf of Sustainable Buildings Canada, THANK YOU to you all and we look forward to working with you on the implementation of this exciting program.

EXECUTIVE SUMMARY

Commencing in 2016, Sustainable Buildings Canada (SBC) undertook to provide the background research and describe the process and requirements for launching an "Energiesprong" initiative in Canada. This Summary Report[1] provides highlights and results of those efforts.

There is an interest and a need for a program that integrates demand, supply, financing, construction and ongoing operations in a holistic, iterative approach to delivering large scale net zero retrofits. The Netherlands experience clearly demonstrates that an open source platform for knowledge sharing would facilitate and replicate the rapid transformation being experienced in Europe. Housing providers are keen to participate and their need is both immediate and substantial. The technical solutions already exist – it is a matter of unleashing the power of the private sector to deliver those solutions on a large enough scale for them to be cost effective.

SBC believes that a regional approach, coupled with a national mandate would be the most effective way to aggregating the demand necessary to engage Industry in the investment required to deliver the transformation. Canada's size and the diverse nature of the stock of homes, local delivery capabilities and climactic conditions means that regional market development teams will be necessary to tailor solutions to the environment and the Industry.

Although there are barriers to adoption, the policy and regulatory regime in Canada has already institutionalized or adopted policy reform in areas that still present barriers to the adoption of Energiesprong in Europe, a condition that will contribute to the ability to rapidly deploy the program.

Having completed the groundwork and with the stated needs and support of housing providers and equipment providers, SBC has 3 overarching recommendations:

1.) The Canadian Government fund the creation of Energiesprong Canada, joining the Energiesprong International Initiative in developing the open source knowledge sharing platform, and facilitating the establishment of regional Market Development Teams;
2.) The provinces, either solely or on a regional basis, fund the initial establishment of Market Development Teams who will be responsible for facilitating the delivery of the Energiesprong initiative in their regions;
3.) The funds derived from Provincial Cap and Trade or Carbon tax regimes be earmarked for the ongoing delivery of Energiesprong refurbishments.

[1] Detailed Reports on the 2 Design Workshops are provided separately.

INTRODUCTION

This Summary Report[2] provides highlights and results of the various activities Sustainable Buildings Canada (SBC) has recently undertaken to develop a program platform for the eventual implementation of the “Energiesprong” program in Canada. Energiesprong (ES) is a unique program approach to retrofitting buildings that was originally developed in the Netherlands. The program aggregates retrofit opportunities to present equipment suppliers and constructors with a large enough demand that encourages them to consider large-scale investment in providing the technical solutions. To date, the Dutch program has focused primarily on providing solutions for the social housing sector though contractor solutions providers have recently begun to apply the technologies developed towards new housing construction as well. SBC proposes to similarly focus on the social housing sector in the short term where aggregation of multiple projects can be achieved by engaging a small number of strategic housing provider partners.

The typical retrofit includes a major re-cladding of the existing home, a complete switch-out of the mechanical system, and the addition of a solar photovoltaic system. The intent is to industrialize the process through the use of pre-fabrication and off-site assembly which facilitates rapid deployment with minimal disruption to tenants. In the Netherlands, the entire retrofit activity typically takes two to five days.

Key features and components of the ES program as determined by the Netherlands experience include:

- The only way to achieve the cost effectiveness goal is through scale. There must be a large enough stock of potential to engage constructors and equipment providers and encourage them to change their business practices. In the initial stages, this will require government incentives to offset the cost. Over time, as the supply channels improve and the cost decreases, the amount of government subsidy required will decrease.
- The market is not just a local one. Initially, providers of equipment will likely be local; however, with the scale will come the interest of international equipment providers. Aggregating international ES programs means that the scale can be huge. This will have the potential advantage of further driving down the costs.
- The net zero energy outcome is the goal; however, for the tenant, the benefit is increased comfort and pride of ownership. The NL has experienced spillover benefits from the implementation of projects that include spruced up neighbourhoods and demand for participation in the program for adjacent communities.
- Housing providers have realized significant utility cost savings which have been reinvested in the portfolios. These savings can also be aggregated with state of good repair budgets to amplify the repair investments – in particular, it is used to undertake the interior retrofits.

[2] Detailed Reports on the 2 Design Workshops are provided separately.

- The program features a performance contract that includes specific maintenance requirements over the entire 30-year period. The housing providers are guaranteed high quality and performance.
- The program is a collaboration between the demand side (housing providers) and the supply side – constructors and equipment providers. The traditional spec and bid approach has been shown not to be effective. Rather, the two sets of interests must work together to develop the solutions. It is understood that costs will be high in the short term and mistakes will be made. This is part of the learning curve and must be allowed to occur without contractual constraints. Once this learning has occurred, the various performance contracts can be secured.
- The supply side must re-engineer both its technical practices and its business approaches. Ideally, the constructors will manage the supply side such that middlemen and related margins are eventually eliminated. This helps to drive down the cost. To facilitate this, there must be enough demand (scale) to get the interest of the constructors and suppliers.
- An independent entity (Market Development Team) needs to be established with the responsibility of facilitating the collaboration of the housing providers and the constructors, developing the required tools, including performance contracts and acting as an independent voice for the initiative. This entity (or entities) will require multi-year funding initially, however over time, can be phased out as the market is developed.
- With successful deployment in the social housing market, the program and approach can then be applied to other sectors.

The ES initiative is now being deployed in other countries in Europe and recently New York State has adopted the program for roll-out there. SBC is keen to fast-track the initiative here in Canada and has implemented a number of concurrent activities as a way to accomplish that objective. These include:

- Engagement with key housing providers and related associations in the province of Ontario;
- Review and assessment of housing provider assets resulting in the identification of priority projects for pilot implementation;
- Development of a detailed scanning process and scan to Building Information Modelling (BIM) model development;
- Development of a user-friendly savings and cost estimating spreadsheet-based tool that provides a detailed net present value assessment;
- Energy modelling for the various options using social housing townhomes in Toronto and Ottawa as the example projects;
- Design workshops in Toronto and Ottawa featuring subject matter experts focusing on key technical and policy issues.
- Development of capital cost estimates for the suite of measures identified in the 2 workshops and subsequent research.

This Report provides the highlights of theses activities and also identifies a set of short term (2017-2019) recommendations that SBC will use as it seeks to move to the next phase of implementation. Note that these conclusions and recommendations were developed in collaboration with the various workshop attendees, ES representatives and delivery partners. These include:

CONCLUSIONS

- The Energiesprong approach is a holistic market transformation program, not simply a technical solution;
- Varying climatic conditions across Canada present challenges to adoption of a universal solution and regional conditions need to be considered;
- Housing typology in Canada typically includes basements and solutions need to be identified for their refurbishment as part of the retrofit activity;
- Varying provincial energy prices and grid generation mix will need to be considered as part of the regional analysis;
- There is limited capacity for offsite manufacturing in Canada with some regions more advanced than others;
- There is a robust field applied over-cladding industry currently operating throughout Canada which can be leveraged as part of the ES activity
- Current diversity of utility and government sponsored incentive programs and their delivery agents perpetuates piecemeal retrofitting. These efforts and costs could be re-purposed to support the ES initiative;
- Current research and development activities has demonstrated that achieving high performance through exterior cladding is both feasible and effective in reducing loads to a point where renewable energy and battery storage can achieve a net zero energy outcome;
- Canada currently employs public private partnerships (P3) contracts in delivering infrastructure and institutional programs and that the framework could be adopted to refurbishments;
- Affordable Housing is in desperate need of refurbishment and this program provides a platform for delivering cost effective solutions that do not require displacement of tenants;
- Housing Providers need external administrative, technical and financial assistance to execute on any refurbishments being considered;
- Estimated construction costs for the Energiesprong NL solution are approximately 20% lower in Canada than the initial NL Construction costs.

RECOMMENDATIONS

- Secure national and regional funding support for the initiative including both for the development of the Energiesprong Canada coordinating organization, the market development teams and related infrastructure and for the actual implementation of the retrofits;
- Develop a comprehensive roadmap to implementation that identifies the various stakeholders, providers, constructors and partners and distinguishes between national and regional elements;
- Identify and secure regional partners who can assume the role of the Market Development Teams;
- Implement a broader communication activity to showcase the opportunity and secure greater interest and participation;
- Develop supporting documents, tools and sample contracts that can be tested as part of an initial pilot phase;
- Develop a social/community housing engagement strategy and package that includes a variety of supporting tools and sample communications including a tenant engagement strategy that is tailored to occupant types;
- Support housing providers with technical and financial tools and expertise;
- Secure pilot projects that can be implemented in the short term (2018-2019). Focus on larger communities at first to minimize travel and associated logistics;
- Implement the initial pilots and prepare the appropriate reporting documents as part of a detailed evaluation;
- Monitor, collect and share performance and durability results of all projects.
- Develop a knowledge sharing web based platform, linked to the ES International website to enable sharing of regional and international best practices and policies.

SBC notes that securing funding support represents a critical requirement for furthering the initiative. Funding requests are currently being developed for sources in Ontario and at the federal level.

SBC is partnering with the Pembina Institute to establish the first Market Development Teams in Canada and to identify potential funding partners. SBC is also actively seeking partners to assist in deployment across the country.

DESIGN WORKSHOP HIGHLIGHTS – TORONTO AND OTTAWA

SBC hosted one-day workshops in Toronto and Ottawa to review the Energiesprong zero energy approach and to investigate the feasibility of delivering such a program in Canada. The overarching goal was to identify solutions that will achieve the net zero energy target (or close to it) in townhome projects through the application of advanced envelope and mechanical solutions. Between the 2 workshops, over 100 participants from government, municipal housing providers, building science professionals, architects, and engineers participated in breakout groups examining both technical and policy issues and opportunities, and weighed those against the qualification criteria of the Energiesprong program. The criteria included:

1) Deliver a zero energy fuel cost solution (NOTE – this was the direction at the time – SBC will revise this goal to be net zero energy only as the new proposition);
2) Complete the onsite refurbishment within seven to ten days to minimize tenant disruption;
3) Pay for the refurbishment through avoided energy fuel cost and Operations and Maintenance (O & M) expenses;
4) Provide a comfort and performance guarantee for 30 years.

Participant teams focused their discussions in two distinct areas:

1. Technical solutions for envelope, mechanical and renewable energy components;
2. Policy issues and related recommendations.

Participants were asked to identify solutions, issues, and potential recommendations/outcomes that can address the various on-site conditions. Toronto Community Housing (TCH) and Ottawa Community Housing (OCH) provided sample projects (two storey attached townhouse blocks) for study purposes and participants in the technical workshop attempted to identify technologies and solutions specific to those projects.

Technical Discussion Highlights

Envelope – Wall Assemblies and Windows

Attendees examined 3 wall assembly options and also considered high performance fenestration requirements noting that the effectiveness of the wall assemblies and their adoptability by an offsite manufacturing facility will be critical ultimately determining that wood frame construction and SIPs panels are likely the best solutions in the short term.

It was noted that the above-grade wall solutions did not take into consideration the basement walls and it was determined that an insulation skirt extending a minimum of three feet below grade would be an inexpensive solution with minimal tenant disruption. Attendees were unanimous regarding the need for triple pane glazing systems. Selective glazing for orientation could be used to maximize solar heat gain and minimize overheating and cooling loads.

Mechanical Systems

It was noted that the systems employed for space heating in Europe are almost exclusively hydronic whereas Ontario low rise social housing is mostly forced air gas or electric baseboard with some central hydronic. Air conditioning is a recurrent problem with low SEER window A/C's providing the bulk of suite air conditioning at considerable expense to housing providers and tenants where it is used. Adding air conditioning as a resiliency measure was recommended citing the City of Toronto Future Weather report as evidence of that need. As well, it was noted that window air conditioners would clearly compromise the air tightness of the windows and affect the overall energy performance.

Community scale geothermal was considered although construction costs would make paid-through savings unlikely. That could change dramatically if the ground loop was assumed by the natural gas utility and included in their rate base capital expenditure. This could be a viable solution that might be explored for larger projects.

Attendees identified a number of mechanical solutions which are readily available and will dramatically decrease the amount of energy required for space conditioning and water heating. The eventual selection of the appropriate mechanical system will require further analysis, including return on investment and market capacity. Technologies identified include:

- Air source VRV/VRF heat pumps including air to air mini splits and air to water hydronic systems in electric baseboard and hydronic applications ;
- Modulating, very high efficiency natural gas furnaces coupled with air source heat pumps and control systems to optimize time of use rates;
- High efficiency heat recovery ventilation and heat pump ventilation and/or water heating.

Renewable Energy

For the purpose of the workshops, the discussion of renewable energy was limited to solar as wind power was determined to be ineffective in the applications due to urban location and tree canopy. Solar thermal was considered but solar photovoltaic (P.V.) was deemed to be more cost effective. Solar thermal would become more relevant if displacing fossil fuel ie natural gas is a priority. Subsequent discussions determined that P.V. is likely to be the only option for renewable energy that is consistent with net zero principles of the program.

Each workshop used the sample project roof configuration to determine the potential electricity generation capacity. In each case, it is estimated that 3 to 5.5 kWp is possible based on the roof configuration. This will in turn provide between 3,600 kW.h and 8,600 kW.h annually. As these estimates were developed using relatively simple approaches and assuming standard P.V. installations, a range of 25% in performance and output can be expected. Based on the energy modelling results, this generation will off-set most of the required energy, but not all of it.

It was also noted that homes that a part of larger community housing developments could also accommodate a larger community energy system. Though the assesment focused on building-mounted P.V., additional PV could be added as parking lot shading as well, adding additional capacity. Access to other roofs in the area for the purposes of contracted P.V. generation is another option that could be used as part of the net zero energy strategy.

Policy Discussion Highlights

The following provides the highlights of the various discussions including recommendations.

- The huge disparity between the price of natural gas and the price of electricity is an issue, with housing providers in particular indicating that ordinarily they would not favour electricity for space heating. Price signals tend to be more important than perceived energy efficiency opportunities. Natural gas can be a bridge fuel;
- Most providers are taking advantage of energy efficiency programs offered by utilities, however these are not deep retrofit programs such as what is contemplated with ES. Ideally, the ES initiative would integrate with utility programs;
- Electricity infrastructure may not be able to accommodate a large migration of natural gas heating over to electricity. This could be the outcome if electric air source heat pumps are part of the solution. Battery storage would be an effective strategy to optimize use of onsite P.V. generated electricity and minimize the impact on the grid – the battery would be used when grid electricity demand is peaking;
- Programs must understand the "asset management" considerations for housing portfolios. Some parts of the portfolios are not good investments and any program schedules will need to integrate with planned investments and upgrades. Part of the filtering process will require housing providers to participate fully in the selection of the projects;
- The Residential Tenancies Act (RTA) may act as a barrier to implementation; however, most non-profits are exempt from these conditions;
- Housing providers are required to follow specific purchasing and contracting guidelines that might limit their flexibility in an energy savings program. Government funding is typically established around specific timing and parameters unrelated to other programming activities;
- There may be labour force barriers, challenges with unionized staff, or access to the properly trained trades. There may also be capacity issues with respect to pre-fabrication;
- Social Housing Providers may not have the staffing resources to evaluate their portfolio for eligibility. This needs to considered as part of the program support.

REVIEW OF HOUSING PROVIDER STOCK

Housing stock information was provided by 10 Housing Providers. Information included address, unit type, number of bedrooms, vintage and utility bill data (where available). For the initial assessment, SBC staff used the address data to assess each building and unit using a Google Map photograph identifying major structural issues, location of gas and electric meters and presence (or not) of chimneys and vents. On this basis, each project was rated on whether it would be considered a good candidate for the pilot project. TCH and OCH provided sample projects on the basis of this selection process. Ideal candidates for the first pilot projects would have relatively simple exterior walls, easy access to the perimeter, and be three to six side-by side townhomes. As a result of the analysis, SBC has identified approximately 20 candidate projects for each housing provider. These represent the likely first pilot projects that will be delivered. Housing providers will ultimately decide on the appropriateness for each.

SCAN TO BIM ASSESSMENT OF POTENTIAL SYSTEMS

Scan to BIM is a technology platform that takes point cloud scans of objects or topography and creates three-dimensional images which can then be manipulated within BIM software programs like Autocad or Revit. The process involves field scanning of the object using ground mounted laser scanners or aerial drones, which create point cloud files. These files are then manipulated to create images with tolerances as finite as 1mm that can then be layered with assemblies such as walls, windows, doors, and ceiling in exploded views to allow design integration of mechanical, electrical, and plumbing (MEP) in 3D. It allows design to accommodate actual site conditions like building settling or out of square assemblies when designing over-cladding to eliminate site adjustment. Field measurements of the Reference project provided by TCHC were undertaken by the SBC team with the assistance of George Brown College. These measurements were rinsed through a BIM model to successfully mock up the retrofit prototypes. These would be provided to prefabricators or constructors as part of the recladding design and construction effort.

ENERGY MODELLING RESULTS

Energy modelling using the Design Builder software and HOT2000 were was undertaken for a variety of wall assembly and HVAC options for each of the Toronto and Ottawa projects. The energy model was developed using the drawings provided from the on-site measurements and the specification of the current HVAC system. This represented the “Reference Case” and was the point of comparison for all the various upgrade options. Several technologies were considered for both domestic hot water heating as well as space conditioning.

Generally, the upgraded wall assembly yielded very similar results for the two options, for both the Toronto and Ottawa projects providing approximately 50% reduction in total energy use. A further 10% to 20% improvement is possible through the application of the various HVAC options. Removing the base loads from the analysis demonstrates that up to 90% of the space and water heating load can be eliminated through the application of the recladding and the HVAC upgrades.

These results demonstrate that significant energy use reductions can be anticipated through the application of an ES style retrofit. Regardless of the heating fuel used, there will be corresponding reductions in the energy bill – representing dramatic savings to the housing provider or end user. While the energy source (natural gas or electricity) has some importance in the final outcome, it is more than compensated for by the large reductions in fuel use that are available through the retrofit activity.

NET PRESENT VALUE AND UTILITY BILL REDUCTIONS – SPREADSHEET TOOL

The Tool was designed to provide a user-friendly framework for housing providers and others to understand the basic information requirements and undertake a simple analysis that provides an estimate of the potential energy reductions and corresponding bill savings. This information is then used to calculate the net present value of the utility bill reductions over a 30-year time frame (consistent with the proposed performance guarantee time frame). Results are generated for an "all electric" unit or a natural gas heated unit. The tool assumes that a PV installation will also be included.

The user can modify any of the inputs, including initial utility bill, estimated savings in percent, generation capability for the PV system etc. A sample output is shown below. This is an example for an actual Ottawa home as provided by OCH and with savings consistent with the estimated energy modelling savings estimates. It is noted that the results will vary for each home, each housing provider and the type of fuel used for space heating.

The tool will also calculate annual and lifetime GHG emissions reductions which can further be used in carbon accounting activity. The tool has already been made available to a number of housing providers and SBC continues to refine the tool based on feedback from users.

NPV Tool Output

Electrical House - 1 unit	electric baseboard heaters	
New Annual Electrity Usage after solar installation	3,250	
Total Annual Electricity Cost	$ 520.00	
Total Annual Electricity Cost Savings	**$ 1,880.00**	
Total Annual Electricity Savings	**11,750**	**kWh**
Electricty emissions factor	50	g/kWh
CO2 reduction per unit - Electricity/yr (tonnes)	0.16	
Total CO2 reduction/unit/LIFETIME (tonnes)	4.88	
Principle		
Nominal Interest Rate	3.00%	
Inflation Rate	1.25%	
Real Interest Rate	1.75%	
Net Present Value	**$43,589.40**	

EQUIPMENT AND INSTALLATION COSTS

SBC contracted with a costing expert who undertook a detailed analysis of the expected capital and installation cost for a typical 4-unit townhome retrofit. SBC used the cost spreadsheet provided by the

ES International team to allow for easy comparisons to other country's experience. The estimates were developed using both primary and secondary research and represent the best available information. While the analysis was done on the basis of 4 housing units, the estimates are provided on a cost per individual unit basis. Note as well that the NL experience indicates that the costs will decrease quickly as the scale increases and the various stakeholders and suppliers fine tune their processes. In the NL, the cost per unit decreased by more than 60% in 4 years.

Cost per Unit – Equipment and Construction

General Breakdown	Specific Item Description	Per Unit Estimate
audit	Modelling and site audit	$ 750
design	BIM and CAD	$ 375
general	Preparation (demolishion and ground work)	$ 2,606
construction	Facades (including openings)	$ 40,164
construction	Floor	$ 540
construction	Roof including gutters and downspill	$ 34,209
mechanicals	HVAC (inc HRV boiler heatpump or air handling)	$ 31,604
mechanicals	DHW (inc water heater, DWHR)	$ 12,150
mechanicals	PV system (including racking and inverter)	$ 13,500
mechanicals	Interior ducting	$ 3,500
mechanicals	Heat distribution hydronic or duct system)	$ 5,353
mechanicals	Water / Gas (changing and terminating connections)	$ 450
mechanicals	Electric installation (including solar and induction cooking)	$ 975
general	Other costs (workspace, measurement, scaffold)	$ 1,000
Sub-Total	**Equipment**	$ 147,176
construction	Side facade (per unit)	$ 4,468
Added overhead	Architects	$ 2,125
Added overhead	Engineering	$ 1,000
Added overhead	General cost	$ 5,588
Added overhead	Contractor profit	$ 5,968
Sub-Total	**Construction**	$ 19,149
Total	**excl. HST**	**$ 166,325**

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