NEXT GENERATION HYDRO

powering our future

Introduction to Next Generation Hydro
Presentation #3 – Educational Concepts
November 26, 2014

Part 1 - Overview

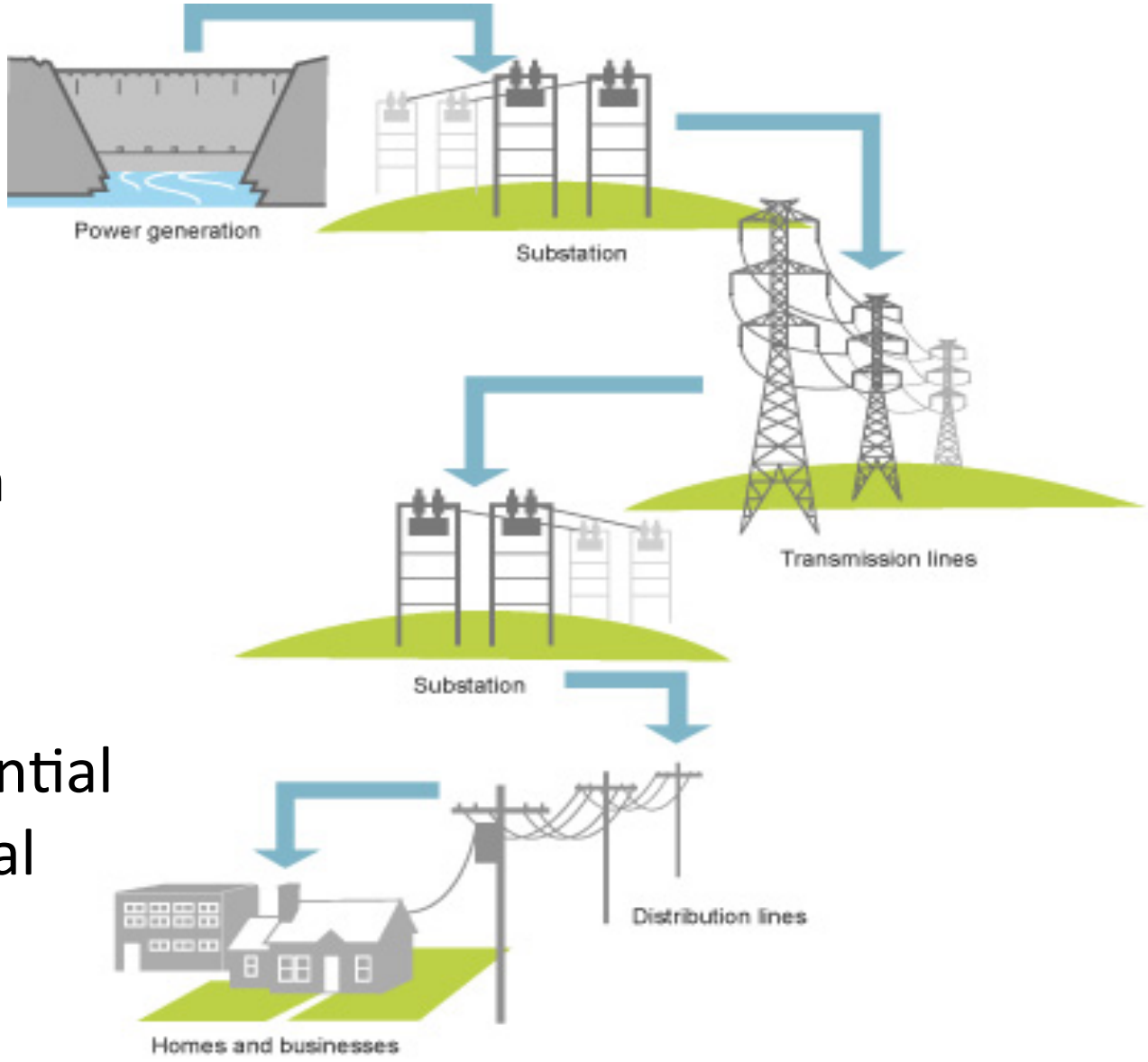
MIDGARD

1. Elements Of The Grid
2. Yukon Grid
3. Energy & Capacity
4. Electricity Demand
5. Electricity Generation
6. Fuel, Not Electricity, Storage
7. Dispatchable & Intermittent Generation
8. Generation meets Demand

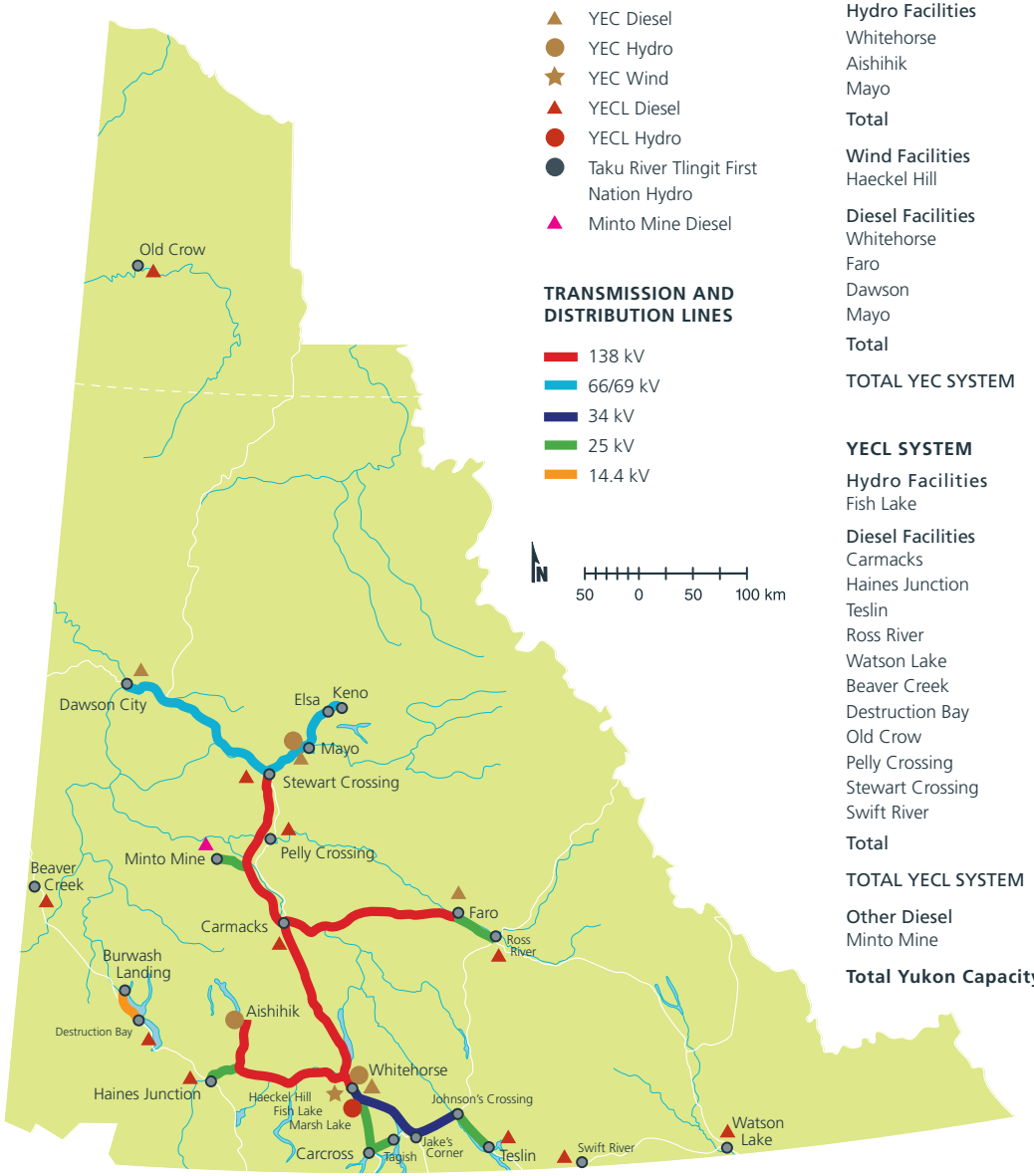
Elements of the Grid

MIDGARD

1. Generation
2. Substation
3. Transmission
4. Substation
5. Distribution
6. Load: Residential & Commercial



Yukon Grid



GENERATING STATIONS

- YEC Diesel
- YEC Hydro
- YEC Wind
- YECL Diesel
- YECL Hydro
- Taku River Tlingit First Nation Hydro
- Minto Mine Diesel

TRANSMISSION AND DISTRIBUTION LINES

- 138 kV
- 66/69 kV
- 34 kV
- 25 kV
- 14.4 kV

YEC SYSTEM	(in MW)
Hydro Facilities	
Whitehorse	40.0
Aishihik	37.0
Mayo	15.1
Total	**92.1**
Wind Facilities	
Haeckel Hill	0.8
Diesel Facilities	
Whitehorse	23.0
Faro	8.5
Dawson	5.1
Mayo	2.5
Total	**39.1**
TOTAL YEC SYSTEM	**132.0**

YECL SYSTEM	(in MW)
Hydro Facilities	
Fish Lake	1.3
Diesel Facilities	
Carmacks	1.5
Haines Junction	1.5
Teslin	1.5
Ross River	1.0
Watson Lake	5.0
Beaver Creek	0.9
Destruction Bay	0.9
Old Crow	0.7
Pelly Crossing	1.2
Stewart Crossing	0.1
Swift River	0.3
Total	**14.6**
TOTAL YECL SYSTEM	**15.9**
Other Diesel	
Minto Mine	8.0
Total Yukon Capacity	**155.9**

Energy & Capacity

MIDGARD

Energy is a measure of power used over time and represents work.

- A 1 MW plant that operates for 1 hour is said to have produced 1 megawatt-hour ("MWh") of energy.

Capacity is a measure of the instantaneous ability of a given power source to produce power

- Typically measured in watts ("W"), kilowatts ("kW"), or megawatts ("MW").

So if both are important to an electrical grid, what do they really mean?

Electricity Demand

MIDGARD

Electricity is important to our daily lives. It is an essential part of participating in the modern world

- Therefore, we want electricity to be available on demand

Two time frames for discussion today

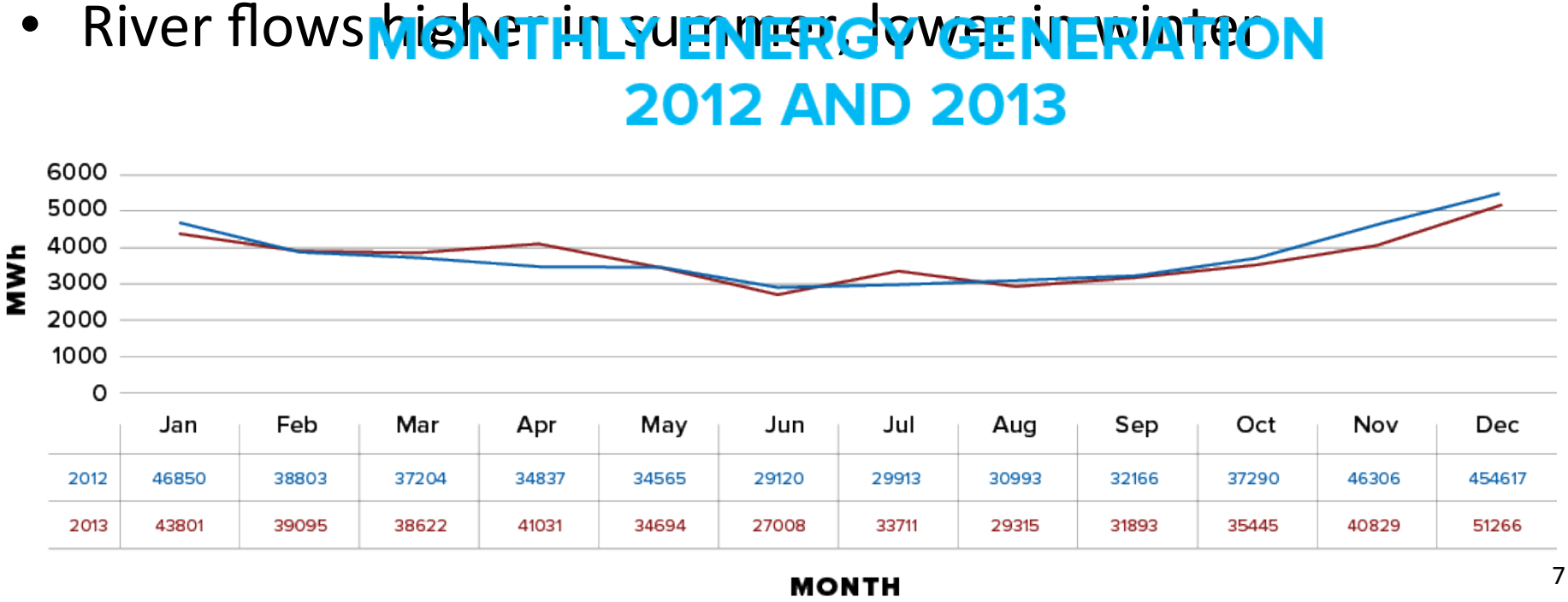
- Seasonal
- Daily/Hourly
  - NOTE: There are other time frames that matter when operating an electrical grid

Let's explore natural patterns across these time frames

MIDGARD

Seasonal

- Warm in summer, cold in winter
- Longer days in summer, shorter days in winter
- Snows accumulates in winter, snow melts in summer
- River flows higher in summer, lower in winter

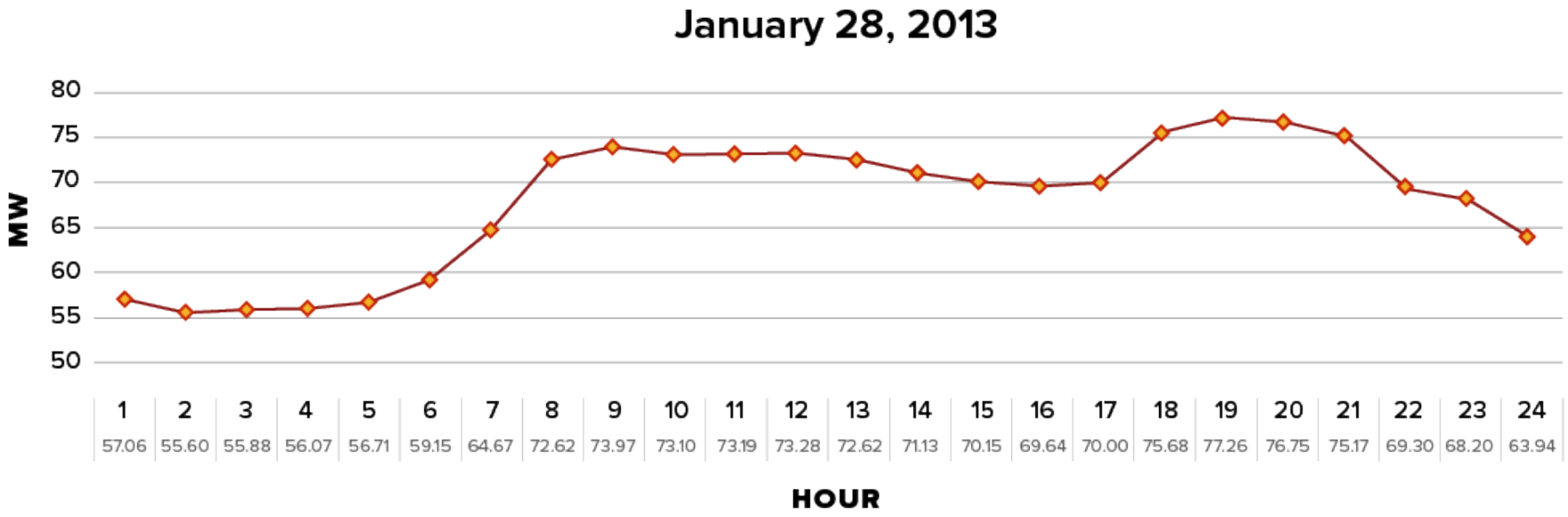


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2012	46850	38803	37204	34837	34565	29120	29913	30993	32166	37290	46306	454617
2013	43801	39095	38622	41031	34694	27008	33711	29315	31893	35445	40829	51266

MIDGARD

Daily

- Sleep at night, awake during the day
- Prepare & eat food each day (e.g. breakfast & dinner)
- Work during the day, home in evening (to chores & TV)
- Turn lights, heating, appliances on & off



Electricity Generation

TOTAL electricity generation (energy & capacity) must match demand across all timeframes:

- Seasonal
- Daily (& Instantaneous)

Or else there will be brown out or black outs

Therefore:

- Seasonal: Generation must be winter peaking
- Daily: Track daily/instantaneous demand changes

A combination of hydro & diesel (soon to include natural gas) meets this need today

Fuel Storage, Not Electricity Storage

MIDGARD

Generation Type	Fuel Storage Forms
Hydroelectricity	Water: Snow, Ice, Water Reservoir (Lake, Reservoirs)
Diesel	Diesel
Natural Gas	Compressed or Liquefied Natural Gas
Biomass	Green Matter (Trees, Garbage, Organic Waste)
Wind	*Fuel Cannot Be Stored*
Solar	*Fuel Cannot Be Stored*

Dispatchable & Intermittent Generation

MIDGARD

Dispatchable: Energy when you want it, in the quantity you want (called "firm" energy)

- Storage Hydro, Diesel, Natural Gas

Intermittent: Energy when fuel is available, not necessarily when you want it (called "non-firm" energy)

- Run-Of-River Hydro, Wind, Solar

	Dispatchable Generation	**Intermittent Generation**
Energy Source	Good	Good
Capacity Source	Good	Poor

Generation Meets Demand

Electricity generation must match demand always, and across all timeframes:

- Seasonal
- Daily (& Instantaneous)

Therefore:

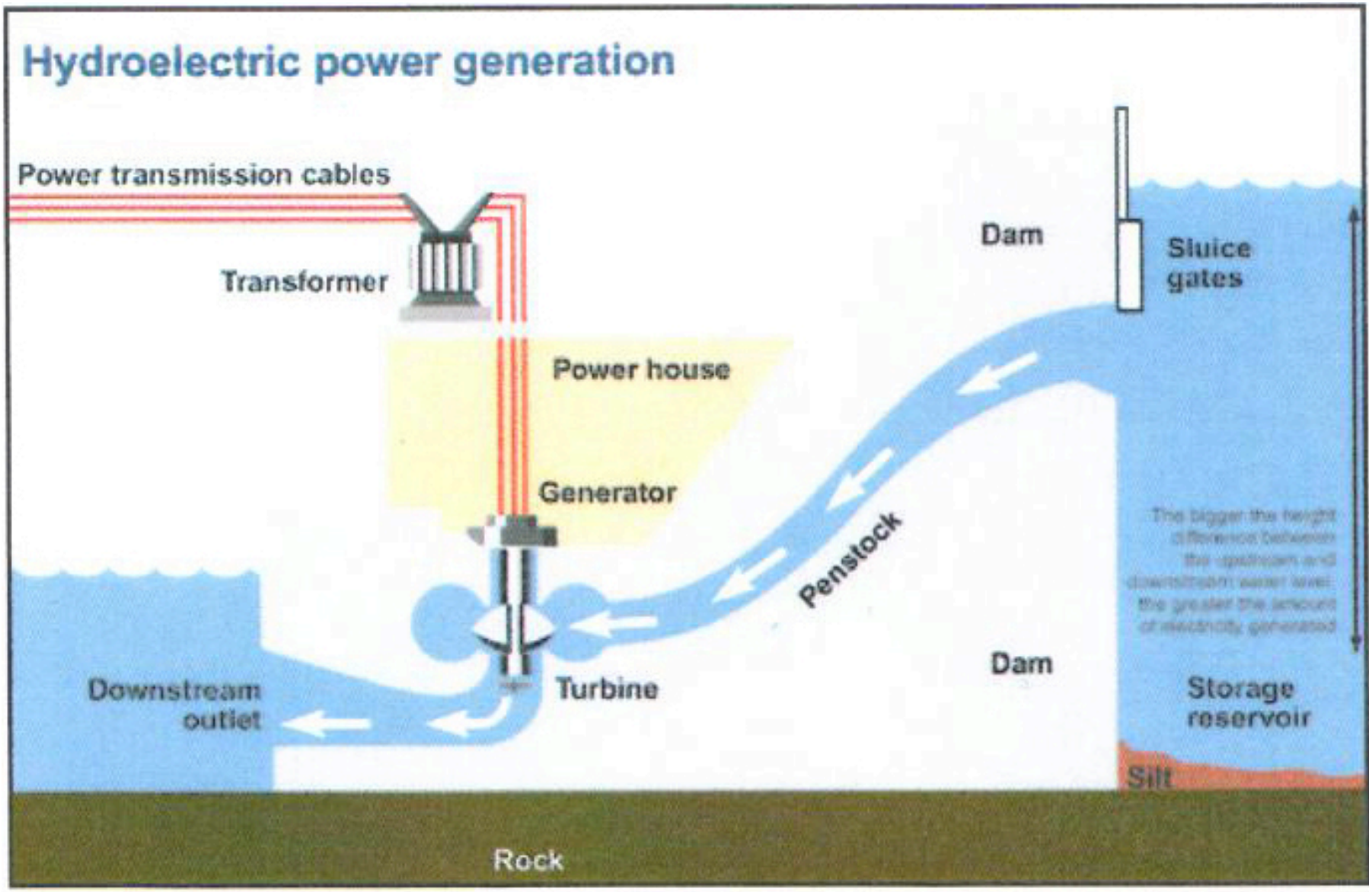
Combination of generation assets required to meet demand

- Energy: Dispatchable & Intermittent
- Capacity ("Firm Energy"): Dispatchable

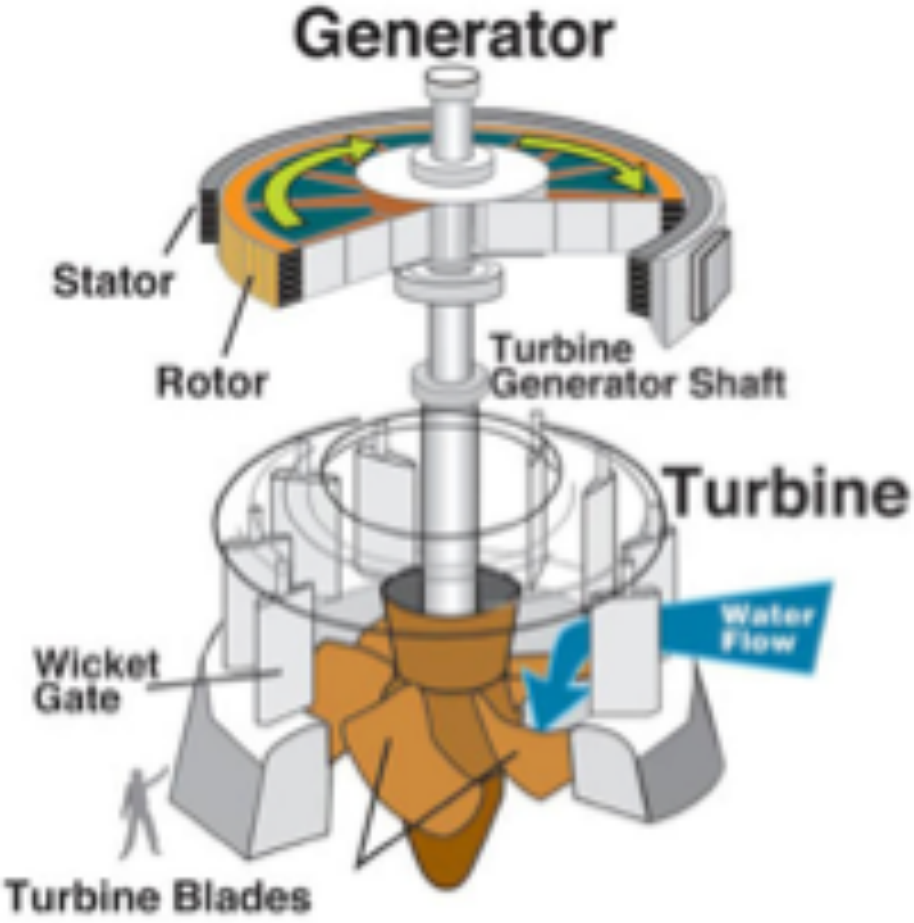
Part 2 - Overview

1. Hydro - Storage
2. Hydro Turbine & Generator
3. Run-Of-River (Low Head)
4. Run-Of-River (High Head)
5. Hydro’s Fit with Yukon

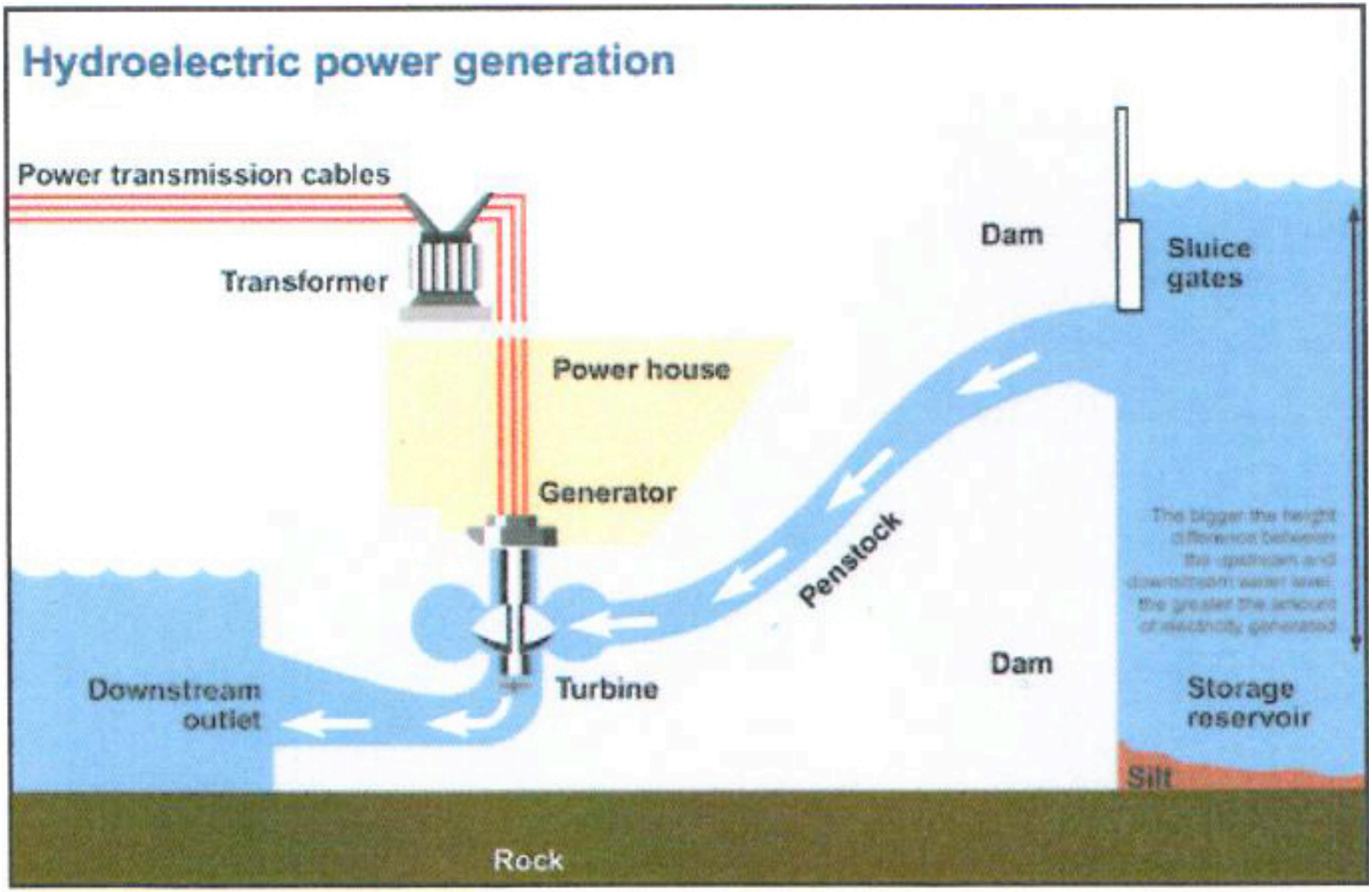
Hydro - Storage



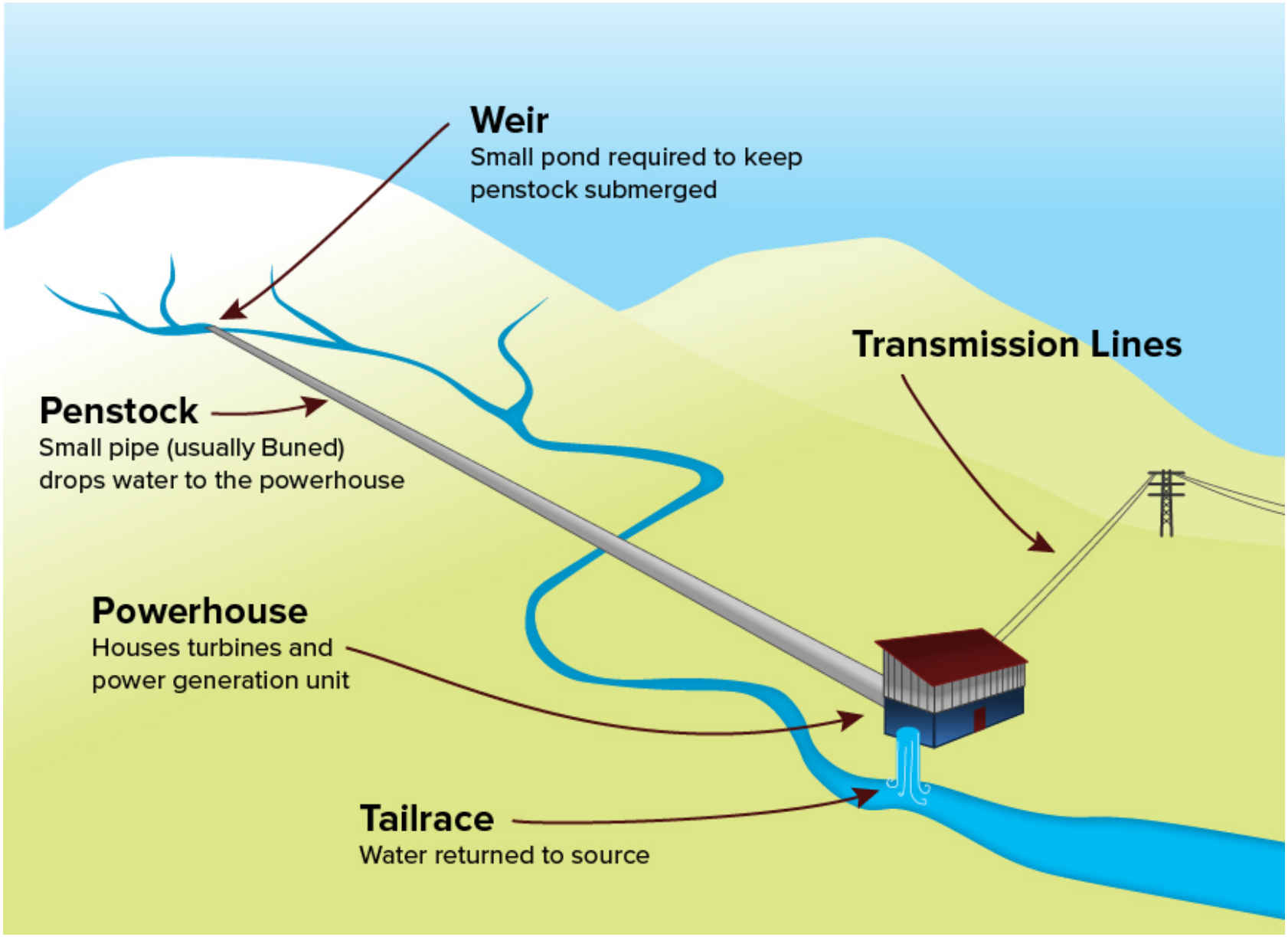
Hydro – Turbine & Generator



Hydro – Run-Of-River (Low Head)



Hydro – Run-Of-River (Higher Head)



Hydro's Fit With Yukon

The seasonal pattern ...

- Warm in summer, cold in winter
- Longer days in summer, shorter days in winter
- Snows accumulates in winter, snow melts in summer
- River flows higher in summer, lower in winter

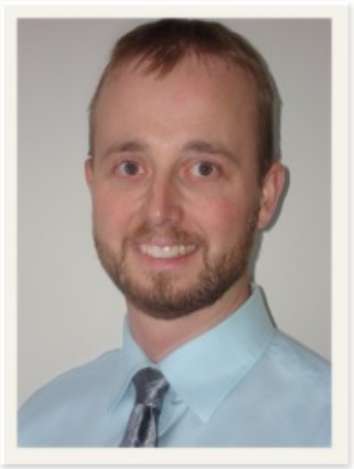
This means …

- Yukon electricity is winter peaking, BUT
- Fuel (Water): Available in summer, less in winter

Therefore …

- Energy: Desire to store summer fuel (water) for winter use
- Capacity: Stored fuel provides dispatchable "firm" energy

Thank You & Questions…



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