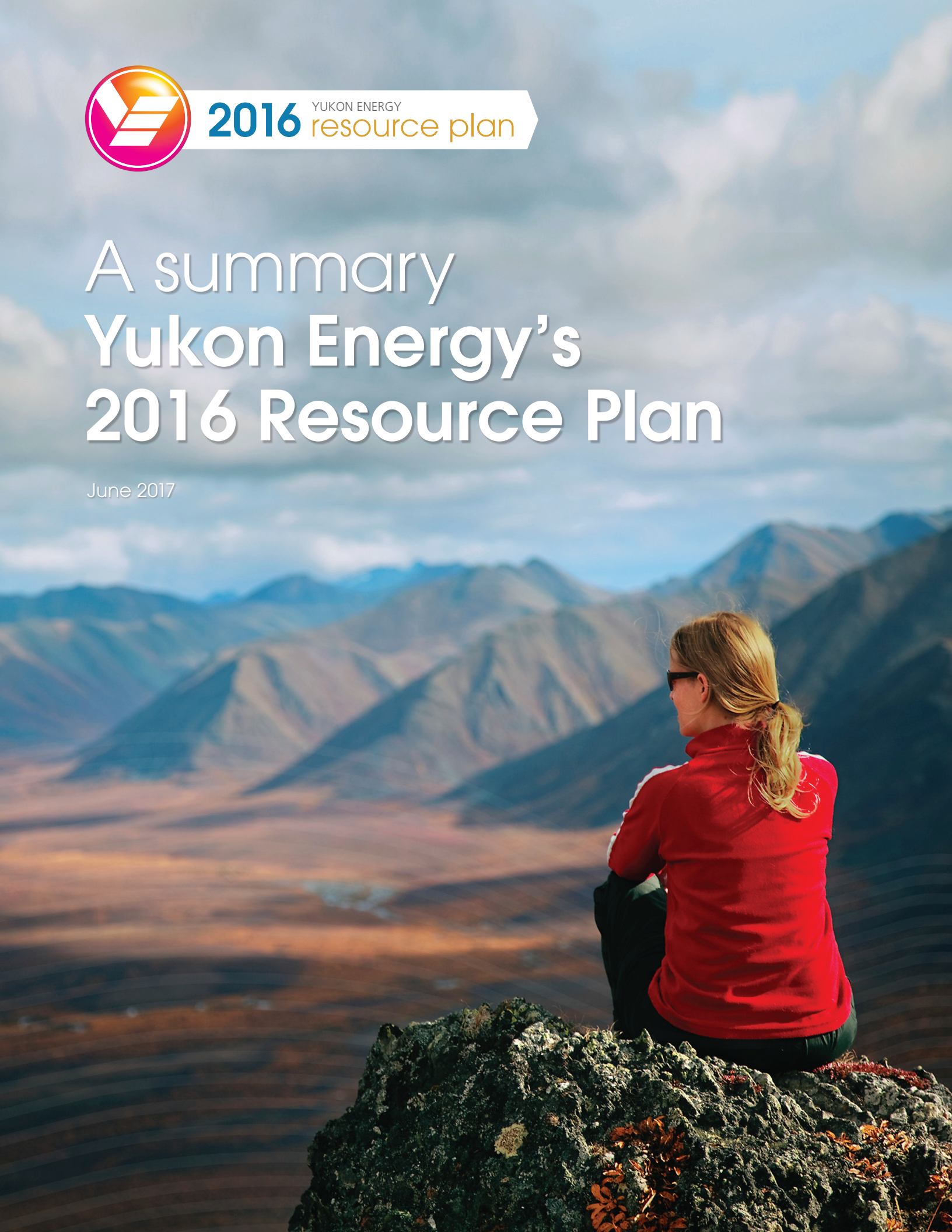
2016 YUKON ENERGY resource plan

A summary Yukon Energy's 2016 Resource Plan

June 2017



Imagine what life in Yukon might be like 20 years from now. What's the state of the economy? Are there mines operating here, and if so, how many? What other industries are thriving? What are people driving for vehicles and how are those vehicles powered? How are people's homes heated? How is electricity generated?

Planning for Yukon's future electricity needs is both crucial and complicated. Yukon Energy has spent the last year and a half working with local First Nations, stakeholders and the public on a plan to address the territory's electricity requirements to the year 2035.

Together, we've created a proposed action plan that takes into account the need for environmental protection, affordable and reliable power, and social responsibility, all things that Yukoners have told us are important to them.

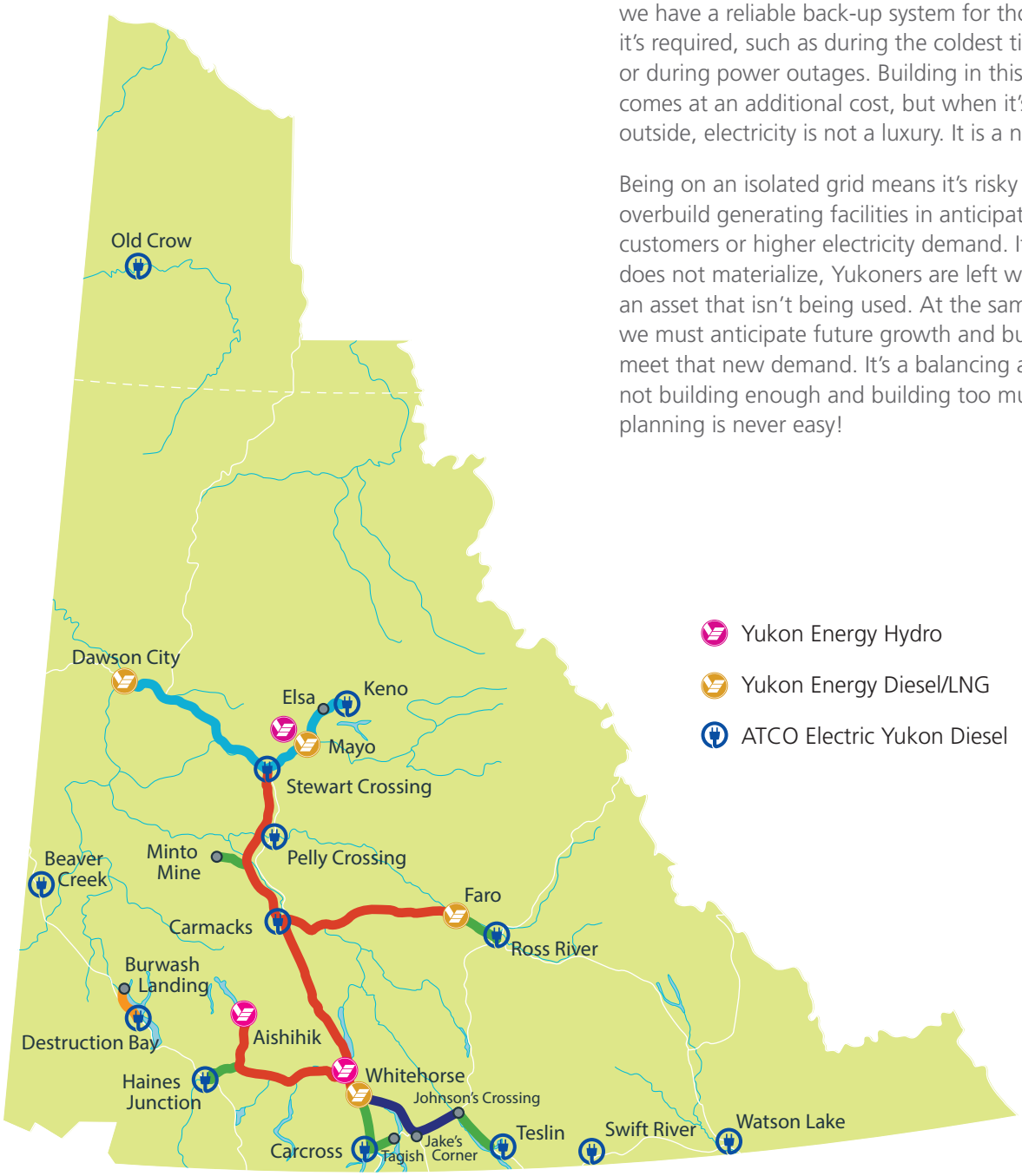
This booklet provides a summary of our 2016 Resource Plan. Please contact us by phone (867.393.5333) or email (janet.patterson@yec.yk.ca) if you have questions. You can find the full 2016 Resource Plan on our website at **resourceplan.yukonenergy.ca.**

Background

Yukon Energy is the main generator and transmitter of electricity in the territory. We sell wholesale power to ATCO Electric Yukon, and they provide it to retail customers in most areas of Yukon. There are some exceptions; we serve a few communities directly, including Dawson City, Mayo and Faro.

Yukon's power system is 'islanded.' Most other areas of North America are part of a large electricity grid that allows power to be bought and sold throughout various jurisdictions. We're not part of that system, meaning we must generate all our own power. This produces some unique challenges when it comes to meeting and planning for the territory's electricity requirements. We must build enough generation to meet Yukoners' electricity needs 365 days a year. This means ensuring we have a reliable back-up system for those times when it's required, such as during the coldest times of the year or during power outages. Building in this 'redundancy' comes at an additional cost, but when it's -40 degrees outside, electricity is not a luxury. It is a necessity.

Being on an isolated grid means it's risky for us to overbuild generating facilities in anticipation of new customers or higher electricity demand. If that demand does not materialize, Yukoners are left with paying for an asset that isn't being used. At the same time though, we must anticipate future growth and build enough to meet that new demand. It's a balancing act between not building enough and building too much. Energy planning is never easy!



The planning process

Yukon Energy followed several steps in preparing the 2016 Resource Plan.

Forecasting load
Oct 2015 – May 2016

Energy options
June – Nov 2016

Analyzing portfolio
Dec 2016 – Jan 2017

Draft plan
Feb 2017

Final plan
June 2017

- We calculated how much we would need over the next 20 years and determined how much power we have now.
- We considered all the possible options for filling the gap.
- We analyzed various 'baskets' of energy options that we think are best suited to meet the electricity needs of Yukoners under various scenarios.
- We prepared a draft resource plan, including a proposed action plan.
- We prepared the final resource plan, which we will submit to our regulator the Yukon Utilities Board in late spring/early summer for review.

Hearing from Yukoners

We sought input from Yukoners during every step in the process, through three rounds of public information sessions, a series of meetings with stakeholders and First Nation leaders, mailers sent to all Yukon households, an interactive website, and social media. Our aim was to find energy solutions that were the most affordable but that also addressed environmental, social and economic needs and took into account the wishes of Yukoners based on a territory-wide survey that was done as part of the resource planning work. You can read more about the survey later in this booklet.

Here are some of the common themes we heard from Yukoners:

- Yukoners strongly support energy conservation/ efficiencies.
- While the values survey indicated low support for thermal (diesel and LNG), many Yukoners said they understood why Yukon Energy is proposing thermal resources for back-up and to meet peak demand.
- Yukoners are pleased that under Yukon Energy's proposed action plan, between 92 and 99 percent of the average annual power produced would be renewable.
- Yukoners are supportive of the social cost of carbon being included in the evaluation of resource projects.
- Yukoners prefer several smaller energy projects over one large project.
- There is broad interest in a variety of energy technologies, especially wind and solar.

What's the need?

Key components of the work done to prepare the 2016 Resource Plan included determining how much electricity we are going to need over the next 20 years, how much we will have from existing resources, and how much of a gap we will need to fill.

In terms of addressing the gap, we must consider both energy and capacity.

Energy is how much we can generate over time. If you look on your electricity bill, it shows how many kilowatt hours you used over a month. At the utility level we generally talk about gigawatt hours used in a year. We need to plan to ensure we have enough energy to meet our needs throughout the entire year. For instance with hydro, we must manage our water so we don't run out in the spring before the system has had a chance to re-fill itself.

Capacity is our ability to generate power at any point in time. That means while most times of the year we might only need 50 megawatts of power, we have to plan for those very cold days when we might need 90 megawatts.

Economic activity, and specifically industrial activity such as mining, is a key driver in determining how much electricity will be needed. Since it's difficult to predict what Yukon's economy may be like in the future, we developed scenarios based on several possible outcomes. We are showing three key ones in the graphs on the next page.

You can see that under low and medium scenarios, we have enough energy, but it would mean using thermal (diesel and LNG) to fill the gap between the future needs and our current capability. For high industrial activity, there is an energy gap.

In the capacity graph, you will see a drop in our available resources starting in 2021. That's because we will need to retire some of our diesel units at that time. You can also see that under all scenarios, we are short on capacity even now, if we were to lose our largest electricity source, our Aishihik hydro plant or the transmission line between that plant and Whitehorse. What that means is if it were a very cold day and we lost access to our Aishihik facilities, we might not be able to provide reliable power. That highlights the fact that in the short term at least, our primary focus must be on projects to close this capacity gap.

Low industrial scenario

This portfolio is based on a scenario of low mining activity, with the Minto mine closing in 2021 and another mine starting to operate that same year.

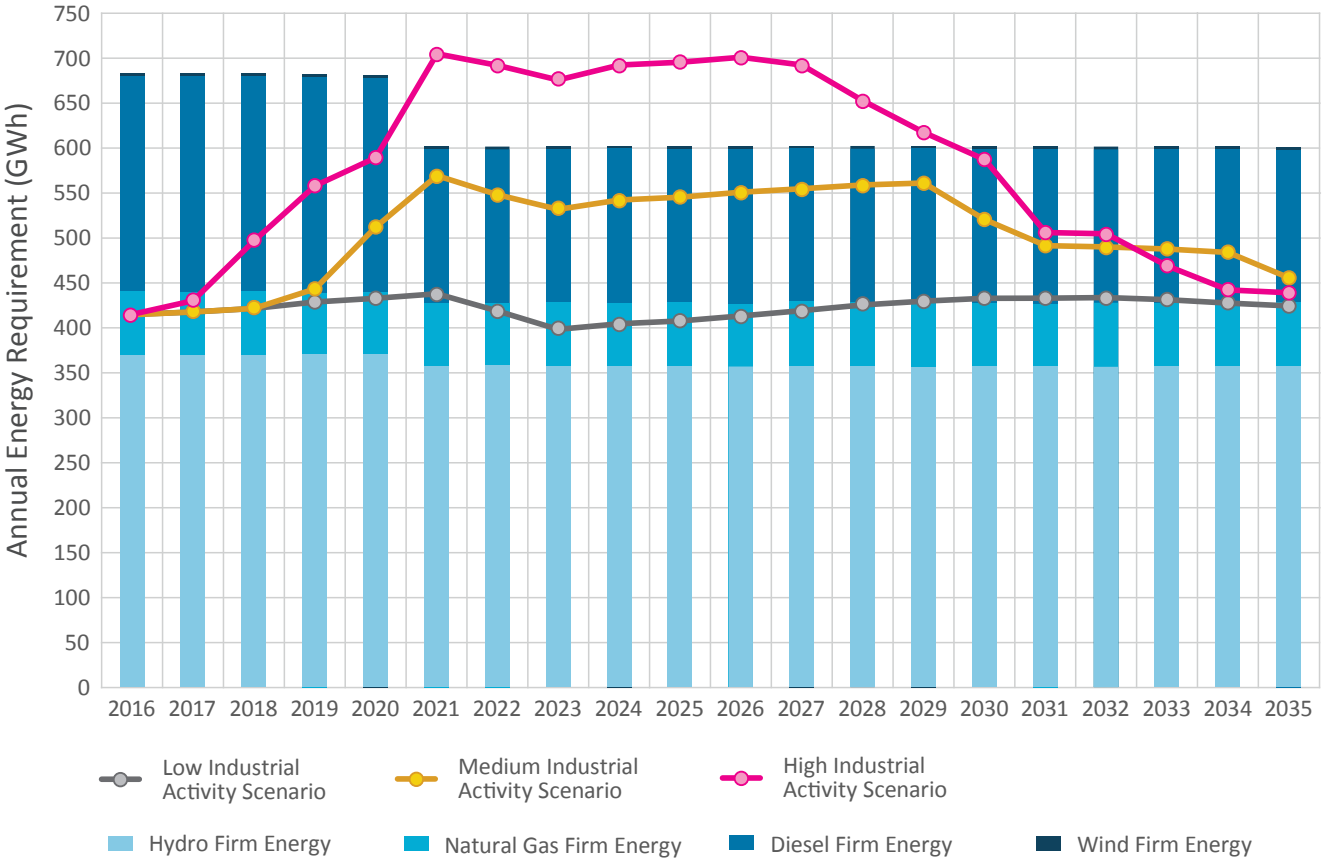
Medium industrial scenario

This portfolio is based on a scenario of medium mining activity with Minto closing in 2021 and two other mines operating (one connected to the grid and one operating off-grid).

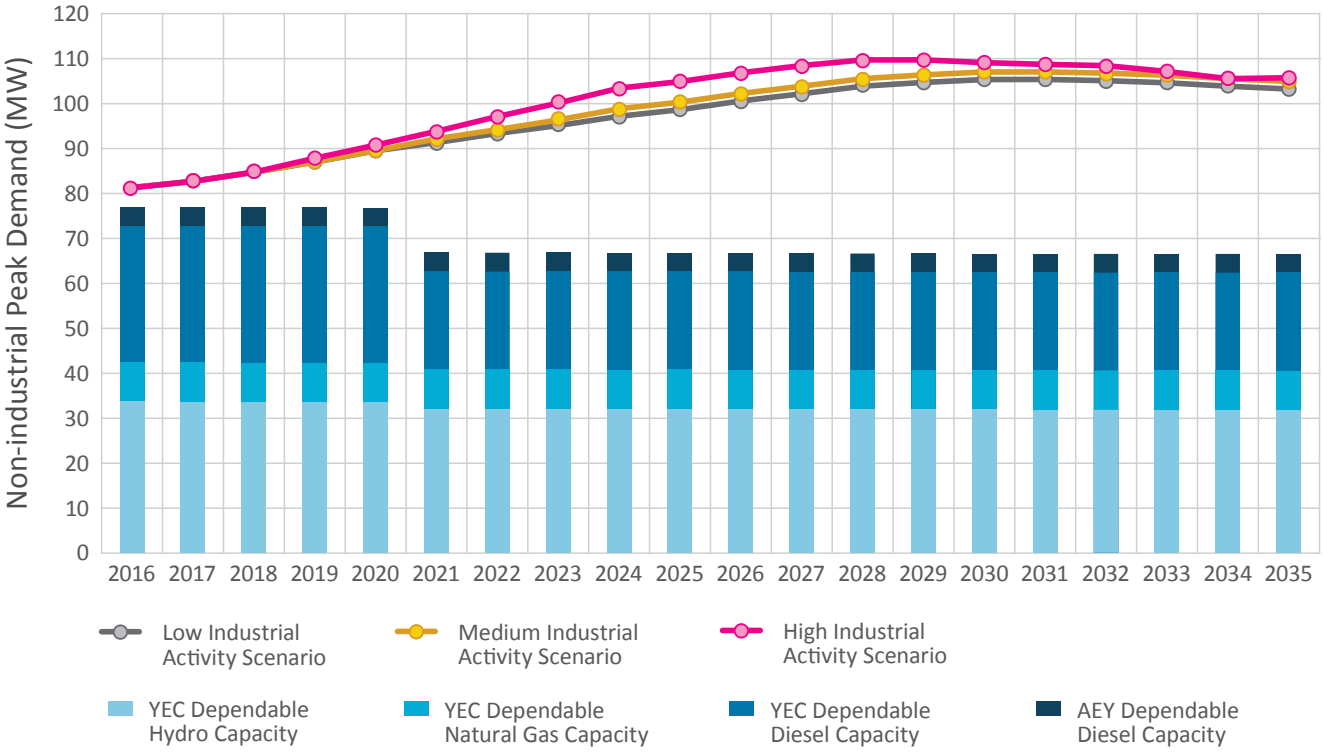
High industrial scenario

This portfolio is based on a scenario of high mining activity with two connected mines and two mines operating off-grid.

Energy



Capacity



Filling the gap

We looked at more than a dozen different options for filling our energy and capacity gaps over 20 years.

- Biogas
- Biomass
- Energy Conservation
  Demand side management
- Energy Storage
  Batteries
- Geothermal
- Pumped Storage
- Small Hydro
- Solar
- Storage Enhancements
  Using existing hydro plants
- Thermal
- Transmission
- Uprating and Refurbishments
  To existing hydro turbines
- Waste to Energy
- Wind

For every one of these options, we first considered technical and financial requirements, and then evaluated them on the basis of their environmental, social and economic attributes.

Technical and financial considerations

To help us choose the best baskets of energy options to provide reliable and affordable electricity, we used a sophisticated model designed for resource planning work. This is a new approach for Yukon, but it is commonly used by other utilities such as BC Hydro.

We gave the model the following 'rules' to follow:

- only suggest energy options that met our needs for both energy and capacity that we can depend on;
- look for the least expensive options; and
- build in a social cost of carbon for all options of between $60/tonne in 2016 to $91/tonne in 2035, to help address issues around GHG emissions.

We analyzed the results to determine what to build, how much to build, and when to build it.

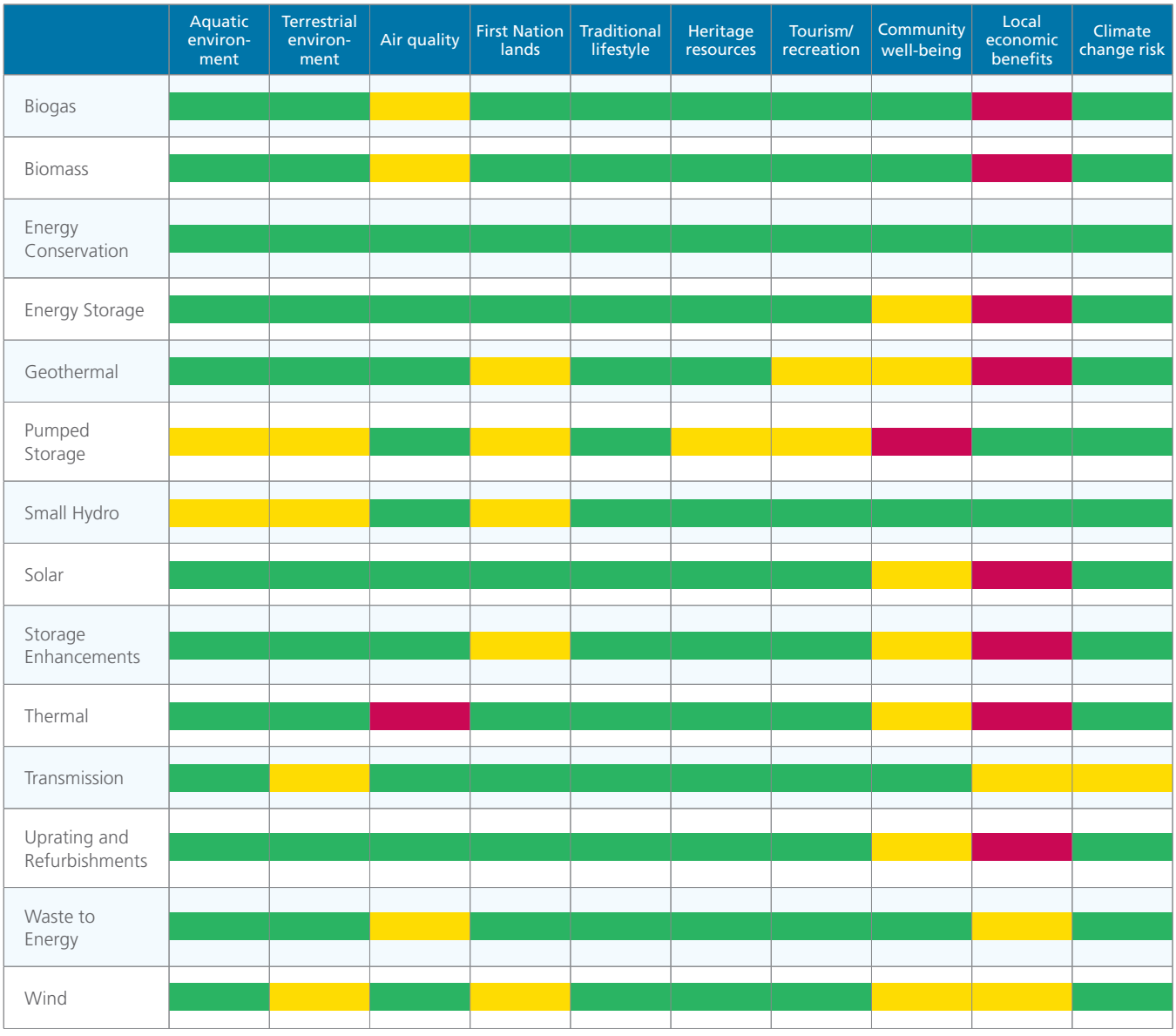
Environmental, social and economic considerations

Our next step was to assess the pros and cons of each option based on their potential environmental, social and economic impacts. The chart below shows a summary of that assessment, with green indicating most favourable, yellow somewhat favourable, and red least favourable.

Red does not mean that a project cannot proceed; only that there are issues that require additional attention.

In the 'local economic benefits' category, options ranked as 'red' merely indicate there would be less capital invested as compared to options evaluated as 'green.'

Note that the final category, climate change risk, looks at the impact that a changing climate could have on the project, and not what effect the project might have on climate change.



Energy portfolios

Working towards the goal of finding future energy solutions that are technically sound, cost effective, and environmentally, socially, and economically responsible, we created the following energy 'baskets' or portfolios, based on various scenarios.

Portfolio breakdowns

	Energy Con-servation	3rd Natural Gas Engine	Battery Storage	Uprates	Southern Lake Enhance-ment	Diesel	Mayo Hydro Refurb-ishment	Mayo Lake Enhance-ment	Wind	Small Hydro	Add-itional Diesel	Total upfront costs	Renew-able Energy
	2018	2019	2020	2020	2020	2021	2022	2022	2022	2023 or 2026	2026	$/ million	%
1 Low industrial scenario	✓	✓	✓	✓	✓	✓	✓				✓	$207	99.8
2 Medium industrial scenario	✓	✓	✓	✓	✓	✓	✓	✓		✓ (2026)		$299	98.1
3 High industrial scenario	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓ (2023)	✓	$458	91.9

Note: This summary shows how Yukon Energy would fulfill both energy and capacity needs. Capacity is having to build extra generation for those peak times when it is needed, even though the generation isn't used on a regular basis.

Incorporating the values survey

The final step in evaluating each portfolio was to consider the results of a territory-wide survey. Last year, the Yukon government's Bureau of Statistics conducted a survey that targeted one-third of all Yukon households. A key finding was that in terms of future energy projects, Yukoners are most concerned about environmental protection, then cost, then reliability, and finally social responsibility.

Overall, the portfolios for all the scenarios – even before taking into account the results of the values survey – are quite favourable towards environmental protection. They range from between 92 and 99 percent renewable. To ensure we fully considered the survey results, we compared two medium load scenarios: one was a mix of new thermal and renewables; the other used renewables-only for new generation. We wanted to know if the 'renewable-only' option was technically possible, what it would cost, and how much 'greener' it would be than one that included both new thermal and renewables.

The charts below compare environmental, social and economic attributes of the 'mixed' portfolio with the 'renewables-only' one. There are impacts in both cases, and in some categories the 'renewables-only' portfolio introduces some additional effects that aren't present in the 'mixed' basket. We concluded that a more renewable portfolio isn't necessarily better for the environment, and in some cases it can have greater environmental impacts.

The 'new renewables' portfolio would produce an average of 99.4 percent renewable energy, compared to 98.1 percent for the 'mixed' basket.

The 'renewables-only' portfolio would cost $785-million; close to three times that of the 'mixed' basket, and it wouldn't allow us to meet peak loads until 2023.

We believe the 'mixed' portfolio best addresses Yukoners' values of environmental protection, cost, reliability and social responsibility.

Mixed portfolio

Most favourable (62) Somewhat favourable (15) Least favourable (13)

	Aquatic environ-ment	Terrestrial environ-ment	Air quality	First Nation lands	Traditional lifestyle	Heritage resources	Tourism/ recreation	Community well-being	Local economic benefits	Climate change risk
3rd Natural Gas Engine	■	■	■	■	■	■	■	■	■	■
Battery Storage	■	■	■	■	■	■	■	■	■	■
Diesel	■	■	■	■	■	■	■	■	■	■
Energy Conservation	■	■	■	■	■	■	■	■	■	■
Mayo Hydro Refurbishment	■	■	■	■	■	■	■	■	■	■
Mayo Lake Enhancements	■	■	■	■	■	■	■	■	■	■
Small Hydro	■	■	■	■	■	■	■	■	■	■
Southern Lakes Enhancements	■	■	■	■	■	■	■	■	■	■
Uprates	■	■	■	■	■	■	■	■	■	■

Renewable-only new generation

Most favourable (79) Somewhat favourable (21) Least favourable (10)

	Aquatic environ-ment	Terrestrial environ-ment	Air quality	First Nation lands	Traditional lifestyle	Heritage resources	Tourism/ recreation	Community well-being	Local economic benefits	Climate change risk
Battery Storage	■	■	■	■	■	■	■	■	■	■
Biomass	■	■	■	■	■	■	■	■	■	■
Energy Conservation	■	■	■	■	■	■	■	■	■	■
Geothermal	■	■	■	■	■	■	■	■	■	■
Mayo Hydro Refurbishment	■	■	■	■	■	■	■	■	■	■
Mayo Lake Enhancements	■	■	■	■	■	■	■	■	■	■
Pumped Storage	■	■	■	■	■	■	■	■	■	■
Small Hydro	■	■	■	■	■	■	■	■	■	■
Southern Lakes Enhancements	■	■	■	■	■	■	■	■	■	■
Uprates	■	■	■	■	■	■	■	■	■	■
Waste to Energy	■	■	■	■	■	■	■	■	■	■

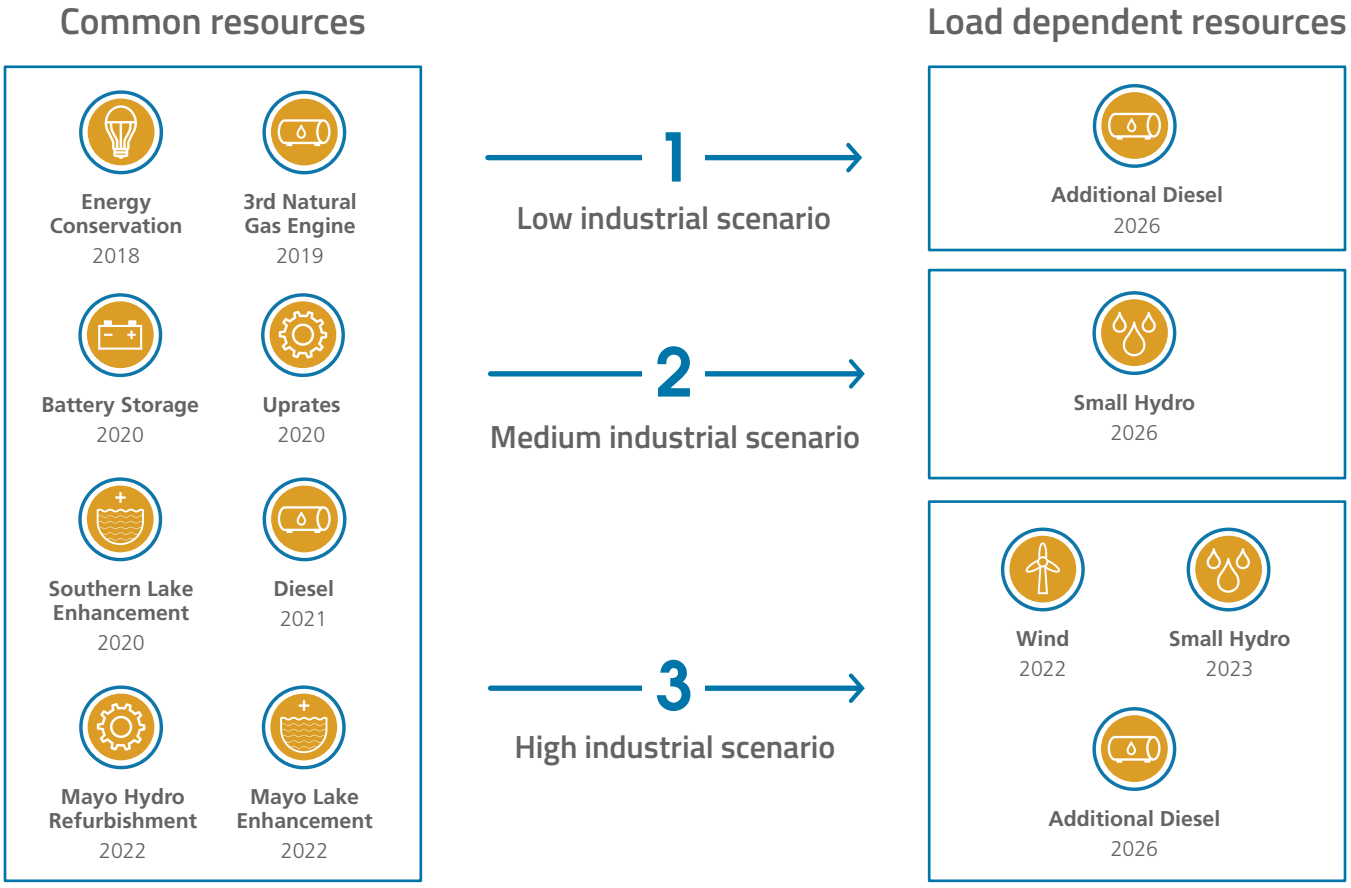
Our proposed action plan

Based on everything we have learned to date, here is our proposed action plan.

The potential projects outlined in the plan are not carved in stone; they are energy options that we would like to discuss further with the Yukon government, First Nations, stakeholders and the Yukon public.

This proposed plan is based on what we know today. It cannot and does not make predictions about any new government policies that may come into effect in the future. The plan is a living document that can be changed to reflect new realities. It also does not address the fact that financing will need to be found to pay for the projects outlined here.

We will work on a common set of potential projects over the short term (from now to 2022; labeled as 'Common resources' in the diagram). We will monitor how our load grows over time to confirm which path we are on. We will add resources to our work plan over the longer term (2022 to 2035), once we know what load scenario is unfolding (labeled as 'Load dependent resources' in the diagram).



Questions?

The resource planning process is complex and we have presented you with a lot of information here. Please contact us if you have questions. You can find the full 2016 Resource Plan on our website at **resourceplan.yukonenergy.ca**.

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