PEMBINA institute

# The True Cost of Energy in Remote Communities

## Understanding diesel electricity generation terms and economics

2nd edition

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### Summary

This backgrounder breaks down some common fuel cost terms that are important for conversations around transitioning remote communities away from diesel. A framework of terms is proposed that will be important when negotiating power purchase rates for renewable energy projects and in particular, determining a fair rate for power produced from renewable resources that are integrated into a diesel micro-grid. We consider three terms in this backgrounder: marginal cost, avoided cost, and true cost.

Neither marginal cost nor avoided cost captures the full cost of diesel energy; the full burden of diesel reliance on communities and society as a whole is still uncounted. As well, when renewable energy rates are set by marginal costs, renewable energy projects appear less economically attractive than they actually are. Expanding the way renewable energy projects are evaluated to include avoided and true costs would acknowledge the full value of these projects.


## A framework for shared terminology

Canada's remote communities rely heavily on expensive diesel fuel for heating, electricity generation, and transportation. The high cost of diesel-based energy for basic living needs is a major expense for residents and businesses in these communities. Additional expenses — high transportation costs to remote communities, costs to maintain and overhaul diesel generation infrastructure, the negative environmental and health impacts from burning diesel fuel, and the largely unknown financial liability of diesel spill clean-up and remediation — render the "true costs" of this energy source even higher. In this backgrounder, we break down some common energy cost terms that are important for understanding and negotiating energy contracts when renewable energy generation is being integrated into a community's energy system.

## Diesel cost versus energy cost

The cost of diesel fuel is usually expressed in terms of dollars per litre of fuel ($/L). This is important for wholesalers and distributors that sell fuel and utilities that buy fuel, and is useful in understanding the costs associated with purchasing the commodity and transporting large quantities of diesel. In remote communities, that same diesel fuel is commonly used to produce both electricity (in a diesel generator) and heat (in a diesel furnace), so the cost of the *energy* is relevant for both power and heat.

Typically, when we talk about electricity, we talk about a kilowatt-hour of electricity (kWh) produced from a diesel generator. Heat energy — for example, the energy produced from a diesel furnace — is more commonly expressed in gigajoules (GJ). The amount of useful electricity or heat that you can get from diesel fuel is very dependent on the efficiency of the equipment used, and is often called *end-use* energy. The cost of end-use energy is thus often expressed as $/kWh for electricity, and $/GJ for heating.

The terms and framework proposed here are intended to ground financial conversations when negotiating power purchase rates for renewable energy projects and, in particular, when determining what constitutes a fair rate for power produced from renewable resources that are integrated into a microgrid. The aim is to improve this framework so it becomes a useful tool to incorporate into financial discussions of clean energy projects. The terms and framework presented below focus on electricity and refer to the *cost of energy* for electricity in remote communities, and it is assumed that diesel fuel is the fuel used and the energy product is electricity.

## Marginal cost of energy

The most obvious costs for powering homes and community buildings in a remote community are the costs to buy fuel, transport it to the community, store it until needed, and finally generate electricity with that fuel. We can define this as the *marginal cost of energy*. These charges — the commodity price of the diesel itself, the cost of transport, service charges, handling charges, and applicable taxes — all vary over time and from community to community. The marginal cost of energy also depends on the efficiency of the diesel generator, which can also vary over time and from community to community. As a result, marginal costs represent a snapshot in time and are often an average value; they represent the cost required to produce *one more* unit of energy in a system that is already operating. This *marginal cost of energy* is depicted in Figure 1.


Figure 1. Factors in the marginal cost of energy[1]

## Avoided cost of energy

Generating electricity from diesel requires the use of an engine and generator, and, therefore, associated costs for operating, maintaining, servicing and overhauling that equipment; storage facilities for the fuel; buildings to contain the generators and associated components; amortized capital costs; and staff to run the system. These can be bundled together with marginal costs to describe the "cost of service" of running the diesel system. Although cost of service is an accurate description, the term *avoided cost* is more commonly used in industry, particularly when considering the price that an electric utility is willing to pay for renewable energy from an independent power producer (IPP).

A renewable energy system may produce clean electricity to completely replace a diesel system, or it may be integrated alongside a diesel system, with both contributing to the overall electricity supply. The *avoided cost of energy* specifically refers to the marginal cost of the diesel energy being displaced because the renewable energy source is now producing a portion of the electricity, *plus* any extra savings that could be realized when the operational time of diesel generators is reduced as a result. There are costs that are *avoided* when diesel consumption is reduced that go above and beyond the simple marginal cost of that diesel energy, which simply assumes that less diesel fuel needs to be purchased, transported and burned.

These extra savings can include the avoided maintenance, repair, and management requirements on the diesel generators (such as oil changes and engine overhauls), as well as avoided staff time necessary to run the diesel system. It can also include *deferred capital costs*, if the addition of renewable energy means that the diesel generators run less often and last longer, therefore delaying the purchase of new equipment. Since a diesel genset is a large purchase that would typically be amortized over the useful life of the asset, the *deferred* capital cost associated with delaying that purchase can be estimated on a per-kWh basis.

[1] Some use the term *landed fuel cost*, but this often represents just the fuel cost and cost to deliver the fuel to the community ($/L). This framework uses marginal cost of energy ($/kWh) only and does not reference landed cost.

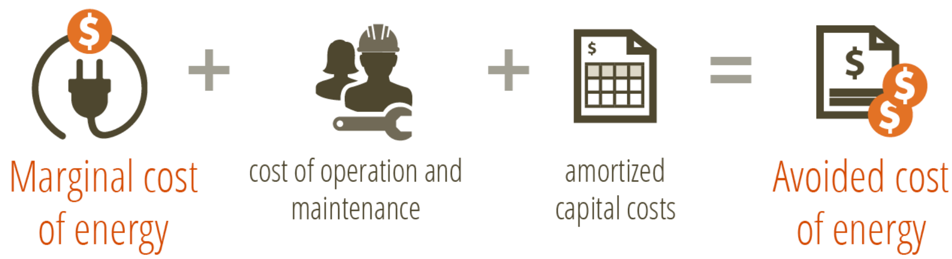


Figure 2. Factors in the avoided cost of energy

The additional amount of incremental financial savings (i.e. the step up from marginal cost to avoided cost) depends on the overall mix of renewable energy versus diesel-based energy. One example of a case where avoided costs can be significant is when a small-scale hydro system is able to replace the majority of the diesel-generated electricity and the diesel system then transitions to backup and emergency use. In this case, fewer engine overhauls and oil changes and less maintenance will be required, and staff time to run the diesel generators may be reduced. The diesel system itself might eventually be replaced with a lower-capacity unit, potentially leading to lower financing costs. Some sort of diesel backup will likely always be required for energy security, so the costs associated with the diesel system will not completely disappear.

If done incorrectly, integrating more renewable energy could also *increase* overall overhead costs associated with the diesel system. For example, the integration of solar, if not done properly, can in some cases allow the diesel generators to operate less efficiently and burn more fuel. Adding intermittent renewables can also increase the cost of control systems in microgrids, as balancing supply and demand in the system becomes more dynamic and complex. Being fully aware of the avoided cost impacts of integrated renewables is very important.

The cost savings resulting from adding renewables on a microgrid can be found by subtracting the cost of operating and maintaining the new renewable energy system from the avoided cost savings on the diesel side. Vigilance and thorough analysis is necessary at the planning stage to ensure that these cost savings are positive overall, so that adding renewables does not increase the overall cost burden to the community of running the microgrid.

The *avoided cost of energy* (i.e. the financial savings from not running the diesel generators or needing to replace diesel infrastructure) can be used to finance the renewable energy system. In other words, this *avoided cost* savings could be transferred to the renewable energy system and be a factor in improving the business case and operating value for the renewable energy system through effective IPP policies.

## True cost of energy

The *true cost of energy* is a final tier that reflects the total burden on communities and society, and is not necessarily something that can be fully expressed in economic terms. These burdens include health-related costs as a result of local air pollution; environmental costs due to diesel spills, contamination, and remediation; societal costs related to climate change; and local economic costs resulting from an expensive and limited energy supply. These costs are difficult to quantify, but are unquestionably significant. For example, it is estimated that there are over 1,000 diesel spills *each year* in remote communities across Canada.[2] These spills are costly to clean up at best, and can cause catastrophic environmental damage at worst.[3]


Figure 3. Factors in the true cost of energy

Further complicating matters is the cost of diesel *subsidies*. To make energy costs more affordable, governments and utilities set subsidized rates in many remote communities. To paint a rough picture, the cost of electricity in Canada's remote communities can be enormous: up to $1.14/kWh in parts of Nunavut, ten times higher than the rates of $0.10–0.15/kWh that the average Canadian pays for electricity.[4] In communities like these, the cost of electricity must be heavily subsidized for most customers, who end up paying a rate of around $0.30/kWh as long as they do not exceed their household limit. This rate, though much lower than the actual (marginal) cost of production, is still double what most Canadians pay. (The structure of diesel subsidies in Canada's remote regions is extremely complex, and will be discussed in a future publication.)

Maintaining the status quo of entrenched policies that define subsidy structures makes the transition from diesel to renewable energy in remote communities more difficult. While it's important to maintain affordability for communities that still rely on diesel fuel, governments and utilities need to start considering how some of the public subsidy of diesel fuel can be

[2] Christopher Pollon, "Why nobody seems to know Canada's total number of diesel spills," The Discourse, December 2, 2017. https://www.thediscourse.ca/energy/how-many-diesel-spills-happen-canada-every-year-nobody-knows

[3] Elizabeth McSheffrey, "First Nation urges Trudeau to rush tanker ban after diesel spill in Great Bear Rainforest," National Observer, October 13, 2016. https://www.nationalobserver.com/2016/10/13/news/first-nation-urges-trudeau-rush-tanker-ban-after-diesel-spill-great-bear-rainforest

[4] WWF-Canada, *Tracking Diesel Fuel Subsidies in Nunavut* (2017). http://assets.wwf.ca/downloads/costing_fossil_fuel_subsidies_in_nunavut.pdf

shifted or expanded to make renewable energy more affordable in Canada's remote communities, to the benefit of all Canadians.

## The importance of considering true cost

The financial feasibility of a renewable energy project that displaces diesel (like a wind system or solar array) is partly determined by the cost of the energy it produces, compared to the cost of diesel energy, and the additional cost to manage the interconnection of multiple generation sources. Neither marginal costs nor avoided costs captures the full cost of diesel energy. This not only obscures the real burden of diesel reliance on communities and society as a whole; it makes renewable energy projects appear less attractive than they actually are.

Popular modelling tools[5] and many government policies, including power purchase rates for renewable energy,[6] only consider the economic benefits of reducing the *marginal cost* of diesel reduction. This undervalues the benefits of renewable energy projects. Considering the reduction in operation and maintenance costs, the *avoided cost of energy,* should be a minimum criteria in evaluating renewable energy projects as it increases their value. To fully reflect the economic benefits of a renewable energy project, however, the analysis should also include avoided health, environmental, and societal burdens — the *true cost* of diesel energy. This increases the value of renewable energy and diesel reduction even further.

Renewable energy projects already tend to be more expensive to develop in remote communities, due to many factors including harsh weather and complicated logistics. When looking at project economics, utilities and governments rarely consider the *avoided cost*, let alone the *true cost* savings these projects would achieve, leading to some much-needed projects not getting off the ground because the financial business case cannot be realized.

### Power purchase agreements

Power purchase agreements (PPAs) and renewable energy project economics are an important topic that will be discussed in future publications, but it should be stressed that the above terminology becomes extremely important when negotiating PPA rates for renewable energy projects that will reduce diesel consumption. The de facto approach currently is to offer PPA rates equal to the *marginal* cost of energy — often undervaluing the true benefits of integrating

[5] HOMER Energy, "Marginal diesel generation cost," July 20, 2016. http://usersupport.homerenergy.com/customer/en/portal/articles/2188636-marginal-diesel-generation-cost

[6] Hydro One, *Hydro One Remote Communities Inc. Renewable Energy Innovation Diesel Emission Reduction (REINDEER) Guideline* (2018). https://www.hydroone.com/abouthydroone/CorporateInformation/Documents/Hydro%20One%20Remote%20Communities%20Inc%20REINDEER%20Guideline%202018.pdf

renewable energy. The further the envelope can be pushed to offer PPA rates that approach, at a minimum, the *avoided* cost of energy (and ideally the *true* cost), the more opportunities there will be for renewable energy projects to succeed. This will ultimately lead to lower economic, health, and environmental costs to communities and society as a whole.

## Conclusion

Considering the business case for renewable energy projects in remote communities by comparing against the *marginal cost* of diesel alone doesn't capture the full value of this energy source. We need to begin quantifying and understanding the *avoided* and *true costs* of diesel energy, so that the integration of renewables into the diesel system can be evaluated on its full merits. This conversation must begin with a collective understanding and agreement on terminology, so that all stakeholders are on the same page.

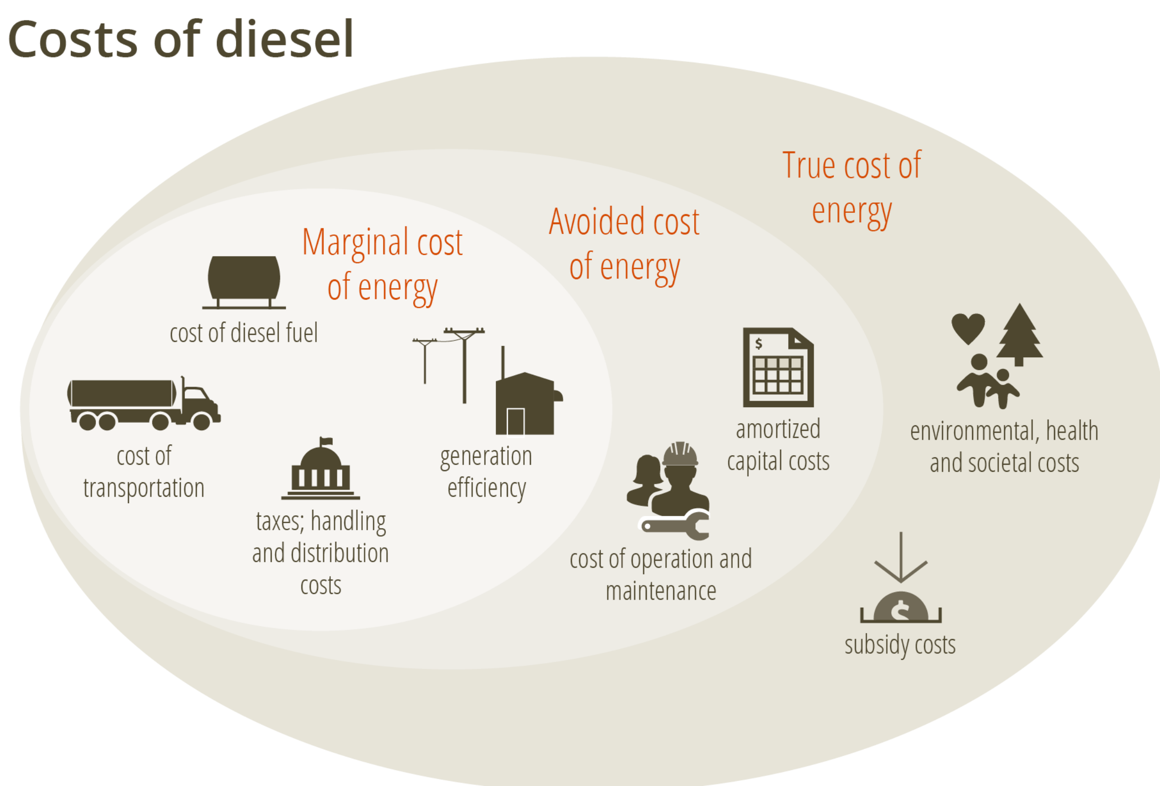


Figure 4. Overview of the costs of diesel