

IMPACTS OF GREENING EXISTING INFRASTRUCTURE

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- ▶ Various proponents are touting the perception that the greening of society, by which they mean replacing all processes producing carbon dioxide, with electrically driven processes, is both simple, easy, and cost effective. All we need, according to them, is the will.
- ▶ This paper examines what such a transition means overall, and provides some conservative assessments of the ease of that transition.
- ▶ All aspects considered in some detail will follow the same methods and explanations for each step are provided.
- ▶ All starting numbers are taken from the NEB 2016 published reports.

INTRODUCTION

- ▶ The NEB report lists the consumption of all energy by the Industrial Sector as 5,798 Petajoules, PJ, a very large unit of energy. This sector includes oil, gas, mining, manufacturing.
- ▶ The sector is already heavily electrified, and indeed generates substantial amounts of electricity in its daily work. With that in mind, an estimate of the amount of existing electrification here is 70% or 4,059 PJ.
- ▶ The gross green opportunity possible is then the difference, or 1,739 PJ.

INDUSTRIAL SECTOR

- ▶ However, when examining the probability of capturing all of the identified opportunity it must be recognized that:
- ▶ Some aspects of the sector cannot be realistically electrified, haulage trucks in mines, using natural gas to produce large amounts of high pressure hydrogen in refineries, replacing hydrocarbon fuels in cement kilns, etc. etc.
- ▶ So complete electrification is not possible or desirable and for this sector the net opportunity identified is estimated at 435 PJ

INDUSTRIAL SECTOR (CONT'D)

- ▶ This sector consumed 2,565 PJ or 23% of the Canadian consumption of energy in 2016.
- ▶ Only five cities in Canada have electrified mass transit. Almost all other transportation is driven by the hydrocarbon fueled engines.
- ▶ So it is estimated electricity only accounts for 128 PJ leaving a relatively large gross opportunity in this sector of 2,437 PJ.
- ▶ Converting personal cars to electric is in progress but converting long haul or heavy haul trucking to electric is not yet material nor is it possible to convert 100 % of the fleet in the future simply due to geography.

TRANSPORTATION SECTOR

- ▶ With the various constraints operating, existing fleet size, existing fleet longevity, size of the country and length of haul distances between developed infrastructure, it is estimated that the likely green opportunity may be only 1,218 PJ or about 50% of the perceived opportunity.

TRANSPORTATION SECTOR (CONT'D)

- ▶ The residential sector is split between single family, or low density housing, and high density housing. Currently, by the NEB numbers, this sector accounts for 1,450 PJ of Canadian consumption or 13% of the total in 2017.
- ▶ The existing amount of electrification in this sector is estimated at 870 PJ, so the potential opportunity is estimated at another 580 PJ.
- ▶ It must be recognized that single family or low density housing is a smaller part of the possible number because in some provinces existing subsidies already favour electric heating.

RESIDENTIAL SECTOR

- ▶ The larger component represented by multi-family high density housing is, however, not generally using electric heat but has large amounts of expensive existing electrical plant installed and reworking of this to preclude hydrocarbon heating will be a very slow process. And displace many people while in progress.
- ▶ Electrification of the family vehicle fleet when combined with rework of building systems will necessarily be dependent on the availability of additional grid based supplies.
- ▶ The short term (thirty year) opportunity in this sector is therefore estimated at only 232 PJ.

RESIDENTIAL SECTOR (CONT'D)

- ▶ The commercial sector is the smallest segment of the energy consumption in Canada at 1,338 PJ or 12% of the total.
- ▶ This sector is already a heavy user of electricity since the typical office tower or large mall is generally rejecting heat via air conditioning during the occupied parts of the day, winter or summer. It is estimated that the existing amount of electrification is about 937 PJ, so the gross amount of additional electrification possible is at most 401 PJ.

COMMERCIAL SECTOR

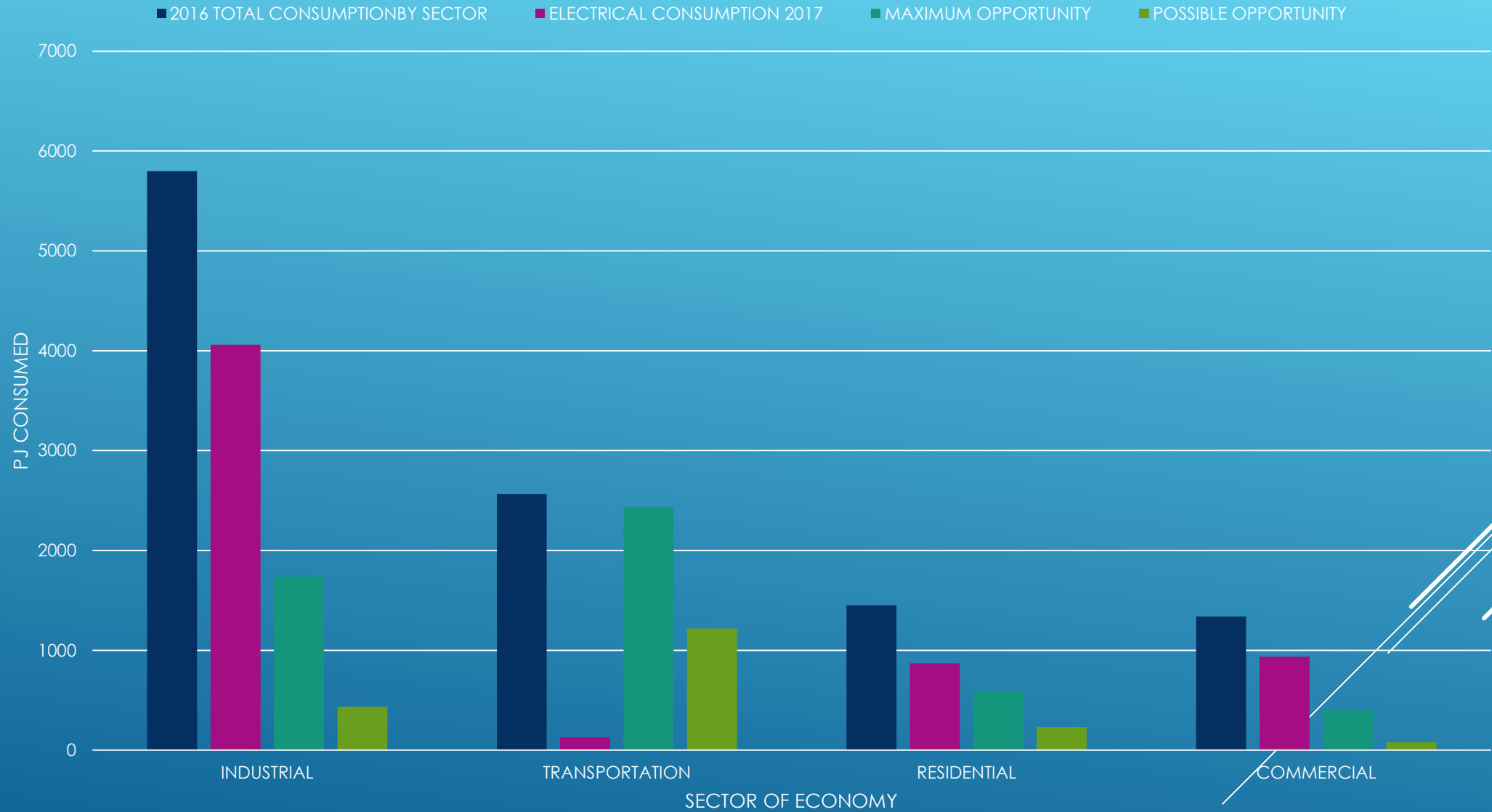
- ▶ Many of the typical office towers or even shopping malls have been constructed around their utilities. It is not unusual to have the major electrical equipment up many stories in a tower, for example, and while this was probably great design when built, it is virtually impossible to make major additions due to space limitations, ability to lift and fit new heavier transformers, and having the building structure support significant weight increases not designed in.
- ▶ The probable amount of increased electrification for this sector is estimated at 80 PJ.

COMMERCIAL SECTOR (CONT'D)

- ▶ The net result of the preceding evaluation is that a realistic greening opportunity for the Canadian energy consumption has been identified.
- ▶ In summary, the evaluation suggests that of the 11,151 PJ of energy consumed in Canada in 2017, 5,993 PJ were already electrical or other locked in supplies, leaving a total of 5,158 PJ of gross opportunity which on further consideration reduced to a total of 1,966 PJ annually.
- ▶ This information is presented graphically on the next slide.

SUMMARY

SUMMARY OF OPPORTUNITIES



- ▶ As stated, a Petajoule, PJ, is a very large quantity of energy. Equal to 277,778 MegaWattHours, MWH.
- ▶ Therefore, the identified net opportunity, as given in the Summary slide of 1,966 PJ equals 500,000,000 MWH.
- ▶ From StatsCan, recently Canada had a total annual electrical consumption of 650,000,000 MWH.
- ▶ Therefore the electrical supply system built up all across Canada in the last 100 years must be increased in size by 84%, nearly doubled, in the next 20 years to deliver the minimum net opportunity for greening.

KEY COMPARISON

- ▶ The foregoing analysis, as reasonable as it sounds, is completely wrong.
- ▶ The major mistake is the first step in the logic chain, assuming the amount of existing electrification to be 5,993 PJ. As reasonable as that sounds, it is entirely unreasonable since the total electricity supplied in Canada, 650,000,000 MWH equals only 2,339 PJ.
- ▶ Even if only half of that $5,993 - 2,339 = 3,654$ PJ shortfall is greened, the total possible to be greened is 3,793 PJ or about 240% of existing total Canadian consumption.

DISCUSSION

- ▶ A wise man once said; “Given time, money, and steel, nothing is impossible.”
- ▶ The existing Canadian electrical system required about 100 years to construct.
- ▶ To capture the greening opportunity in the next 20 years, or 30, or 40, requires us to construct more than twice as much capacity as we currently have. Base load capacity, not wind, not solar.
- ▶ We have neither the time, the money, or the steel to meet this challenge. Therefore greening as proposed is impossible.

CONCLUSION