Hibbing Public Utilities
Restorative Utility Plan

05.10.2022

A Path to Net-Zero

The Challenge: Why Change is Needed

The impetus for this work came from the MPCA's request to assess the cost effectiveness of NOx and SOx emission reduction controls for HPU as a result of its coal burning operations.

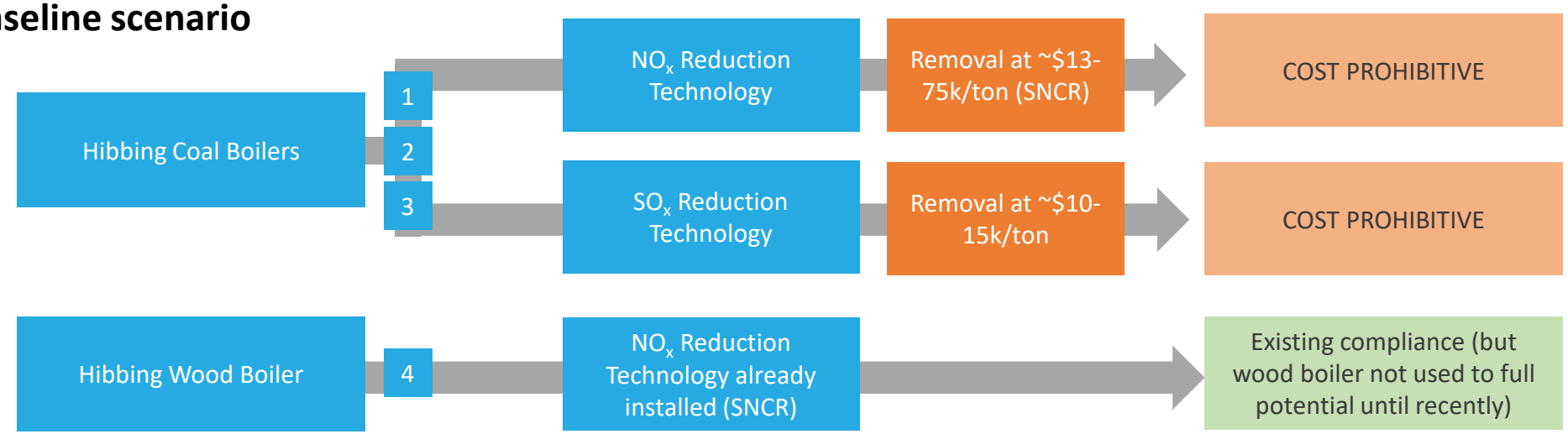
While installing emission reduction technologies would contribute to the important goal of reducing regional haze, it presents a multi-million-dollar capital investment that would further increase the "sunk costs" of coal operations, cementing in place fossil fuel use and stifling HPU's ability to innovate, revitalize the local economy & create jobs through alternative means. It risks putting a "band-aid" on much larger challenges that the utility is facing:

- ❑ How to keep rates affordable without an operational loss
- ❑ How to ensure reliability as equipment ages and energy markets are highly volatile
- ❑ How to make investments under the prospect of a declining population and regional economic hardship
- ❑ How to adapt with the mining industry as it faces an uncertain future

Thus, investments required for MPCA compliance should be seen as an opportunity to create a sustainable, long-term strategy for Hibbing Public Utility, and a future where the utility becomes a catalyst for regional economic transition.

The Challenge: NOx and SOx Reduction is Cost-Prohibitive

Baseline scenario



NO_x Reduction would have some benefits:	BUT, made in isolation, the investment risks:
+ Cleaner air and reduction of regional haze	- Sinking capital into retrofitting of equipment that is already past its expected lifespan.
+ MPCA compliance	- With only partial emission reduction achieved, investment does not contribute to future-proofing the utility for an eventual net-zero scenario
	- Further increasing “sunk costs” of coal operations, cementing in place fossil fuel use and stifling ability to innovate, revitalize local economy & create jobs through alternative means

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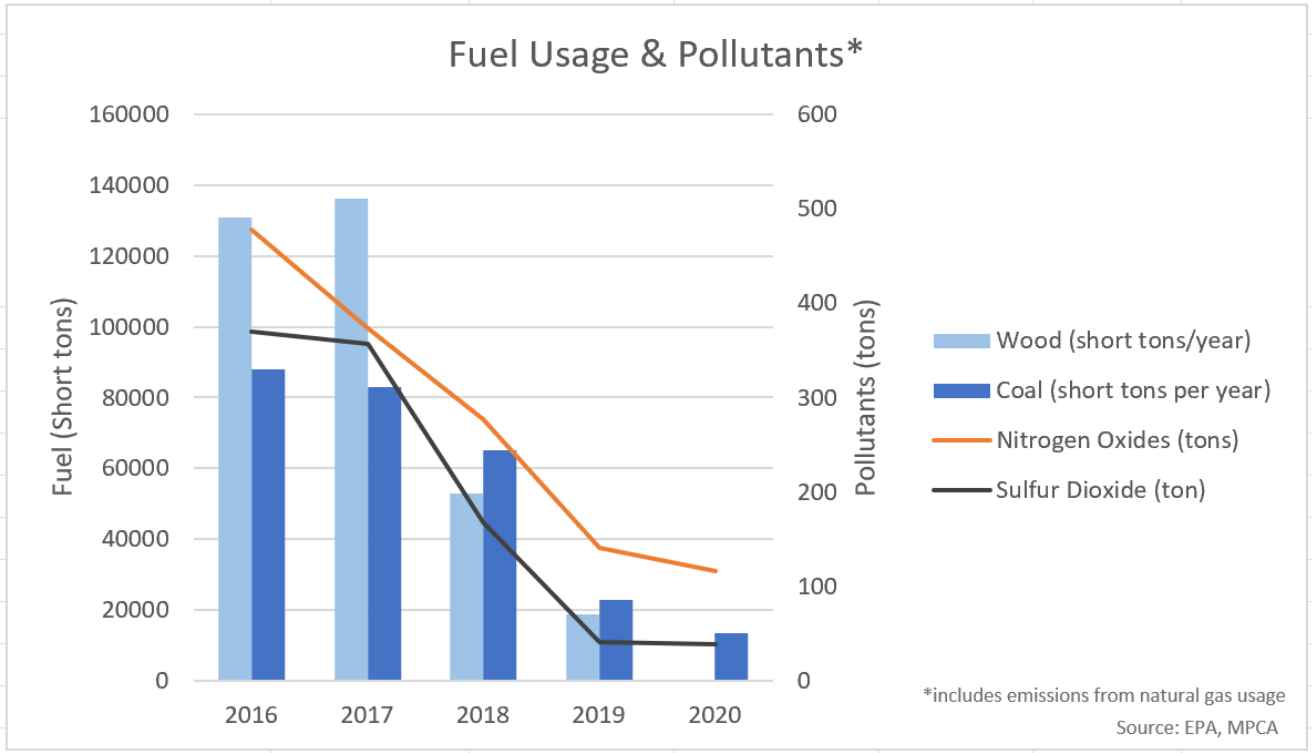
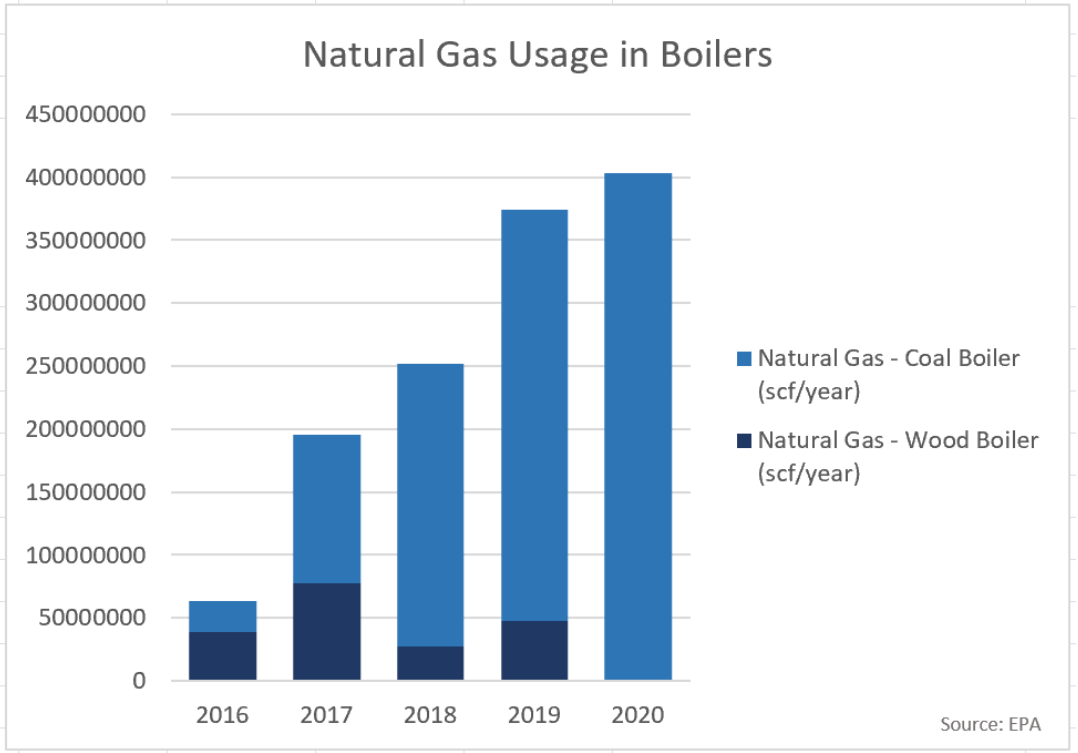
Local & Regional Context

Fuel Usage & Pollutants 2016-2020





- NO_x and SO_x have steadily declined from 2016-2020 due to lower overall load and decrease usage of coal/wood in favor of natural gas. NOx have decreased 75% since 2016.
- In the near future, HPU's commitment to produce electricity and steam at 20MW capacity will rely on a mixture of wood fuel and market purchases. Firing the wood boiler at 130,000 tons/year would create X tons of NOx emissions. Should the wood boiler exceed permitted NOx emissions, the installed SNCR technology can be readily deployed to reduce emissions.

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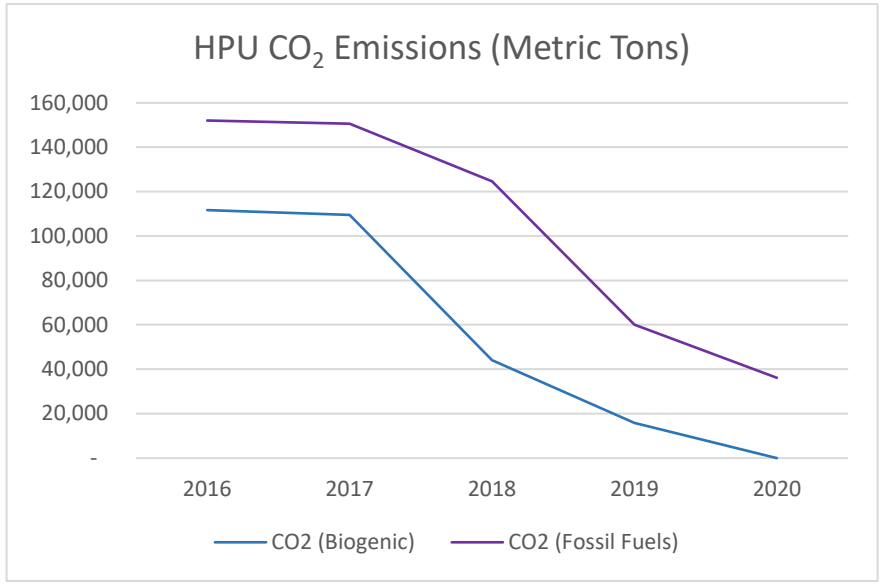
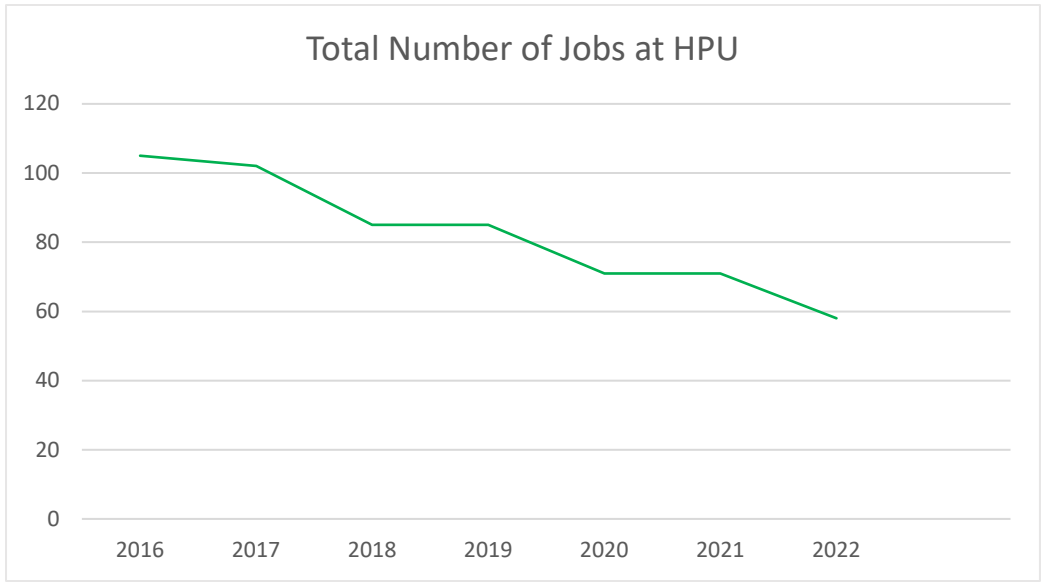
Good decline, bad decline…





Source: EPA, HPU

City of Hibbing: Dramatic decline of the male workforce

From 2015 to 2020, Hibbing (Population 12,600) lost **672 MALE** and **51 FEMALE** workers.
Of the males, 430 left the city or aged out of working age/passed away, and 242 dropped out of the active labor force.

KEY TAKEAWAY: From 2015-2020, **Hibbing lost 7% of its male working age population.**
Of those remaining, male labor force participation dropped by 6.5%.
The female population has stayed the same and labor force participation dropped by less than 1%.

Source: U.S. Census

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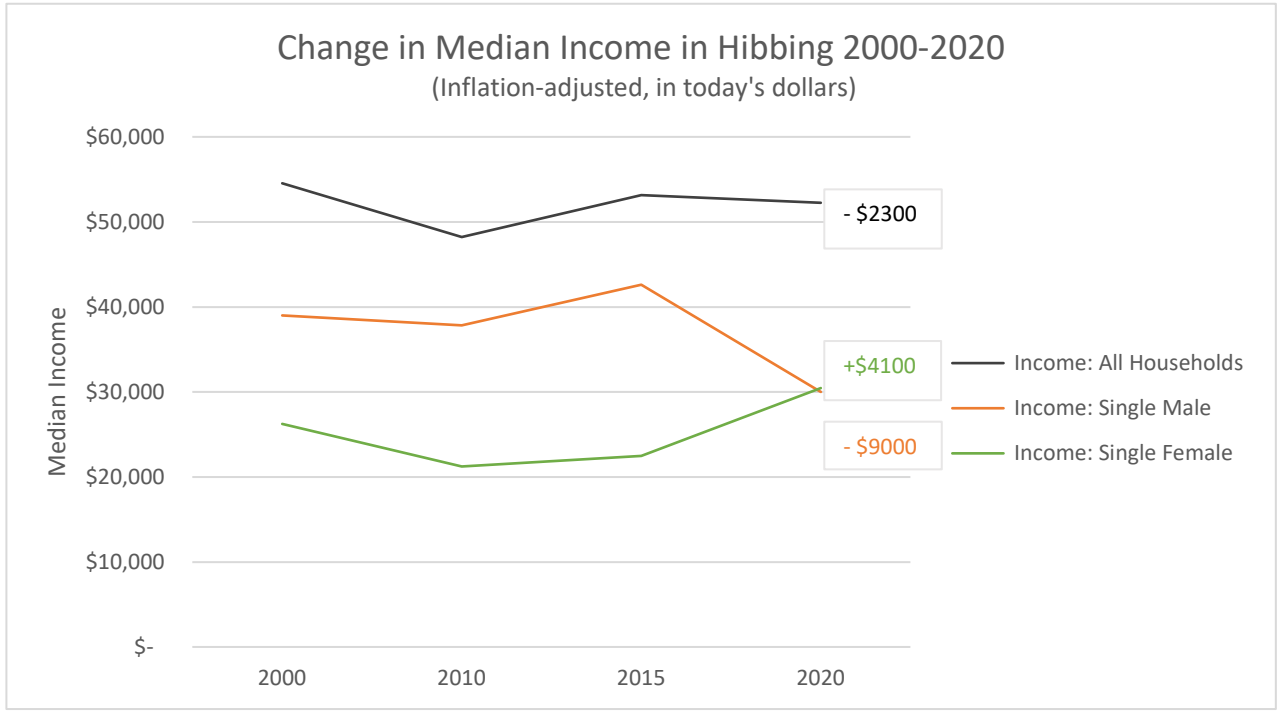
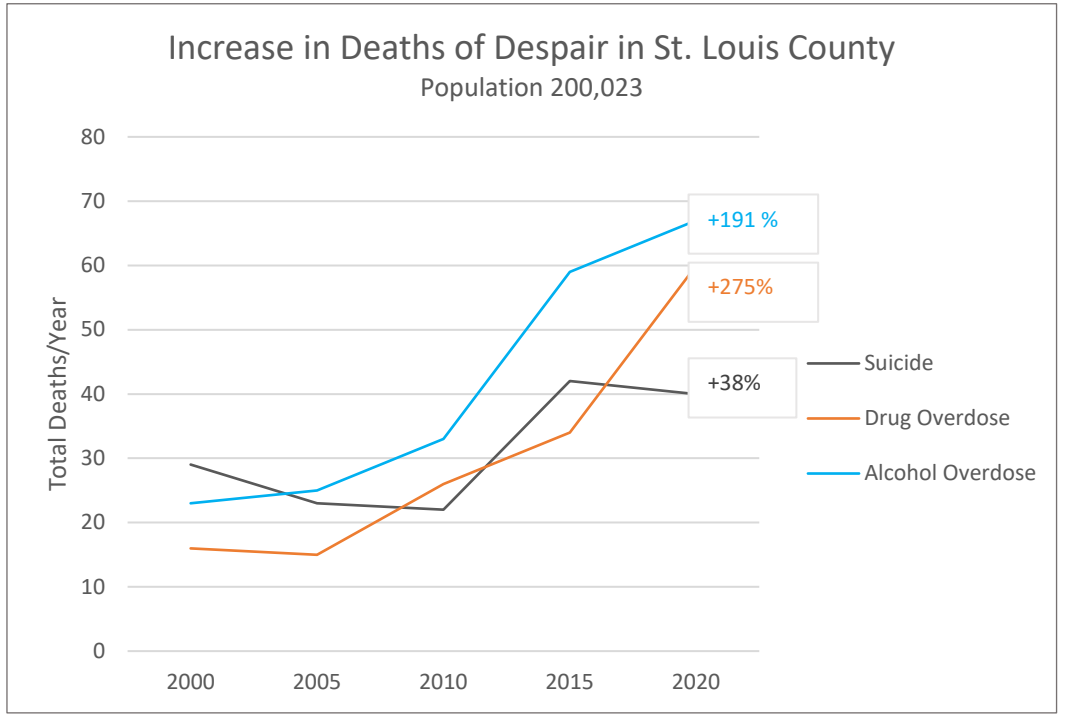
Regional Expressions of Economic & Social Hardship





KEY TAKEAWAY: Median incomes in Hibbing have gone down 4% for all households and 23% for single male households since 2000. **The income decrease for single males since 2015 is 30%.**

KEY TAKEAWAY: Deaths of despair have increased significantly county-wide. Data for Hibbing is not available but likely follows these trends.

Source: U.S. Census, CDC

Short Term Vision: Better Utilization of Existing Assets

Utility Plan: A Path to Restorative Development

How can a clean energy transition catalyze a transition to a new economy in the Iron Range, where the utility can support entirely new industries?

Short Term

Long Term

2024 Goal: Ensure reliable and affordable services to residents

- Extend permit to use coal boilers as a back up for wood boiler
- Optimize use of existing wood boiler and lay the groundwork for expansion
- Create plan to position utility as catalyst for economic transition

2028 Goal: Provide reliable, affordable and clean energy:

- Phase out coal in favor of sustainably sourced wood, thereby significantly reducing SOx emissions and controlling for NOx
- If deemed feasible, phase in renewable energy to support hydrogen hub
- Begin to phase in new industries (i.e. CO_2-to-methanol to fuels/olefins) to support economic transition

2050 Goal: Net-positive economic, social and environmental performance

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Utility Plan: Big Picture Considerations

Investments in increased efficiency: Due to aging infrastructure and system inefficiencies, the current system is only about 30 percent efficient. Some strategies:

- Investments in infrastructure upgrades to increase system efficiencies
- Increase district heating and cooling system to new residents, commercial and industrial customers
- Reuse waste heat to improve quality of life, i.e. heated sidewalks, heated sports fields, etc.

Locally sourced biomass: Increased demand for biomass from HUP could have economic, social and environmental benefits for the region:

- Using waste wood from Minnesota forests can provide carbon reduction benefits (CO_2 is captured and reused as methanol, rather than released into atmosphere through decomposition) (any calculation on this?)
- Increased demand for forest residue could incentivize increased forest management, thereby reducing the risk of wildfires and associated emissions.
- Hibbing could attract the state's first cross-laminated timber (CLT) manufacturer and utilize wood waste as fuel

Iceland uses waste heat from homes (water at 86F) to melt snow on sidewalks and parks.

Long Term Vision: Restorative Development in the Iron Range

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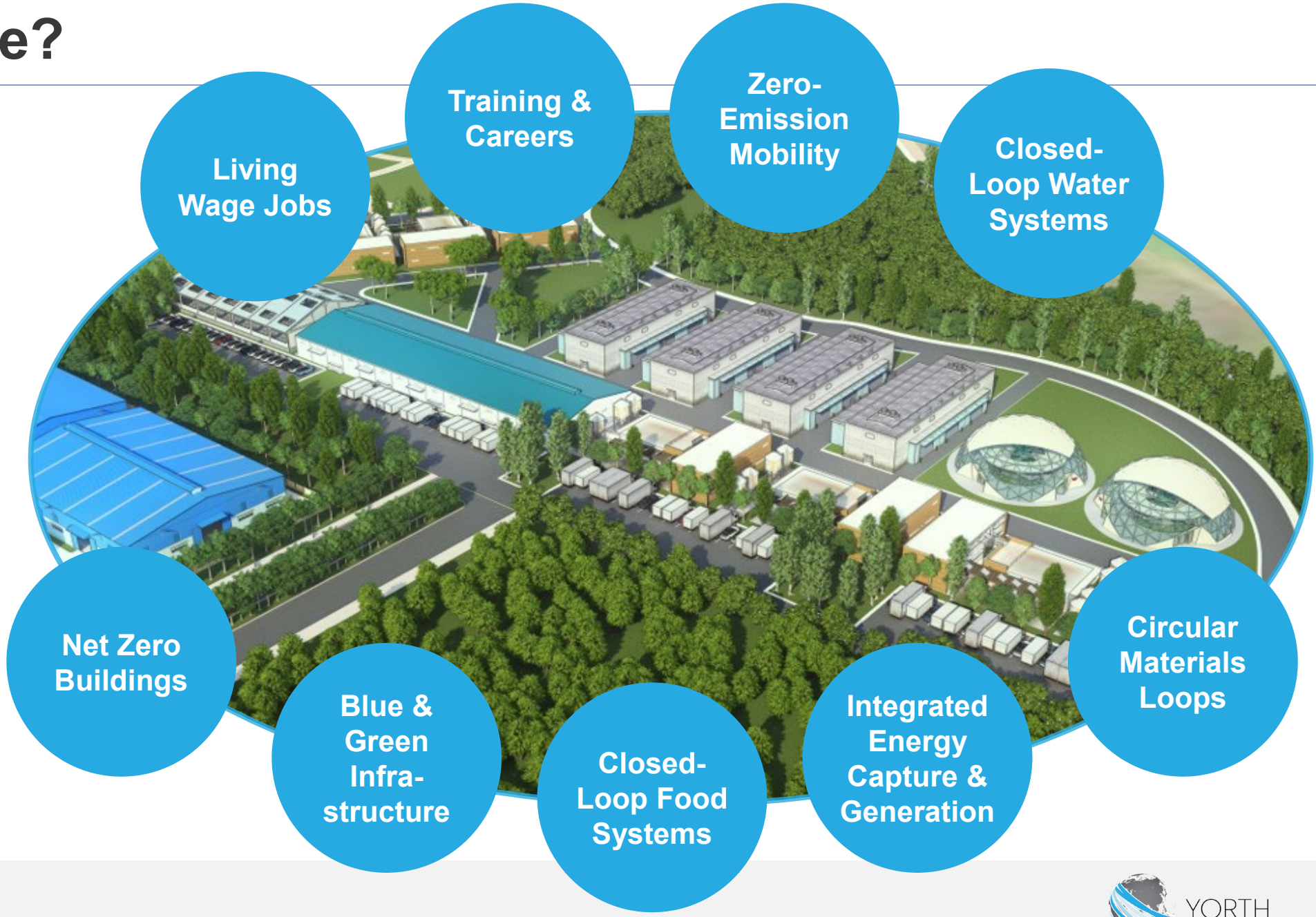
Key Ingredient #1: Circular Vision

A new way of economic and regional development

What's possible?

Local and regional goals will not be achieved through investment in current infrastructure and systems.

Hibbing Public Utilities could serve as a catalyst for a transition towards circular regional development.



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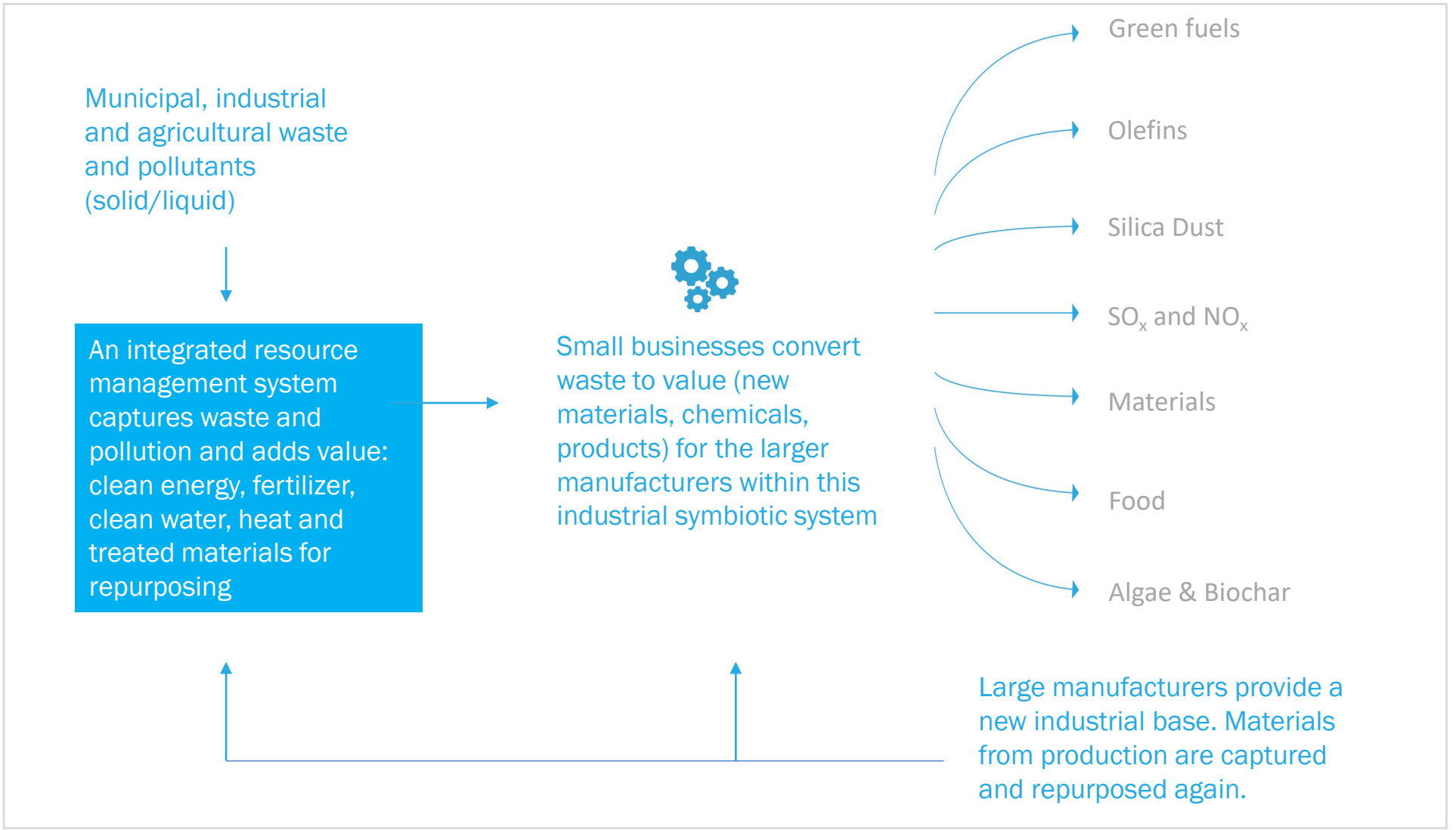
Circular Development: Logic Model

The utility of the future is a resource management organization that connects energy, water, food and materials systems.

This visual describes the logic model of resource management in a circular system, where closed-loop systems create continuous cycles of value creation.



Key Ingredient #2: Wood & Biomass

Diversifying the regional economy through a sustainable resource.

Why transition from coal to wood?

Regional Haze Goals

- Compared to coal, using wood as fuel nearly eliminates SOx to meet the Regional Haze goals.
- The existing wood boiler has NO_2 reduction technology installed, and future boilers can be outfitted with them.

Carbon Reduction Goals

- Even as the carbon impact of biomass is subject to debate, wood-fired combined heat and power (CHP) is a viable option in Northern Minnesota, which has plenty of wood residue and fewer other renewable energy sources.

New Industry

- The Iron Range could be home to a cross-laminated timber (CLT) plant, manufacturing this non-toxic, carbon-capturing “building material of the future” and generating residue for the power plant.
- A scaled-up HPUC facility that supplies multiple industrial customers with biomass energy could also make a wood pellet manufacturer viable in Minnesota.

CLT or mass timber, the building material of the future.

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Case Study: CLT Manufacturer in Austria

The powerplant of CLT manufacturer *binderholz* moonlights as an event center, restaurant, and art exhibition space in Austria.

[Visit the Feuerwerk Website]

Key Ingredient #3: Hydrogen

Green hydrogen is key to achieving regional and national energy goals .

Why transition to hydrogen?

Benefits for the City of Hibbing

- Key to net-zero development
- Basis for new industrial development and move from raw-material only to a value-added economy
- Supplement fuel for heating
- Possible energy storage to hedge against seasonal fluctuations of energy prices

Benefits for Regional Economy

- Methanol production + new chemical industries
- Fuel for mining dump trucks
- Fuel for heavy-duty transport, including trucks, rail and ships
- Decarbonization of steel production (caveat: currently not MN-based)
- Many more applications TBD

Komatsu aims for lead in hydrogen-powered mining trucks

Caterpillar rival looks to keep pace with resource groups' shift away from carbon

> Are hydrogen hubs the key to unlocking the storage and distribution challenge for heavy-duty mobility?

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Ways to produce hydrogen (commercialized tech)

- **Electrolysis of water, preferably from renewable energy**
  - Solar installations on top of mine tailings
  - Regional untapped potential for hydropower?
  - Wind could become more competitive with hydrogen as storage
  - Import of excess renewable energy in MN (?)

- **Reformation of natural gas**
  - Low-carbon way to create “blue” hydrogen if done from CCS
  - Not net-zero, but qualifies for federal subsidies

- **Gasification of biomass**
  - Conventional H_2 production from biomass creates CO_2, but new technology/processes are working to improve the equation.
  - Use case: A region in Bavaria, Germany seeks to become a hydrogen hub based solely on clean biomass gasification.

Chevron Turns Mine Tailings into Solar Farm

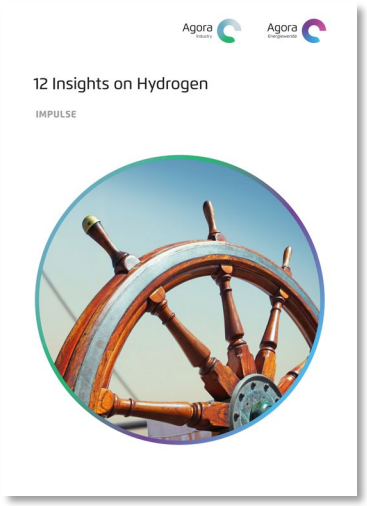
By Admin

May 17, 2020 • 3 mins

This 1MW demonstration plant powers 300 New Mexican homes. A similarly sized installation (2MW) exists in Grand Rapids, MN, also powering 300 homes.

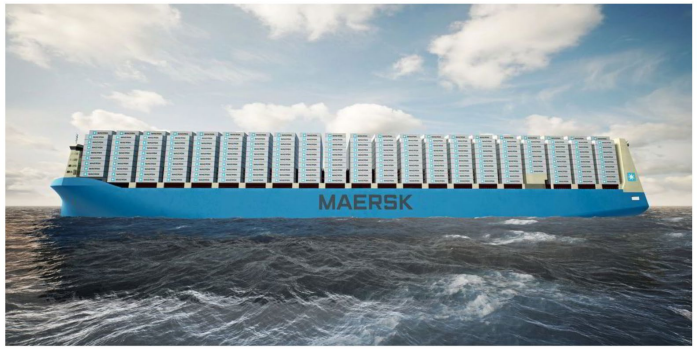
Scaling up: towards a regional hydrogen & e-fuels cluster?

Developing a hydrogen strategy at a regional scale may augment overall feasibility. Some ideas are mapped below, but many more are surely waiting to be uncovered.



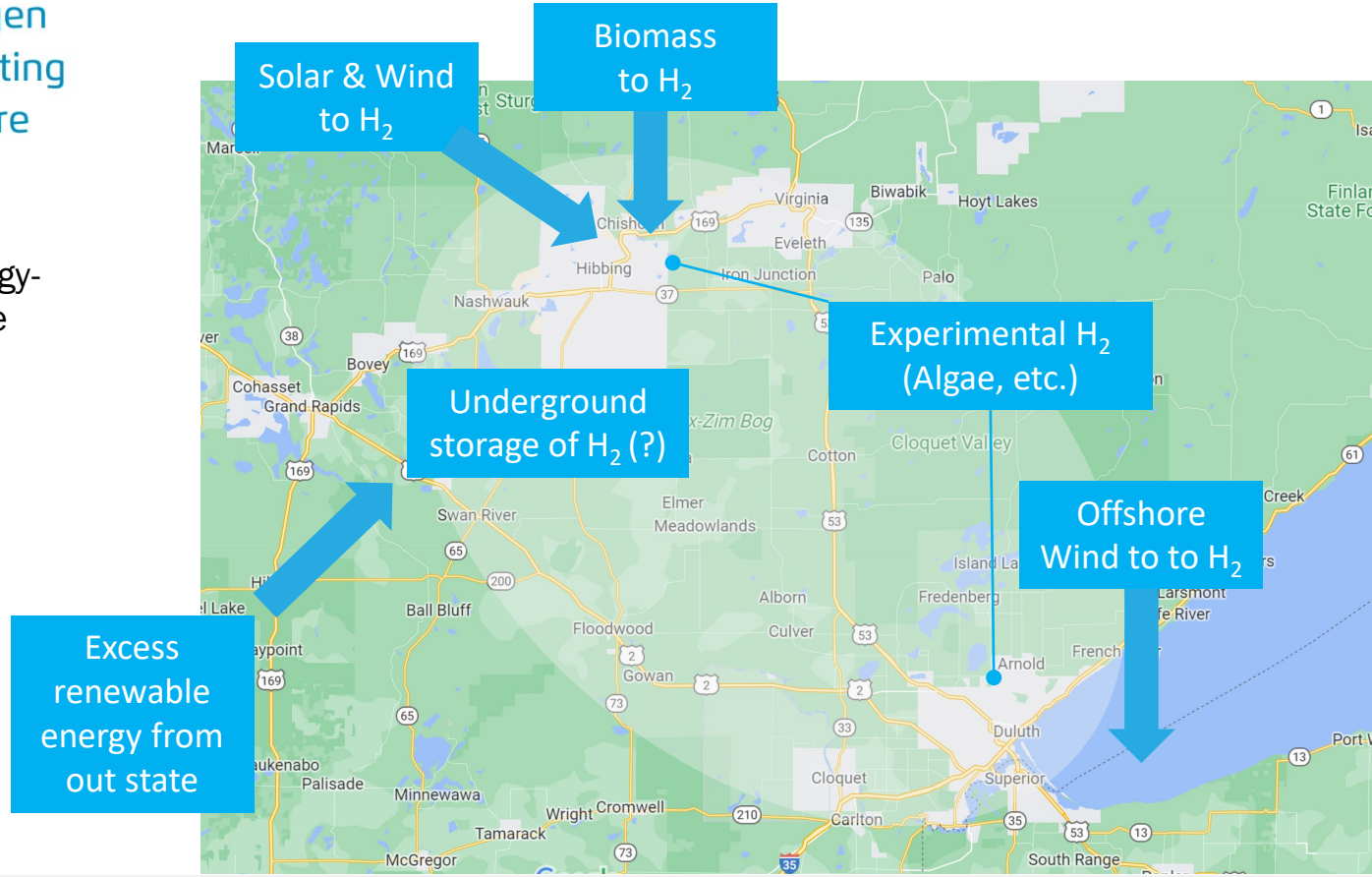
> Ports will be a hotspot for a hydrogen refuelling infrastructure and a meeting place for industry users and offshore renewables

Ports are often home to clusters of energy-intensive industries that would make the deployment of local hydrogen networks worthwhile.



Shipping giant Maersk to become major green hydrogen consumer as it embraces methanol fuel

Maersk will use green hydrogen to create renewable methanol for 12 ships.



Key Ingredient #4: Methanol

Capturing CO_2 from utilities and industrial process to create e-fuels and value-added products.

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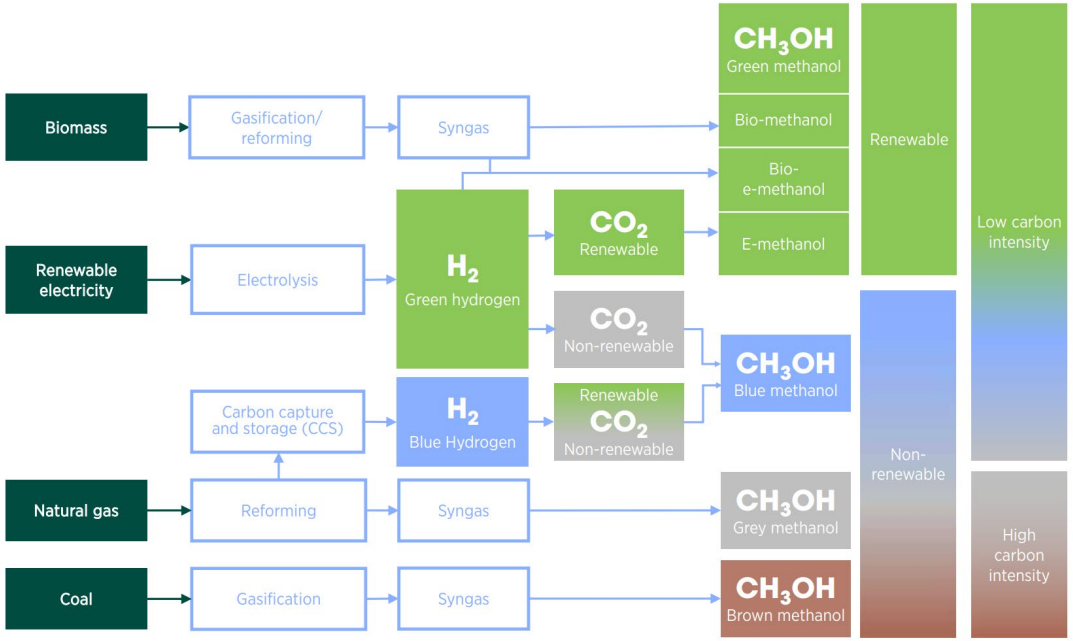
Why transition to green methanol and other fuels?

- Methanol and other e-fuels are close relatives to hydrogen and can be used for various industrial applications
- Methanol is **liquid at ambient temperature** and can utilize existing infrastructure like tanks, pipelines, and fueling stations as well as existing propulsion technologies.
- It produces very low pollutant emissions: no SOx, no soot (PM), and very low NOx.
- Renewable methanol can be created from biomass and municipal solid waste (bio-methanol) or from captured CO_2 and hydrogen. (E-methanol)

Read more: [Innovation Outlook "Renewable Methanol" by the International Renewable Energy Agency]

Figure 19. Proposed classification of methanol from various feedstocks



Source: Innovation Outlook "Renewable Methanol" by the International Renewable Energy Agency

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Methanol Market Outlook

- The global methanol market is projected to grow from $29b in 2021 to $39b in 2028 at a CAGR of 4.5%
  - Rising demand from the construction and automotive industries due to shift towards greener fuels and materials.
  - Demand may further increase due to renewed need for energy independence.
- The global olefin market is projected to grow from $21 billion in 2021 to $30 billion by 2027 at a CAGR of 6.13%.
  - Olefins are used to manufacture several key plastics, polymers and resins such as Polyethylene.
  - Olefin fibers are 100% recyclable.

Methanol end-use industries:

- Construction
- Automotive
- Electronics
- Appliances
- Paints & Coatings
- Insulation
- Pharmaceuticals
- PET plastic 100% recyclable
- Packaging (PET bottles)
- Solvents
- Others

Carbon Recycling International's methanol plant in Iceland, just one of many such plants.

Towards Net–Zero through Industrial Symbiotic Development

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3 Phases Towards an Industrial Symbiotic Community

Municipal, industrial and agricultural waste and pollutants (solid/liquid)

An integrated resource management system captures waste and pollution and adds value: clean energy, fertilizer, clean water, heat and treated materials for repurposing

Small businesses convert waste to value (new materials, chemicals, products) for the larger manufacturers within this industrial symbiotic system

Phase 1	Green fuels	Methanol Clean electricity Steam Hydrogen
Phase 2	Olefins	Bioplastics Green textiles
	Silica Dust	Bricks Concrete
	SO_x and NO_x	Fertilizer Pharmaceuticals Other chemical industries
	Materials	
Phase 3	Food	
	Algae & Biochar	

Materials from production are captured and repurposed again.

3 Phases Towards an Industrial Symbiotic Community

Phase 1: Methanol plant

A green methanol plant captures CO_2 from HPU's utility operations and converts it to renewable methanol.

Phase 2: Chemical Industry Cluster

Methanol can be sold or turned into olefins, which serve as an input for diverse industries to manufacture bioplastics, fertilizers, adhesives, dye, pharmaceuticals, etc. Byproducts from nearby mining can become additional input materials, for example silica dust can be turned into concrete and brick production for road and building construction.

Phase 3: Full industrial symbiosis

Value can be created from municipal and industrial waste streams (solid and liquid) through anaerobic digestion and water treatment, with outputs used for fish farms, greenhouse, algae and biochar production. Green and blue infrastructure provides high quality of life and an attractive destination for visitors, companies and investments.

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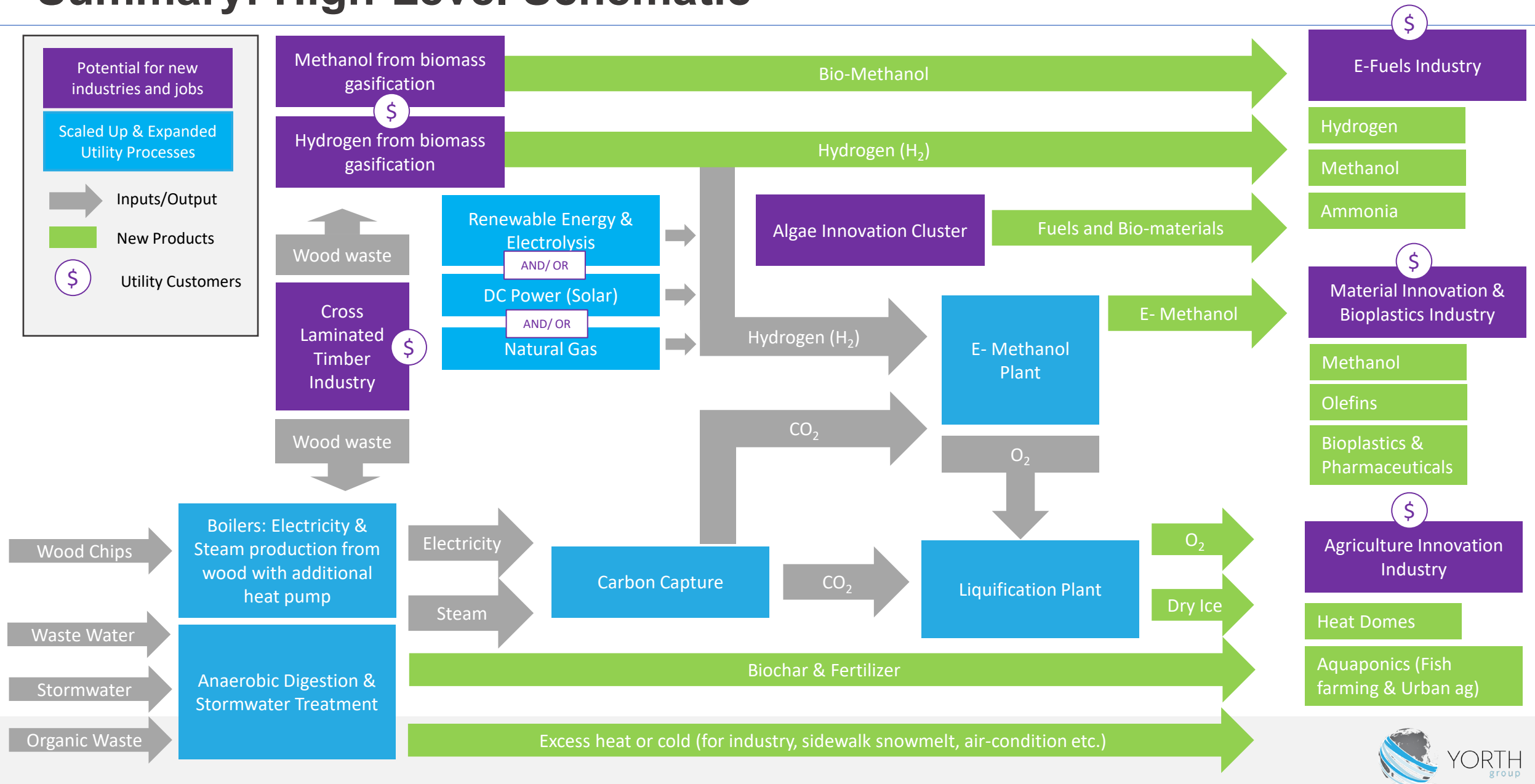
Summary:
High-Level Schematic

Summary: High-Level Schematic



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Thank you!

For questions, please contact:

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