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Request for Proposal (RFP)
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Proposal To: Natural Resources Canada
We hereby offer to sell to Her Majesty the Queen in right of Canada, in accordance with the terms and conditions set out herein, referred to herein or attached hereto, the goods, services, and construction listed herein and on any attached sheets at the price(s) set out therefor.

Proposition à: Ressources Naturelles Canada
Nous offrons par la présente de vendre à Sa Majesté la Reine du chef du Canada, aux conditions énoncées ou incluses par référence dans la présente et aux annexes ci-jointes, les biens, services et construction énumérés ici sur toute feuille ci-annexée, au(x) prix indiqué(s).

Comments – Commentaires

Issuing Office – Bureau de distribution

Finance and Procurement Management Branch
Natural Resources Canada
580 Booth Street, 5th Floor
Ottawa, Ontario K1A 0E4

Title – Sujet
Electrification Potential Study for Canada

Solicitation No. – No de l'invitation	**Date**
NRCan- *5000052474*	April 9, 2020
Requisition Reference No. - Nº de la demande	**Amendment – Modification**
5000052474	001

Solicitation Closes – L'invitation prend fin
at – à 02:00 PM EST
on – le May 19, 2020

Address Enquiries to: - Adresse toutes questions à:
Daniel Burley
Daniel.Burley@canada.ca

Telephone No. – No de telephone	**Fax No. – No. de Fax**
(343)-543-7809	N/A

Destination – of Goods and Services:
Destination – des biens et services:

Natural Resources
Office of Energy Research and Development
580 Booth Street, Ottawa Ontario

Security – Sécurité

There is security requirements associated with this requirement

Vendor/Firm Name and Address
Raison sociale et adresse du fournisseur/de l'entrepreneur

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_____ _____
Signature **Date**

Amendment 001

Amendment 001 is raised to replace both Annex "A" – Statement of Work in its entirety and Appendix "2" – Financial Proposal form, therefore amend as follows:

INSERT: Annex "A" Statement of Work

Statement of Work (SOW)

SW.1.0 TITLE
Canadian Electrification Potential Study

SW.2.0 BACKGROUND
The Office of Energy Research and Development (OERD) and the Electricity Resources Branch (ERB) in Natural Resources Canada's (NRCan) conduct activities related to meeting Canada's climate change objectives through policy development and program delivery. Programming support covers research, development, demonstration, and deployment. It is important to ensuring these programs represent both an efficient and effective means of meeting our GHG targets while limiting the impacts on Canadians and the Canadian economy.

A key component of meeting Canada's climate change goals will be leveraging and building on our existing clean electricity resources. A large-scale consultation on Canada's energy future, Generation Energy, identified switching to cleaner power as a key priority for Canadians. The Pan-Canadian Framework on Clean Growth and Climate Change echoes the importance of this low-carbon strategy. On Dec. 7, 2018, Canada's First Ministers met and agreed to lead a discussion on a Clean Electric Future for Canada. A recent report from the IEA noted that the future appears to be increasingly electric, but many uncertainties still must be resolved. The challenge will be to do so in a cost-effective way and weigh this approach against alternatives. The objective should be to pursue the most cost effective opportunities to electrify energy end uses where it represents a lower cost pathway to reducing greenhouse gas emissions than simply improving energy efficiency.

NRCan funds research into technologies across the energy system, including research into non-electric end-use, cleaner fossil fuels, renewable fuels (including hydrogen), and carbon capture, usage, and sequestration (CCUS); research into end-use electrification both competes with and complements these technology areas. On these topics, there is close collaboration between OERD, ERB, and the Office of Energy Efficiency (OEE). This is critical to shifting technologies from technical viability to economic viability, and eventually deployment. For OERD, this means balancing R&D investments so they are both 1) targeted at the most promising pathways, and 2) effectively diversified in the case of technological uncertainty. For the OEE and ERB, this means ensuring their programs are deploying technologies that are the most cost-effective based on consistent economic assumptions relative to alternatives. Furthermore, it is critical that NRCan as a whole have a cross-sectoral, consistent, and comprehensive understanding of the viability, or lack thereof, for electric technologies as a means of meeting emissions targets. With these needs in mind, NRCan is initiating a project meant to indicate the overall viability of

existing electric end-use technologies as a replacement for end-uses which currently rely on carbon-emitting fuel sources.

NRCan hopes to address these needs by conducting a bottom-up study which quantifies the technical and economic potential of (carbon-emitting to electric) fuel-switching technologies. The study aims to develop both a snapshot of this potential today and a projection of the potential out to 2030, 2040 and 2050. This is meant to inform strategic guidance on the need to pursue both electric and non-electric energy research and development to enable deep decarbonisation scenarios. The goal is not to create a range of specific scenarios, but to create a tool and reference scenario on which sensitivity analysis can be conducted and new data can be inputted.

SW.3.0 OBJECTIVES

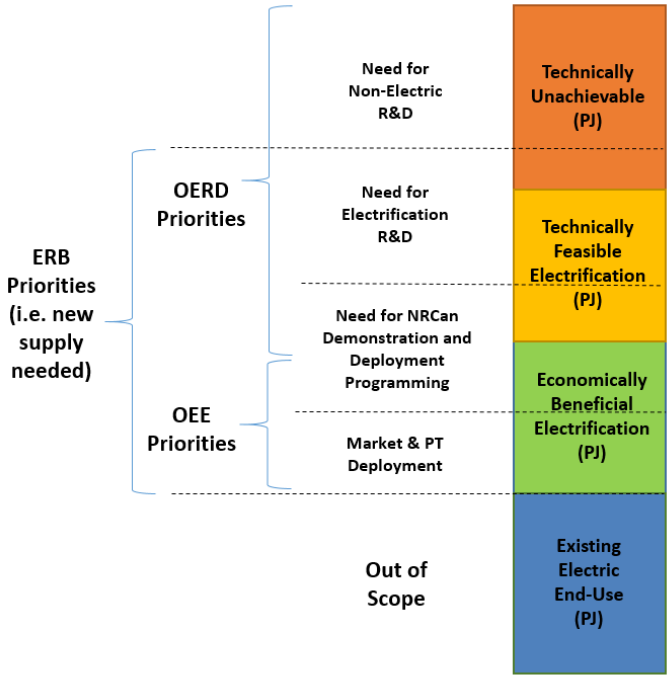
The objective of this project is to develop a comprehensive, energy system-wide with provincial perspectives, cross-sectoral techno-economic understanding of the potential (or lack thereof) for existing commercial electric end-use technology mitigate GHGs emissions from carbon-emitting end-uses. The study will do this using a common set of assumptions and a harmonized dataset, within a utility-style potential study framework. NRCan also requires an appropriate and accessible database and tool (if agreed upon, could be Excel-based), to enable analysis following the completion of the project. This tool will help ensure NRCan only prioritizes the electrification pathways that provide net benefits to Canadians. The following is some key questions in different areas that NRCan hopes can be answered using the outputs of this study.

To be clear, the consultant should not answers these questions directly, but should conduct the analysis with them in mind. The goal of the study is to collate data which can be used by NRCan to conduct analysis

Written analysis by the consultant should be limited to data commentary (i.e. methodology of collection and analytics, technology overviews, descriptions of dynamics of scenarios under task 5 and 6).

Primary Objectives

- To what extent is electrification a cost-effective climate change mitigation strategy compared to alternatives using existing technologies, assuming a zero-carbon electricity supply?
- How should research, development, demonstration and deployment (RDD&D) funding be prioritized between electric and non-electric technologies?
- Using existing technologies, how might electricity demand change and what are the potential effects on load shape under electrification scenarios?
- What changes might we expect in the electricity system between now and 2050, through technological innovation?



PJ: Peta Joules

A key output of the study should resemble the diagram, and will be used to consider priorities for R&D funding and potentially other federal programs.

PT means "Provinces and Territories"

Energy Demand

- What is the total primary energy demand of end-uses reliant on carbon-emitting fuels?
- How much could total primary energy consumption be reduced as a result of electrifying end uses using current technology? (ignoring economic or technical viability at the grid level)
- How much of total primary energy demand cannot be electrified using existing commercially viable technology?
- What is the total amount of additional electricity production which would be required to electrify all carbon-emitting end-uses with current technology by 2020, 2030, 2040 and 2050?
- What are the GHG emissions associated with different end-uses?

Cost-effectiveness

- How far are commercially available fuel-switching technologies from economic viability? What is the sensitivity of this to different assumptions?
- Which fuel-switching technologies are cost-effective, and to what extent?
- Which fuel-switching technologies are sufficiently close to cost-effectiveness that this could be impacted by R&D investment? Technology demonstration? Deployment programs?
- Which fuel-switching technologies have sufficiently ***low*** cost-effectiveness that this technology is unlikely to be viable regardless of additional R&D investment?
- What impacts might demand response on energy efficiency initiatives have on these fuel-switching technologies?

- What is the sensitivity of cost-effectiveness to changes in economic assumptions (e.g. price of electricity, carbon price, discount rate)?
- How does viability change under different costs tests in the California Standard Practice Manual?
- How does cost-effectiveness change when assuming early replacement of the baseline technology versus replacement on burnout?
- How cost-effective are partial electrification technologies (e.g. duel-fuel ASHPs) and what are their advantages against alternatives?

Grid Considerations

- What is the potential capacity demand (i.e. in kilowatts) associated with deploying all technically viable fuel switching technologies, by 2020, 2030, 2040, to 2050 and beyond?
- What is the potential impacts on load profile including consideration of diurnal and seasonal impacts?
- How controllable and dispatchable are the loads of different fuel/feedstock-switching measures? E.g., using aggregated electric resistance loads to provide frequency control or other grid ancillary services.
- To what extent can duel-fuel technologies (i.e. electric plus natural gas) decrease carbon-emissions while maintaining their flexibility advantage?
- Could these technologies provide benefits to the electricity system? If so, how should electricity markets evolve to take advantage of these resources?

High-level Policy questions

- To what extent can electrification be relied upon as a low-carbon pathway?
    - In which Canadian sectors will electrification have significant impact and can be relied upon as a low-carbon pathway?
    - In which Canadian provinces and/or regions and/or sectors will electrification be most applicable as a low-carbon pathway?
    - Are our programs appropriately targeted at the most viable existing opportunities in electrification?
    - Are our investments properly balanced across electric and non-electric technologies?
- How do the results of this study compare to existing reports projecting low-carbon pathways for Canada which rely heavily on electrification (e.g. Deep Decarbonization, Trottier Energy Futures)?
- How do these questions change when looking at different provinces versus Canada as a whole? Do these questions change when looking at rural vs. urban?
- If high-efficiency technologies were to achieve the same costs as their baseline technologies, how would these answers change?
- Given adoption rates and capital stock turnover of fuel switching technologies, what is the most cost effective or otherwise optimal pace of electrification from now until 2050?

SW.4.0 PROJECT REQUIREMENTS

SW.4.1 Tasks, Deliverables, Milestones and Schedule

The final deliverables will be:

1. **A Final Report**, in Word and PDF formats.
2. **An appropriate database and analytical tool (as agreed upon, may be Excel based)**, which, at minimum:
    a. Can be used by any government employee using programs within the Microsoft Office suite, NRCan employees' primary data management and analysis tools are Microsoft Access, Excel, and Power BI. The consultant shall not propose a platform which requires the purchase or licensing of a specific piece of software by NRCan.
    b. Catalogs a list of the assumptions for all carbon-emitting and electric end-uses analyzed in the report and that can be inputted and outputted in .csv format,
    c. Enables NRCan to change assumptions and indefinitely add new technologies and baselines after the project has been completed
    d. Provides Electrification Potential study results as both a snapshot of current opportunity and presents potential adoption and capital stock turnover over time based on optimizing for various parameters (e.g. lower energy demand, lower emissions, lowest costs etc.)
    e. Enables NRCan to conduct sensitivity analysis on the study results and ability run new analyses
3. **A Slide Deck**, in PPT and PDF formats, outlining the results.

Task 1 – Kickoff Meeting
The first task will be a kickoff meeting where the project will be discussed as a whole, and key objectives and requirements will be clarified. The consultant will be asked to join a meeting (ideally in-person) with key NRCan stakeholders and technology experts from CanmetENERGY. Please note any travel costs must be incorporated into the total contract cost and listed explicitly. The proposal should state which staff will attend this meeting in-person or via teleconference. The meeting will be used to discuss the project as whole and provide an opportunity for the consultant to introduce the overall project plan, ask for clarifications, and answer questions from key NRCan stakeholders.

Regular 30 minute check-ins by teleconference will be scheduled during this meeting. Longer, potentially in-person check-ins should be associated with the delivery of tasks 4 and 5. The consultant should recommend meeting frequency and overall time commitment in their proposal.

Deliverables:
- Meeting Agenda – delivered via-email, in .docx format, by forty-eight (48) hours before the meeting takes place.
- Meeting Minutes – delivered via e-mail, in .docx format, within one week of the kickoff meeting.

Task 2 – Project Plan
Before the actual compilation of data commences, NRCan would like to validate the planned approach for the completion of Tasks 3-5. This meeting should occur two (2) weeks following the kickoff meeting. This will be an opportunity for the consultant to make any key revisions based on the comments received by the kickoff meeting.

The consultant's approach for conducting the economic assessment should also be articulated at this

stage. This includes assumptions related to fuel prices (current and estimates around future pricing), discount rates and carbon tax implications, among other metrics necessary for conducting cost-benefit analysis according to the California Standard Practice Manual.

NRCan does not currently have a preference for what assumptions are used for the “reference” data, and will be relying on the consultant to present options and tradeoffs of different approaches. Limited effort should be expended on calculated “realistic” long-term supply costs, as these questions will be addressed through sensitivity analyses of the “reference” assumptions agreed upon at this stage.

Options for deliverables could include briefing materials clearly outlining the character of assumptions, inputs, and outputs, or a simplified version of the database and analysis tool (could potentially be an Excel file) to be delivered in task 5 and 7.

- Deliverables:
    - Briefing materials or simplified examples of study outputs, presented via teleconference.
    - Briefing materials on preliminary plan for economic assumptions
    - Meeting Minutes – delivered via e-mail within one week of the kickoff meeting.

Task 3 – Develop Catalog of Baseline Carbon-emitting End-uses
The consultant should recommend an approach to create a breakdown of carbon-emitting end-uses in Canada which will act as the baseline technologies associated with each of the electric end-uses developed in Task 4. This breakdown should be provided in the proposed database (potentially Excel) and indicate how many GJs of energy are associated with each end-use, and the total and GHG/GJ impact associated with each end-use. Total energy use should also be calculated and agreed upon methodology described. **All data should be broken down on a province-by-province basis - a regional breakdown (e.g. Prairies, Atlantic Canada) is not sufficient.**

It is expected this task will be completed by collating existing studies and data, and any data gaps will be filled using educated assumptions developed and clearly documented by the consultant. The consultant should identify key data sources they expect to use during this task, articulate key expected gaps, and speak to potential strategies for filling these gaps using educated assumptions. If the consultant believes NRCan may be able to acquire or have access to information that would be useful during this stage, they should identify this in the proposal, and whether it is cost-effective to include it within the project budget, or if it would be a value add if additional funds are available. Similarly, any primary data collection conducted by the consultant should have a limited level of effort associated with it or high value relative to effort (i.e. cost data application across many contexts); this also applies to Task 4 as well. NRCan understands data quality will range across provinces and end-uses and only asks that data quality is clearly identified and assumptions clearly documented. The consultant should propose an approach to catalog data quality either within this task or as part of the draft and final report.

It should be noted that NRCan will be able to deploy some junior-level resources to assist the consultant with basic research tasks; the consultant can speak to this in their proposal as a way to boost value but should not rely on this for project execution.

Please note that the following fuels are in scope:

- Propane used in all contexts (e.g. including BBQs)
- Oil products in all contexts aside from electricity generation (e.g. all transport fuels including domestic aviation, fuel oil for heating, industrial thermal and non-thermal uses, diesel usage outside of diesel gensets)
- Natural gas in all contexts (e.g. heating and industrial processes, including the heat component of Combined heat and power (CHP)/cogeneration)
- Coal used outside electricity generation (e.g. industry, home heating)

The following energy uses are excluded:

- Fuels used for the generation of electricity in all contexts (e.g. including off-grid communities and the electric production from CHP facilities)
- Transport fuels used for international travel (e.g. international aviation and shipping)
- Bioenergy in all end-uses, which is considered to be carbon-neutral for the purposes of limiting study complexity

Please note that energy use across all economic sectors in Canada are in scope, and end-uses should be broken down accordingly, including provincial/territorial breakdowns:

- Residential
- Commercial (including institutional)
- Industrial (e.g. mining, chemical production, agriculture, oil and gas production)
- Domestic Transport (e.g. including domestic aviation)
- Off-grid (e.g. excluding power generation, including fuel oil for heating)

Treatment of other End-Uses, including CHP

Total primary end-use energy consumption (i.e. excluding thermal power losses in power plants) from electricity and direct use of biomass should be presented alongside the final GJ-from-carbon-emitting fuel figure (also by province), ***but a breakdown does not need to be calculated or provided***. It is assumed that the incremental effort associated with this will be immaterial to the project budget, but the consultant should explicitly advise whether or not this will be the case in their approach. The only exception to this is CHP.

For CHP, the heat component is in scope but the electric component is not in terms of overall carbon emitting end-use. However, the analysis must acknowledge that switching from carbon-emitting CHP to a direct electric technology (e.g. heat pumps or electric resistance) may have impacts on electricity production. This loss of electricity production should be cataloged during this task as it will impact the economics of fuel-switching measures with a CHP baseline.

The consultant will be asked to propose an approach to account for this during task 4. Possible approaches may be include adding lost electricity production to the final electric consumption of a technology, or creating a separate category of lost electric production for each technology with a CHP baseline. In any case, the consultant must clearly state their preferred approach to address this problem such that the lost electric production can be accounted for in economic analysis. The consultant and NRCan will work together to determine the value of these avoided costs.

The consultant should recommend an approach to address any uncertainties and/or exclusions in their proposal and clarify during the kickoff meeting. NRCan is amenable to changes to this scope so long as objectives can still be met and project budget is unchanged.

Deliverable:

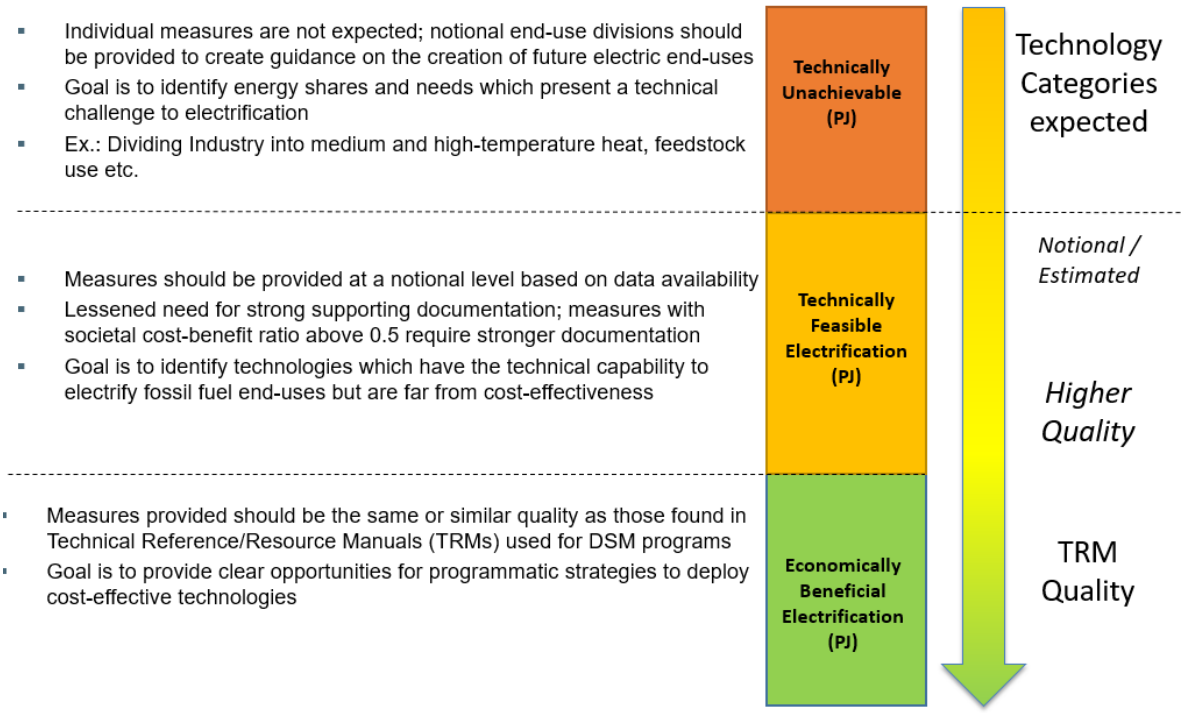
- Deck presented to project team via teleconference outlining results, challenges, and implications for next steps.
- Draft proposed database and analysis tool (may be an Excel file) with assumptions

Task 4 – Catalog of Electric End-uses Technologies

The consultant will conduct desk research to develop technical assumptions for various electric end-uses which are commercially available. These will be used to calculate the potential for end-use electrification in Task 5. The consultant will work with NRCan's CanmetENERGY laboratories in the development of assumptions. It is expected that this task will be a significant portion of the overall level of effort on the project. We require a technical reference/resource manual for all commercially available fuel-switching technologies in an agreed-upon appropriate format, contextualized by qualitative information in the report.

The following are the minimum data requirements for electric end-use technologies. These data requirements are considered indispensable in order to generate a net present value figure. The consultant may propose adding to or excluding from the list any data they believe is not necessary for this objective:

- Baseline carbon-emitting end-use
- Applicable sectors and subsectors (e.g. industrial and steel manufacturing, etc.)
- Operating hours/year
- Technical assumptions (e.g. EER (energy efficiency ratio), COP (coefficient of performance), capacity)
    - Assumptions should be developed for the current baseline efficiency as well as the highest efficiency commercially available
- Expected useful life in years
- Baseline carbon-emitting demand in GJ
- New carbon-emitting demand (e.g. fuel-use after full or partial electrification)
- Max electric demand in kilowatts (kW) and kilowatt hours (kWh)
- New electric demand in kilowatts (kW) and kilowatt hours (kWh)
- GHG reduction assuming a carbon-neutral electricity supply
- Incremental cost in CAD with zero baseline cost (early replacement), 50% baseline cost (mid-life replacement), and 100% baseline cost (replace on burnout)



Please note that the information in the above diagram is notional guidance for the consultant – the consultant should propose a more specific approach to documenting and prioritizing data quality.

In addition, the consultant is asked to propose a simplified approach to cataloging the peak coincidence and/or the ability to modulate the electric measures kW impact through demand response (e.g. Air Source Heat Pumps may have high peak coincidence, but have some level of dispatchability, where dual-fuel heat pumps will have the same potential coincidence but high dispatchability). The consultant is asked to limit the level of effort on this task and propose a simplified approach, but one that could provide useful data to a more detailed follow-on study on this topic.

The consultant should advise on the number of core technologies (e.g. air source heat pump) they plan to catalog, as well as the overall number of permutations they plan across all measures (e.g. air source heat pumps across different sectors, early replacement versus retrofit etc.). This number can be approximate and revised during project execution. In any case, the consultant should outline their approach to determining level of effort on the developing both core technologies and associated permutations – this will be used during project execution to manage NRCan's expectations on the number of technologies and permutations changes.

In general, the core electric technologies developed should address the following areas:

- Space and water heating in all sectors outside transport
- Industrial Processes (including but not limited to heat)
- Transport technologies (including all domestic travel)
- Oil and gas industry processes (including electric alternatives in the oil sands)

The following is a list of the “core technologies” to be analyzed identified by NRCan. The consultant should speak to their ability to develop assumptions regarding these technologies or technology areas, as well suggest additional technologies NRCan may not be aware of. Assumptions should be developed such that core technologies have applicability to a wide range of sectors and baseline technologies.

In scope:

- Electric resistance in all sectors
- Air Source Heat Pumps
- Ground Source Heat Pumps
- Water source Heat Pumps
- Solar thermal
- Replacement of instrument gas
- Non-road electric vehicles
- Light Duty electric vehicles
- Short-haul electric planes
- All other electric vehicles, to the extent applicable
- Advanced heating electrotechnologies (e.g. induction, infrared, microwave)

Out of scope

- Any technologies which do not rely on direct use of electrical energy (e.g. electrolysis for hydrogen production in industry)

Key Clarifications

Carbon-emissions from Electricity Supply: For the purposes of this study, it is assumed that all electricity is generated from zero-emissions sources. The potential cost scenarios associated with the need for new supply will be addressed during sensitivity analysis.

Transport Treatment: The consultant should propose a simplified approach for light-duty electric vehicles and any other vehicles which the consultant believes have commercially available electrification potential. Detailed/granular work on electric vehicles potential should be relatively limited, though high-level figures or assumptions should be well-documented.

Partial electrification: Technologies across sectors (e.g. duel-fuel heat pumps) should be assessed to some extent, the consultant should provide recommendations on how to handle these measures when determining the final potential figures.

Energy Efficiency: As noted earlier in this section, assumptions should be developed for both the regulated baseline efficiency of a fuel-switching technology and the highest commercially available efficiency.

Level of Detail: Technologies should be described at a high level in the report appendix, it is expected that each core technology will have a description no longer than 300 words. Any further description of core technologies in different contexts should be limited to 200 words. Assumptions regarding each

permutation of the technology should be delivered in the database (could be Excel).

Provincial Specificity: The only strict requirement is that there are different avoided cost assumptions for each province (which can also be properly aggregated for the national result on technical versus economic potential). It is up to the consultant to propose a level of granularity at the technology level that balances the budget available with the range of objectives listed. For technologies whose performance or price is not significantly affected by the jurisdiction – for instance due to a globally determined price or the climate zone having limited impact on performance) - a single national “measure” may be used. That said, there should be at least a notional reflection of the distinctions in technology cost and performance between jurisdictions. For instance, one would expect that most heating/cooling technologies would at least climate zone specific measures, as well as potentially differing incremental costs based on the maturity of the local market, assuming it is a determinant of price, which may or may not be true. In all cases, some form of simplifying assumptions will be necessary, and the consultant should be clear on why it was used.

Technology Readiness Levels: The consultant should focus their efforts on technologies which have met Technology Readiness Level 9, or more specifically, technologies which have been successfully demonstrated at scale and which could be practically procured by an organization with the appropriate financial and organizational resources (regardless of whether this would necessarily constitute a good investment or whether this technology is regularly procured). A key focus should be electric technologies which are functional but largely unused given fuel or capital costs (enabling an assessment of the potential for R&D to have an impact). This likely includes electric resistance in many contexts. The consultant should recognize that there is no direct relationship between the TRL level and the economic viability of a technology, and the study should reflect the complexity of a technology's economic viability depending on the assumptions used.

The consultant is asked to propose how they plan to balance the level of effort on more complex electric technologies. For instance, NRCan is interested in investigating the scalability and economic potential of the Drake’s Landing Solar Community (https://www.NRCan.gc.ca/energy/publications/sciences-technology/buildings/17864) under different economic assumptions. A key aspect of the project will be to create notional assumptions on innovative approaches highlighted by CanmetENERGY researchers to understand how far these technologies may be from economic viability. The consultant should recommend a level of effort associated with measures of this kind as a percentage of overall level of effort on Task 4. CanmetENERGY may also wish to develop their own measures for inclusion. This would occur during this stage, and NRCan will coordinate this input through the project authority.

The consultant will not be asked to coordinate the input of multiple groups, however the database and analysis tool (may be an Excel-based tool, or another option which does not require the purchase of liscensing of software) must be capable of incorporating an ***unlimited number of additional electrification measures and technology baselines*** in the long run. The consultant must clearly outline how to input this data into the tool both during the project and for future use, and provide the opportunity for these to be inputted into the tool during the project so long as CanmetENERGY researchers follow the requested data format.

It is important to note that the goal of this project is not to have highly accurate data on specific

technologies in different permutations. Rather, it is to collate existing assumptions and estimate impacts which are less clear such that economic assumptions can be applied, enabling the assessment of different challenges within a tool that can be used by NRCan going forward.

Deliverables:

- Draft of report appendix (in the agreed upon database and tool (or potentially Excel)) with descriptions of technologies, assumptions, and relevant references
- Draft proposed database and analysis tool (may be an Excel file) with assumptions

Task 5 – Current Technical and Economic Potential and Sensitivity Results

The next task is to finalize and apply the economic assumptions to the data collected during tasks 3 and 4. However, the consultant should have already been conducting this analysis on a preliminary basis during technology research.

During this stage, the consultant should finalize a cost-benefit figure for each technologies in each relevant context. The consultant should then develop an approach which uses the data collected during the previous two (2) tasks to determine the technical and economic potential of current electric end-use technologies. The consultant will develop multiple scenarios to test the sensitivity of this question to different assumptions.

The discount rate selected should be used consistently across all scenarios. NRCan will make the final decision on this figure during project execution in consultation with other parts of NRCan.

Naturally, this will change based on the cost-test used. The tool(s) should provide the ability to conduct cost effectiveness testing at the provincial, national, and technology level.

NRCan is primarily interested the following tests:

- Total Resource Cost test (including $50 carbon tax, with the ability to vary the carbon tax price)
- Participant Cost Test (including $50 carbon tax, with the ability to vary the carbon tax price)
- Societal Cost Test (parameters to be determined)

The consultant should also propose an approach to applying the Ratepayer Impact Measure test while limiting level of effort with regard to complexity across provinces, with a view to demonstrating the potential to lower distribution rates through electrification, rather than the potential need for new peak capacity.

These tests should be conducted as per the California Standard Practice Manual[1] or an alternative as proposed by the consultant. The consultant may propose to calculate additional cost tests to provide added value.

For the purposes of determining net present value (NPV), current fuel costs should be assumed to

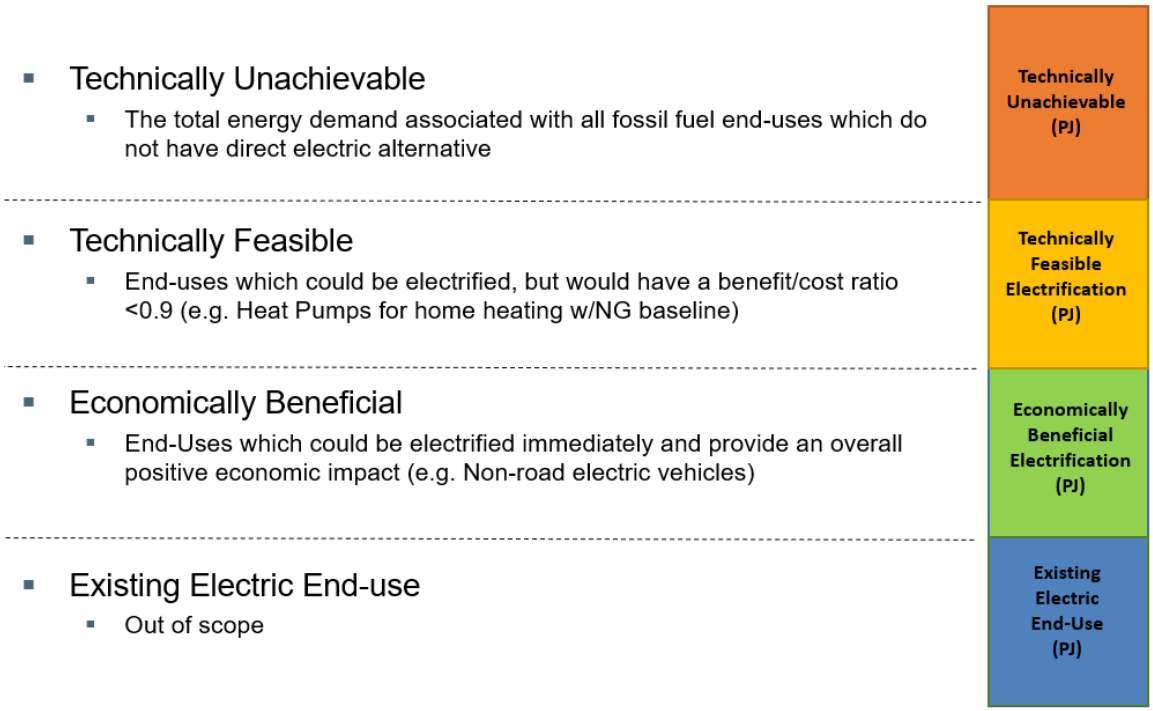
[1] http://www.calmac.org/toolkitEE.asp

increase by the rate of inflation or, ideally, at a rate indicated by utilities during rate filings. *The tool should include an easy to use "dashboard" enabling adjustments to all variables.*

The following scenarios should be analyzed:

- Scenario which prioritizes economic benefits
- Scenario which prioritizes low energy consumption
- Scenarios assuming all technologies are deployed on an early replacement basis
- Scenarios assuming all technologies are deployed only when the baseline technology needs to be replaced
- Scenarios designed to show the sensitivity of the results to electricity and fuel prices
- Scenarios which prioritize partial electrification measures with high levels of dispatchability or more limited peak coincidence (e.g. duel-fuel heat pumps)

The diagram below outlines what is expected in each of these scenarios alongside the relevant assumptions.



The consultant should outline how they plan to develop these outputs using existing capabilities or a custom-built tool.

Deliverable:

- Draft slide deck delivered via teleconference

Task 6 – 50-year Achievable Potential and Sensitivity Results

The final major research task is to analyze the extent to which electrification is a viable pathway to meeting 2050 targets. The consultant will do this by applying the techno-economic results from the

previous tasks by assessing both capital stock turnover and potential adoption curves (including the ability to force the adoption of certain technologies) for these technologies and baselines, including the potential effect of incentives. The tool should project results as a far as 2070 in order to understand the potential to overshoot on our 2030, 2040 and 2050 net-zero objective and/or potential benefits of mitigating through other means.

These outputs should be designed to provide guidance/insight/advice to NRCan on the most promising paths forward on end-use electrification given different economic and environmental considerations and sensitives.

The tool should be able to provide separate results for Task 5 (i.e. a snapshot) and Task 6 (i.e. a projection).

Deliverable:

- Draft slide deck presented in-person at Natural Resources Canada, 580 Booth St., Ottawa

Task 7 – Database and Analysis Tool Package (e.g. Excel Files) and Draft-Report
The draft report should outline the study's approach, high-level results, data-quality commentary, and commentary on the sensitivity of the results to various scenarios. The draft report should also include an appendix (in an agreed upon format, potentially Excel) providing the documentation on each of the technologies researched and how assumptions were developed. The database and analysis tool (possibly an Excel file) should also be delivered at this time.

Deliverable:

- Draft report and file package

Task 8 – Final Report and Revised Database and Analysis tool
The final report and PowerPoint should be submitted within 2 weeks of receiving feedback from NRCan.

Deliverable:

- Final report delivered electronically
- Final Slide Deck delivered electronically
- Final database and analysis tool (may be an Excel file) with assumptions

Table 1: Tasks, Milestones & Timelines

Task	Deliverable/Milestone	Schedule
Task 1	• Meeting Agenda – delivered via-email by forty-eight (48) hours before the meeting takes place. • Meeting Minutes – delivered via e-mail within one week of the kickoff meeting.	To be determined at contract award
Task 2	• Briefing materials or simplified	*To be determined during*

	examples of study outputs, presented via teleconference. • Briefing materials on preliminary plan for economic assumptions • Meeting Minutes – delivered via e-mail within one week of the kickoff meeting.	*kickoff meeting*
Task 3	• Deck presented to project team via teleconference outlining results, challenges, and implications for next steps. • Draft proposed database and analysis tool (may be an Excel file) with assumptions	*To be determined during kickoff meeting*
Task 4	• Draft of report appendix with descriptions of technologies, assumptions, and relevant references. • Draft proposed database and analysis tool (may be an Excel file) with assumptions	*To be determined during kickoff meeting*
Task 5	• Draft slide deck delivered via teleconference	*To be determined during kickoff meeting*
Task 6	• Draft slide deck presented in-person at Natural Resources Canada, 580 Booth St., Ottawa	*To be determined during kickoff meeting*
Task 7	• Draft report and file package	*To be determined during kickoff meeting*
Task 8	• Final report delivered electronically • Final Slide Deck delivered electronically • Final database and analysis tool (may be an Excel file) with assumptions	February 28, 2021

SW.4.2 Reporting Requirements

This project will be managed by an OERD project manager in collaboration with a manager from ERB. The OERD project manager is the main contact and lead of this project. Additional support will be provided by a researcher and will be conducted using primarily external resources.

The lead Project Authority will work to ensure that the contract is on budget and of an acceptable quality through working in close consultation with the contractor and through requiring regular status updates (at minimum biweekly) and opportunities to review and comment on work as it is progressing.

SW.4.3 Method and Source of Acceptance

All deliverables and services rendered under any contract are subject to inspection by the Project Authority. The Project Authority shall have the right to reject any deliverables that are not considered satisfactory, or require their correction before payment will be authorized.

SW.5.0 OTHER TERMS AND CONDITIONS OF THE SOW

SW.5.1 Contractor's Obligations

In addition to the obligations outlined in Section 2 of this Statement of Work, the Contractor shall:

- keep all documents and proprietary information confidential;
- return all materials belonging to NRCan upon completion of the Contract;
- submit all written reports in electronic Microsoft Office Word, PowerPoint, Excel and otherwise agreed-upon formats;
- supply other deliverables or results in the format(s) identified and agreed upon by the Project Authority and the Contractor (ex. electronic database, transfer password or administrative rights, etc.);
- will return or surrender access to any databases, specialized tools or software supplied by the OERD or otherwise, that will be used to continue to collect, store, monitor, analyze and/or report OERD, ERB and OEE performance;
- participate in teleconferences, as needed;
- store all data and documentation in a secure area.

SW.5.2 NRCan's Obligations

NRCan will facilitate the completion of the project by providing the following:

- access to program information relevant to the project, including Government publications, reports, studies, etc.;
- access to a staff member who will be available to help coordinate activities;
- access to facilities and meeting rooms with associated equipment, telephone, etc, if conducting work onsite at NRCan (if and as agreed by the Project Authority);
- if and as agreed upon in writing the project authority, OERD, ERB or OEE may provide access to or cover the cost of supplemental data (ex. Statistics Canada microdata) and/or specialized tools that may be necessary to carry out work;
- provide comments on draft reports within five (5 working days) and/or,
- provide other assistance or support, as appropriate.

SW.5.3 Location of Work, Work Site and Delivery Point

Work will primarily be conducted at the Contractor's place of business. If and as agreed upon in writing by the Project Authority and Contractor, the Contractor may be required to conduct work or attend meetings onsite at NRCan in Ottawa.

SW.5.4 Insurance Requirements

It is the sole responsibility of the Contractor to decide whether or not any insurance coverage is necessary for its own protection or to fulfill its obligations under the Contract, and to ensure compliance with required federal, provincial or municipal law. Any such insurance shall be provided and maintained by the Contractor at its own expense.

Any insurance secured is to the benefit and protection of the Contractor and shall not be deemed to release or diminish its liability in any manner including as may be referenced elsewhere by the provisions of this Contract.

INSERT: Appendix "2" – Financial Proposal Form

APPENDIX "2" – FINANCIAL PROPOSAL FORM

1. FIRM PRICE - Milestone Payments

Bidder tendered all-inclusive firm price to perform the work is in Canadian funds, applicable taxes excluded. Any Travel and Living Expenses and other miscellaneous expenses must be included in the firm price.

The bidder must complete the schedule below indicating the firm proposed amounts for each step according to the indicated percentages:

Milestone	Deliverable/Milestone	Milestone Firm Price
1	0% of Payment • Meeting Agenda – delivered via-email by forty-eight (48) hours before the meeting takes place. • Meeting Minutes – delivered via e-mail within one week of the kickoff meeting.	
2	8.3% of Payment • Briefing materials or simplified examples of study outputs, presented via teleconference. • Briefing materials on preliminary plan for economic assumptions • Meeting Minutes – delivered via e-mail within one week of the kickoff meeting.	
3	25% of Payment • Deck presented to project team via teleconference outlining results, challenges, and implications for next steps.	
4	16.7% of Payment • Draft of report appendix with descriptions of technologies, assumptions, and relevant references. • Draft Database and Analysis tool package with assumptions	

5	16.7%% of Payment • Draft slide deck delivered via teleconference	
6	16.7% of Payment • Draft slide deck presented in-person at Natural Resources Canada, 580 Booth St., Ottawa	
7	8.3% of Payment • Draft report	
8	8.3% of Payment • Final report and slide Deck • Final Database and Analysis tool package with assumptions	
	TOTAL:	**$**