



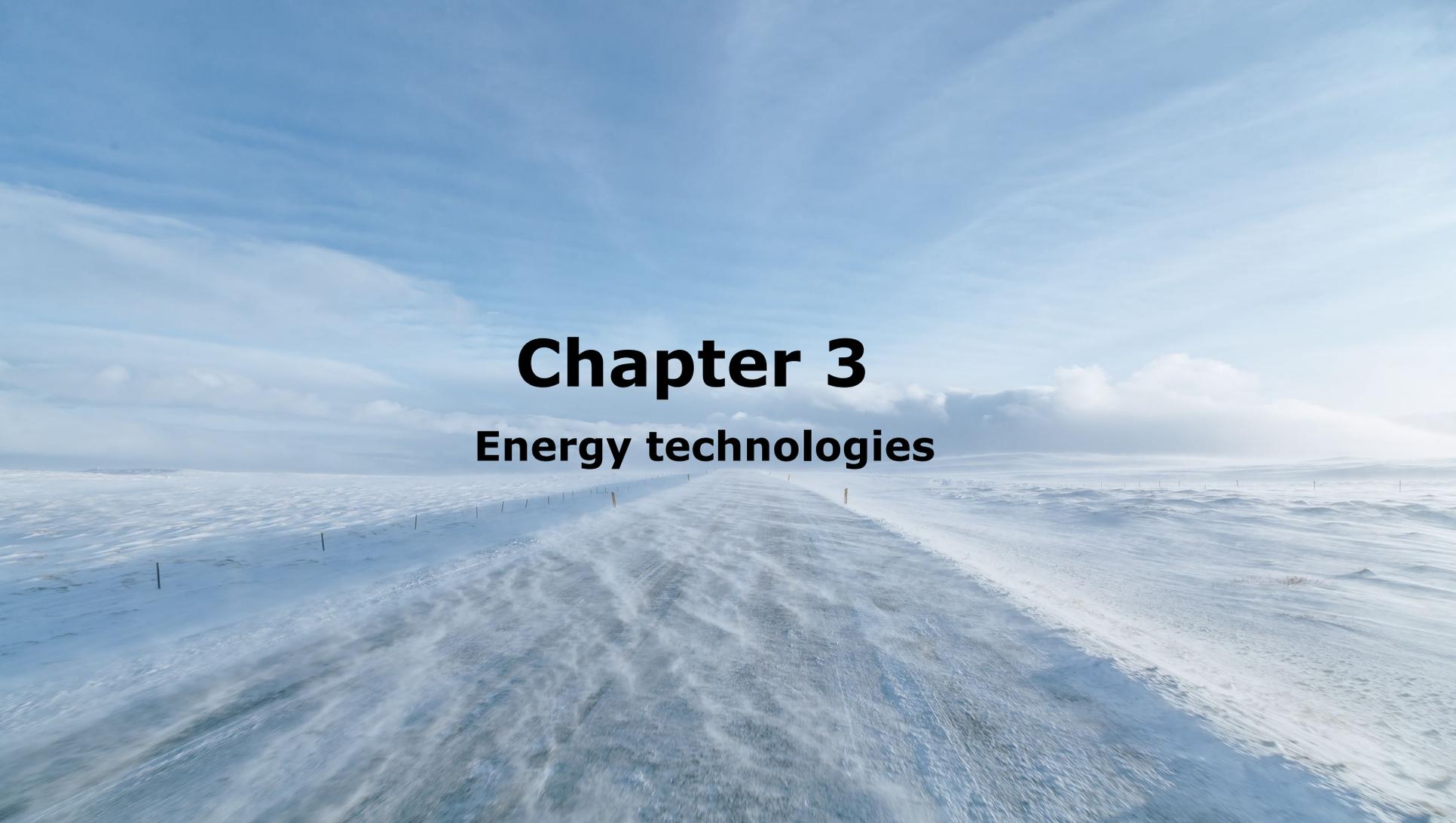
Shining Lights

Energy Literacy and Language in the NWT

Understanding your Energy Story



ARCTIC ENERGY
ALLIANCE



Chapter 3

Energy technologies

Electricity versus heating



Electricity versus heating

- Remember, end-use energy can be in the form of **electricity**, **heat**, **cooling** and **motion**.
- Electricity is used for many things including lighting, running appliances and electronics.
- Electricity is one form of energy that is also often used for heating.
- A good example of this is a gas stove versus an electric stove. Both heat, but one uses a fuel and another uses electricity.



Electric heating

- Another example is heating your home. Furnaces that use diesel fuel, or stoves that use wood can heat a home. Electric baseboard heaters or portable heaters can also be used.
- Sometimes, both types are used – a main wood stove (thermal heat) with baseboard or plug-in heaters (electric heat).
- It is understood that there is not a lot of electric heat as the main heating source in the NWT because it's too expensive, but let's keep this in mind. Portable and plug-in heaters are used sometimes.



This can make the analysis of energy use in the home complicated – because electricity can be used for everything – lighting, appliances, electronics, cooking and space heating.

KEEP THIS IN MIND

Electricity versus heating

	Electricity	Heating
House heating system	Yes – baseboards, plug-in heaters, heat pumps	Yes – diesel, biomass
Hot water heating	Yes	Yes – diesel, biomass
Lighting	Yes	No
Appliances	Yes	No
Computer, electronics	Yes	No

Electricity used for heating (even partial) can make understanding energy use in your home complicated.

Non-Renewable Technologies

Electricity production in remote communities



Electricity production

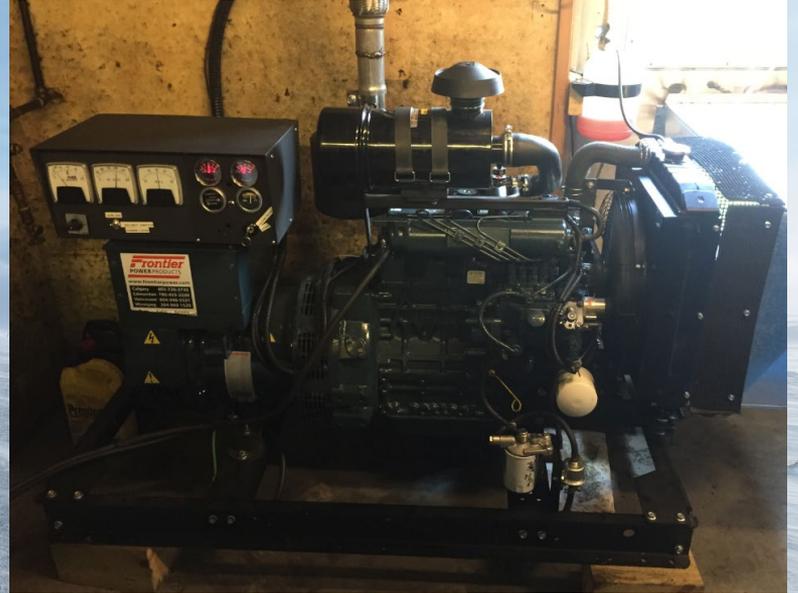
- In NWT remote communities, like most remote communities across Canada, electricity is produced primarily by diesel generators.
- There are a few communities in the NWT with natural gas electricity generators (Norman Wells, Inuvik).
- There are other remote communities in Canada (mostly in British Columbia and Quebec) that have micro-hydro systems that produce the electricity – Bluefish, Snare and Taltson in NWT for example.
- Some communities in the NWT (example Yellowknife, Behchoko and Dettah) are powered by hydro through regional hydro grids.

Diesel Generators

- All vary in size, complexity, age and the capacity rating - **kiloWatts (kW)** or **MegaWatts (MW)**



5 MW diesel generator



25 kW diesel generator

Non-Renewable Technologies

Heat production in remote communities



Diesel furnaces and boilers

- Diesel furnaces and boilers burn diesel fuel to heat air or water. This hot air or water can then be used within the home to heat your space or your water.
- Diesel fuel is stored on-site near or inside the building – usually in a 350 gallon drum.



Diesel storage tanks



Diesel furnaces

Diesel furnaces and boilers

- Diesel furnaces and boilers burn diesel fuel to heat air or water. This hot air or water can Diesel furnaces are generally used to provide space heating to a home by heating air and distributing it through the home.
- Diesel boilers can be used to heat water through a hydronic system, provide heat to a home, or provide hot water for direct usage in the home (showers, baths, washing dishes).



Diesel storage tanks



Diesel furnaces

Conversion Efficiency

Wasted energy / inefficiencies



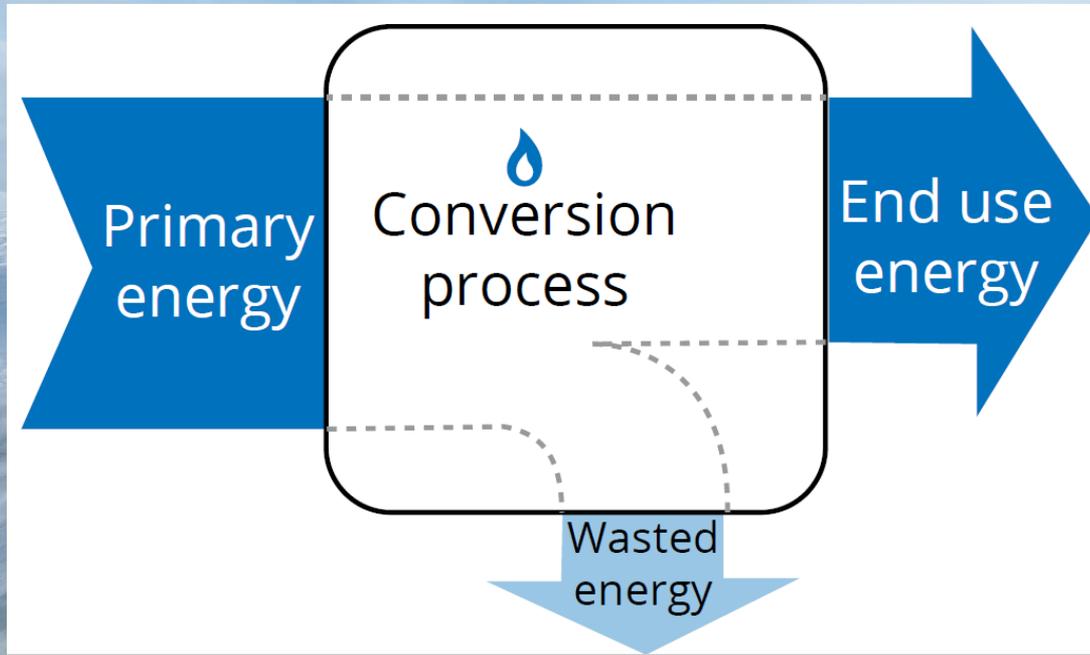
Conversion efficiency

- Any technology cannot extract 100% of the primary energy into end-use energy
- This is true for technologies that extract energy for fossil fuels (i.e. natural gas or diesel fuel), but also true for renewable energy technologies.



Conversion efficiency

- This factor is referred to as the *conversion efficiency* of the technology. There is always wasted energy from a conversion process. There is no technology that is 100% efficient.



Comparison of conversion efficiency

Generating electricity

- Electricity from diesel generators on average have a conversion efficiency of 25% - 35%.
- This means that for three units of energy, only **one** unit of electricity can be used, and **two** units are wasted.



WHAT THAT MEANS: For every three barrels of diesel that is produced, trucked, shipped or flown into a community, two of them are essentially thrown away as waste energy.

THINK OF THE COST OF THAT

Comparison of conversion efficiency

Producing heat

- Diesel furnaces have a conversion efficiency anywhere between 55% (very old) - 95% (very new and efficient). It all depends on how energy efficient the diesel furnace is.
- For an average efficiency of approximately 65%, this means that for three units of energy, about **two** units of end-use electricity is produced, and **one** unit is wasted.



*WHAT THAT MEANS: Heating air or water with diesel furnaces or boilers is generally **twice as efficient** as heating air or water with electricity in remote communities.*

*An old, inefficient furnace is only a bit better than an electrical generator.
But a high-efficient furnace or boiler is by far better than heating with electricity.*

The case of the hot water tank

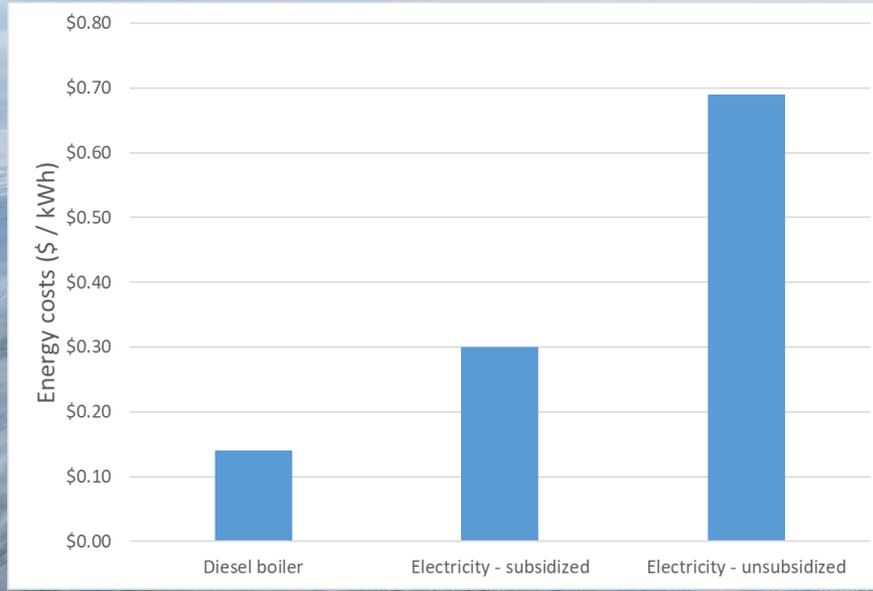
- You have two hot water tanks – one that heats water using electricity (that is generated using a diesel generator) and one that heats water using diesel fuel (efficiency around 80%). Both heat the same amount of water.
- Which one costs more and uses more diesel fuel to heat that water?



The case of the hot water tank

Normalized to common values (we'll go into this more in detail later):

- Heating water with a diesel boiler costs around **\$0.14 / kWh** (80% efficient boiler)
- Heating water with electricity costs **\$0.30 / kWh** at a subsidized rate
- Heating water with electricity could cost **\$0.69 / kWh** at the unsubsidized rate



Unsubsidized rate
is **VERY** high!!

The case of the hot water tank

- It is way more cost effective to heat water with a diesel boiler - \$0.14 versus \$0.30 / kWh
- AND the diesel boiler is more efficient (around 80%) than producing electricity to heat water (around 30%)

How many of you have electric hot water tanks?

If you do, heating with hot water costs you a lot of money.

Renewable technologies

Renewable energy technologies can be used to produce both **electricity** and **heat**.

It depends on the technology.



Renewable technologies

Electricity production – main forms of electricity production

- **Solar photovoltaic** (producing electricity from the sun)
- **Wind turbines** (producing electricity from the wind turning the blades)
- **Micro-hydro** (producing electricity from flowing water)
- Combined heat-and-power biomass (less common, but using technology that burns biomass and produces both heat and power)
- Geothermal (producing electricity using steam captured from hot water deep within the earth's subsurface)

Electricity production – main forms of electricity production

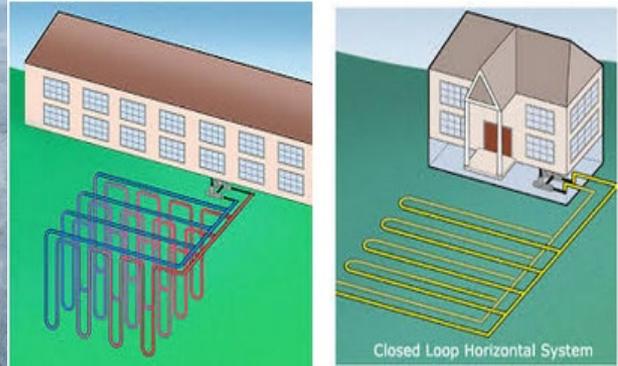


Renewable technologies

Heat production – main forms of heat

- **Passive solar** (heating a space directly from sunlight)
- **Solar hot air** or **solar hot water** (heating air or water)
- **Biomass thermal** (wood stoves, pellet stoves, district heating – for space or water heating)
- **Geo-exchange** (air-source heat pumps, ground-source heat pumps – for space or water heating)

Heat production – main forms of heat

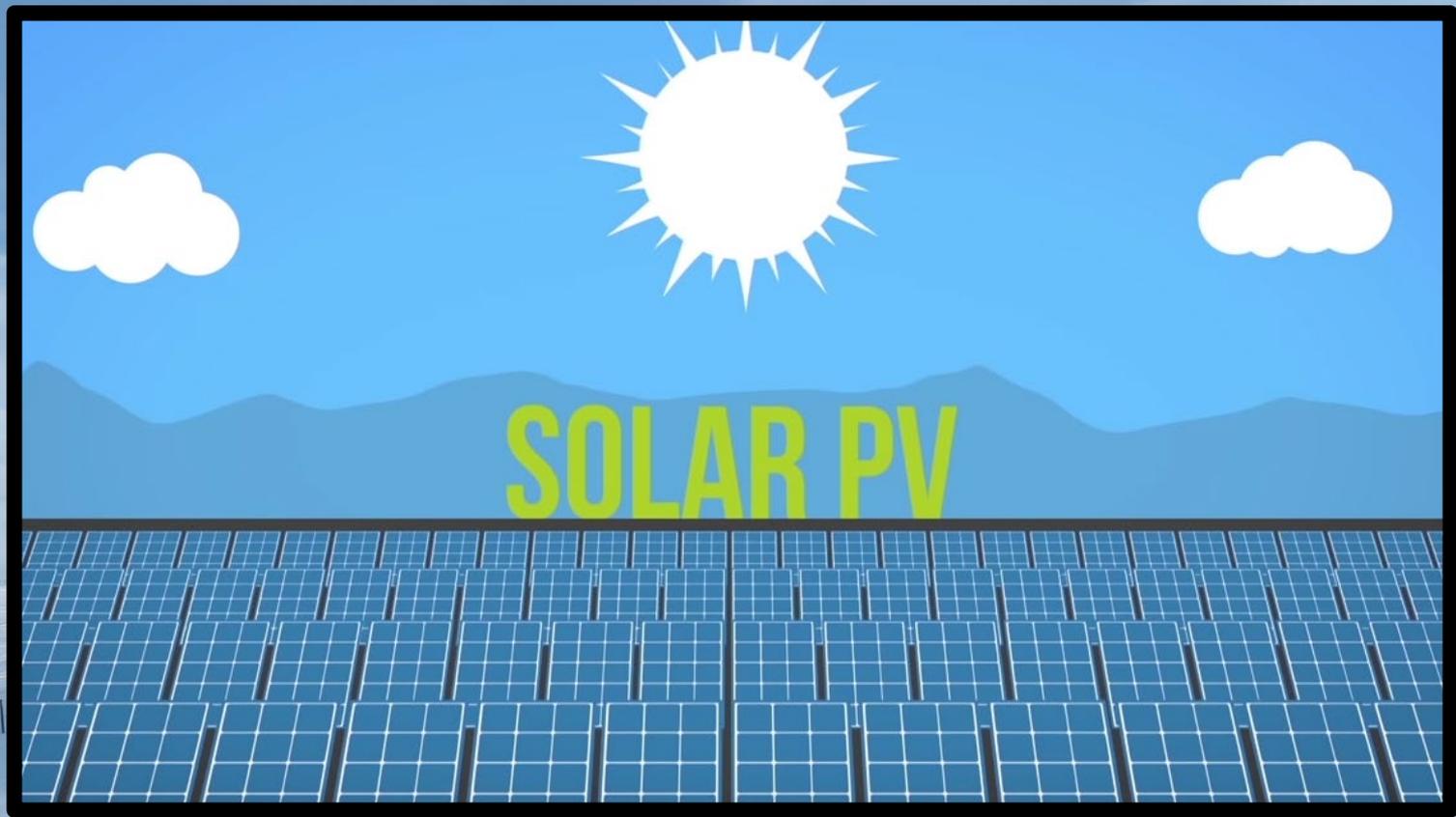


Heat production – main forms of heat - biomass





Renewable energy 101



Solar PV 101

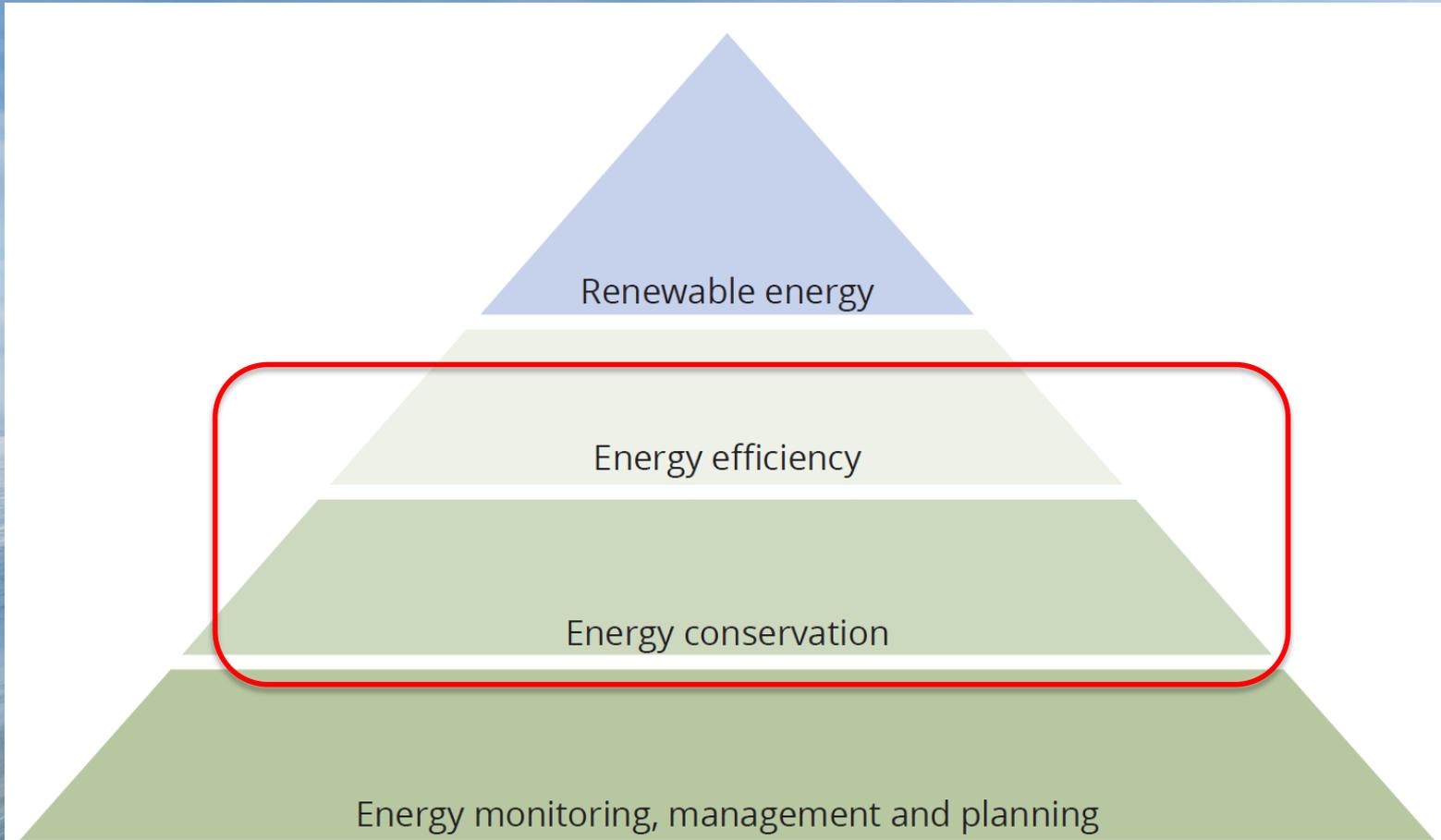


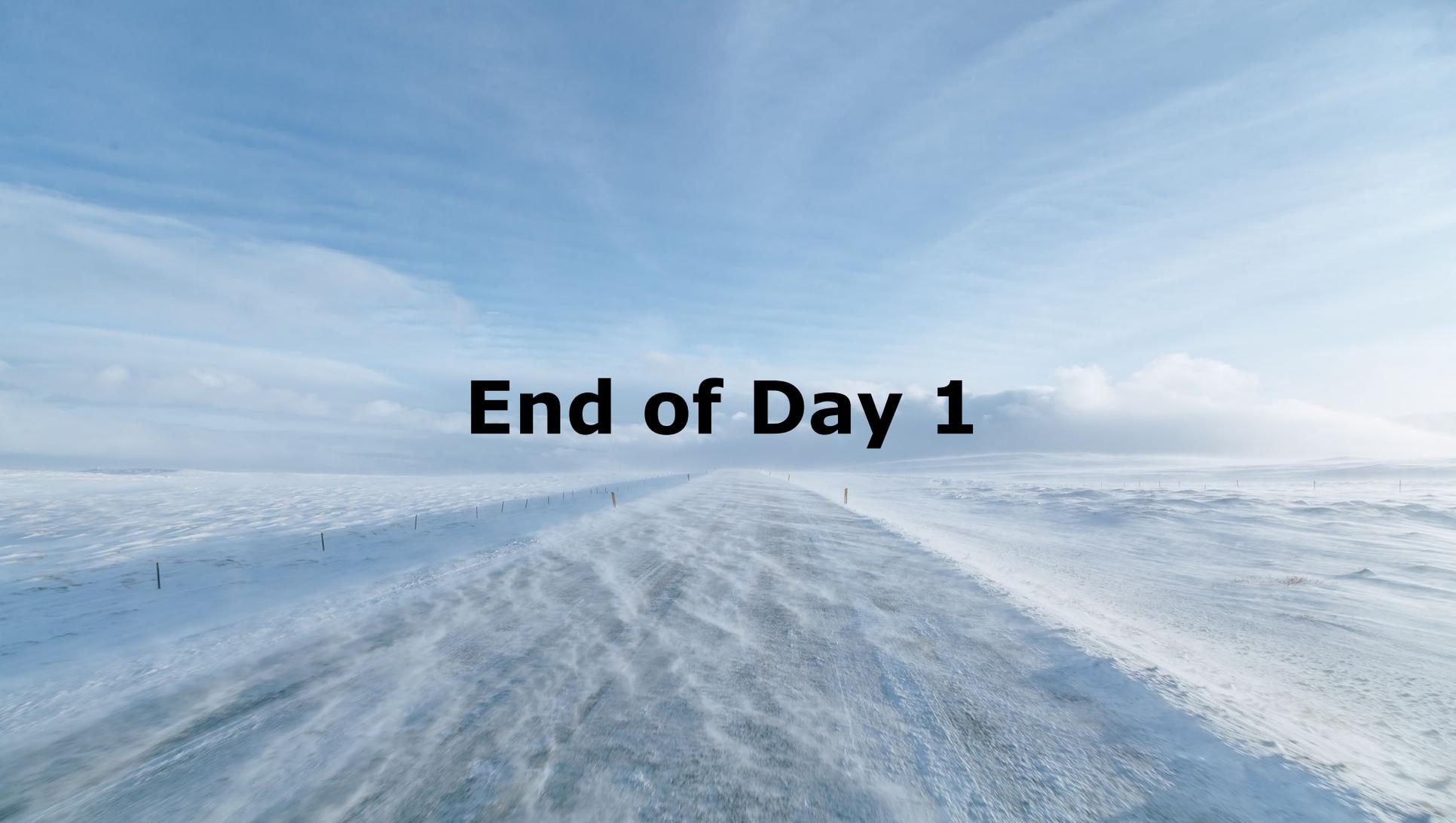
Wind power 101

The Energy pyramid

- This project is about **reducing** energy in your homes and **saving your family money**.
- Less energy use means less electricity, less diesel and less wood used.
- This project is not specifically focusing on generating energy in your homes or communities with renewable energy ... although that would also be a way to use less electricity, diesel and wood.
- This project is about conserving energy and being more efficient with energy use.

The Energy pyramid

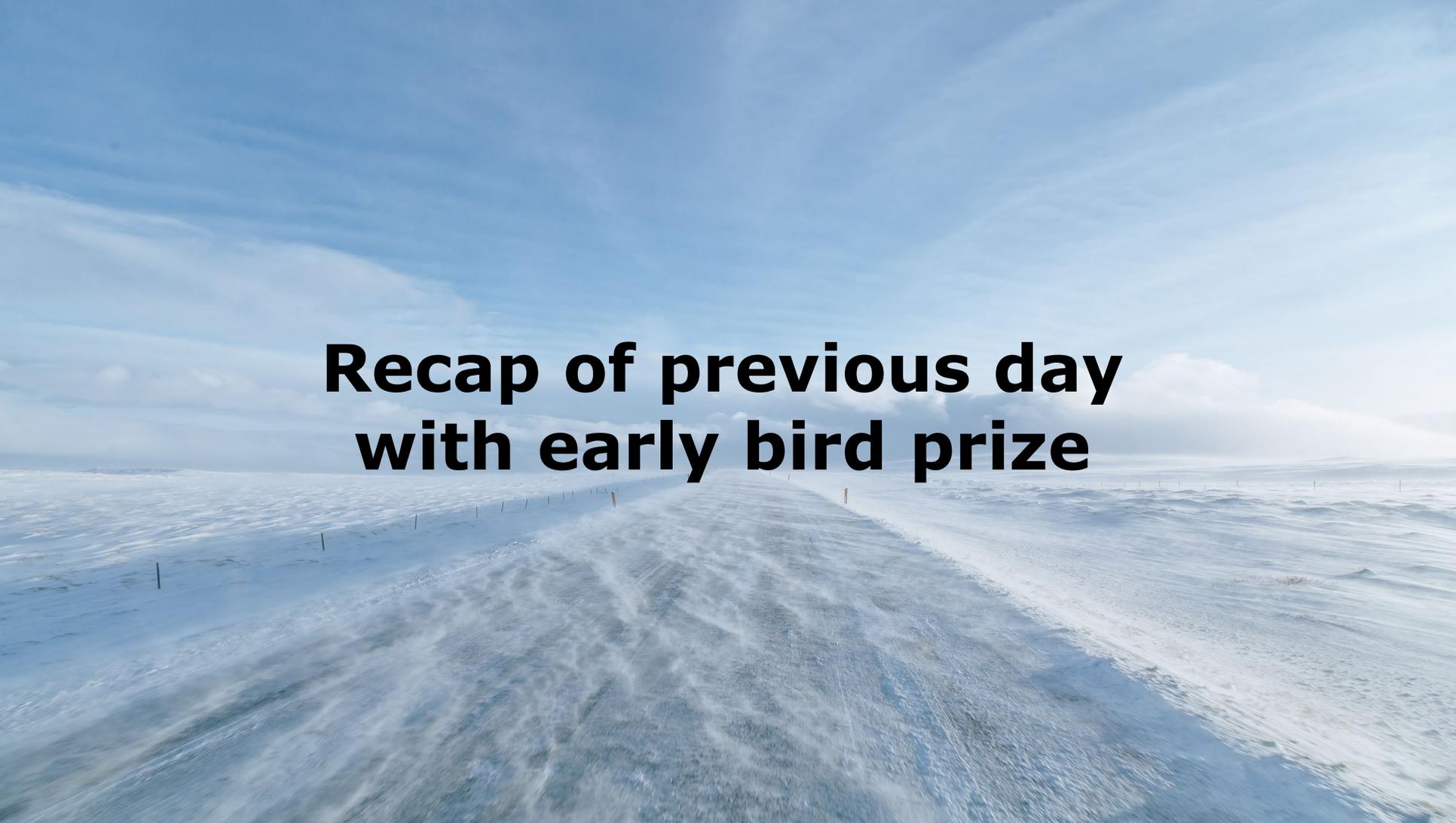




End of Day 1



Day 2



**Recap of previous day
with early bird prize**

Chapter 3 Continued

Energy technologies



Discussion – Traditional Activities

- What traditional activities have been replaced or lost by energy technologies – either non-renewable or renewable?
- What impacts has this had on you, your community, your family?

Energy in the home

An introduction



Energy In The Home

Every home is unique in terms of its energy sources, the annual energy required to heat and power, and the annual costs.

Some homes use a variety of energy sources for heating – wood, diesel furnace and even electric heat.

Factors that affect how much energy is needed for a home:

- Size of home.
- How many people live in the house.
- What the house is used for.

Energy In The Home

Factors that affect how much energy is needed for a home:

- Energy sources and technologies used – how is it heated: space heating and hot water – diesel, electricity, wood. Conversion efficiencies.
- Quality of building envelope – how well is it insulated, are there any gaps in doors and windows, how energy efficient are the windows
- How well is it ventilated
- **Climate and weather is also a HUGE factor**

Energy in the home

This makes it very difficult to give broad direction as to what efforts on reducing energy will have the best effect.

It largely depends on your different energy sources, energy costs, their conversion efficiencies and how much they contribute to overall energy profile that dictate energy reduction and energy \$\$ savings.

EACH HOME AND SITUATION IS UNIQUE

BUT THERE ARE STILL GOOD GENERAL GUIDANCES TO MAKE BIG IMPACTS AND REDUCTIONS OF ENERGY USE.

Energy In The Home

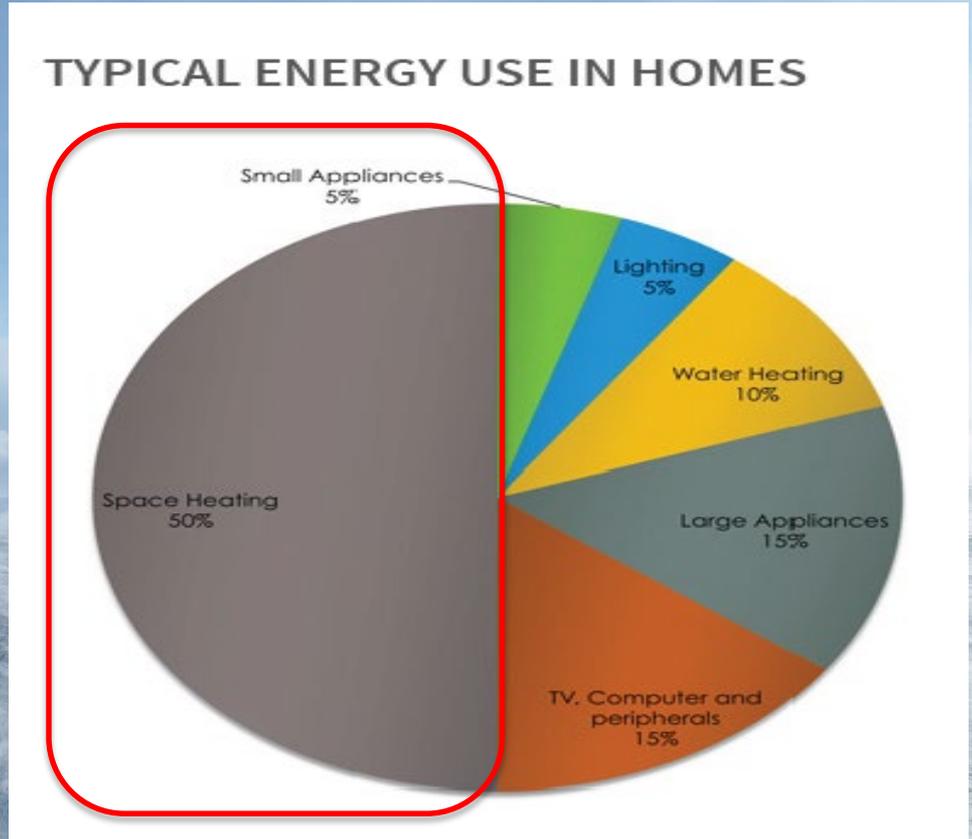
REMEMBER: **What does energy do?**

- Energy **heats** and **cools** our home and makes it comfortable.
- Energy **powers** our appliances – keeps our food cold, cooks our food, washes our dishes.
- Energy **powers** our leisure devices – our television, our internet, our radios, music, cell phones.
- Energy **lights** our homes – on the inside and outside.
- Energy **heats** our water – for cooking, for showers, baths, and for laundry.

Energy In The Home

A very general estimate on energy use:

Category	Percentage of energy use
Space heating	50 – 65%
Water heating	10 - 15%
Lighting	5 – 10%
Large appliances	10 – 15%
Small appliances, electronics	5 – 10%



Approximately half the energy used is for space heating.

Energy In The Home

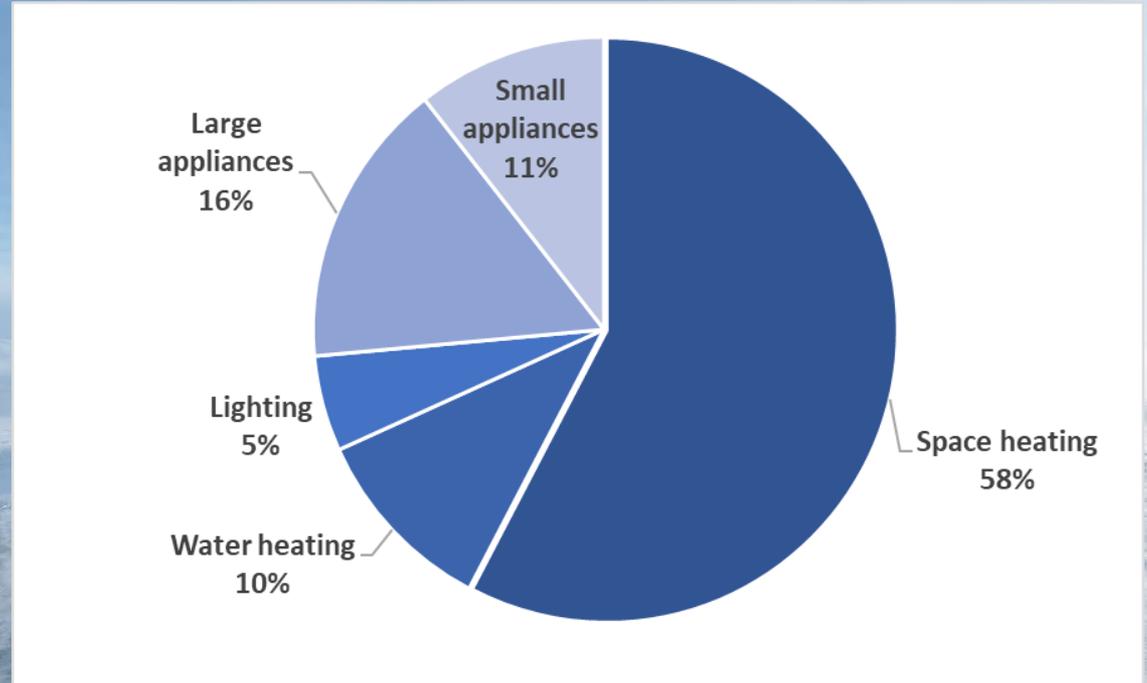
*With space heating being at **least half** of energy use in the home, reducing energy use or being more efficient on how your home is heated will have the biggest positive impact on energy consumption and costs.*



Home Energy Use In The NWT

General numbers

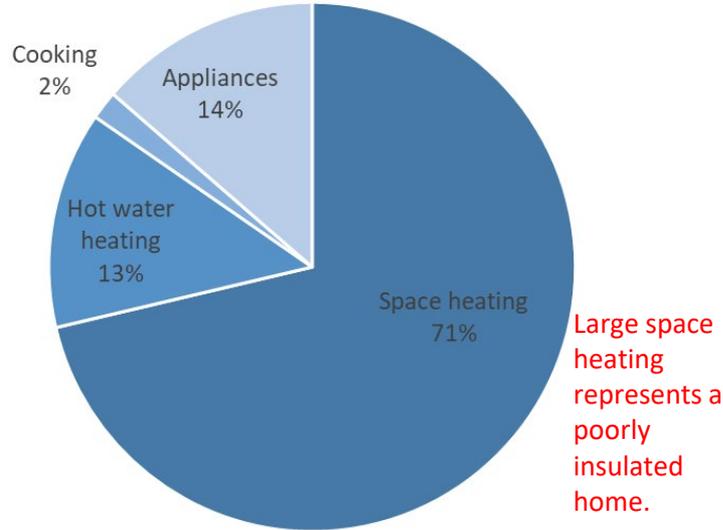
Category	Annual energy use (kWh)
Space heating	30,302
Water heating	5,560
Lighting	2,780
Large appliances	8,340
Small appliances	5,560
Total	52,542 (kWh)



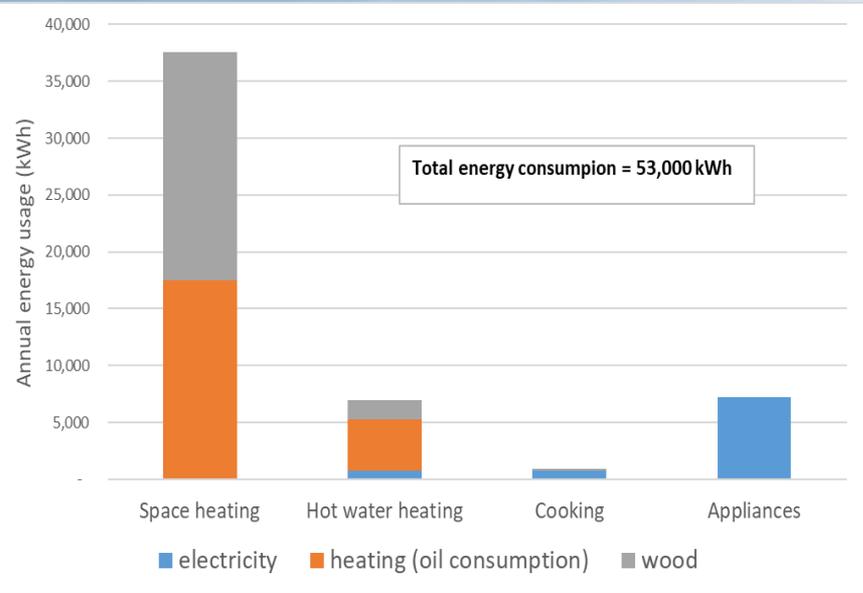
*Annual energy use is 52,500 kWh per year.
That's **53 MWh** per year, or **189 GJ**.*

Home Energy Use In The NWT

Real case example

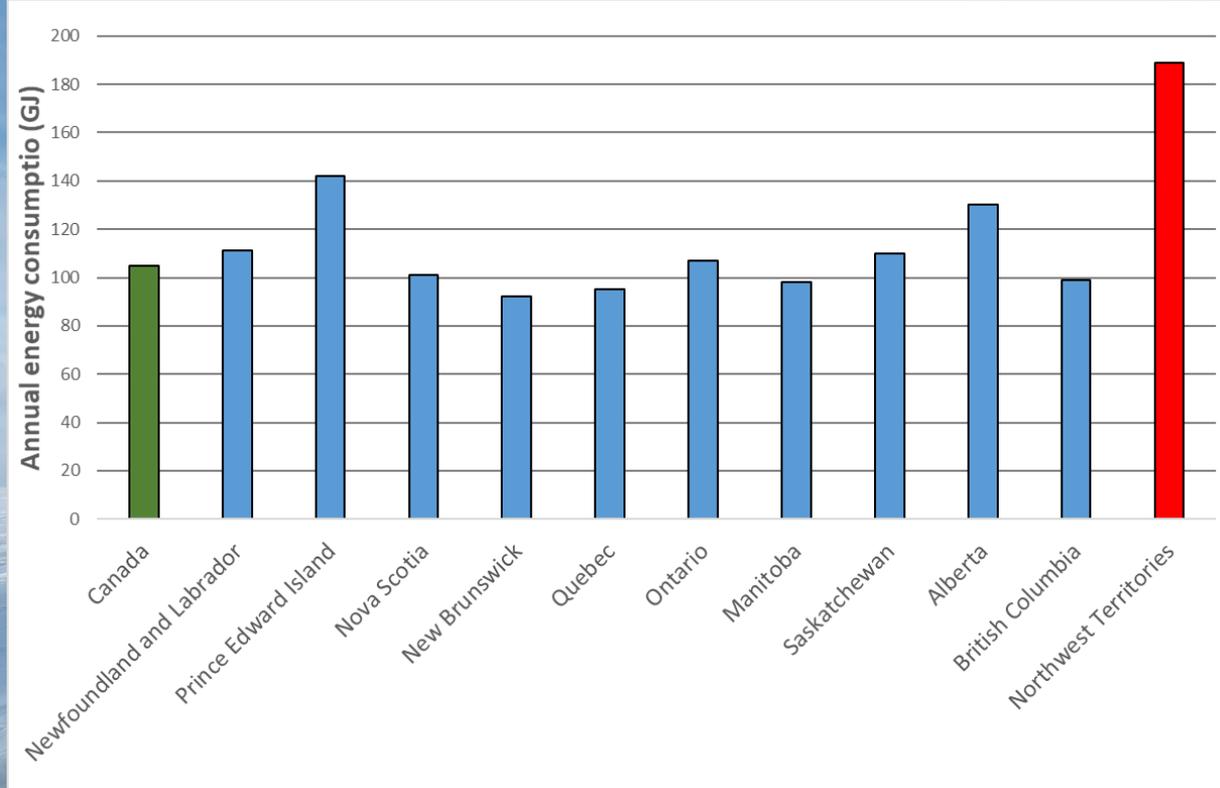


Home heated by both a diesel furnace and wood stove



Annual energy use is 52,700 kWh per year.

Home Energy Use In The NWT



Homes in the NWT use **80% more energy** than an average home in Canada.
189 GJ (NWT) compared to 105 GJ (Canada)

How much diesel actually is that?

- Let's consider how much diesel fuel is actually needed to provide a home with 53 MWh of energy.
- Let's assume a home is heated with a diesel furnace (65% efficient), diesel hot water heater (65% efficient) and powered with electricity (30% efficient)

Barrel of Oil Equivalent (BOE)

A Barrel of Oil

- a barrel of oil contains 160 litres of oil
- The amount of available energy in a barrel of oil is called the **Barrel of Oil Equivalent (BOE)**

A Barrel of Oil Equivalent (BOE)

- **1 Barrel of Oil Equivalent (BOE)** is approximately 5.8 GJ
(Available energy, or primary energy is the total available amount of energy released from burning oil. But more on that later)



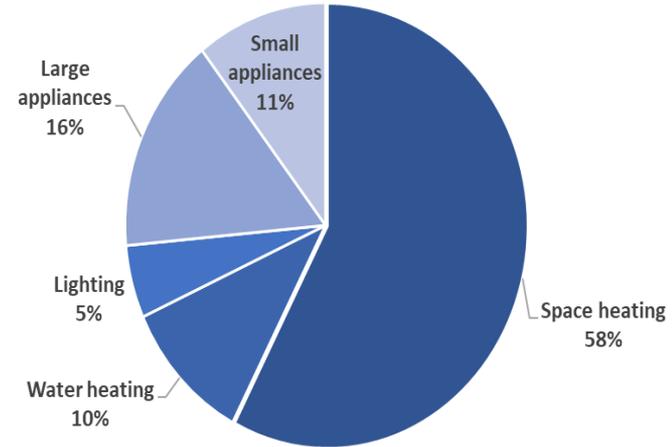
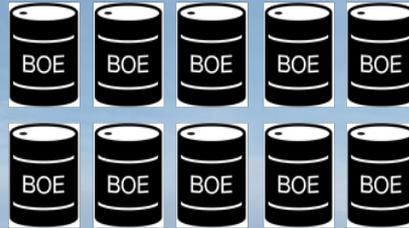
5.8 GJ of available
energy

What is the Barrel of Oil Equivalent?

Heat – 22 BOE



Electricity – 10 BOE



Energy equivalence of 53 MWh:

32 BOE

- 22 BOE for heat

- 10 BOE for electricity

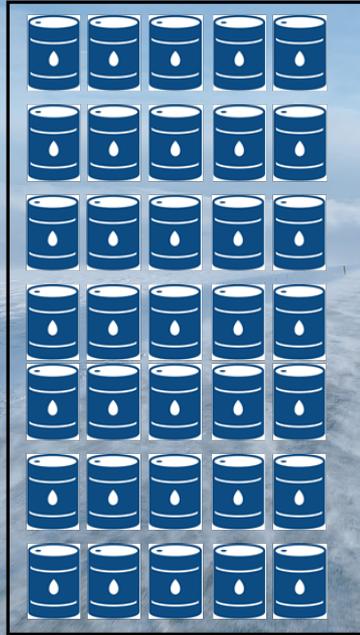
How much diesel is that?

Actual diesel needed to produce that much end-use energy:

Heat – 34 barrels of oil



Electricity – 35 barrels of oil



69 barrels per year needed to provide that energy to one home

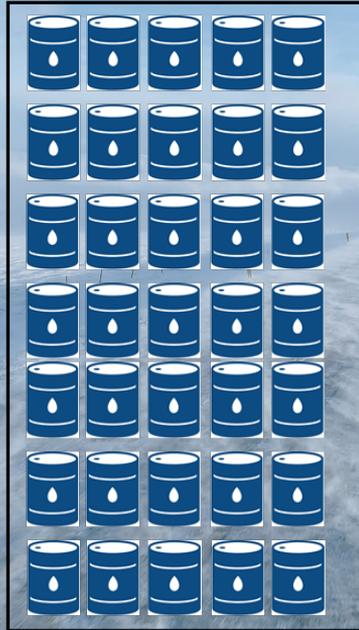
How much diesel is that?

Actual diesel needed to produce that much energy and to transport it to the community

Heat – 34 barrels of oil



Electricity – 35 barrels of oil



Transportation – 3 barrels of oil (estimation)



72 barrels per year needed to provide that energy to one home

How much natural gas do we need to make that much diesel?

Oilsands example – how much natural gas is needed to produce 72 barrels of oil?

Remember, 27 m³ of natural gas contains 1 GJ of energy.

And for average oilsands production, it takes 1.3 GJ natural gas to produce one barrel of oil



This is a 1,000 litre (1 m³) water tote.
It measures 1m x 1m x1m

How much natural gas do we need to make that much diesel?

Oilsands example – how much natural gas is needed to produce 72 barrels of oil?



X 2,500

2,500 of these totes filled with natural gas is needed to produce 72 barrel of oil which is needed to heat and power your home in the NWT for one year!

It takes about 2,500 m³ of natural gas to produce 72 barrels of oil

How much natural gas?

This is only 1,000 m³ of natural gas



How much natural gas?

Let's just think about this:

*It takes about 2,500 m³ of natural gas to produce
72 barrels of diesel.*

72 barrels of diesel is needed

TO HEAT AND POWER ONE AVERAGE HOME IN THE NWT

EVERY YEAR

Think about the upstream impacts of producing that much diesel every year.

Energy Name Game

- Split into 5 groups, about 5 people per group.
- We each come up with a name with an energy term that has the same letter as the first letter of our name.
- For example – Solar Shianne.

KEY TERMS TO REMEMEBER



Conversion efficiency

The efficiency of a technology to convert the primary energy into usable end-use energy

Diesel generator

Technology that uses diesel fuel to produce electricity

Diesel boiler or furnace

Technology that uses diesel fuel to heat air or water

Bioenergy

Energy that can be derived from biomass – thermal heat, electricity, methane gas

Biomass

Any form of organic material that can be used to produce bioenergy (wood, wood chips, pellets, organic kitchen waste)

Combined heat and power

Technology that uses biomass to produce both heat and electricity

Solar photovoltaic

Technology that uses the energy in sunlight to produce electricity

Wind generator

Technology that uses the energy in wind to produce electricity

Other terms?

Are there other important terms we missed?