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CONSULTING INC.

PUTTING NGH IN CONTEXT: OTHER SOLUTIONS TO MEET YUKON'S LONG TERM ENERGY FUTURE

26 November 2015

Table of Contents

PART 1 – INTRODUCTION

Objectives

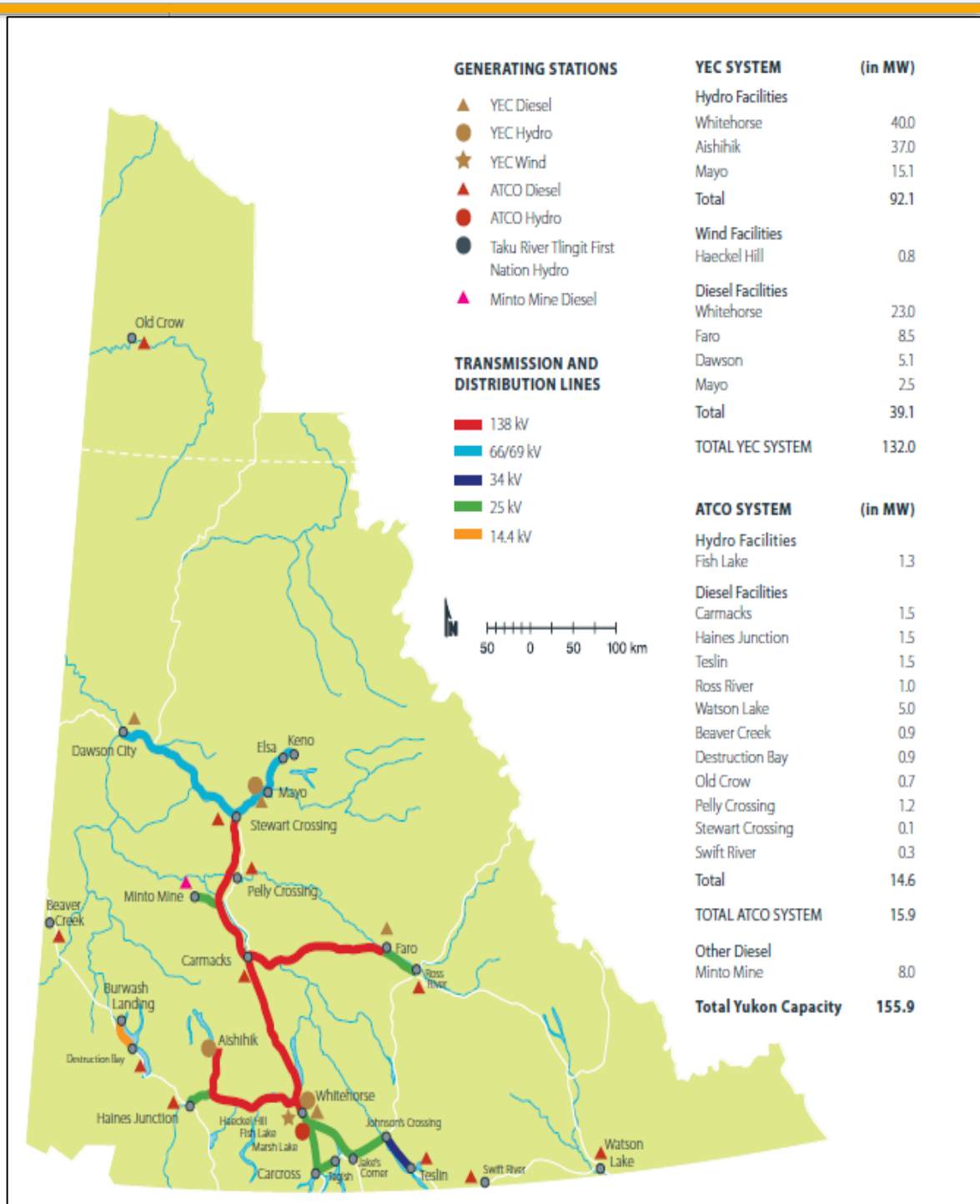
Review alternative energy development scenarios for Yukon based on the following objectives:

1. Provide Next Generation Hydro (NGH) context by presenting Impacts & Trade-offs of energy development scenarios.
2. Promote a fact-based conversation around potential solutions and alternatives
3. Consistent framework with which to compare NGH and other potential energy developments.

Yukon Electrical Grid

Yukon is an islanded grid with 132 MW of installed capacity as follows:

1. 92 MW Hydroelectric: Whitehorse (40 MW), Aishihik (37 MW), and Mayo (15 MW)
2. 39 MW Thermal Generation: Diesel and Natural Gas
3. 0.8 MW Wind: Two wind turbines on Haeckel Hill



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

ATCO 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 ATCO SYSTEM	15.9
Other Diesel	
Minto Mine	8.0
Total Yukon Capacity	**155.9**

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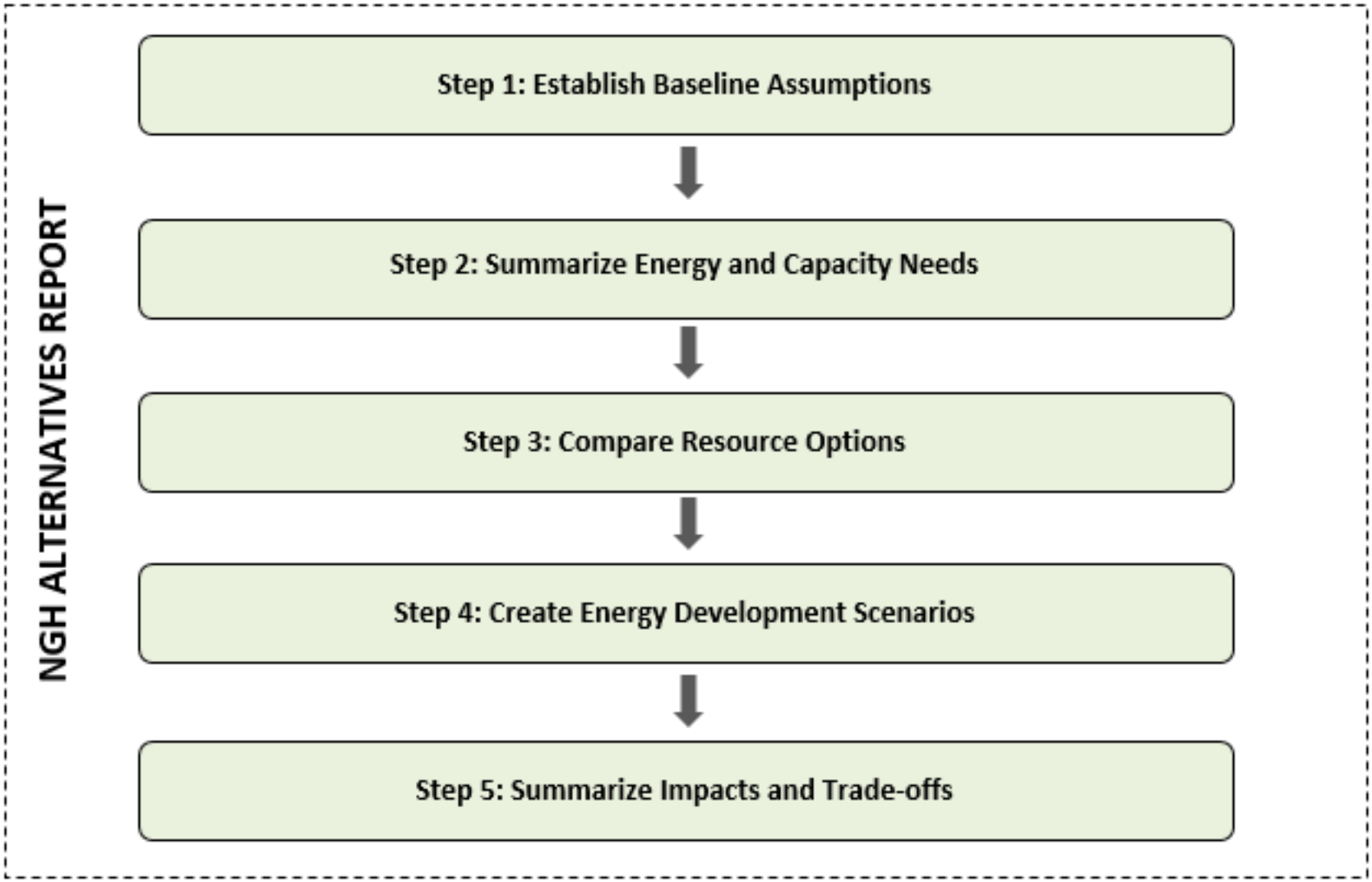
PART 2 – METHODOLOGY

Methodology

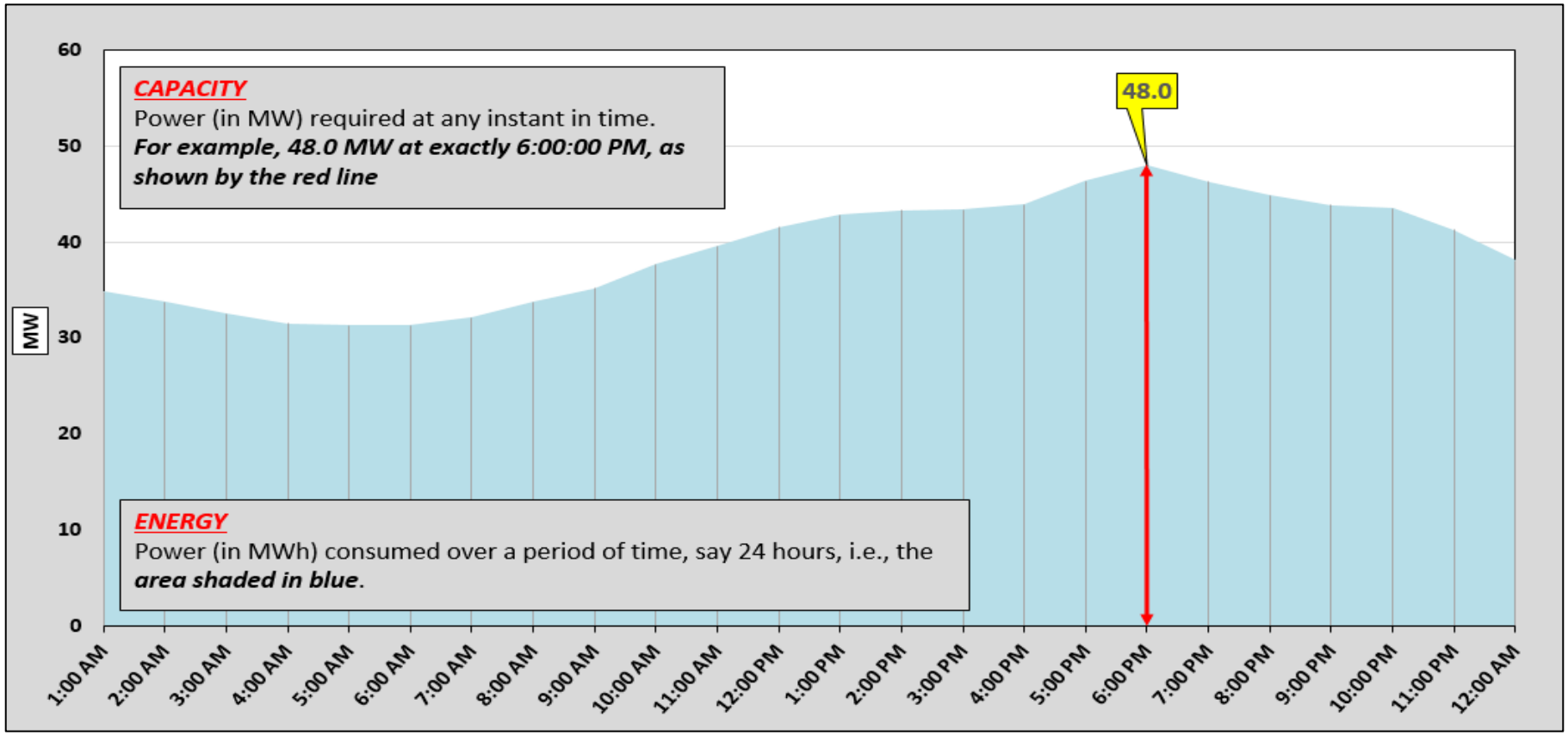


Factors of Interest

Generation resources were compared using four primary factors

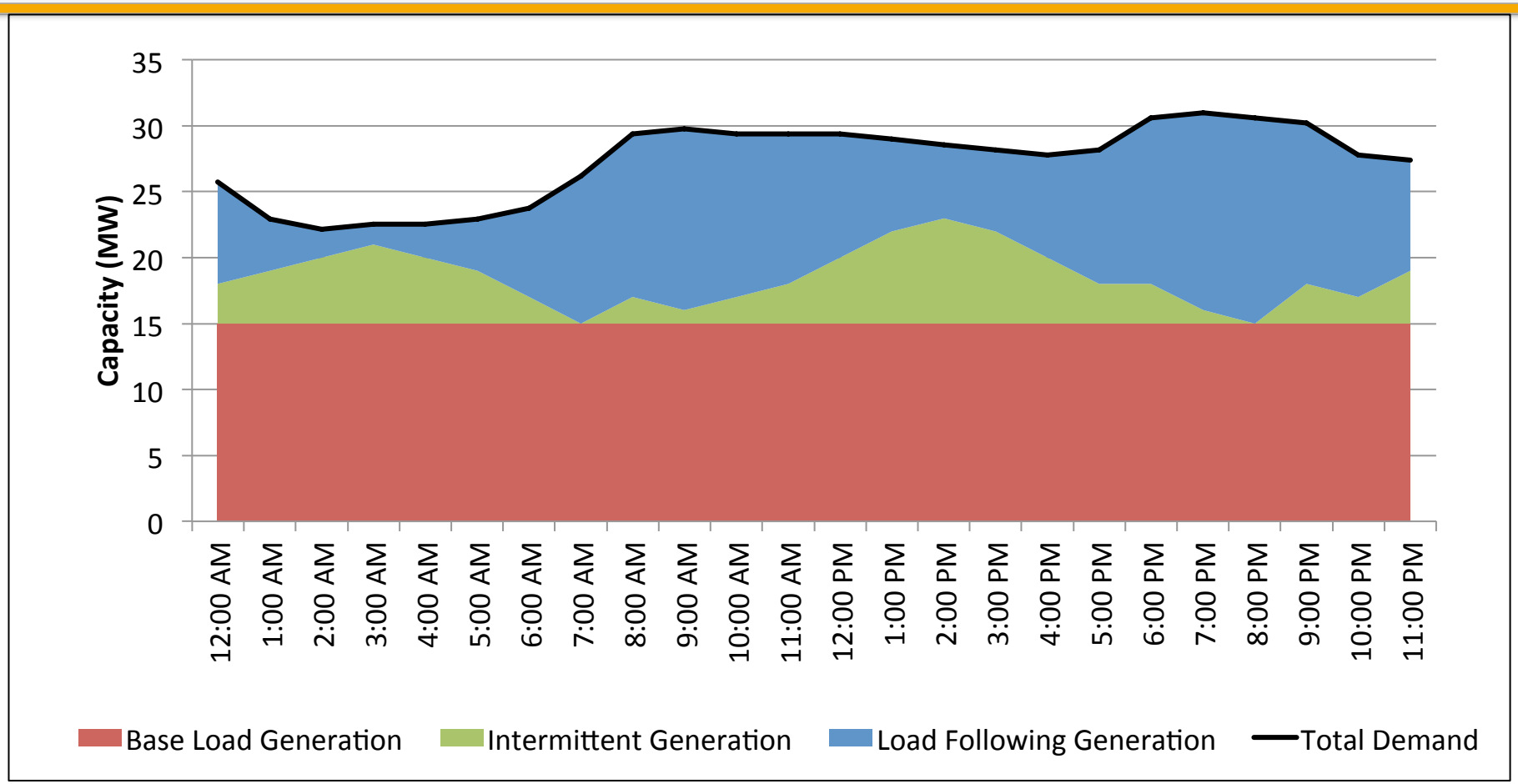
Technical	Economic	Socio-Economic	Environmental
• Energy • Capacity	• Full Utilization LCOE • Forecast Utilization LCOE	• Potential Social Impact	• Land Use Footprint • GHG Emissions

Technical Factors



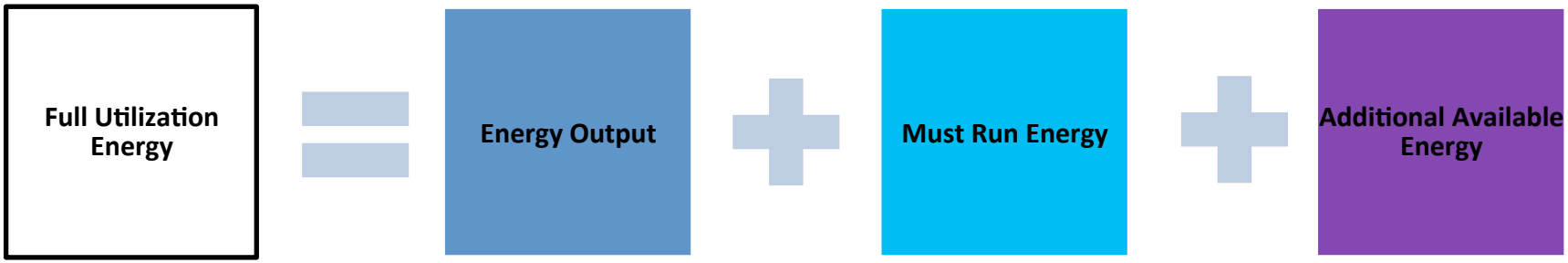
1. **Installed Capacity** represents the maximum power output
2. **Firm Capacity** represents dependable capacity at time of maximum need (e.g. Yukon winters)
3. **Energy** generated by the resource is a measure of power used over time

Technical Factors

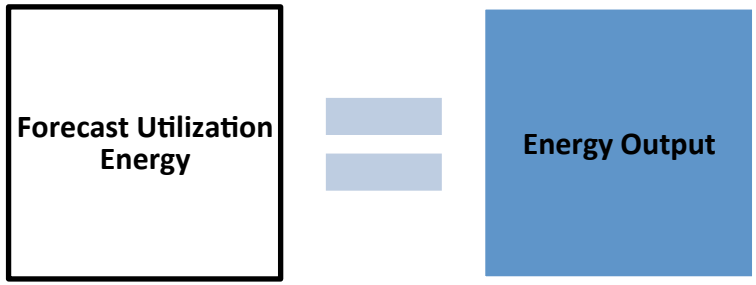


3. **Resource Type**:
   a) Renewable / Non- Renewable
   b) Firm / Intermittent

Economic Factors



Full Utilization LCOE=*Total Present Value of Costs/Total Present Value of* **Full Utilization Energy**



Forecast Utilization LCOE=*Total Present Value of Costs/Total Present Value of* **Forecast Utilization Energy**

Socio-Economic Factors

Simplified assessment of socio-economic factors:

- Potential for social acceptance assumes that concerns and negative impacts are adequately mitigated or offset by positive benefits

	Wind	Solar	Hydro	LNG	Diesel	Coal	Nuclear
Potentially socially Acceptable?	✓	✓	✓	✓	✓	X	X

Environmental Factors

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Land-Use Footprint

1. Direct Land Use: Direct footprint, Flooded area, Right of Way, etc.
2. Indirect Land Use: Transportation, laydown areas, component manufacturing, etc.

Direct Land Use	Indirect Land use
✓	X

Green House Gas (GHG) Emissions

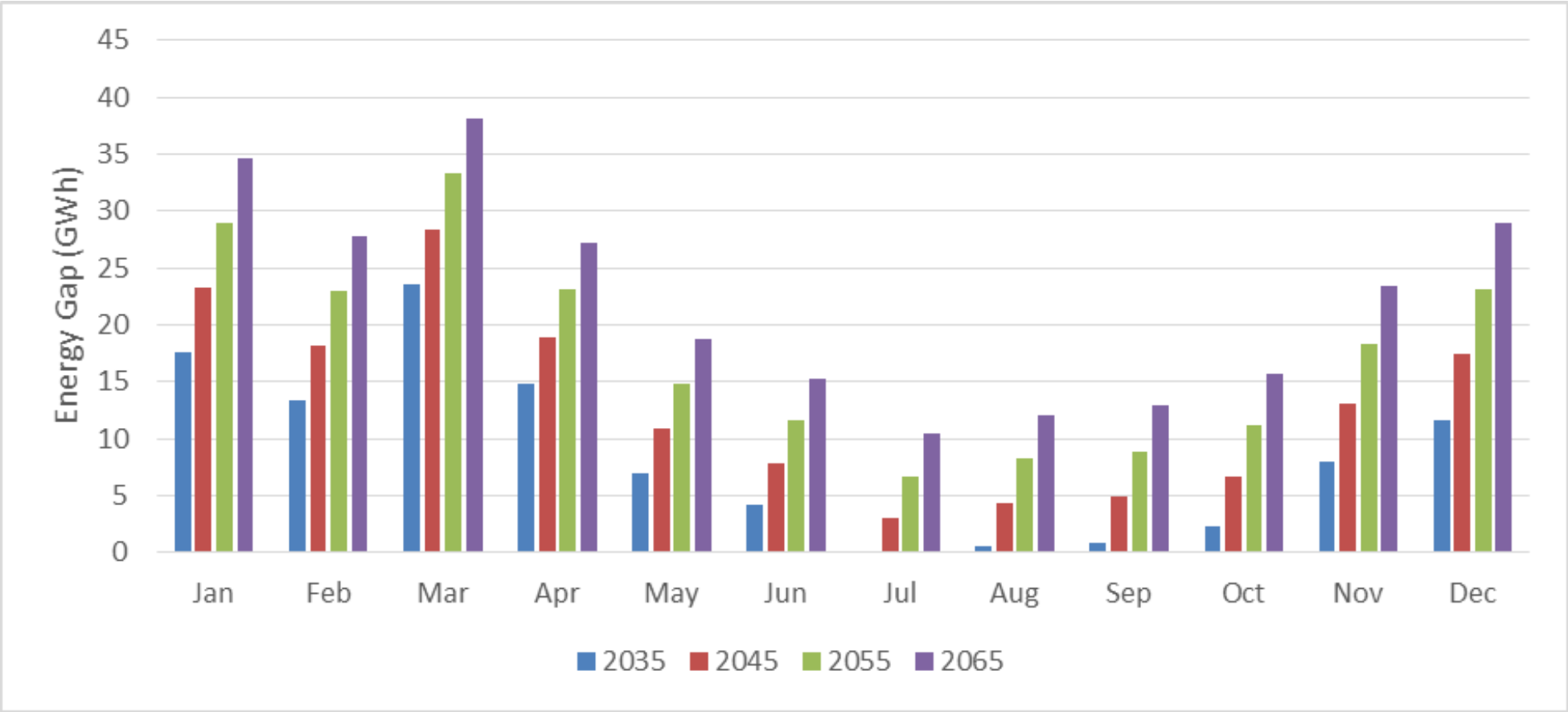
1. GHGs include *"Carbon Dioxide (CO2)"* and *"Methane (CH4)"*
2. Direct GHG Emissions: Due to electricity generation only
3. Indirect GHG Emissions: Fuel processing, component manufacturing, transportation, construction, etc.

Direct GHG Emissions	Direct GHG Emissions
✓	X

PART 3 – FORECAST YUKON ELECTRICITY DEMAND

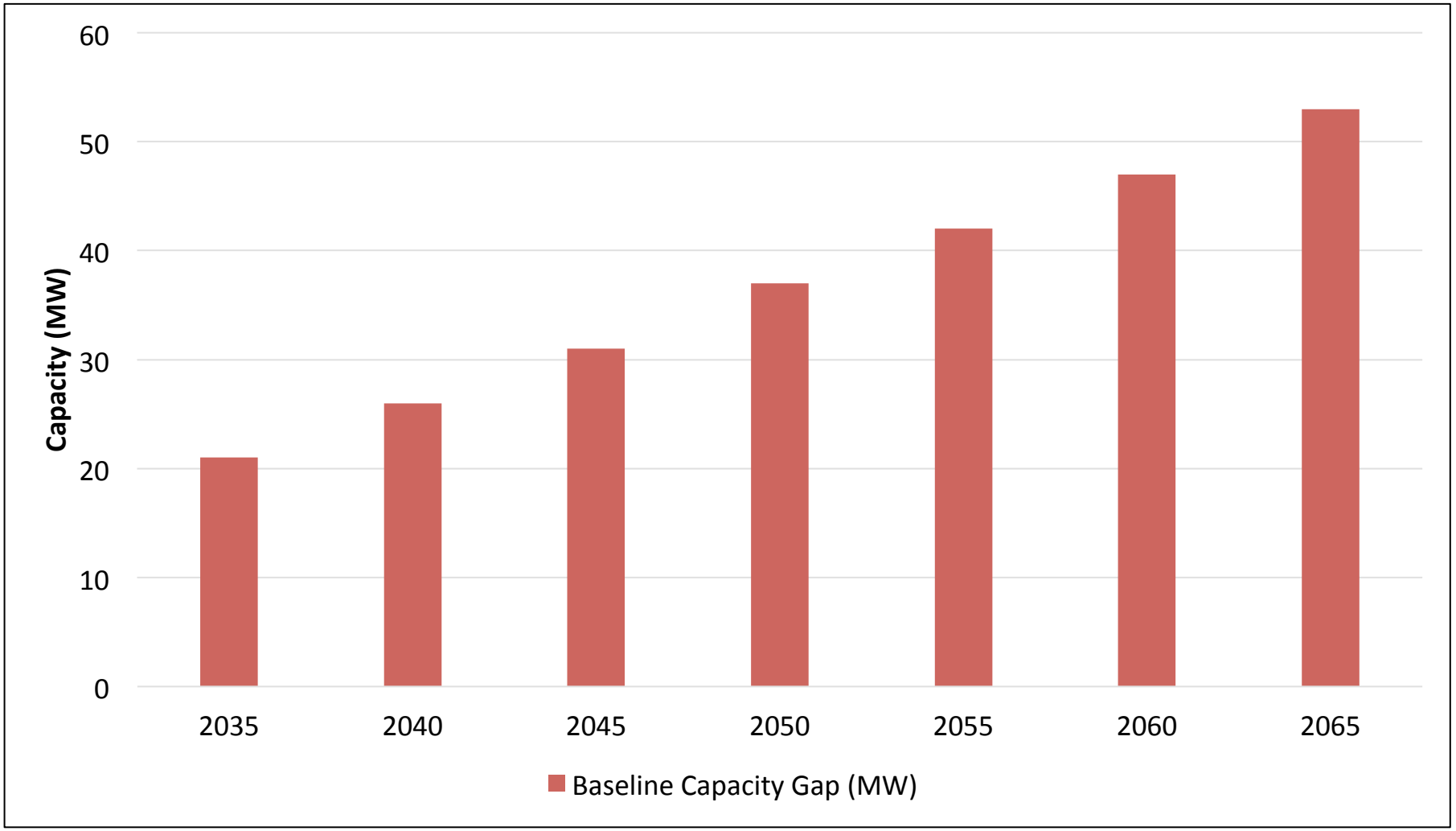
Baseline Energy Demand

1. Larger need for energy during the colder weather months of November through April
2. Lesser need for energy during the warmer months of May through October



Baseline Capacity Gap

1. Peak electricity demand in the Yukon occurs in cold winter months



Yukon Demand Summary

	Annual Energy Gap		Peak Capacity Gap	
	2035	**2065**	**2035**	**2065**
Forecast Gap	103 GWh/ Year	265 GWh/ Year	21 MW	53MW

1. **2035 Capacity Demand :**
   - One Whitehorse hydro (24 MW winter firm energy) facility is needed by 2035
2. **2065 Capacity Demand :**
   - Two Whitehorse hydro facilities and one Mayo Hydro will be needed

PART 4 – GENERATION RESOURCES

Generation Resources

Potentially acceptable resources evaluated are:

1. Wind
2. Solar Photovoltaics
3. Next Generation Hydro (“NGH”)
4. Small Hydro Storage
5. Run-of-River Hydro (“ROR”)
6. Pumped Storage Hydro (“PS”)
7. Natural Gas (“Nat Gas”)

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PART 4.1 – WIND GENERATION

Wind Generation

Converts the kinetic energy of wind into electricity using a wind turbine.

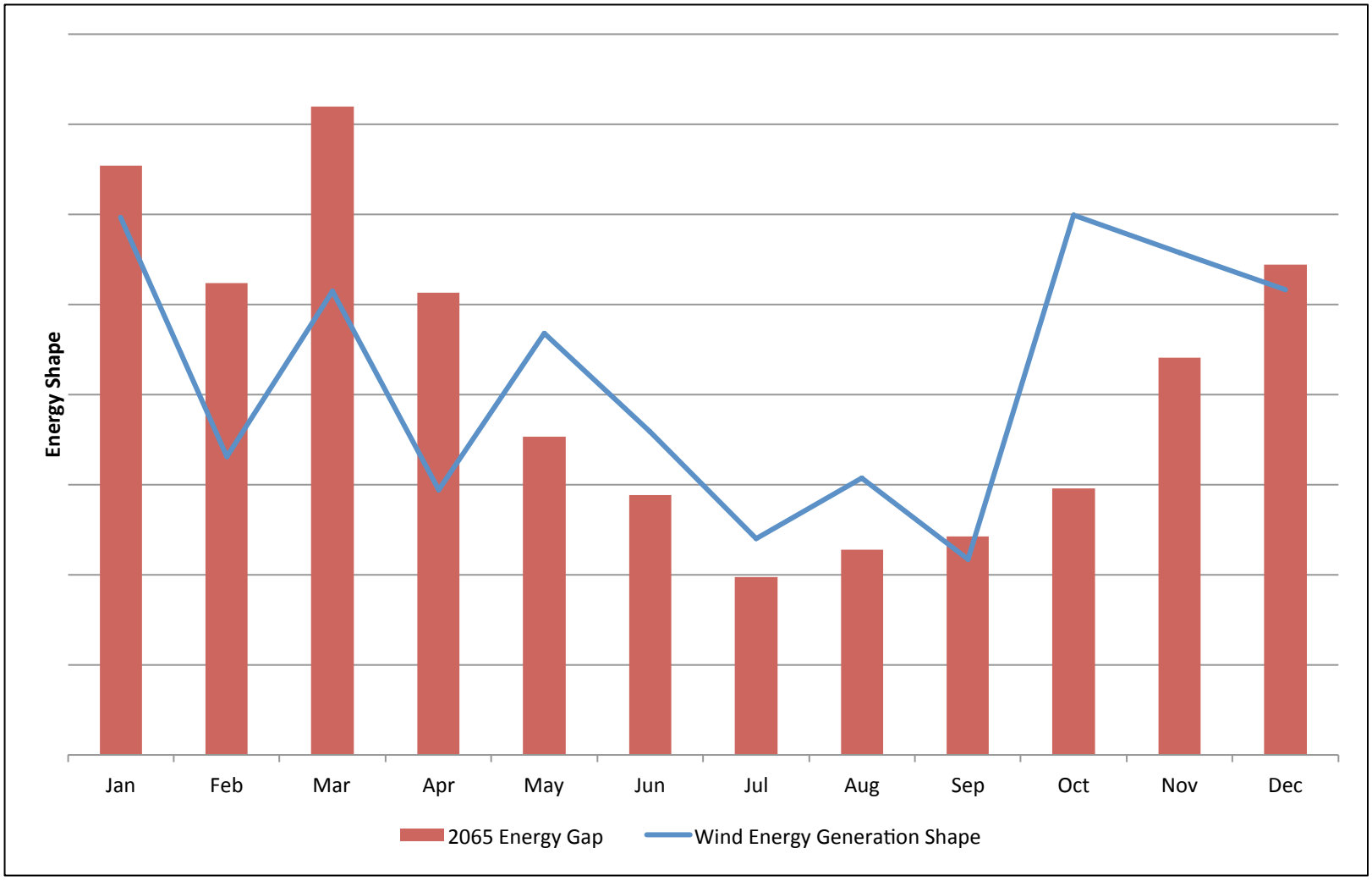
Yukon characteristics:

1. **Fuel:** Wind
2. **Energy:** Good match to Yukon demand
3. **Type**: Renewable Intermittent
4. **Installed Capacity**: 28MW in 2065 (20% of demand w/ battery support)
5. **Firm Capacity**: Zero

Wind Energy Shape

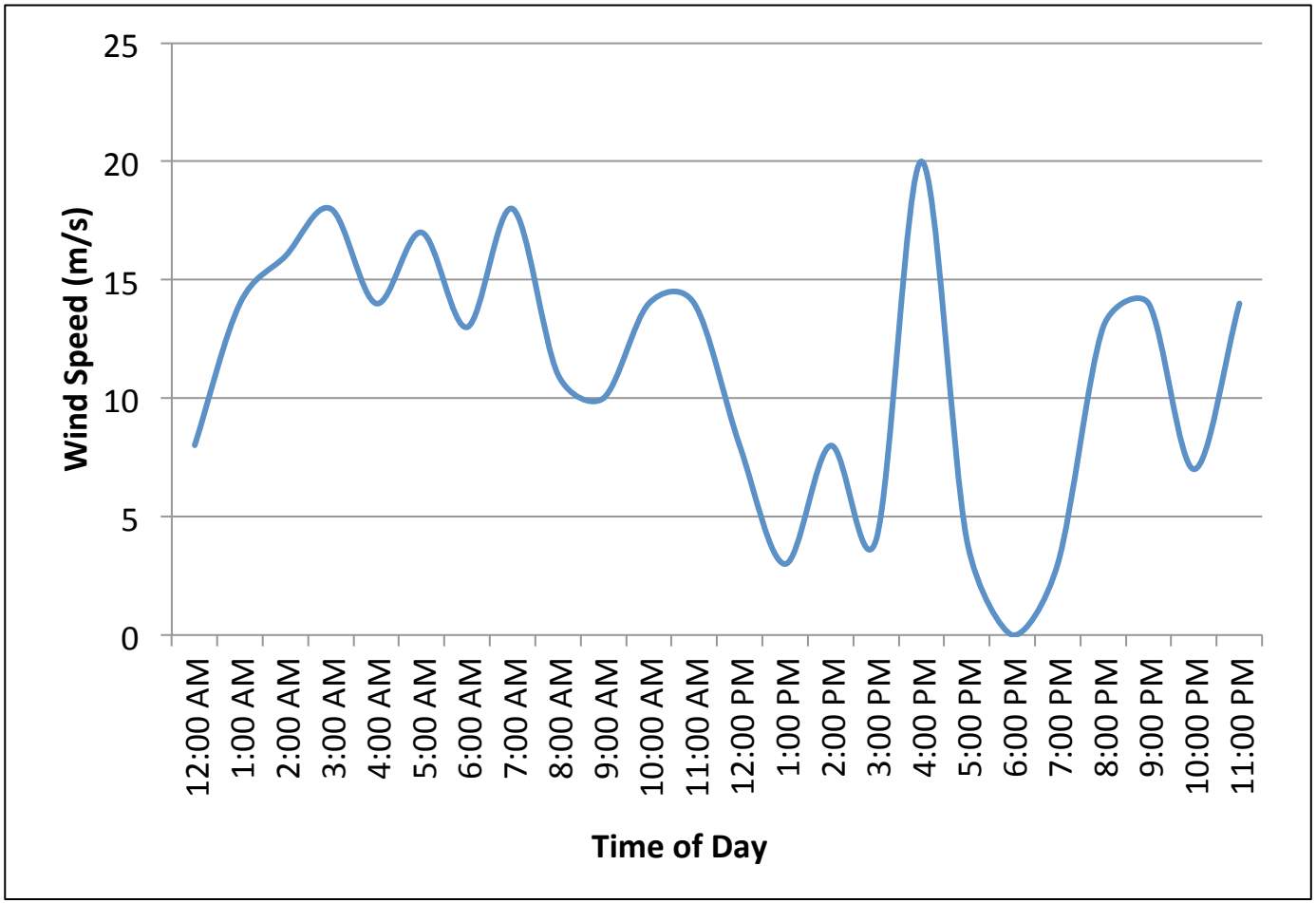
Energy: Good shape

1. Higher in winter when the demand is highest
2. Lower in summer when the demand is lower

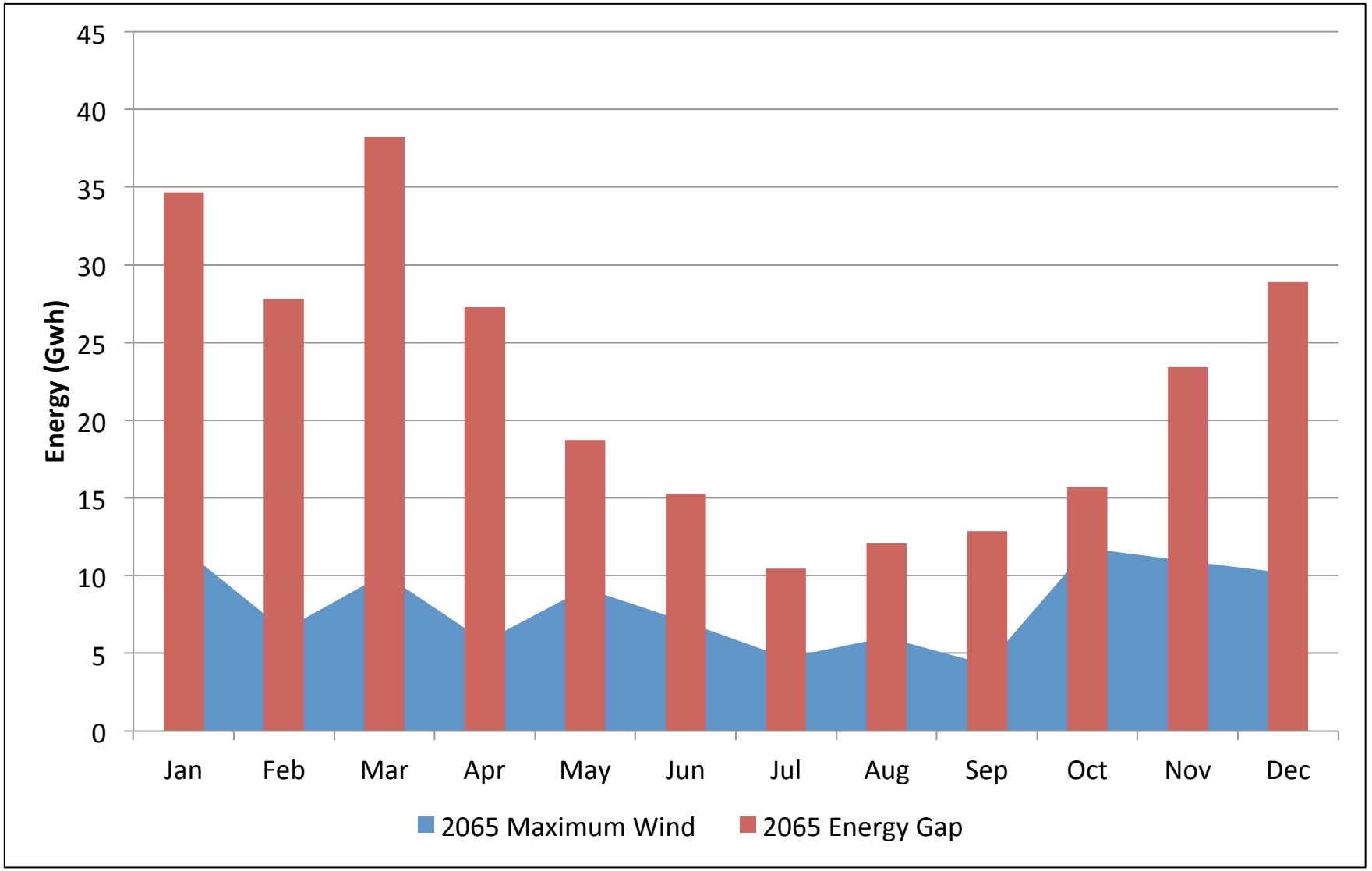


Wind Capacity

1. **Installed Capacity:** 28MW in 2065 (20% Limit w/ battery)
   a) Generation fluctuations impact grid operations
   b) Utility Scale Battery can reduce short term fluctuations
2. **Firm Capacity:** Zero



Wind: What does this mean?



- Cannot meet Yukon energy and capacity demand on a standalone basis

Wind: What does this mean?

TECHNICAL	ECONOMIC
Cannot Meet demand on a standalone basis	Turbine costs falling, but Yukon conditions will create a cost floor
ENVIRONMENTAL	**ENVIRONMENTAL**
Low land-use footprint	Zero GHGs

Wind Generation Summary

	Technical			Economic	Socio-Economic	Environmental	
	Max. 2065 Energy (GWh /year)	Max. 2065 Installed Capacity (MW)	Max. 2065 Firm Capacity (MW)	Full Utilization LCOE ($/ MWh)	Social Impact	Land-Use Footprint (hectares /MW)	Production GHG Emissions (gCO_2e /kWh)
Without Battery Storage	65	21	0	157	✓	36 ± 22	0
With Battery Storage	88	28	0	192	✓	36 ± 22	0

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PART 4.2 – SOLAR GENERATION

Solar Generation

Solar technologies use the sun's energy to generate electricity

- e.g. photovoltaic ("PV") panels

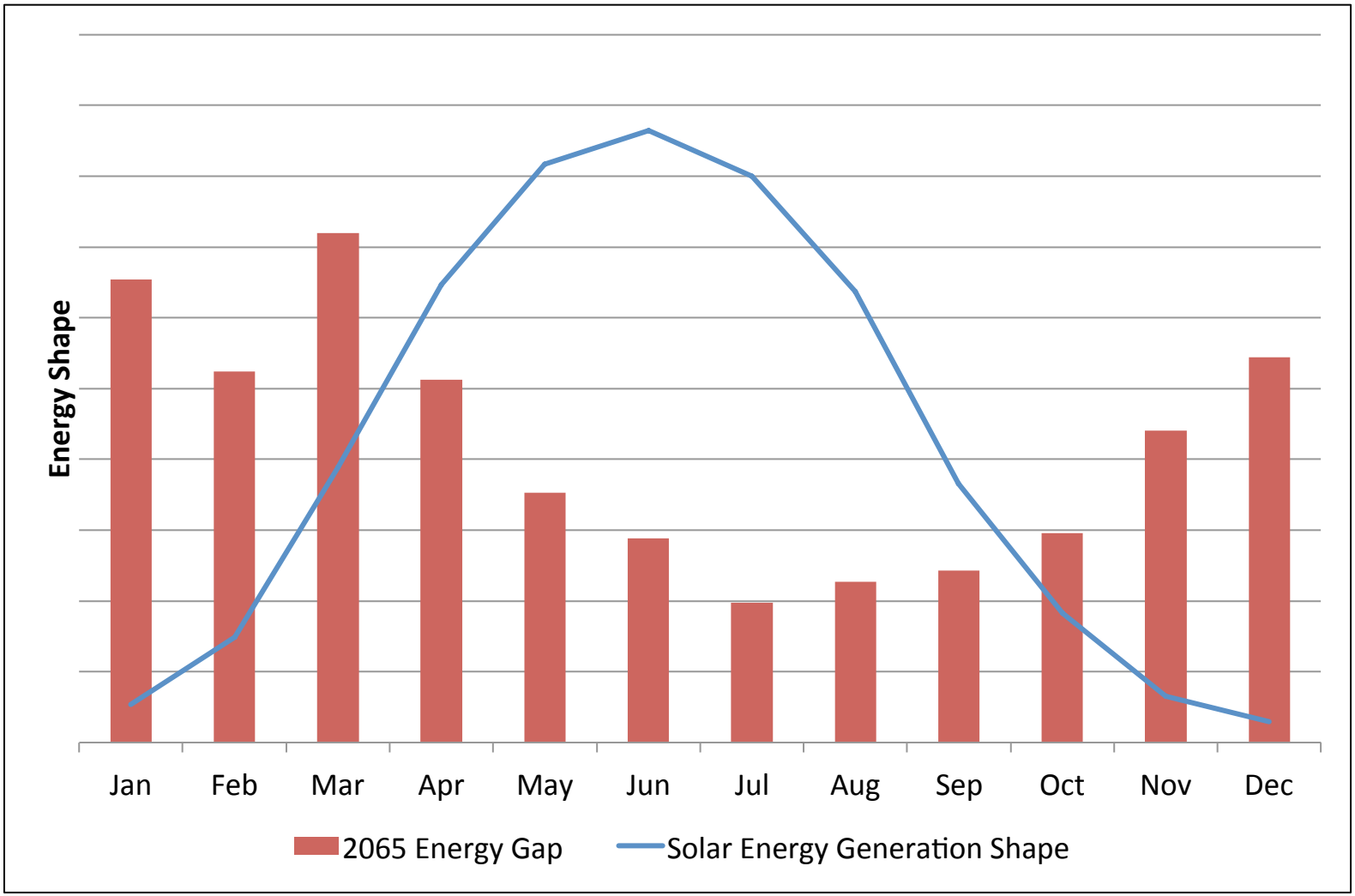
Yukon characteristics:

1. **Fuel:** Solar Radiation
2. **Energy:** Not ideal match
3. **Type**: Renewable Intermittent
4. **Installed Capacity**: 14MW in 2065 (10% of demand)
5. **Firm Capacity**: Zero

Solar Energy

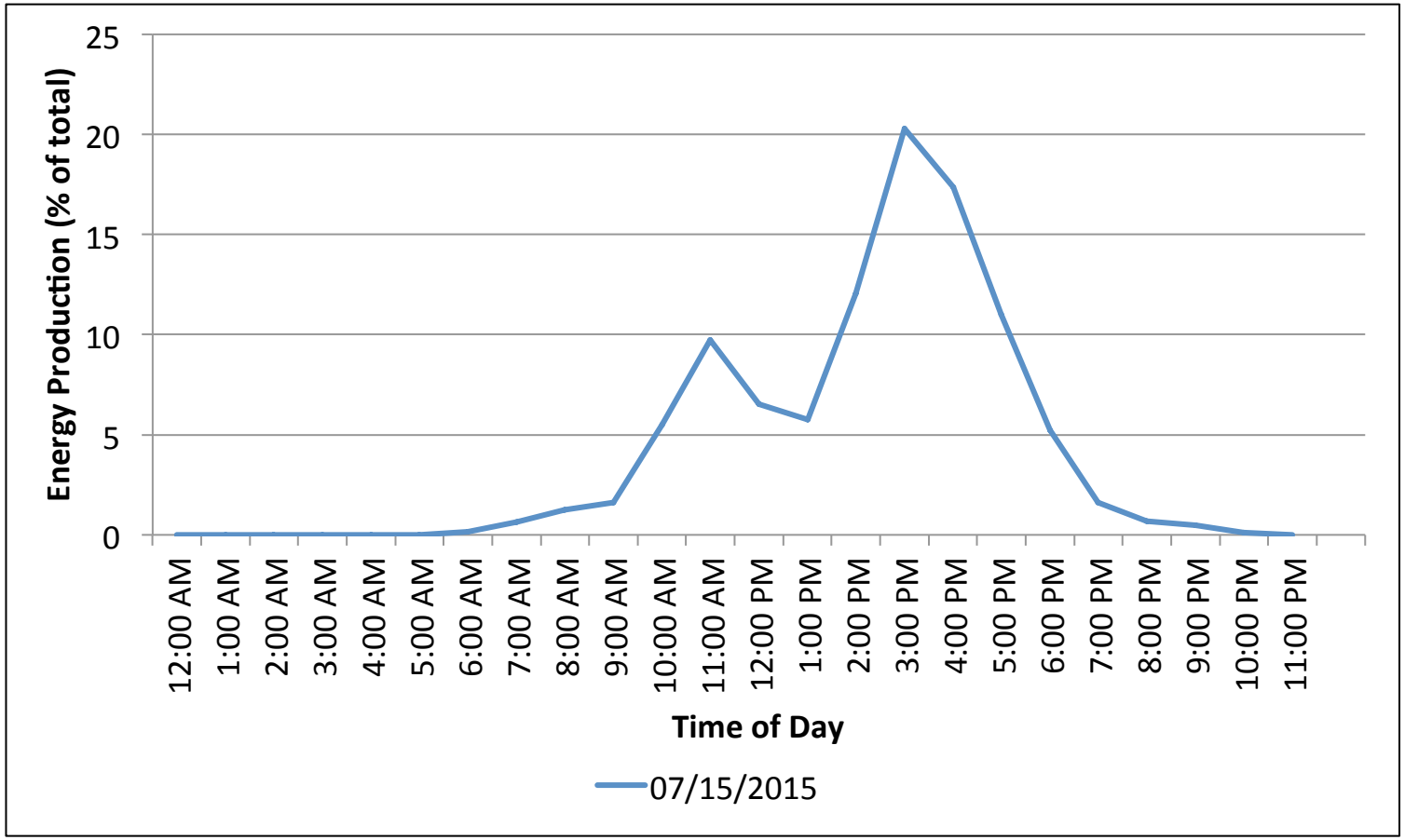
Energy: Not ideal shape

1. Lower winter generation (but some March/April)
2. Higher summer generation

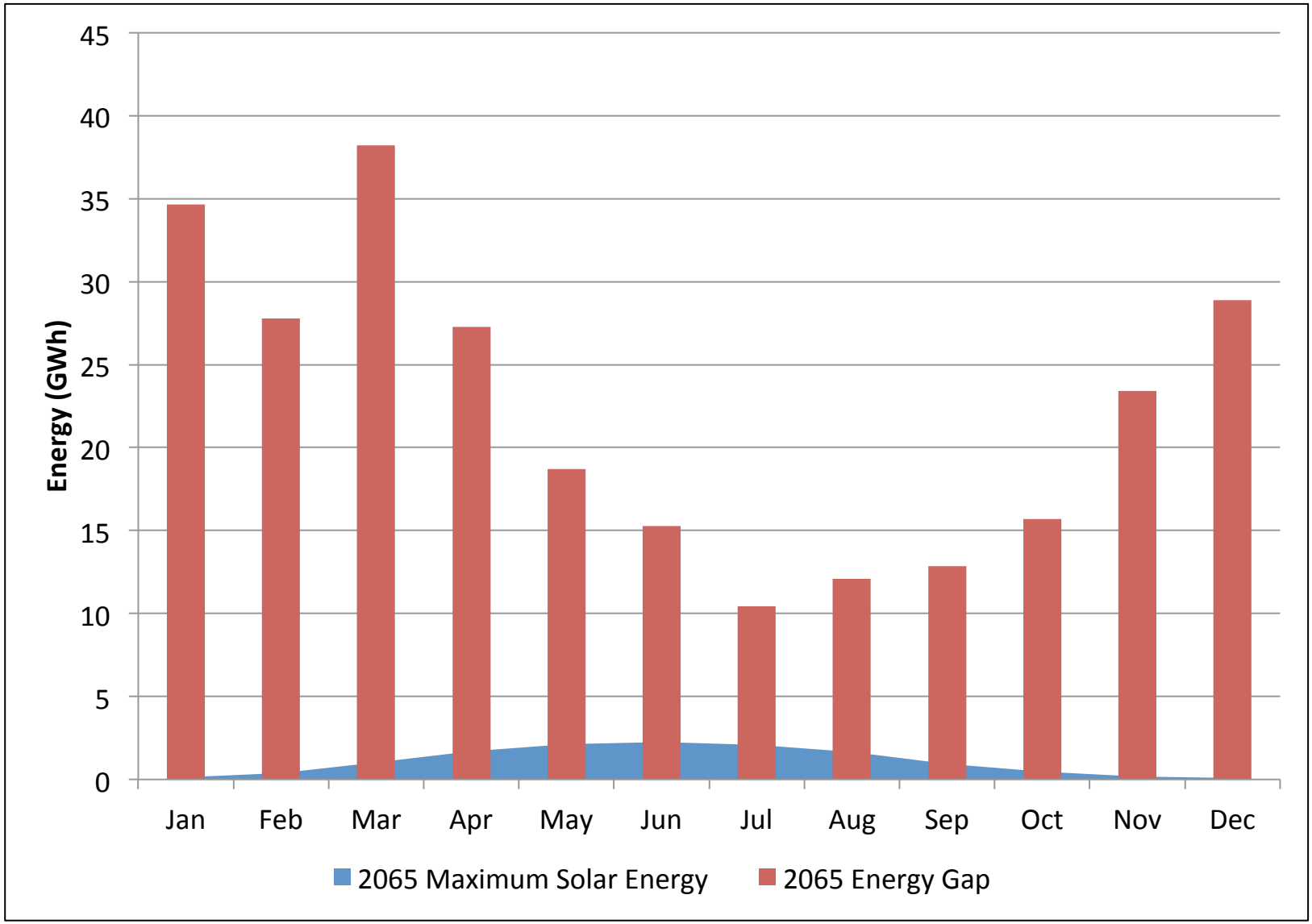


Solar Capacity

1. Generation limited by sunlight and weather conditions
    a) Daylight hours only
    b) Weather dependent (e.g. clouds, frost, snow)
2. **Installed Capacity**: 14MW in 2065 (10% Limit)
3. **Firm Capacity**: Zero



Solar: What does this mean?



- Cannot meet Yukon energy and capacity demand on a standalone basis

Solar: What does this mean?

TECHNICAL	ECONOMIC
Cannot meet Yukon demand on a standalone basis	Solar panel costs falling, but Yukon conditions will create a cost floor
ENVIRONMENTAL	**ENVIRONMENTAL**
Low land-use footprint	Zero GHGs

Solar Generation Summary

Technical			Economic	Socio-Economic	Environmental	
Max. 2065 Energy (GWh/year)	Max. 2065 Installed Capacity (MW)	Max. 2065 Firm Capacity (MW)	Full Utilization LCOE ($/MWh)	Social Impact	Land-Use Footprint (hectares /MW)	Production GHG Emissions (gCO_2e /kWh)
13	14	0	192	✓	0-3.5	0

PART 4.3 – NEXT GENERATION HYDRO (LARGER HYDRO W/ STORAGE)

Next Generation Hydro (NGH)

Hydroelectricity is generated from the gravitational force of falling or flowing water.

Yukon characteristics:

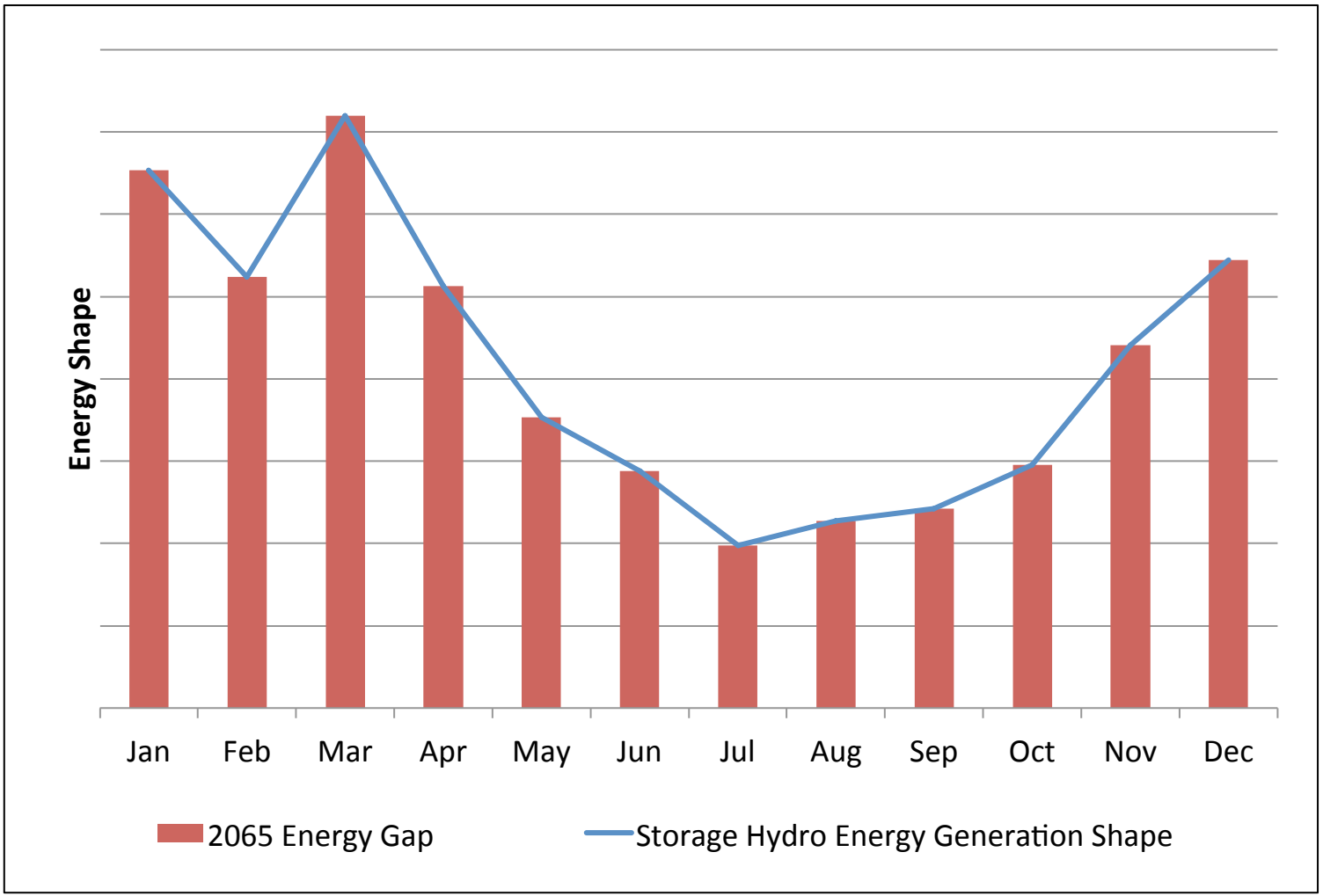
1. **Fuel:** Stored Water
2. **Energy:** Excellent Match to Demand
3. **Type**: Renewable Firm
4. **Installed Capacity**: 57MW in 2065
5. **Firm Capacity**: 57MW in 2065

*Capacity expandable to 90-107MW as required

NGH Energy Shape

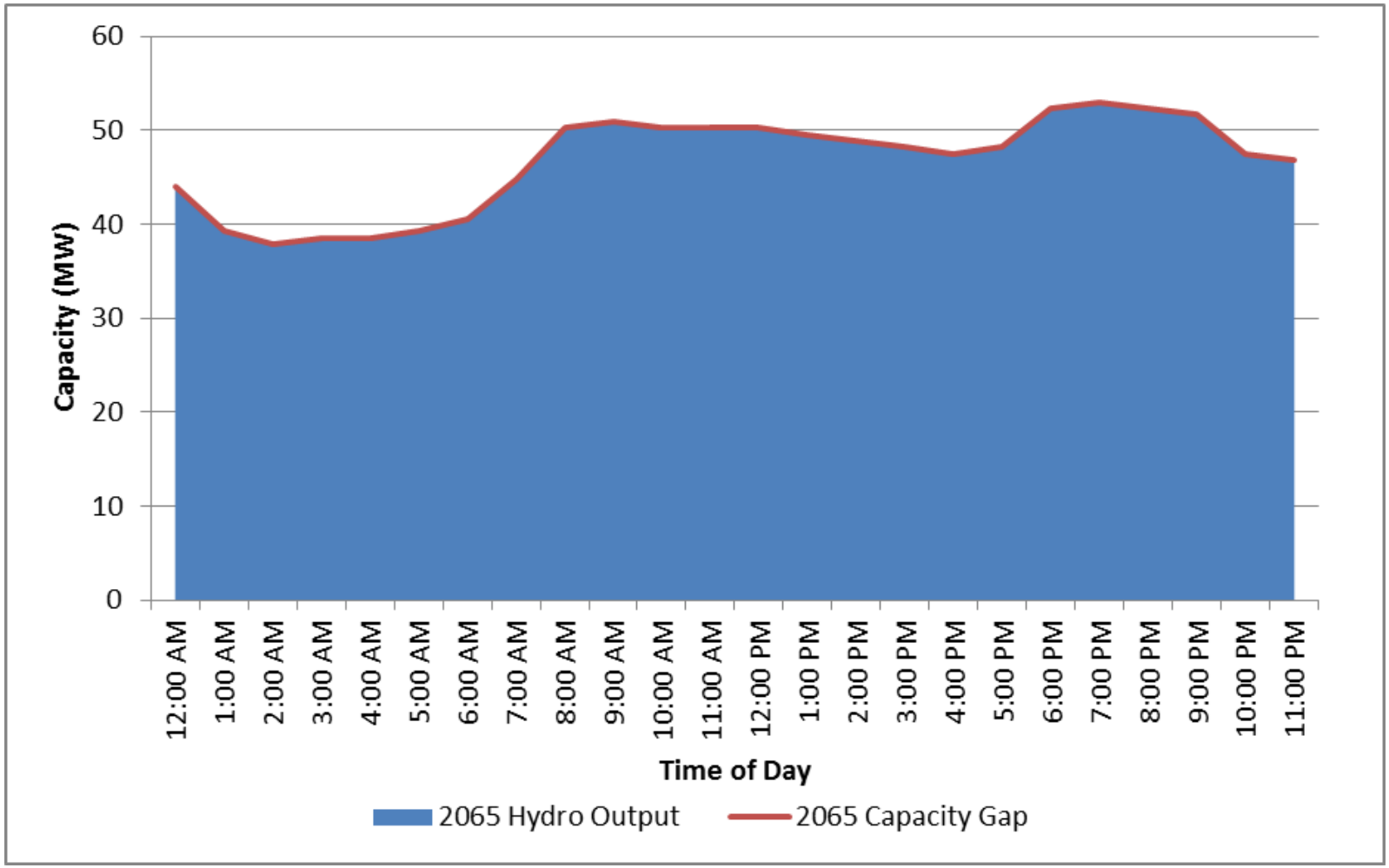
Energy: Generation matches demand using stored water (fuel)

1. Satisfies annual energy demand
2. Satisfies winter energy demand
3. Surplus summer water stored for winter use and/or spilled

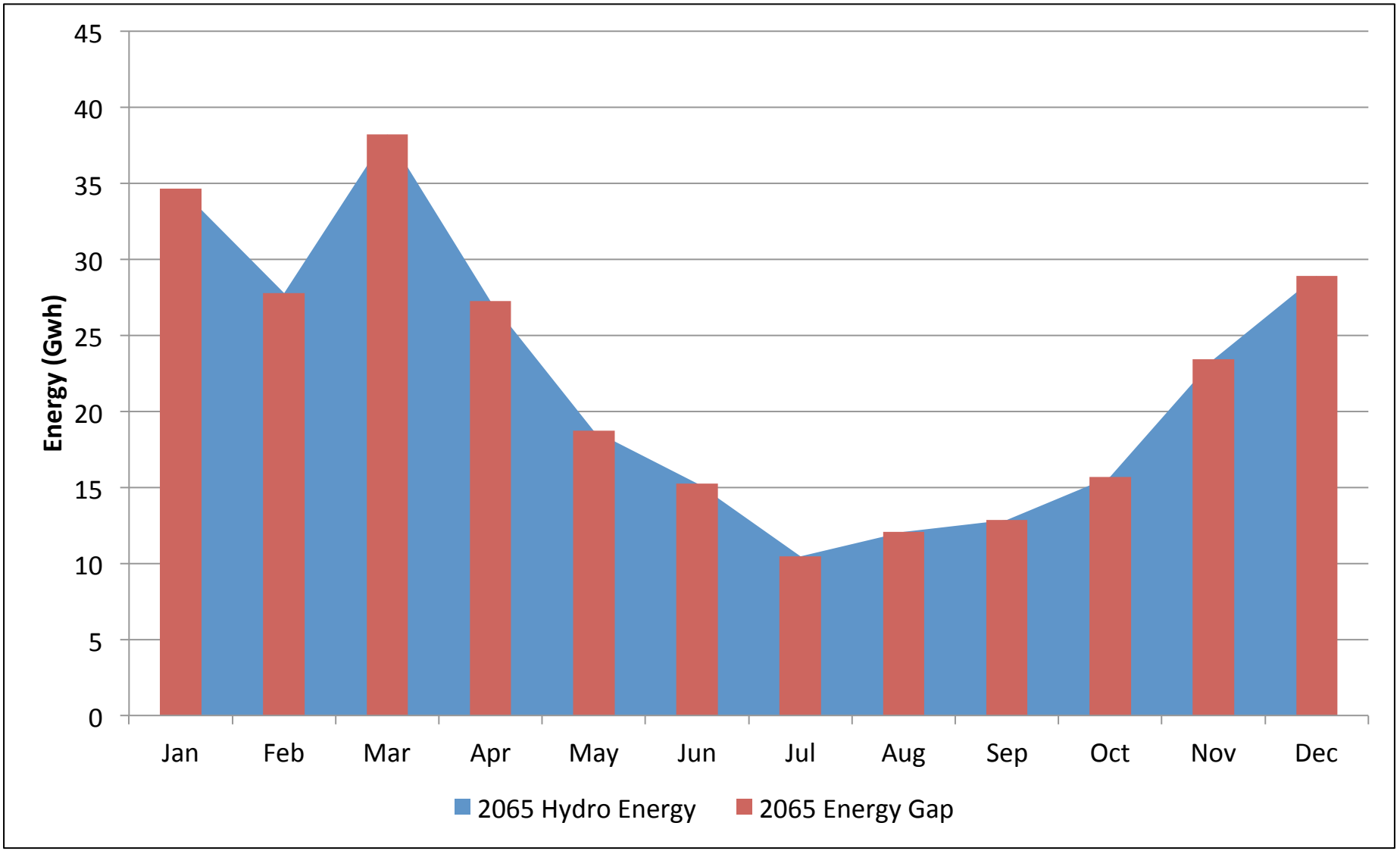


NGH Capacity

1. **Installed Capacity**: 57MW in 2065 (expandable to 90-107MW)
2. **Firm Capacity**: 57MW in 2065 (expandable)



NGH: What does this mean?



- Meets Yukon energy and capacity demand on a standalone basis

NGH: What does this mean?

TECHNICAL	ECONOMIC
Meets Yukon demand on a standalone basis	Large capital investment but low operating cost
ENVIRONMENTAL	**ENVIRONMENTAL**
High land-use footprint (e.g. reservoir	Zero GHGs

NGH Generation Summary

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Technical			Economic	Socio-Economic	Environmental	
Max. 2065 Energy (GWh /year)	Max. 2065 Installed Capacity (MW)	Max. 2065 Firm Capacity (MW)	Full Utilization LCOE ($/ MWh)	Social Impact	Land-Use Footprint (hectares /MW)	Production GHG Emissions (gCO_2e /kWh)
557	57	57	92	✓	313 (Range: 187–545)	0

PART 4.4 – SMALL HYDRO STORAGE GENERATION

Small Hydro with Storage

Small hydro storage projects (<15MW) are the same in principal as NGH, but on a smaller scale

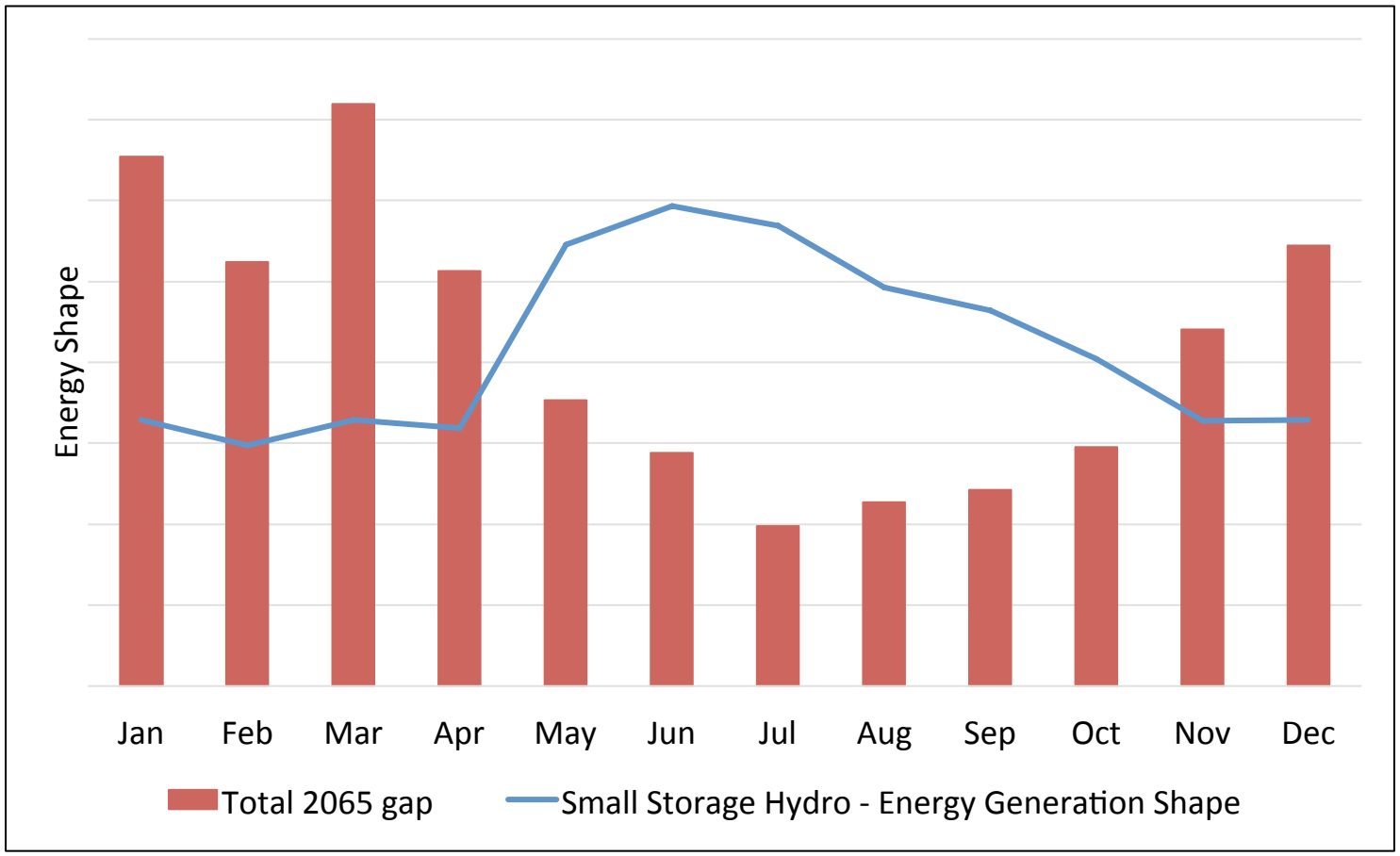
Yukon characteristics:

1. **Fuel:** Stored Water
2. **Energy**: Fair Match To Demand
3. **Type**: Renewable firm
4. **Installed Capacity**: 6.5MW/ project
5. **Firm Capacity**: 4.2MW/project

Small Hydro Storage Energy

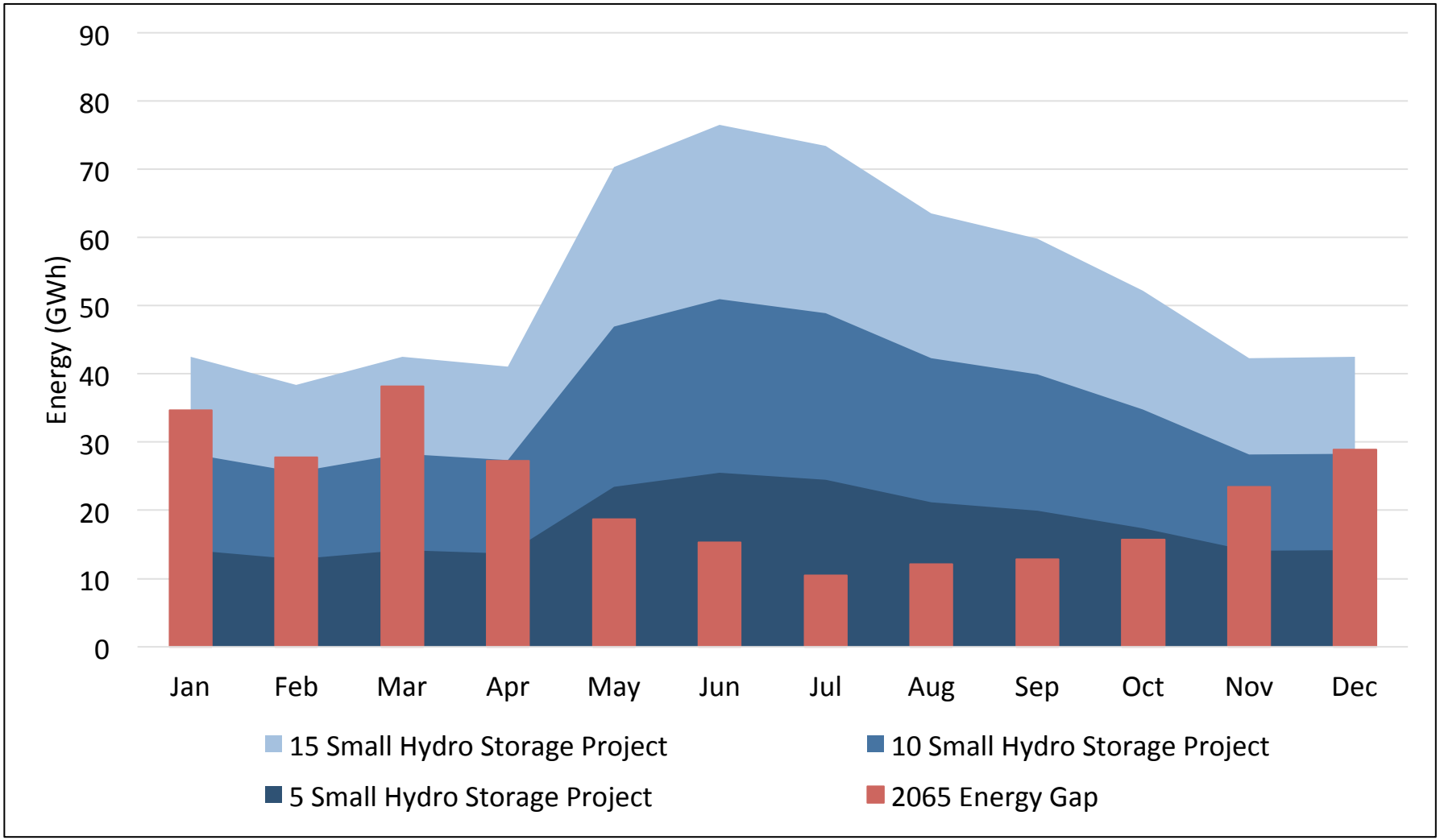
Energy: Fair Match using stored water (fuel)

1. Provides firm winter energy
2. Surplus summer water stored for winter use and spilled
3. Annual energy: 43 GWh/project



Small Hydro Storage Capacity

1. **Installed Capacity**: 6.5MW/project
2. **Firm Capacity**: 4.2MW/project
3. Requires multiple (14-ish) projects to meet demand



Small Hydro Storage

TECHNICAL	ECONOMIC
Cannot meet Yukon demand on a standalone basis	Limited number of projects close to the grid / long transmission lines
ENVIRONMENTAL	**ENVIRONMENTAL**
Use of pre-existing water bodies (e.g. lakes)	Zero GHGs

Small Hydro Storage Summary

Technical			Economic	Socio-Economic	Environmental	
Typical Installed Capacity (MW / project)	Typical Firm Capacity (MW / project)	Typical Annual Energy (GWh / project)	Full Utilization LCOE ($/ MWh)	Social Impact	Land-Use Footprint (hectares /MW)	Production GHG Emissions (gCO_2e /kWh)
6.5	4.2	43	126+	✓	390 (Median)	0

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PART 4.5 – RUN-OF-RIVER HYDRO GENERATION

Run of River (ROR) Generation

Hydroelectric facilities without water storage

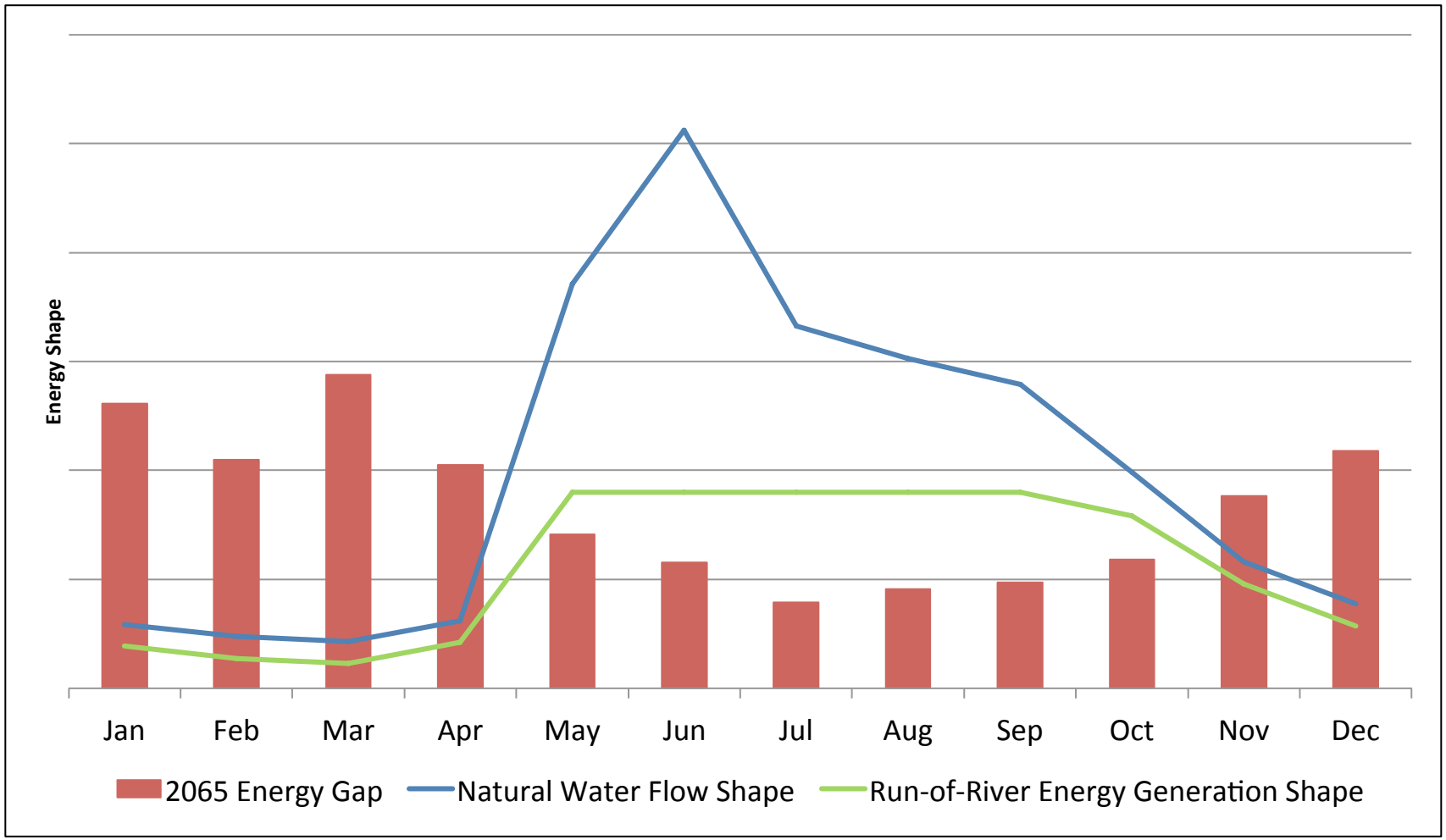
Yukon characteristics:

1. **Fuel:** Natural River Flows
2. **Energy**: Poor Match To Demand
3. **Type**: Renewable intermittent
4. **Installed Capacity**: 4.7MW project
5. **Firm Capacity**: 0.6MW/ project

ROR Energy Shape

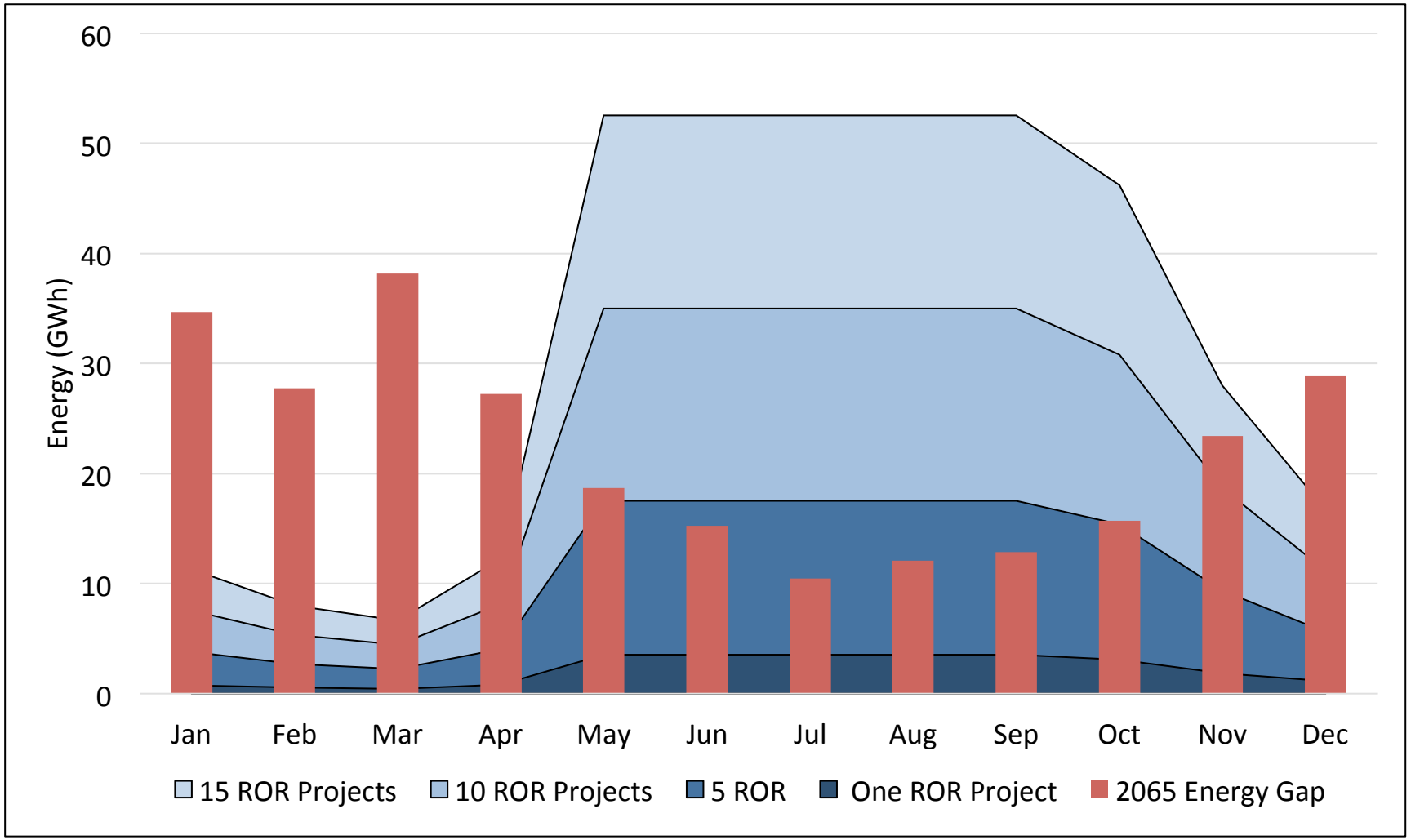
Energy: Poor generation shape

1. Higher generation in spring/summer freshet
2. Lower generation in winter months
3. Annual Energy: 23.4 GWh/project



ROR Capacity

1. **Installed Capacity**: 4.7MW per project
2. **Firm Capacity**: 0.6MW per project
3. Require over 80 projects to meet Yukon demand



ROR: What does this mean?

TECHNICAL	ECONOMIC
Cannot meet Yukon demand on a standalone basis	Expensive source of winter energy and capacity
ENVIRONMENTAL	**ENVIRONMENTAL**
Low land-use footprint	Zero GHGs

RoR Hydro Generation Summary

Technical			Economic	Socio-Economic	Environmental	
Typical Installed Capacity (MW /project)	Typical Firm Capacity (MW/ project)	Typical Annual Energy (GWh /project)	Full Utilization LCOE ($/ MWh)	Social Impact	Land-Use Footprint (hectares /MW)	Production GHG Emissions (gCO_2e /kWh)
4.7	0.6	23.4	116+	✓	≈11	0

PART 4.6 – PUMPED STORAGE HYDRO GENERATION

Pumped Storage Hydro (PSH)

Hydroelectric with two (2) modes of operation:

a) Pumping mode
b) Generation mode

Net consumer of energy

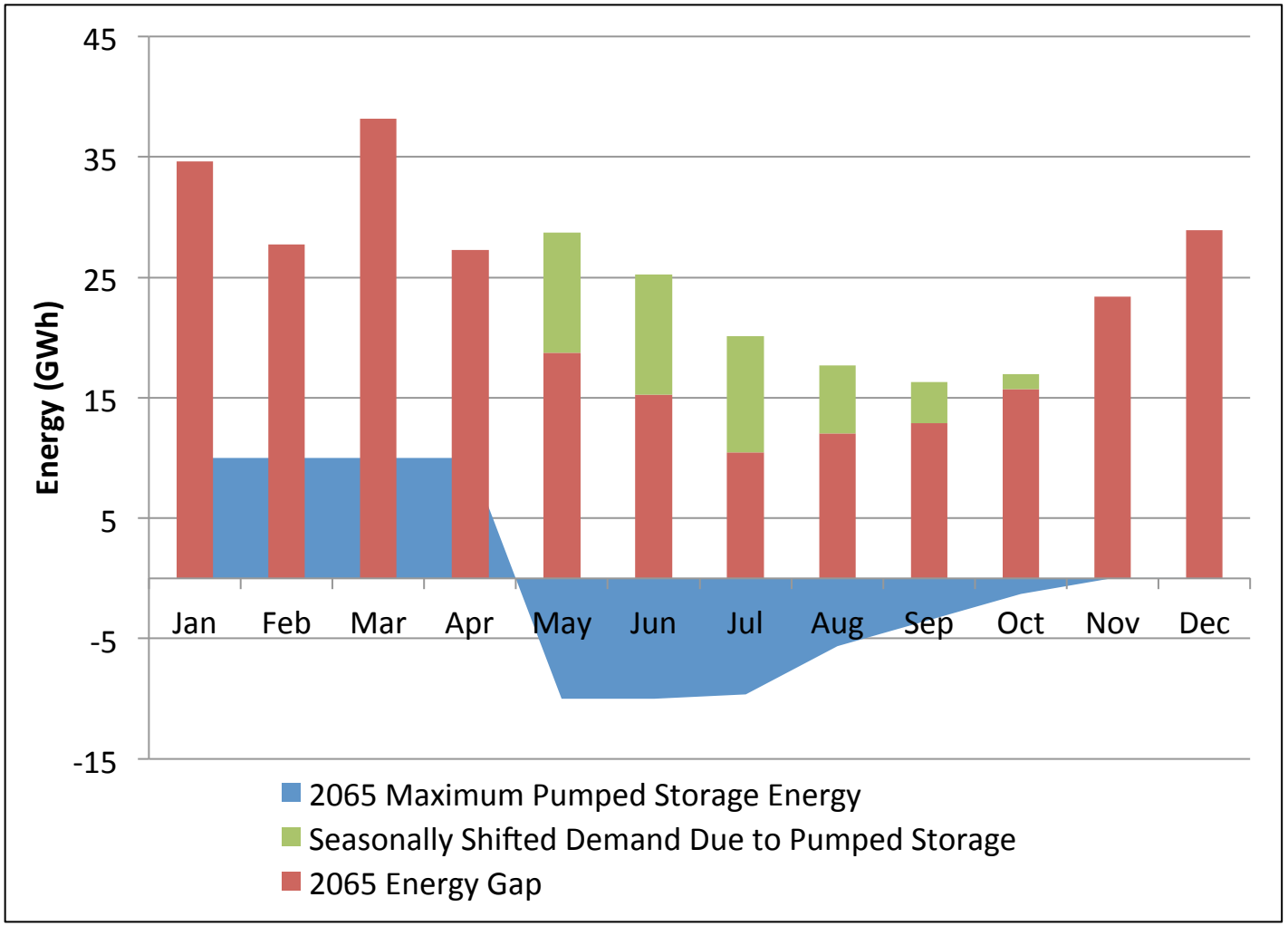
Yukon characteristics:

1. **Fuel**: Stored Water
2. **Energy**: Excellent Match To Demand
3. **Type**: Renewable Firm
4. **Installed Capacity**: 20MW (1 Project)
5. **Firm Capacity**: 20 MW

Pumped Storage Energy

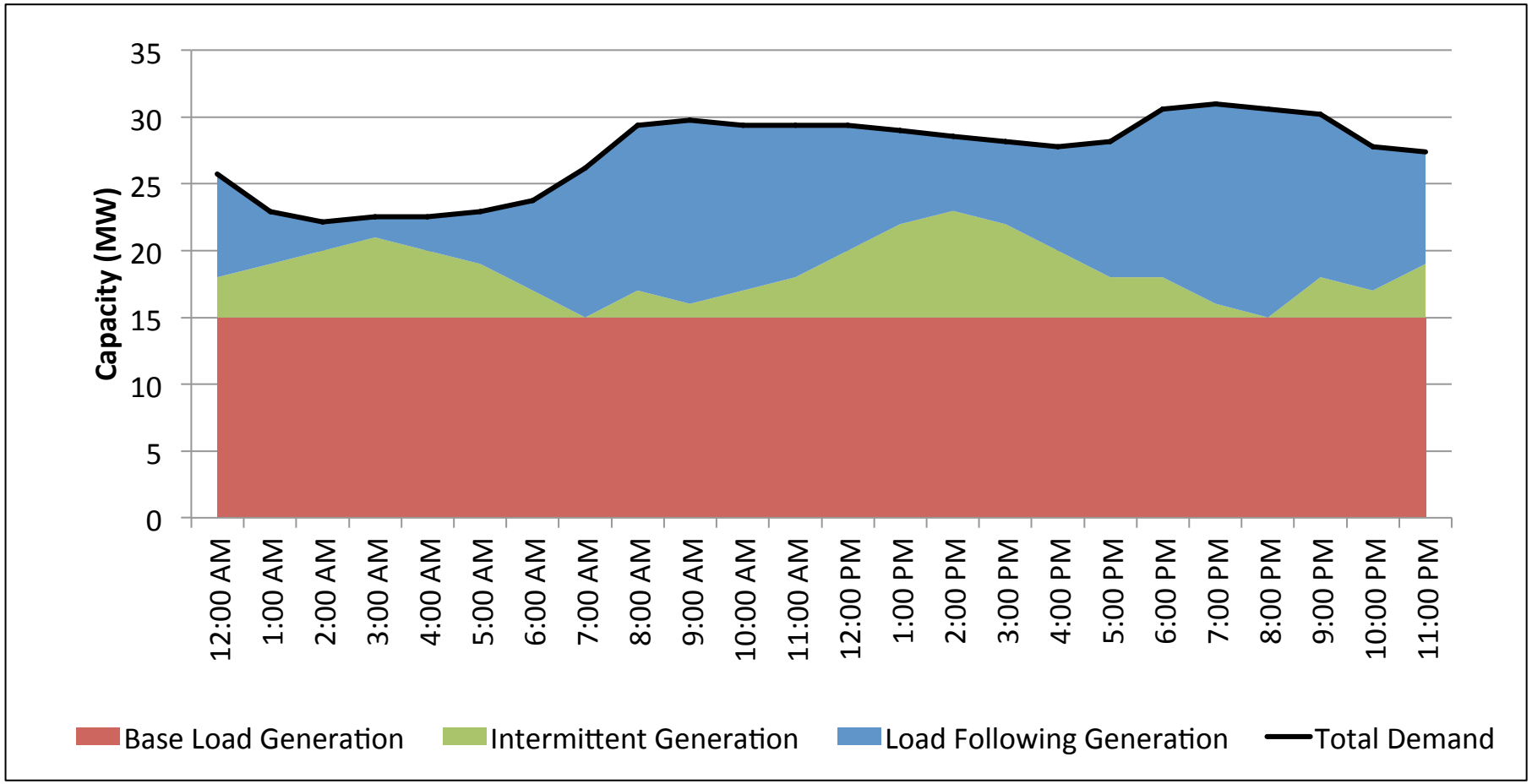
Energy: Net consumer of energy. Shifts energy temporally

1. Stores surplus summer energy as water (fuel) in an upper reservoir for use in the winter
2. 80% efficient (e.g. 50GWh summer -> 40 GWh winter)



Pumped Storage Capacity

1. **Installed Capacity**: 20MW
2. **Firm Capacity**: 20MW
3. Enables intermittent renewables (e.g. wind, solar, ROR)



PSH: What does this mean?

TECHNICAL	ECONOMIC
Cannot meet Yukon demand on a standalone	High cost generation asset, but value is in enabling renewable generation
ENVIRONMENTAL	**ENVIRONMENTAL**
Medium land-use footprint	Zero GHGs

Pumped Storage Hydro Summary

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Technical			Economic	Socio-Economic	Environmental	
Max. 2065 Energy (GWh /year)	Max. 2065 Installed Capacity (MW)	Max. 2065 Firm Capacity (MW)	Full Utilization LCOE ($/ MWh)	Social Impact	Land-Use Footprint (hectares /MW)	Production GHG Emissions (gCO_2e /kWh)
-10	20	20	183	✓	145	0

PART 4.7 – NATURAL GAS GENERATION

Natural Gas Generation

Combusts natural gas to generate electricity in a reciprocating engine, simple cycle gas turbine, or combined cycle gas turbine.

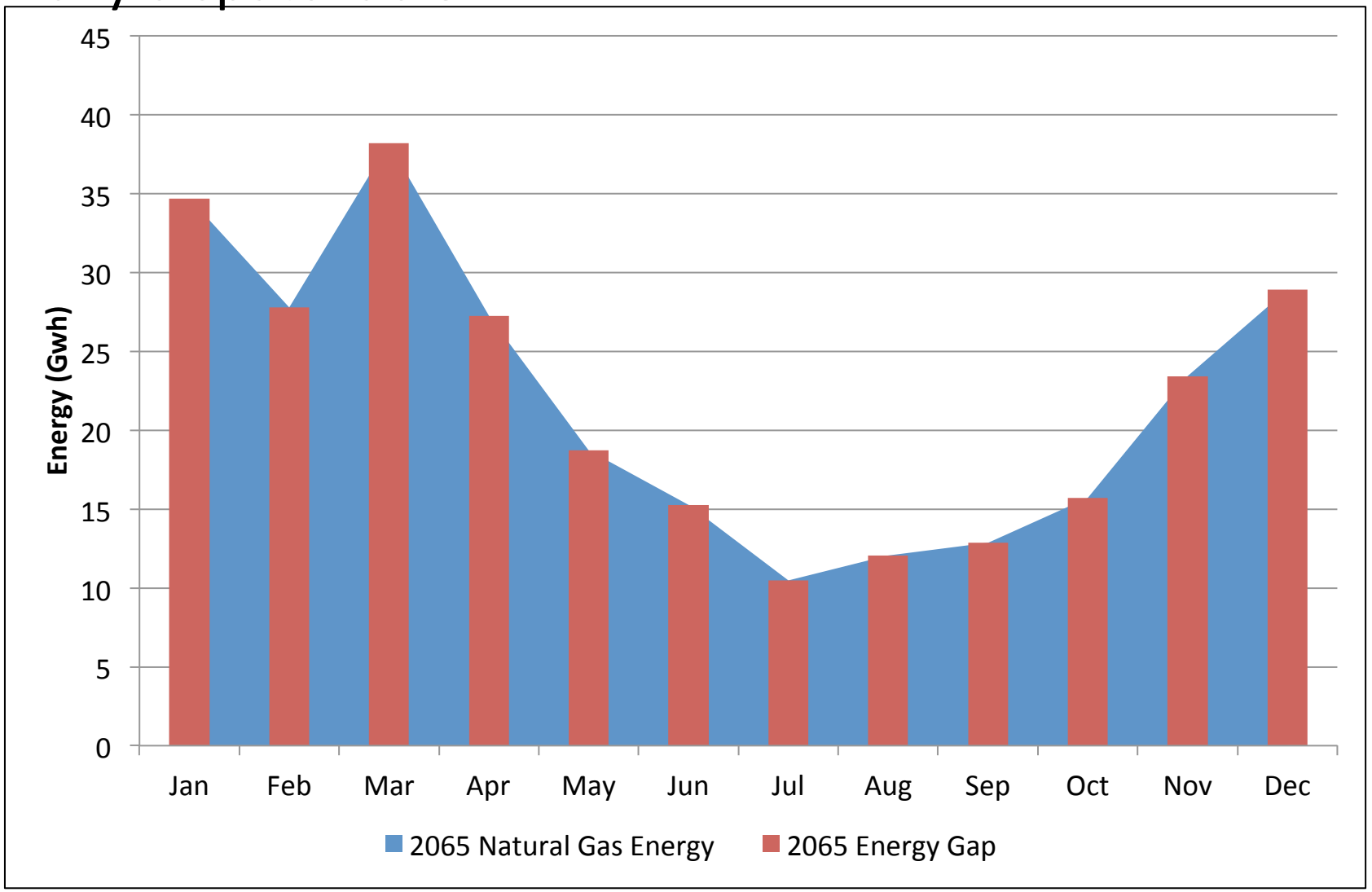
Yukon characteristics:

1. **Fuel**: Natural Gas (stored as Liquefied Natural Gas)
2. **Energy**: Excellent Match To Demand
3. **Type**: Fossil Fuel, Firm
4. **Installed Capacity**: up to 53 MW in 2065
5. **Firm Capacity**: up to 53 MW in 2065

Natural Gas Energy

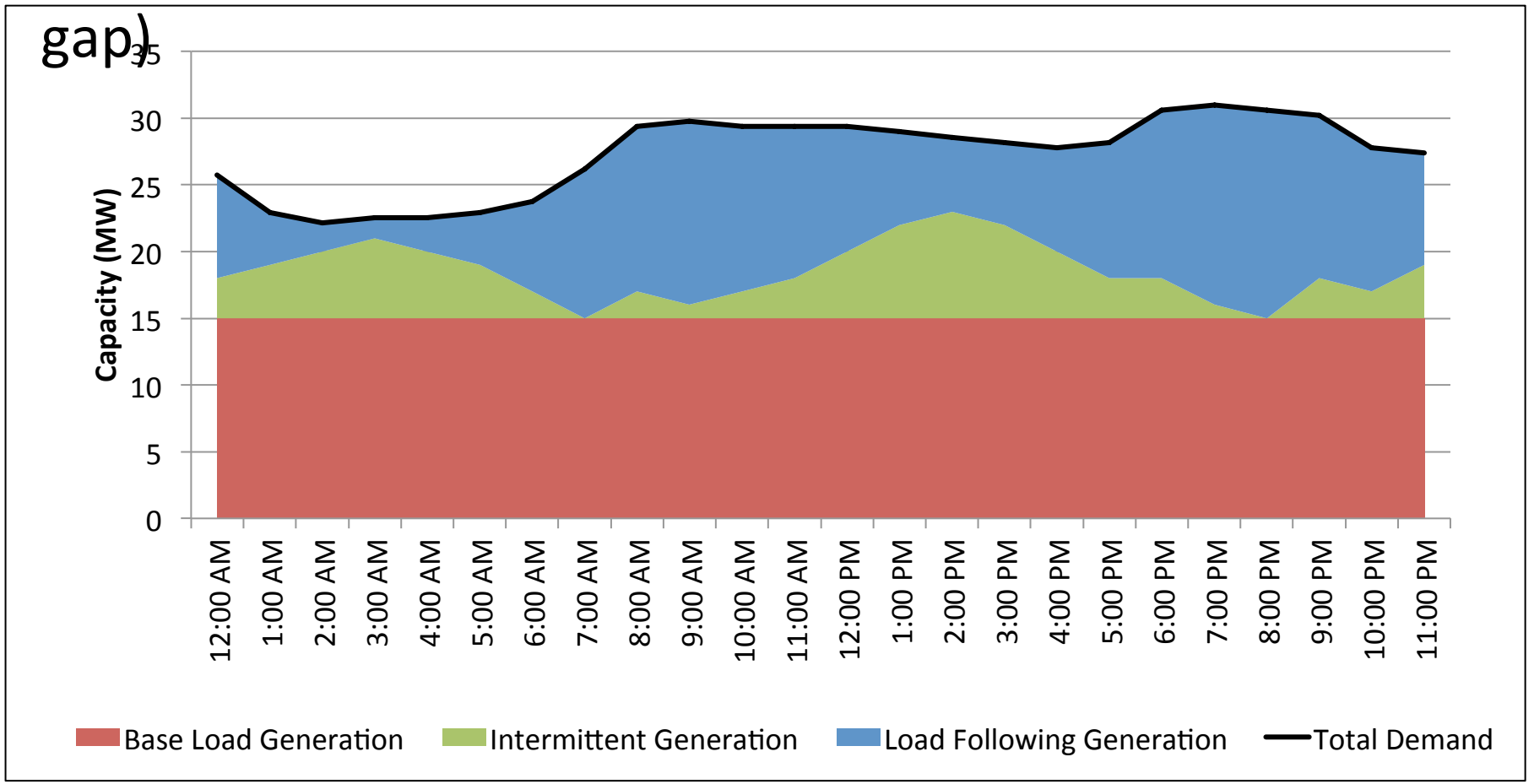
Energy: Fossil fuel stored and available on demand

1. Generation matches shape of energy demand
2. Fully dispatchable



Natural Gas Capacity

1. **Installed Capacity**: 53 MW in 2065
2. **Firm Capacity**: 53 MW in 2065
3. Load following resource (e.g. peak demand/generation gap)



LNG: What does this mean?

TECHNICAL	ECONOMIC
Meets Yukon demand on a standalone basis	Cost effective source of capacity and winter energy
ENVIRONMENTAL	**ENVIRONMENTAL**
Low land-use footprint	High GHGs

LNG Generation Summary

Technical			Economic	Socio-Economic	Environmental	
Max. 2065 Energy (GWh /year)	Max. 2065 Installed Capacity (MW)	Max. 2065 Firm Capacity (MW)	Full Utilization LCOE ($/ MWh)	Social Impact	Land-Use Footprint (hectares /MW)	Production GHG Emissions (gCO_2e /kWh)
710	Unlimited	Unlimited	229	✓	0.28-0.42	708

Generation Resource Summary

	Technical			Economic	Socio-Economic	Environmental	
Resource	**Max. 2065 Energy (GWh)**	**Max. 2065 Installed Capacity (MW)**	**Max. 2065 Firm Capacity (MW)**	**Full Utilization LCOE ($/MWh)**	**Social Impact**	**Land-Use Footprint (ha/MW)**	**Production GHG Emissions ($kgCO_2e$/MWh)**
Wind + Battery Storage	88	28	0	192	✓	36 ± 22	0
Solar	13	14	0	192	✓	0 - 3.5	0
Next Generation Hydro	557	57	57	92	✓	313 (Range: 187 – 545)	0
Run-of-River Hydro	Unlimited (@23.4GWh / project)	Unlimited (@4.7MW / project)	0.6MW / project	116+	✓	≈11	0
Small Hydro with Storage	Unlimited (@43.6GWh / project)	Unlimited (@6.5MW / project)	4.2MW / project	126+	✓	390 (Median)	0
Pumped Storage Hydro	-10* *PS does not produce energy	20	20	183	✓	145	0
Natural Gas	710	Unlimited	141	229	✓	0.28-0.42	708

PART 5 – ENERGY DEVELOPMENT SCENARIOS

Energy Development Scenarios

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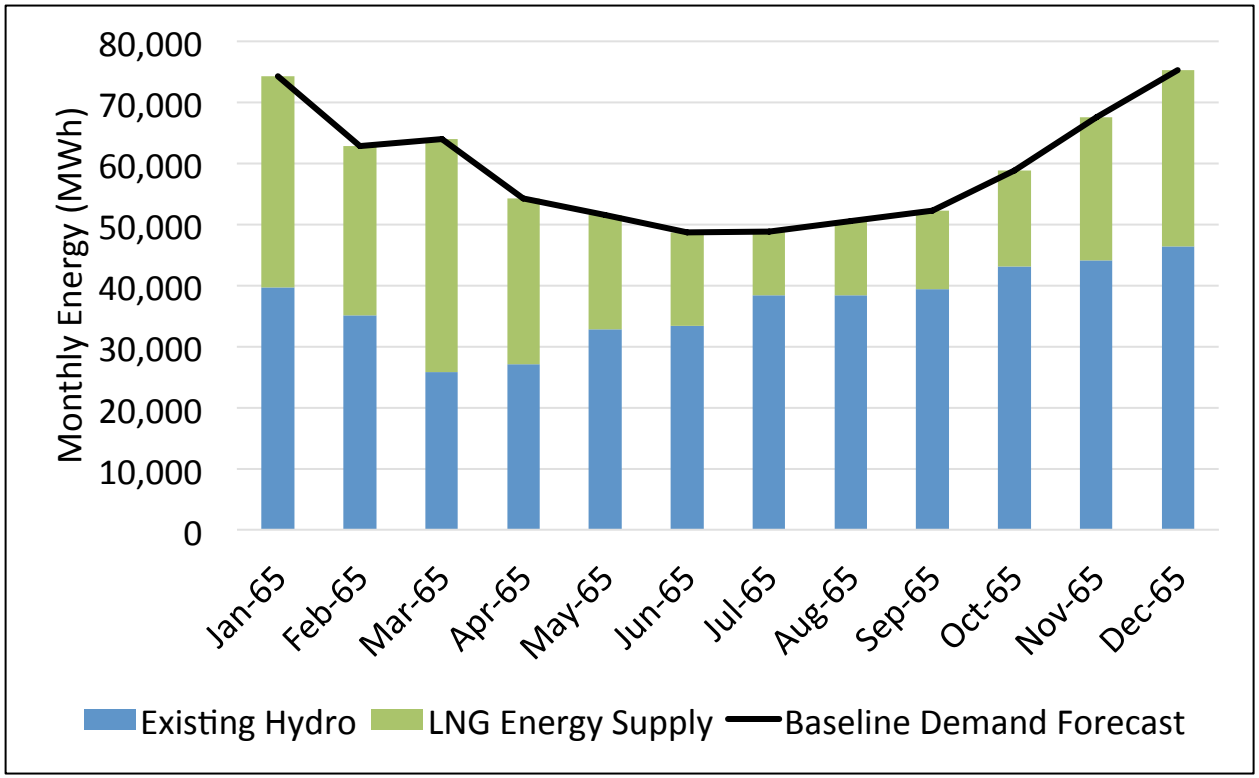
Resource	Standalone Resource	Rationale
Wind	No	Integration limit
Solar	No	Integration limit
Next Generation Hydro	Yes	Source of firm energy & capacity
Small Hydro with Storage	No	Practical limits (e.g. economics)
Run-of-River	No	Practical limits, Poor source of winter energy & capacity
Pumped Storage	No	Net energy consumer
Natural Gas	Yes	Source of firm energy and capacity

Energy Development Scenarios

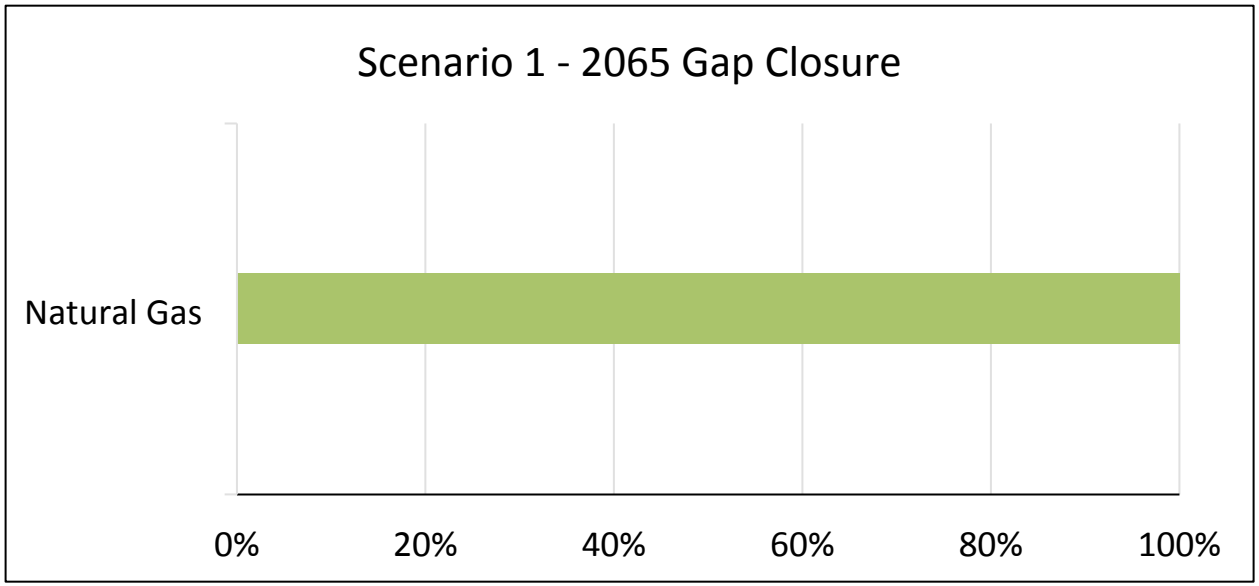
Scenario	Wind	Solar	NGH	Small Hydro	ROR	PSH	Natural Gas
Scenario 1 – Natural Gas							✓
Scenario 2 – Next-Generation Hydro			✓				
Scenario 3 – Renewables Portfolio (No Pumped Storage)	✓	✓		✓	✓		✓
Scenario 4 – Renewables Portfolio with Pumped Storage	✓	✓		✓	✓	✓	✓

Natural Gas in Scenario 3 and Scenario 4 is used only to fill the residual capacity gaps (no energy is generated)

Scenario 1 – Natural Gas



2065 Energy Generation and Gap Closure



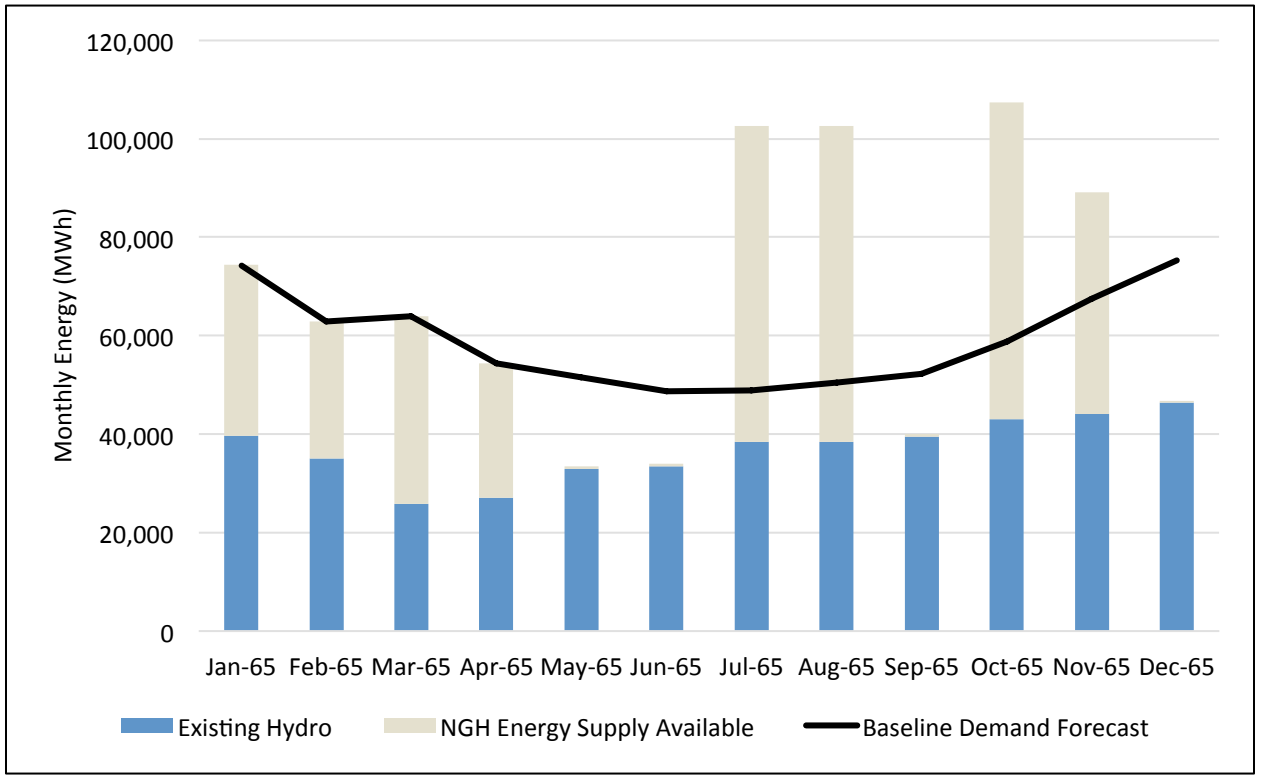
2065 Capacity Gap Closure

Scenario 1 - Summary

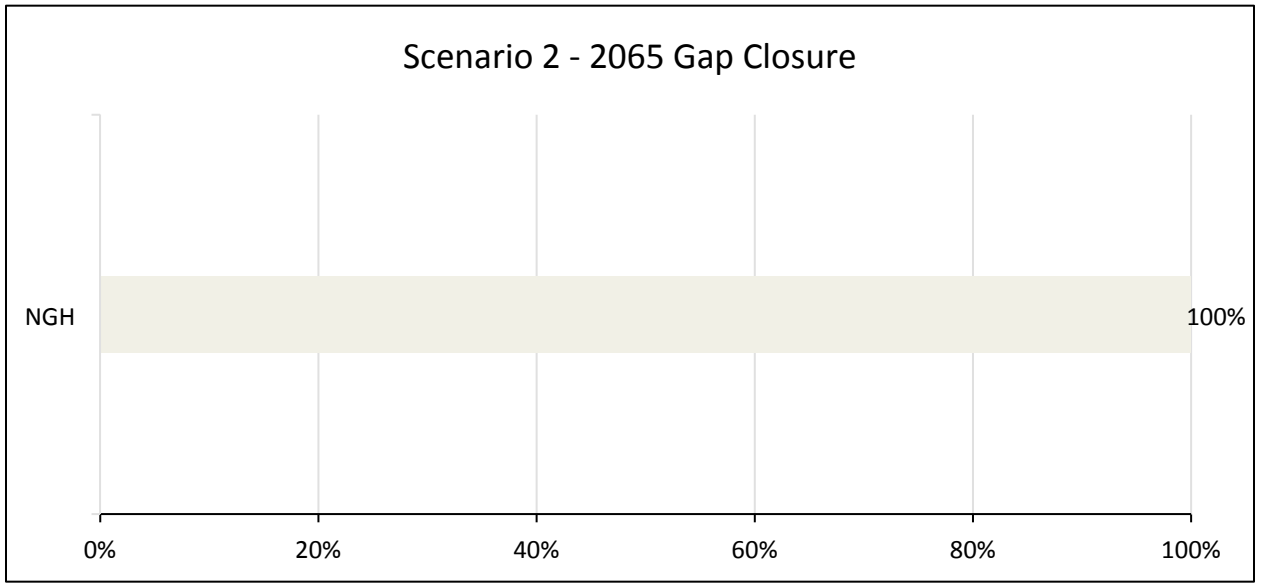
A series of natural gas projects (12x4.4MW) is required to meet the Yukon 2065 forecasted electricity demand

		2035	2065
Technical	**Energy**	444 GWh Existing Hydro 103 GWh Natural Gas	444 GWh, Existing Hydro 265 GWh Natural Gas
Technical	**Installed Capacity**	92 MW Existing Hydro 22 MW Natural Gas	92 MW Existing Hydro 53 MW Natural Gas
Economic	**Forecast Utilization LCOE**	$250/MWh	
Environmental	**Land-Use Footprint**	9 ha	22 ha
Environmental	**GHG Emissions**	74,000 tonnes/year	190,000 tonnes/year

Scenario 2 – NGH



2065 Energy Generation and Gap Closure



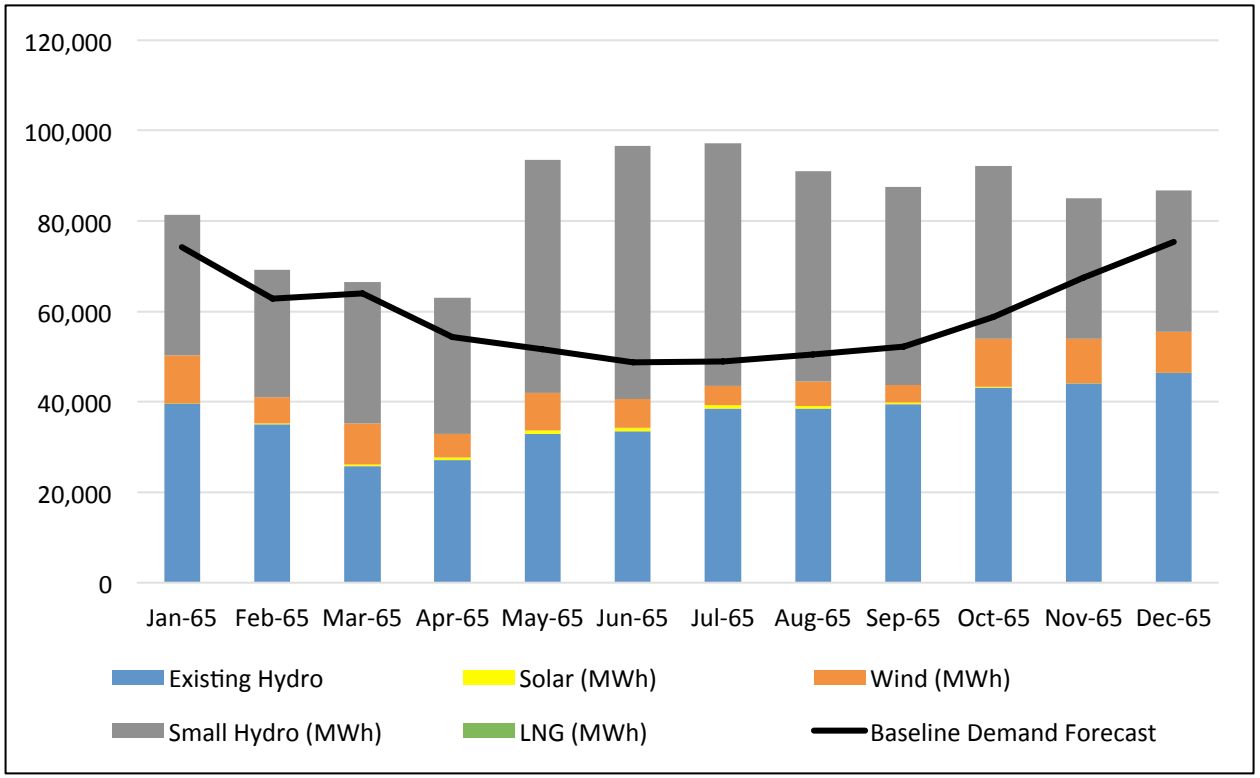
2065 Capacity Gap Closure

Scenario 2 – Summary

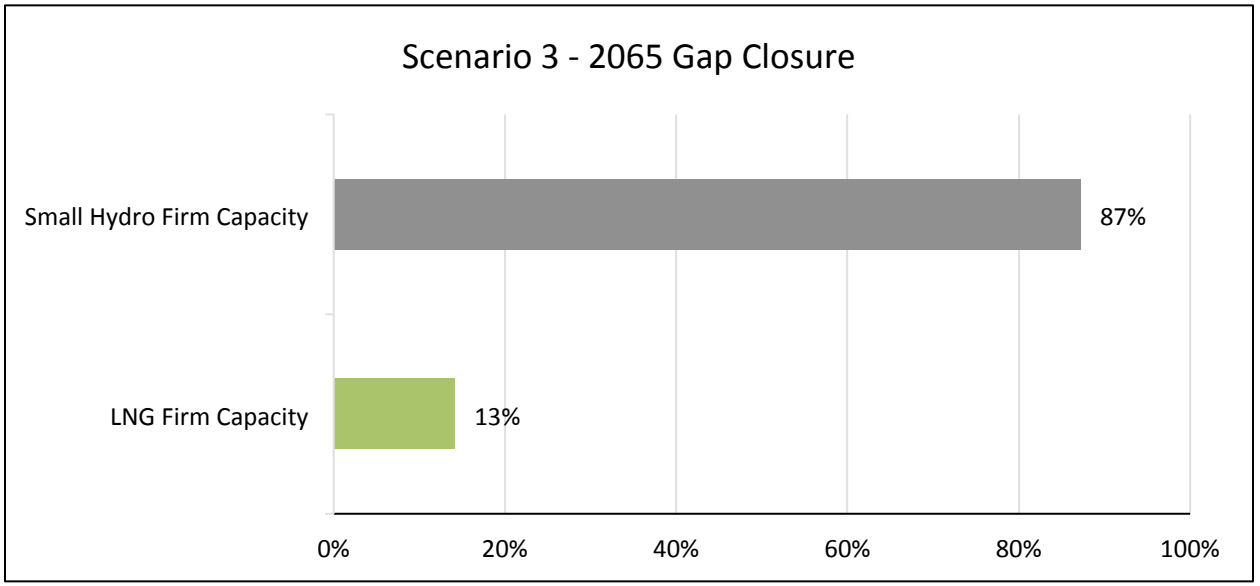
A single NGH project is required to meet the Yukon 2065 forecasted electricity demand

		2035	2065
Technical	**Energy**	444 GWh Existing Hydro 103 GWh NGH	444 GWh Existing Hydro 265 GWh NGH
Technical	**Installed Capacity**	92MW Existing Hydro 38 MW NGH	92 MW Existing Hydro 57 MW NGH
Economic	**Forecast Utilization LCOE**	$240/MWh	
Environmental	**Land-Use Footprint**	18,000 ha	18,000 ha
Environmental	**GHG Emissions**	0 tonnes	0 tonnes

Scenario 3 – Renewables (no PSH)



2065 Energy Generation and Gap Closure

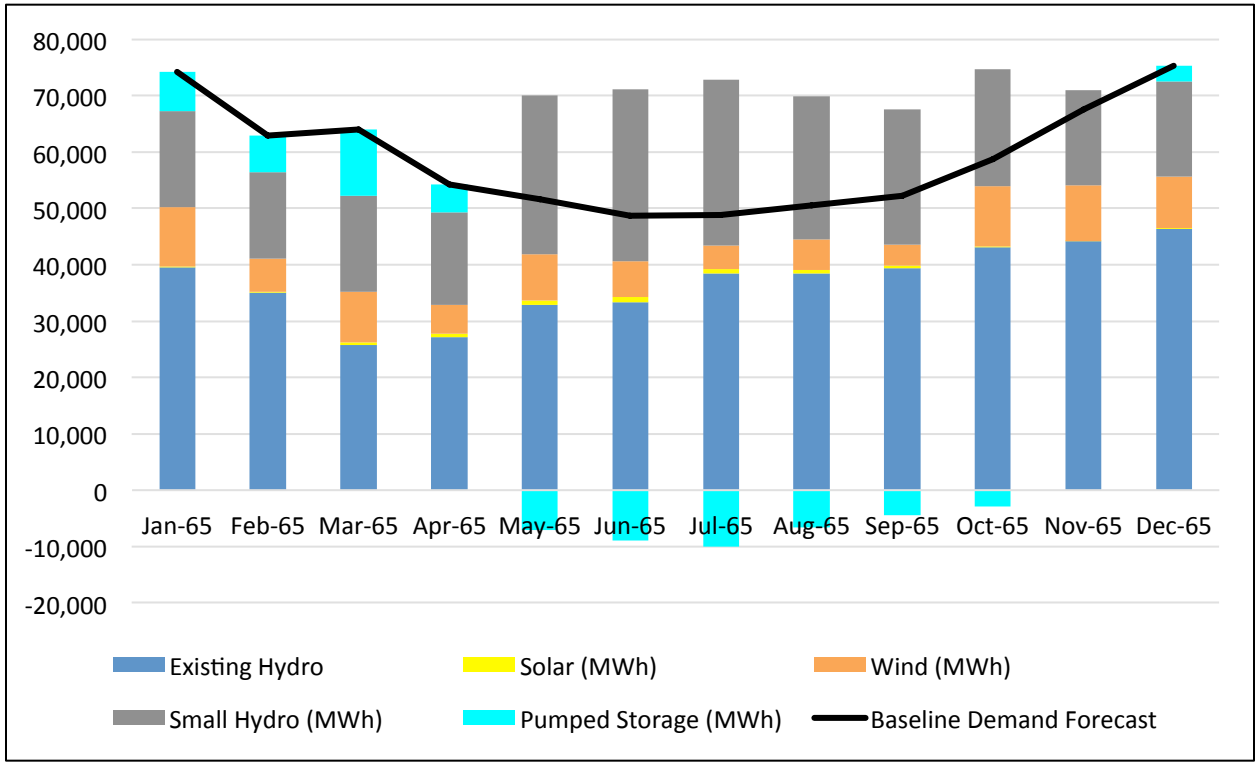


2065 Capacity Gap Closure

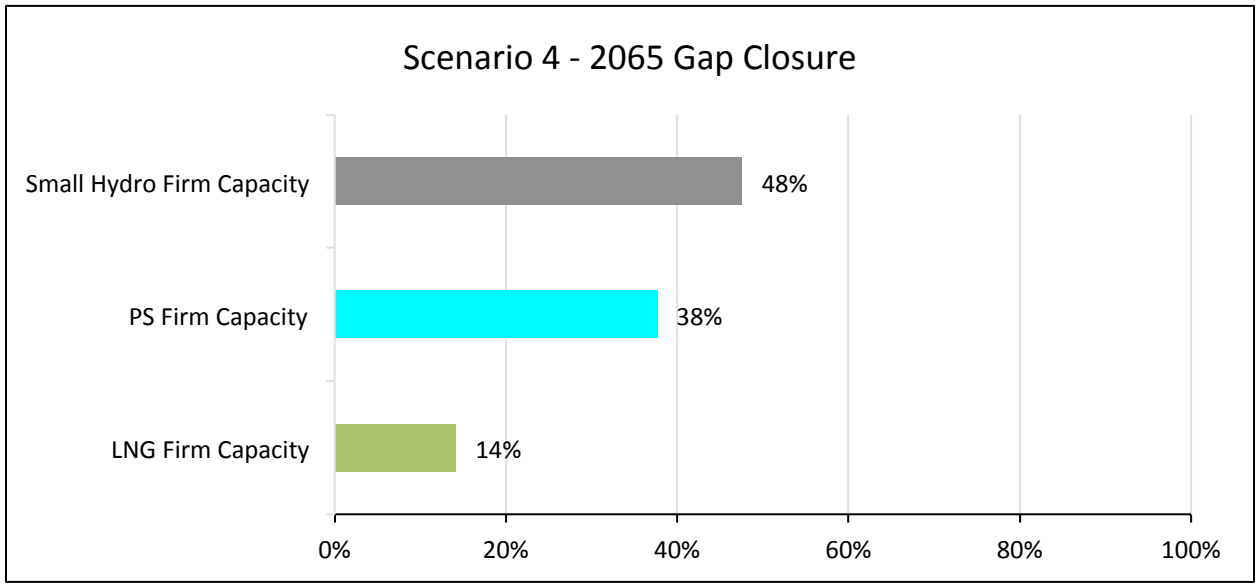
Scenario 3 – Summary

		2035	2065
Technical	**Energy**	444 GWh Existing Hydro 66 GWh Wind 1 GWh Solar 36 GWh Small Hydro Storage	444 GWh Existing Hydro 88 GWh Wind 5 GWh of Solar 172 GWh Small Hydro Storage
Technical	**Installed Capacity**	92 MW Existing Hydro 22 MW Wind with Battery Integration (7.5MW) 1 MW of Solar 39 MW Small Hydro Storage 0 MW Natural Gas	92MW Existing Hydro 29 MW Wind with Battery Integration (7.5MW) 5 MW Solar 72 MW Small Hydro Storage 8.8 MW Natural Gas
Economic	**Forecast Utilization LCOE**	$360/MWh	
Environmental	**Land-Use Footprint**	16,000 ha	29,000 ha
Environmental	**GHG Emissions**	0 tonnes	0 tonnes

Scenario 4 – Renewables (+PSH)



2065 Energy Generation and Gap Closure



2065 Capacity Gap Closure

Scenario 4 – Summary

		2035	2065
Technical	**Energy**	444 GWh Existing Hydro 66 GWh Wind 1 GWh Solar 42 GWh Small Hydro -6 GWh Pumped Storage	444 GWh Existing Hydro 88 GWh Wind 5 GWh Solar 180 GWh Small Hydro -8 GWh Pumped Storage
Technical	**Installed Capacity**	92 MW Existing Hydro 22 MW Wind with Battery Integration (7.5MW) 1 MW Solar 13 MW Small Hydro 20 MW Pumped Storage 0 MW Natural Gas	92 MW Existing Hydro 29 MW Wind with Battery Integration (7.5MW) 5 MW Solar 39 MW Small Hydro 20 MW Pumped Storage 8.8 MW Natural
Economic	**Forecast Utilization LCOE**	$270/MWh	
Environmental	**Land-Use Footprint**	9,000 ha	20,000 ha
Environmental	**GHG Emissions**	0 tonnes	0 tonnes

Scenario - Summary

	Technical		Economic	Socio-Economic	Environmental	
Scenario	**Meets Yukon Energy Needs?**	**Meets Yukon Capacity Needs?**	**Forecast LCOE ($/MWh)**	**Social Impact**	**2065 Land-Use Footprint (hectares)**	**2065 GHG Emissions (tonnes CO_2e)**
Scenario 1 – Natural Gas	Yes	Yes	250	Potentially Acceptable	22	190,000
Scenario 2 – Next-Generation Hydro	Yes	Yes	240	Potentially Acceptable	18,000	0
Scenario 3 – Renewables	Yes	Yes (with Natural Gas capacity)	360	Potentially Acceptable	29,000	0*
Scenario 4 – Renewables with Pumped Storage	Yes	Yes (with Natural Gas capacity)	270	Potentially Acceptable	20,000	0*

CONCLUSIONS

Conclusions

1. All scenarios potentially meet forecasted 2065 demand
   a) Only Natural Gas and NGH can be standalone
   b) Other generation types must be combined together

2. Generation types to pursue is a selection among tradeoffs
   a) Economics, GHG, Land Use, and Social Acceptability

3. Therefore NGH remains a viable candidate for further consideration :
   a) Similar cost compared to other generation types
   b) Zero GHG emissions
   c) Meets energy and capacity demand

Thank you & Questions…

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APPENDIX

Scenario 1 – Project Parameters

Project Type	Number of Projects	GHG Emissions / Project	GHG Emissions Total	Footprint / Project	Footprint Totals	Energy / Project	Energy Totals	Capacity / Project	Capacity Totals
Existing Hydro	-	-	-	-	-	-	444 GWh	-	92 MW
Natural Gas	12	16,000 tonnes/ yr	190,000 tonnes/ yr	1.8 ha	22 ha	22 GWh	265 GWh	4.4 MW	53 MW
Totals	12		190,000 tonnes/ yr		22 ha		710 GWh		150 MW

Scenario 2 – Project Parameters

Project Type	Number of Projects	GHG Emission / Project	GHG Emissions Total	Footprint / Project	Footprint Totals	Energy / Project	Energy Totals	Capacity / Project	Capacity Totals
Existing Hydro	-	-		-	-	-	444 GWh	-	92 MW
Next Gen Hydro	1	0	0	18,000 ha	18,000 ha	265 GWh	265 GWh	57 MW	57 MW
Totals	1		0		18,000 ha		710 GWh		150 MW

Scenario 3 – Project Parameters

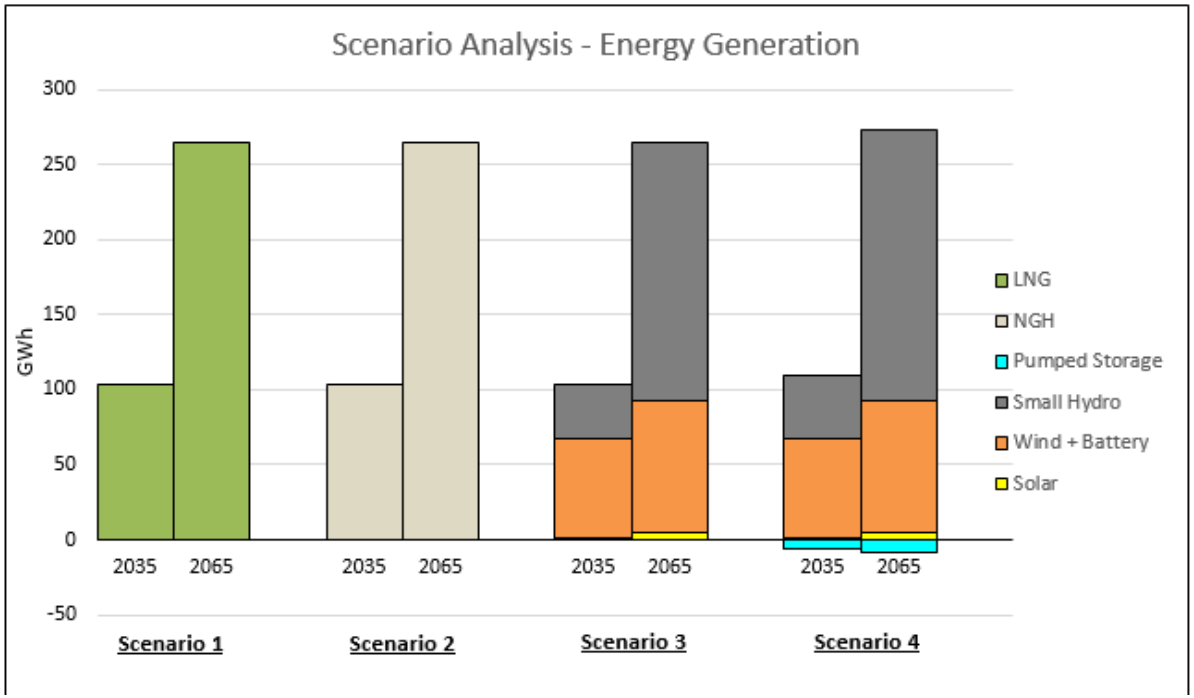
Project Type	Number of Projects	GHG Emissions / Project	GHG Emissions Total	Footprint / Project	Footprint Totals	Energy / Project	Energy Totals	Capacity / Project	Capacity Totals
Existing Hydro	-	-	-	-	-	-	444 GWh	-	92 MW
Wind	4	0	0	300 ha	1200 ha	22 GWh	88 GWh	7.2 MW	29 MW
Solar	5	0	0	0	0	1 GWh	5 GWh	1 MW	5 MW
Small Hydro	11	0	0	2500 ha	27500 ha	16 GWh	176 GWh	6.5 MW	72 MW
Natural Gas	2	≈0	≈0	1.8 ha	3.6 ha	≈0	≈0	4.4 MW	8.8 MW
Totals	22		≈0		29000 ha		710 GWh		207 MW

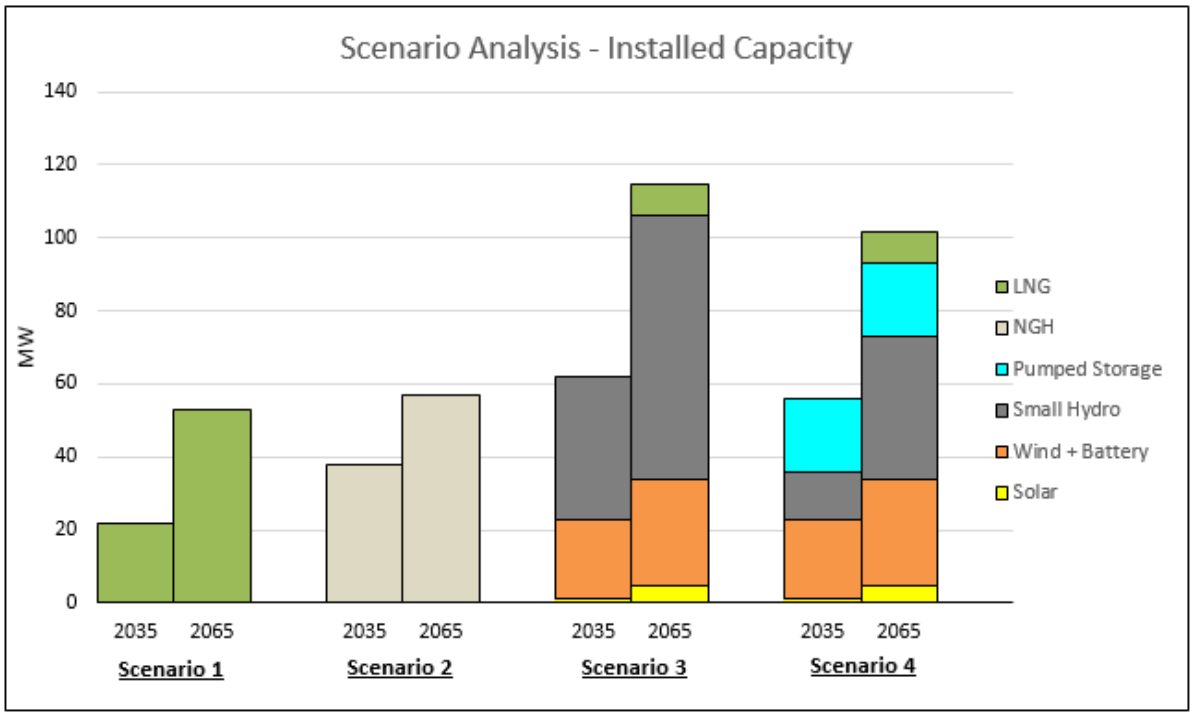
Scenario 4 – Project Parameters

MIDGARD

Project Type	Number of Projects	GHG Emissions / Project	GHG Emission Total	Footprint / Project	Footprint Totals	Energy / Project	Energy Totals	Capacity / Project	Capacity Totals
Existing Hydro	-	-		-	-	-	444 GWh	-	92 MW
Wind	4	0	0	300 ha	1200 ha	22 GWh	88 GWh	7.2 MW	29 MW
Solar	5	0	0	0	0	1 GWh	5 GWh	1 MW	5 MW
Small Hydro	6	0	0	2500 ha	15000 ha	30 GWh	180 GWh	6.5 MW	39 MW
Pumped Storage	1	0	0	2900 ha	2900 ha	-8 GWh	-8 GWh	20 MW	20 MW
Natural Gas	2	≈0	≈0	1.8 ha	3.6 ha	≈0	≈0	4.4 MW	8.8 MW
Totals	18		≈0		20000 ha		710 GWh		194 MW

Scenario Comparison





Wind – Whitehorse Average Speed