Michigan Renewable Natural Gas Study
Stakeholder Meeting #1

Philip Sheehy
Technical Director, ICF

January 10, 2022

Some ground rules

Lines will be muted.

Submit questions in the chat box.

We're recording!

Submit written questions to Virginia Halloran (HalloranV@michigan.gov) via email on or before Jan 24. Comments will be posted publicly.

Technical issues? E-mail Merideth Hadala, HadalaM@michigan.gov.

Scheduled break from 3:15PM to 3:30PM.

Agenda

- Introduce Study Team
- Background on Study
- Review Study Approach
- Study Timeline

ICF: An Overview

A growing company since 1969

Global advisory, digital services provider

Over 7,000 people

Headquartered outside Washington, D.C. with **70+ offices worldwide**

Publicly traded with **$1.51B** in annual revenue

RNG Highlights

Strategic **decarbonization support and analysis** for diverse clients

Premier **environmental commodity forecasting** for project financing

RNG resource assessment for New York State Research and Development Authority

Technical support to policymakers considering **low carbon fuel programs**

Conducted **national-level RNG resource assessment** in 2019

Completed more than **35 certified fuel pathways** for RNG into California's LCFS

Prime contractor to US EPA's Office of Transportation and Air Quality

Owner and independent **engineering support** for project developers

ICF Team

Philip Sheehy

Dr. Sheehy has more than fifteen years of experience in the transportation and energy sectors. His work at ICF is focused on the regulatory, technical, and economic drivers for conventional and alternative fuels and advanced vehicle technologies. Dr. Sheehy leads ICF's work on issues including but not limited to RNG, transportation electrification, fueling infrastructure assessments, emission impacts of transportation fuels, and vehicle technology assessments.

Maurice Oldham (Mullion)

Mr. Oldham is a senior consultant with more than 13 years of experience from the public and private sectors related to decarbonization policy development. He leads Mullion's contribution to climate and energy projects, focused on North America for diverse clients, including governments, corporations, utilities and non-government organizations.

Background on RNG Study

Why we are doing this work

Public Act 87, Public Acts of 2021 | Approved Sept 2021

Section 1002, (1)

1) From the funds appropriated in part 1 for public service commission renewable natural gas study, the public service commission must conduct a study into the potential for renewable natural gas development in this state. The study shall do all of the following:
   a) Identify existing and potential sources of renewable natural gas in this state and provide, to the greatest extent possible, an estimate of the energy content and greenhouse gas abatement potential of these sources.
   b) Estimate the cost per unit of heat, should the potential sources of renewable natural gas identified in subdivision (a) be utilized to the greatest practical extent.
   c) Estimate the greenhouse gas emission reduction, per unit of heat, that would be achieved should the potential sources of renewable natural gas in subdivision (a) be utilized to the greatest practical extent.
   d) Compare the estimated per-unit cost savings of greenhouse gas emission reductions estimated for RNG sources to the estimated per-unit cost savings likely to be achieved by comparable use of other carbon abatement technologies, including, but not limited to, hydrogen blending, building electrification, and similar technologies.
   e) Estimate the production potential by applicable feedstock sources for renewable natural gas in this state.
   f) Identify barriers to developing and utilizing renewable natural gas in this state.

Why we are doing this work, ctd

Public Act 87, Public Acts of 2021 | Approved Sept 2021

Section 1002, (2) and (3)

2) The commission shall identify and engage interested stakeholders in the development of the study provided for in subsection (1). The commission may engage an independent contractor to conduct the study under the commission's direction.
3) By July 30, 2022, the commission shall submit a draft report on the study to interested stakeholders for comment to the commission. By September 30, 2022, the commission shall submit a final report to the standing committees of the senate and house with primary jurisdiction over energy and environmental issues.

Study Approach and Outline

Study Objectives

Broadly speaking, the work seeks to answer three questions:

What is the RNG production potential from Michigan-based resources?

What is the corresponding greenhouse gas (GHG) emission reduction potential?

How much will the RNG cost?

And how does the abatement cost of RNG compare to other abatement strategies?

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Project Review: Objectives and Scope

Assess the theoretical, feasible, and achievable potential for renewable natural gas (RNG) development for injection into natural gas pipelines or use as a transportation fuel and carbon abatement in Michigan. Three distinct resource potential scenarios with clearly defined characteristics:

1) **Theoretical**: a higher-level analysis of all the potential methods of generating RNG by feedstock sources and develop a list of sources.
2) **Feasible**: will include any sources of RNG that are applicable to MI while eliminating sources from the theoretical list due to relative cost effectiveness.
3) **Achievable**: a smaller subset list of sources based on technical, economic, and environmental factors.

Analysis will consider different end uses of the RNG supply, including:

Onsite electricity generation | Industrial consumption | Transportation fuel | Pipeline injection

Study will also include an analysis of RNG production costs and the GHG emissions from the development, production and deployment of RNG.

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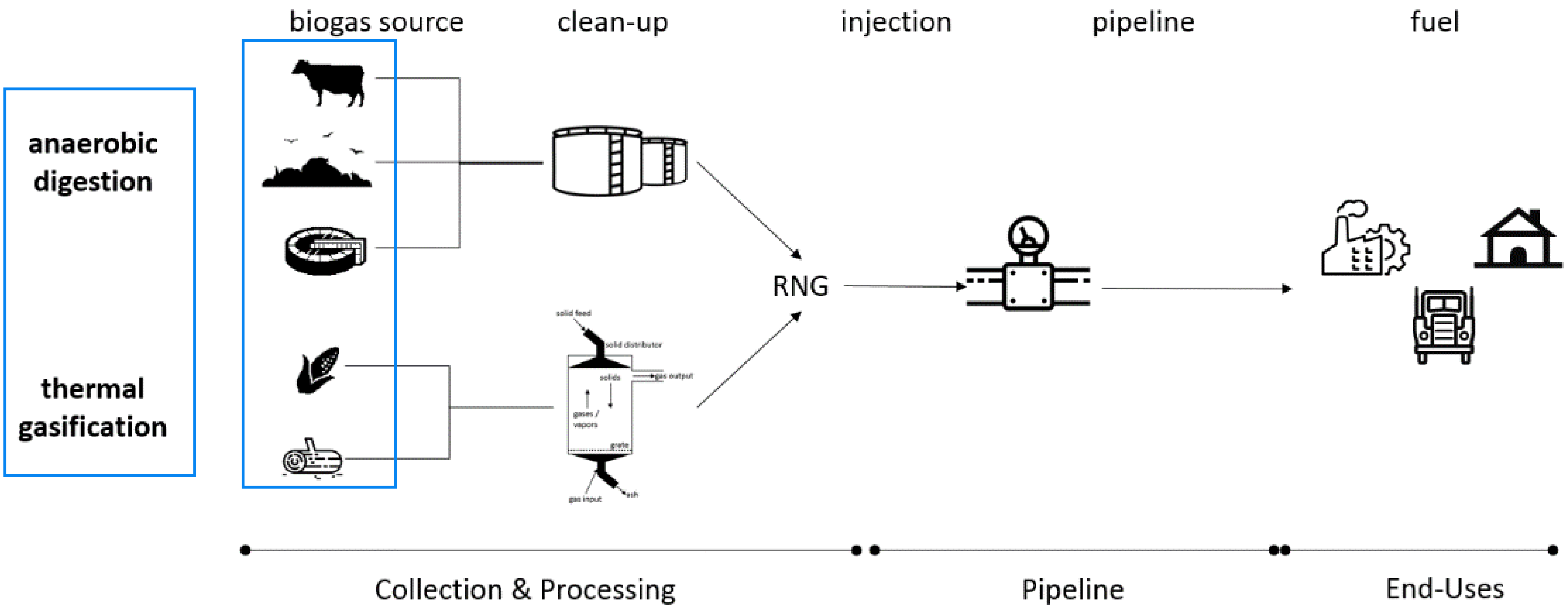
Overview of RNG Production

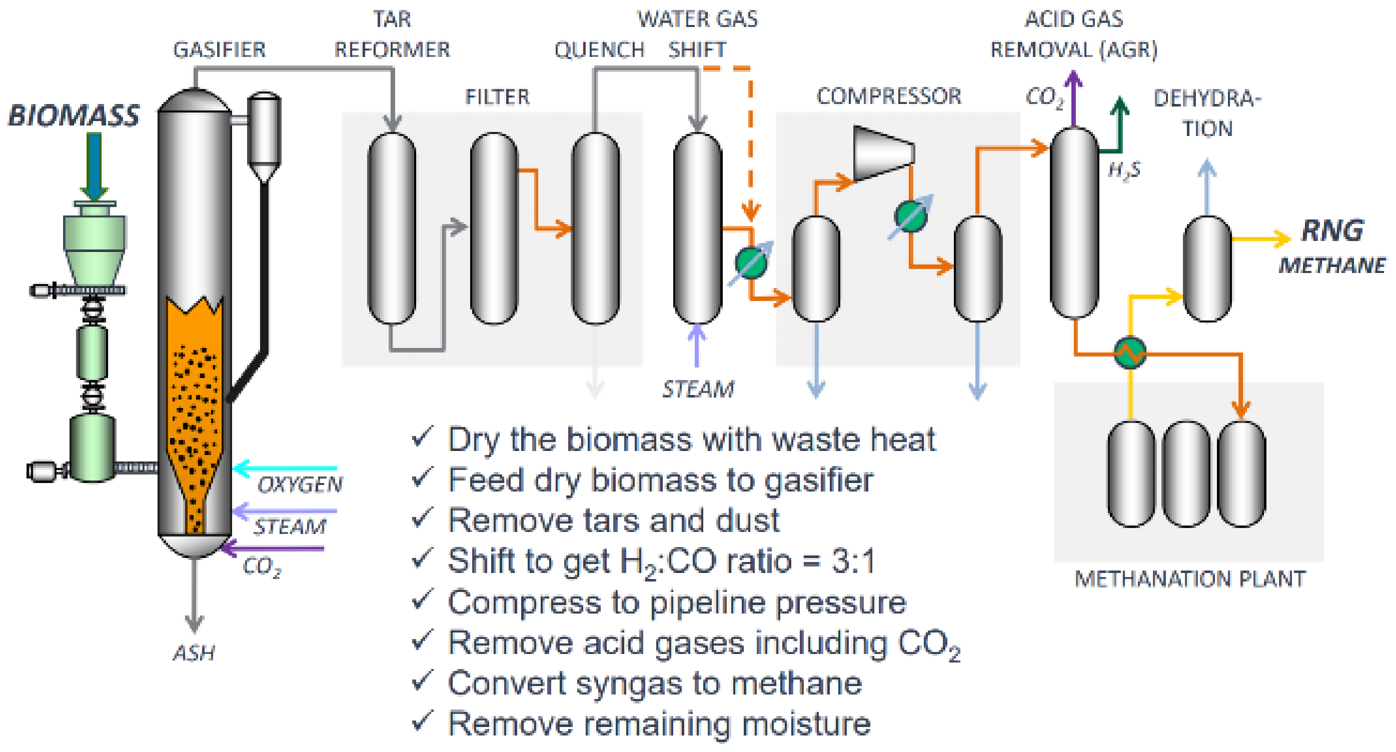


Anaerobic Digestion (AD) of Waste

- Most common way to produce RNG.
- Microorganisms break down organic material to produce 'biogas' – a combination of methane, carbon dioxide and other constituents.
- AD process generally takes place at a landfill or in a controlled environment, referred to as a digester or reactor.
- Landfills break down organic matter over a number of years, with a gas collection and control system used to extract the raw biogas.
- Organic material in a digester is broken down by microorganisms over a shorter time (e.g., days).
- Biogas is subsequently upgraded and conditioned to yield RNG (biomethane), and capable for injection into common carrier natural gas pipelines.

Thermal Gasification (TG) of Renewable Resources

- TG reflects a broad range of processes that convert carbon-based feedstocks to synthetic gas, or 'syngas'.
- Syngas can include hydrogen, carbon monoxide, steam, carbon dioxide, methane, and trace amounts of other gases.
- Process generally occurs at high temperatures and varying temperatures (depending on the gasification system).



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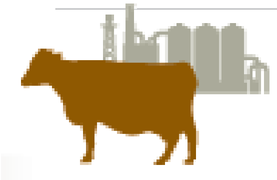
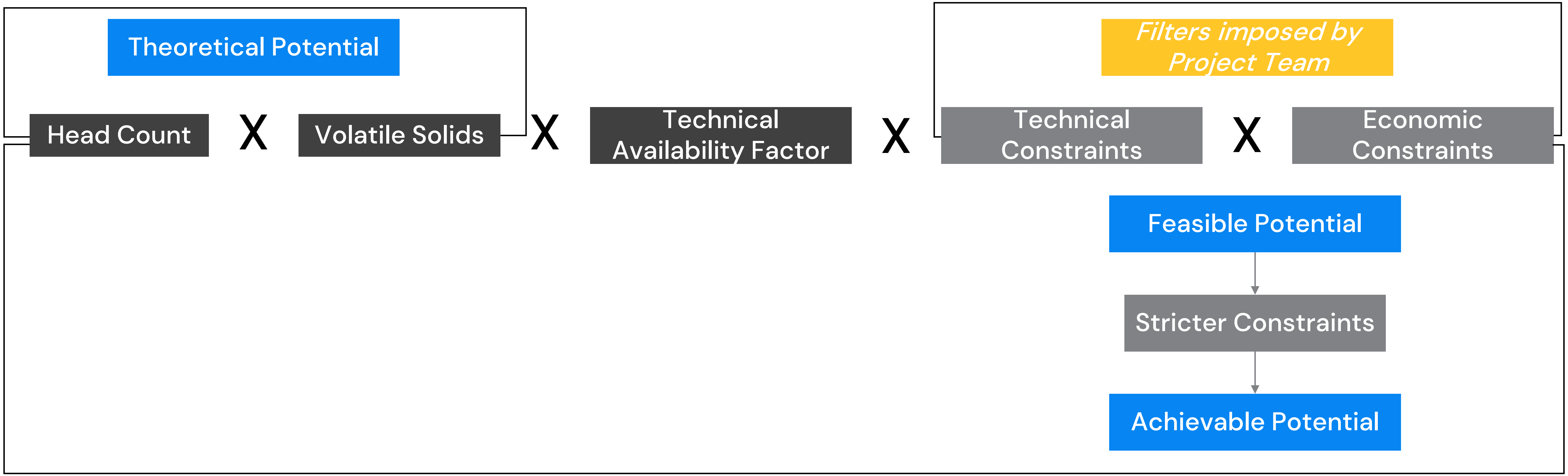
Feedstocks for RNG Production

	Feedstock for RNG	Description	Key Resources for Assessments
Anaerobic Digestion	Animal manure	Manure produced by livestock, including dairy cows, beef cattle, swine, sheep, goats, poultry, and horses.	▪ U.S. Environmental Protection Agency (EPA) AgStar Project Database ▪ U.S. Department of Agriculture (USDA) Census of Agriculture
Anaerobic Digestion	Food waste	Commercial, industrial and institutional food waste, including from food processors, grocery stores, cafeterias, and restaurants.	▪ U.S. Department of Energy (DOE) 2016 Billion Ton Report ▪ Bioenergy Knowledge Discovery Framework (KDF)
Anaerobic Digestion	LFG	The anaerobic digestion of organic waste in landfills produces a mix of gases, including methane (40–60%).	▪ U.S. EPA Landfill Methane Outreach Program ▪ Environmental Research & Education Foundation (EREF)
Anaerobic Digestion	WRRF	Wastewater consists of waste liquids and solids from household, commercial, and industrial water use; in the processing of wastewater, a sludge is produced, which serves as the feedstock for RNG.	▪ U.S. EPA Clean Watersheds Needs Survey (CWNS) ▪ Water Environment Federation
Thermal Gasification	Agricultural residue	The material left in the field, orchard, vineyard, or other agricultural setting after a crop has been harvested. Inclusive of unusable portion of crop, stalks, stems, leaves, branches, and seed pods.	▪ U.S. DOE 2016 Billion Ton Report ▪ Bioenergy Knowledge Discovery Framework
Thermal Gasification	Energy crops	Inclusive of perennial grasses, trees, and annual crops that can be grown to supply large volumes of uniform and consistent feedstocks for energy production.	▪ U.S. DOE 2016 Billion Ton Report ▪ Bioenergy Knowledge Discovery Framework
Thermal Gasification	Forestry and forest product residue	Biomass generated from logging, forest and fire management activities, and milling. Inclusive of logging residues, forest thinnings, and mill residues. Also materials from public forestlands, but not specially designated forests (e.g., roadless areas, national parks, wilderness areas).	▪ U.S. DOE 2016 Billion Ton Report ▪ Bioenergy Knowledge Discovery Framework
Thermal Gasification	Municipal solid waste (MSW)	Refers to the non-biogenic fraction of waste that would be landfilled after diversion of other waste products (e.g., food waste or other organics), including construction and demolition debris, plastics, etc.	▪ U.S. DOE 2016 Billion Ton Report ▪ Waste Business Journal

Renewable Natural Gas: Feedstock to Production Potential



Illustrative Approach for Animal Manure to RNG Production Potential



Renewable Natural Gas: Feedstocks

Illustrative Scenarios re: Feedstock Utilization | Achievable, Feasible, and Optimistic

Feedstock for RNG		Achievable	Feasible	Optimistic
Anaerobic Digestion	Animal manure	30% of technically available	45% of technically available	60% of technically available
	Food waste	40% @ $70/ton	55% @ $70/ton	70% @ $70/ton
	LFG	Collection in place: 25% Candidate landfills: 25%	Collection in place: 50% Candidate landfills: 50%	Collection in place: 75% Candidate landfills: 75%
	WRRF	30% of facilities w/ >7.5MGD	60% of facilities w/ >7.5MGD	90% of facilities w/ >3.3MGD
Thermal Gasification	Agricultural residue	30% @ $40/ton	40% @ $60/ton	50% @ $80/ton
	Energy crops	30% @ $40/ton	40% @ $60/ton	50% @ $80/ton
	Forestry & forest product residue	30% @ $40/ton	45% @ $60/ton	50% @ $80/ton
	MSW	30% @ $40/ton	45% @ $60/ton	60% @ $80/ton
% of Total Feedstock		~20%	~35%	~50%

Renewable Natural Gas: Michigan's Resource Potential

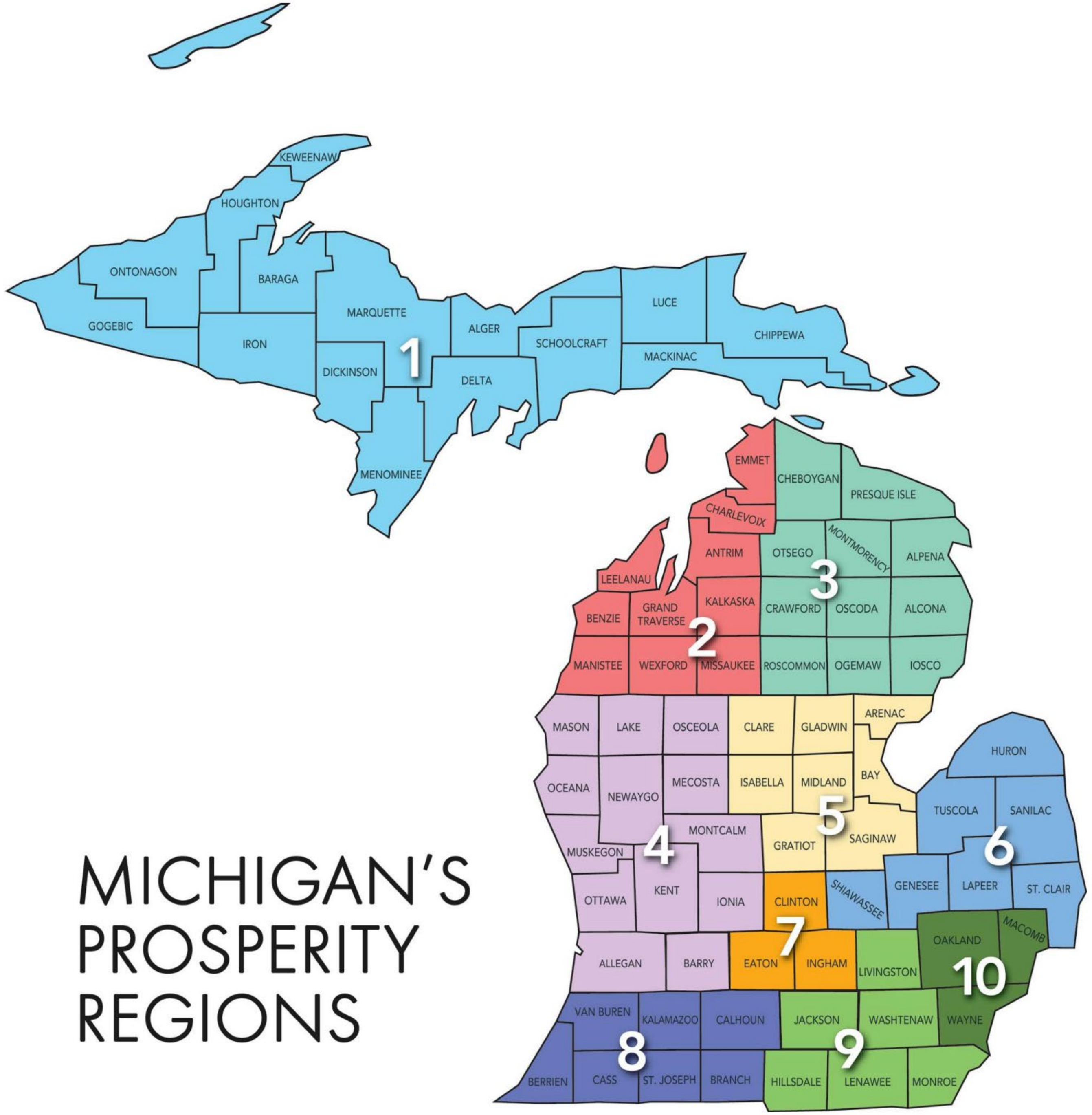
ICF seeks to present the RNG potential in a way that is accessible.

Challenge:

- State-level: Not granular enough / too high level
- County-level: Too many (83 Counties); get lost in detail

Proposed approach

- Use Michigan's 10 Prosperity Regions



Renewable Natural Gas: Production Cost Inputs

Capital Costs

Facility Sizing

- Differentiate by feedstock and technology type: anaerobic digestion and thermal gasification.
- Prioritize larger facilities to the extent feasible

Gas Conditioning & Upgrade

- Vary by feedstock and technology

Compression

- Capital costs for compressing the conditioned/upgraded gas for pipeline injection

+

O&M Costs

Operational Costs

- Operational Costs for each equipment type including utility charges for estimated electricity and natural gas consumption.

Feedstock

- Feedstock costs (for thermal gasification), ranging from $30 to $100 per dry ton.
- Can be revenue rather than cost e.g., via tipping fees

Delivery

- Financing, constructing, and maintaining a pipeline to deliver RNG: $1 to $5/MMBtu.

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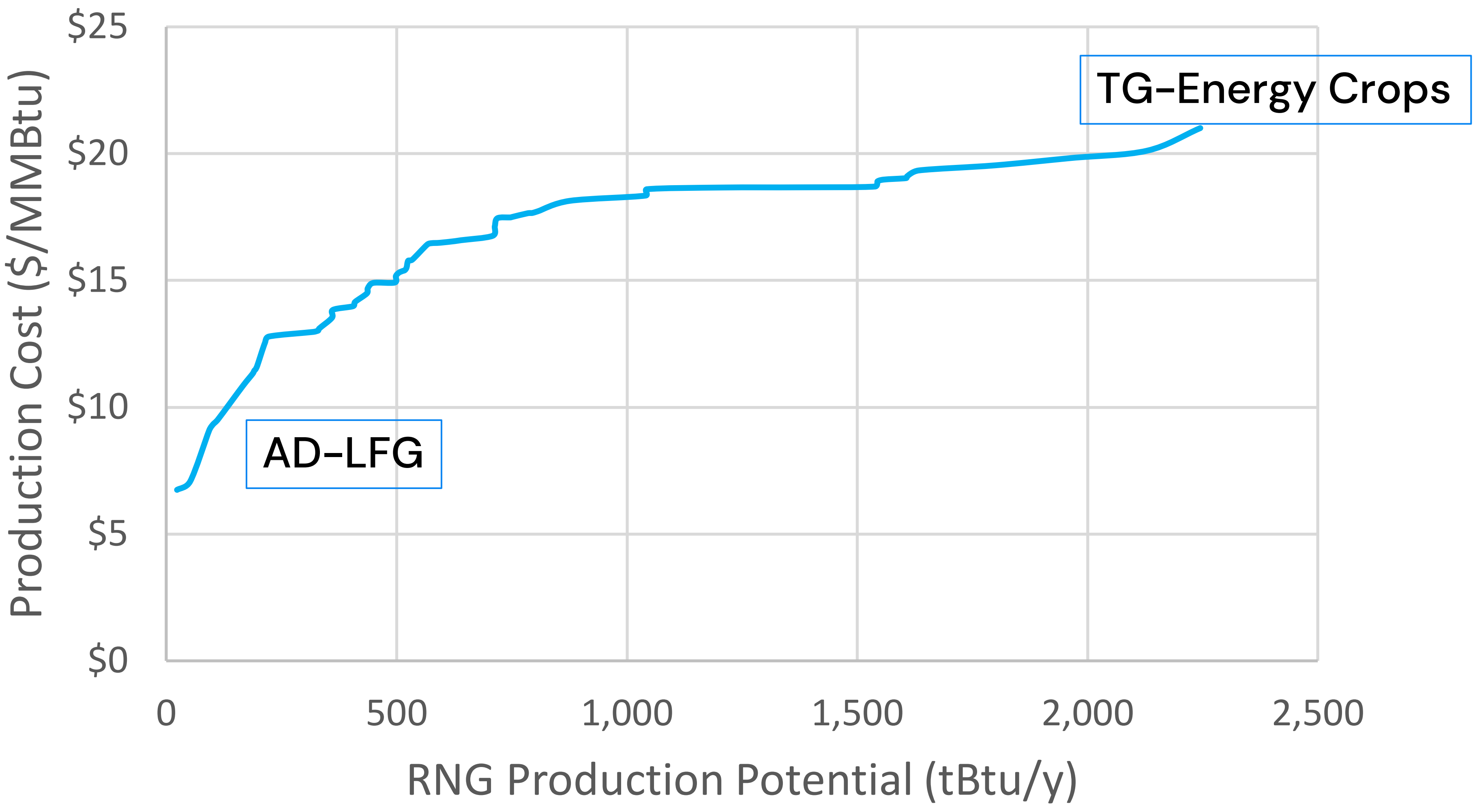
Levelized Cost of Gas $/Mmbtu

Calculated based on the initial capital costs in Year 1, annual operational costs discounted, and RNG production discounted accordingly over a 20-year project lifetime.

RNG Production Costs from Previous Work

- Supply curve is built up on a **facility-by-facility** basis where possible
- Account for **cost reductions** to the extent feasible
- Characterize resources by **production technology and feedstock**



Background

- GHG emission accounting is a common practice that is used to evaluate the respective GHG impacts of various energy sources or fuels, and to enable comparison between them. GHG emission accounting is used in practice by regulators and private actors for a variety of reasons, including to develop GHG emission inventories, as part of broader environmental reports, and to track carbon as an environmental commodity in carbon markets.

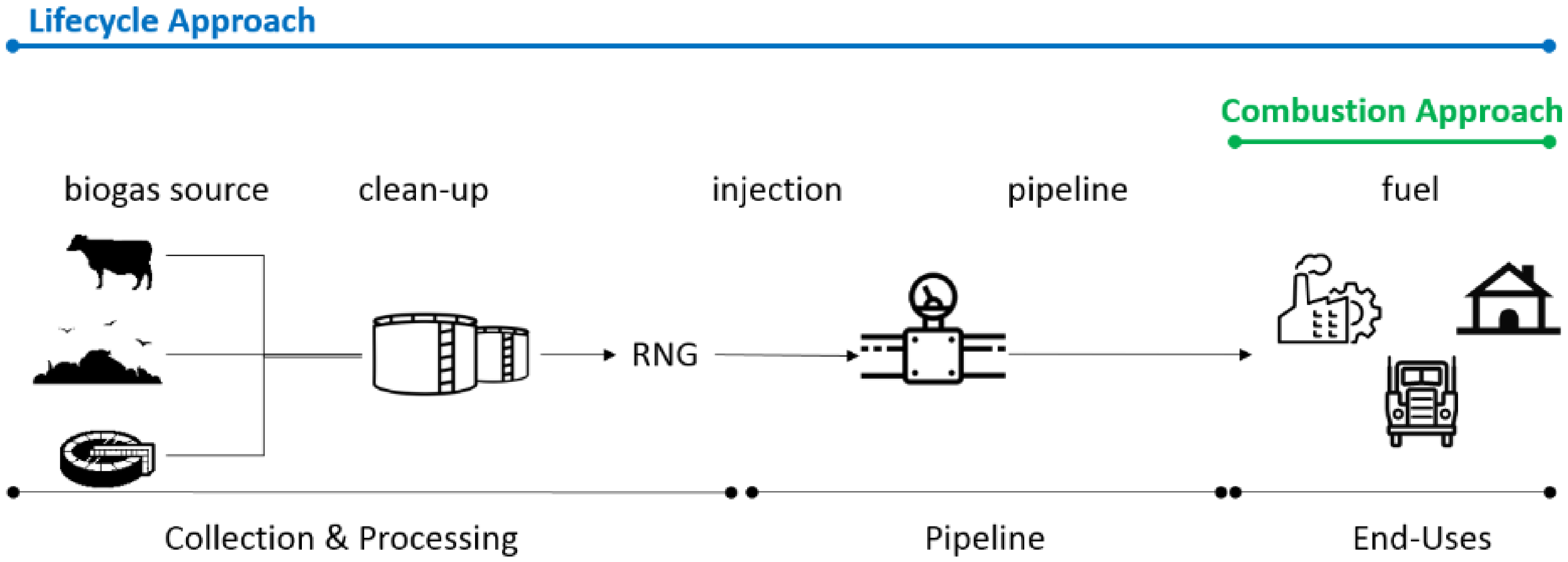
- GHG emission accounting is applied in practice by multiplying a GHG emissions factor and the associated activity data for the fuel of interest. In other words, the total GHG emissions are calculated as a product of the emissions factor and the amount of energy consumed—the equation below highlights this for the case of natural gas, with the GHG emissions factor in units of kilograms of carbon dioxide equivalents per unit energy of natural gas, in units of million British thermal units ($kgCO_{2e}$/mmBtu) and the amount of natural gas used reported in units of mmBtu.

$$GHG\ Emissions = GHG\ Emissions\ Factor\ {}^{Lifecycle}_{Combustion} \left[\frac{kgCO2e}{mmBtu}\right] \times\ Activity\ [mmBtu]$$

GHG Emissions of RNG

- The GHG accounting methodology has a significant impact on estimating the carbon intensity of RNG:
  - Combustion accounting framework – RNG from biomass is carbon neutral, or zero-rated, across feedstocks.
  - Lifecycle accounting framework – can be positive or negative (varies by feedstock among other factors)
- Using combustion approach, will develop estimates of GHG reduction potential for each scenario, differentiated by feedstock and end use.

GHG Accounting Frameworks

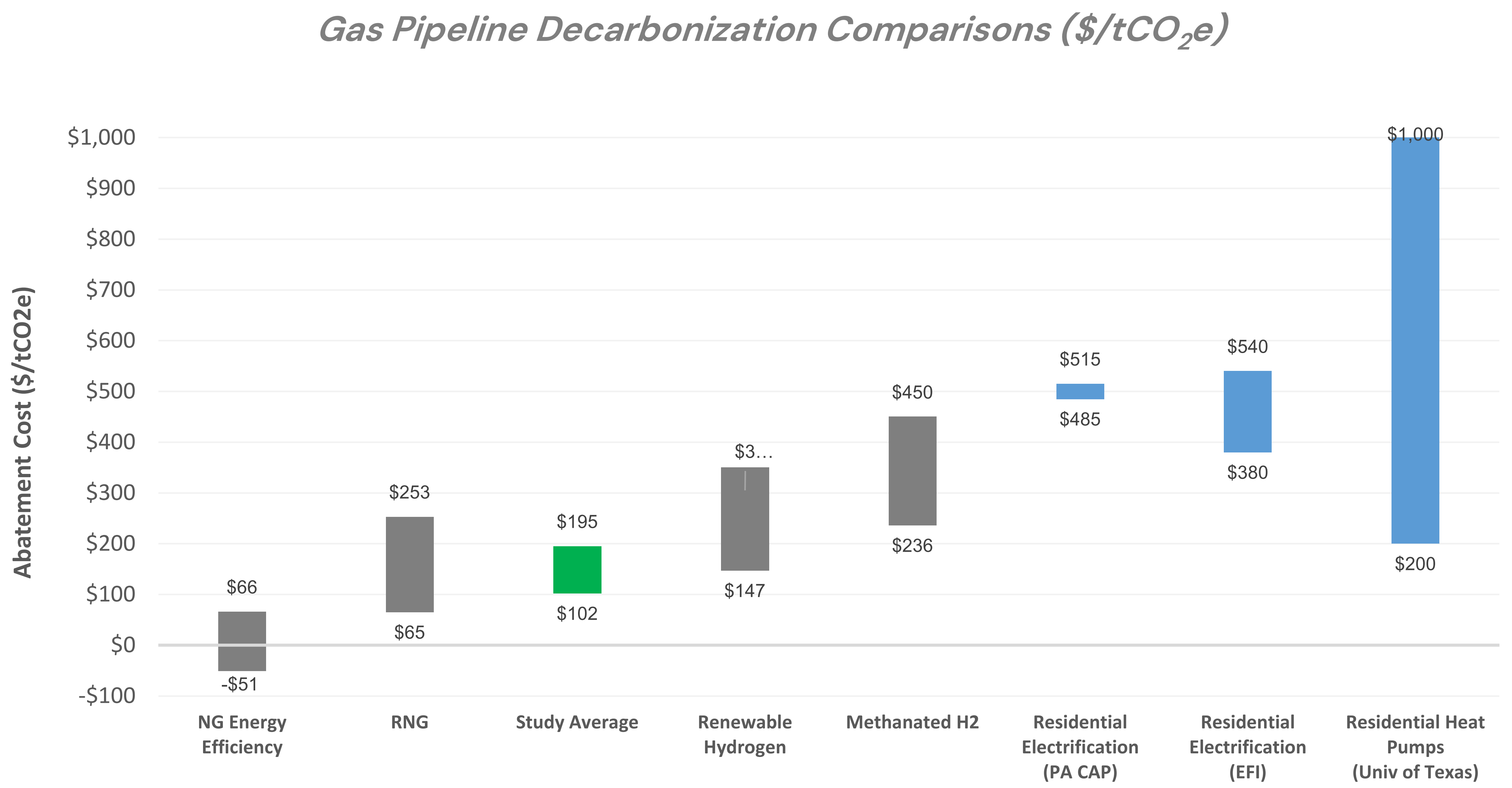


Estimate GHG Reduction Potential

- Using a combustion approach, develop estimates of the cost-effectiveness of RNG as an emission reduction measure.
  - Differentiated by feedstock and end use.
- Apply the dollar per ton of CO_2 equivalent ($/t$CO_2$e) metric to compare across other abatement measures:
  - Renewable hydrogen blending;
  - Building electrification;
  - Electricity generation;
  - Transportation electrification; and
  - Other technologies and options as identified by ICF and MPSC Staff.

- ICF proposes to use existing research, studies and sources to develop a range of abatement costs for the abatement options listed above.
- ICF will work with MPSC Staff to identify the most pertinent comparisons, particularly in the context of abatement options relevant to Michigan.

Estimate RNG Abatement Costs & Abatement Option Comparison

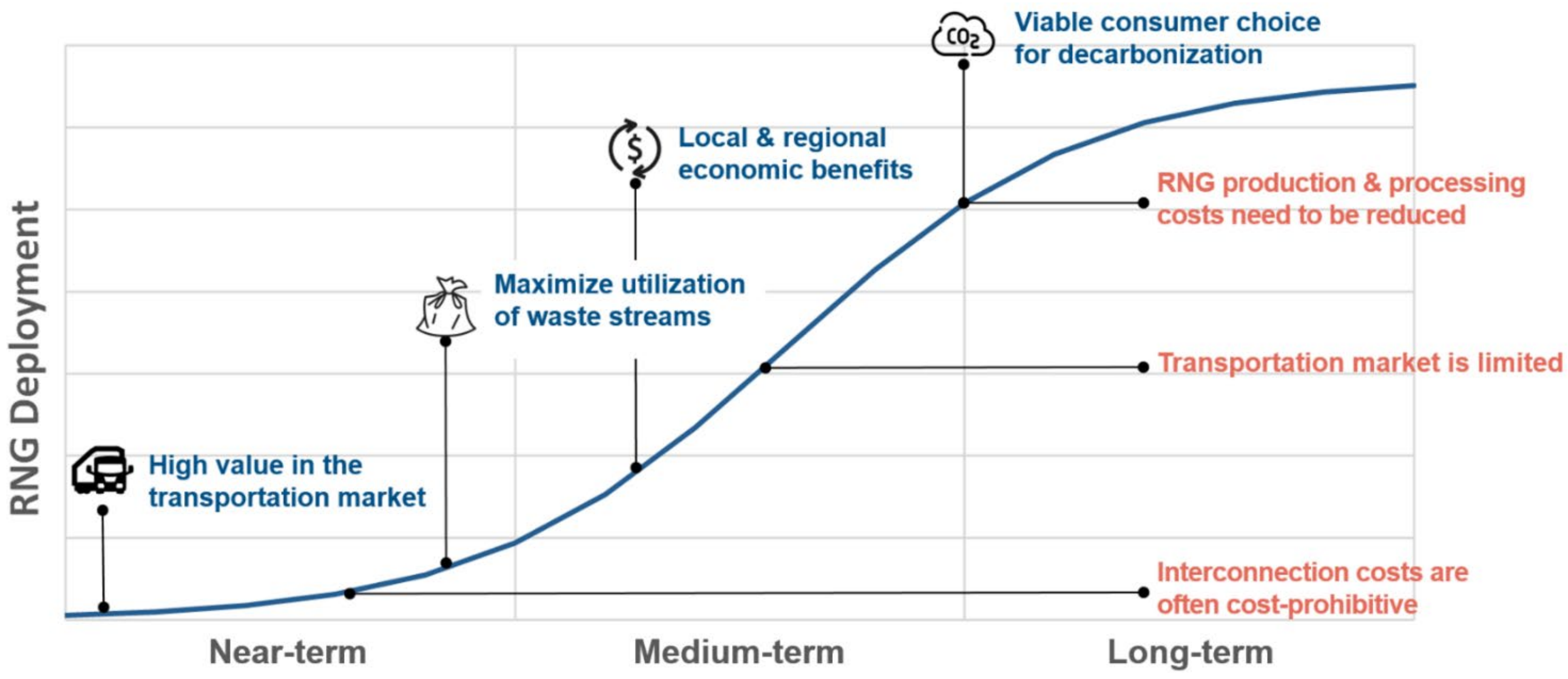


Example Outputs of GHG Abatement Comparison

Analyze Opportunities & Barriers to RNG Production Potential

- Analyze opportunities and barriers to RNG production and deployment in Michigan across three linked areas:
  - Technical
  - Market
  - Regulatory
- Will include an economic forecast of relevant programs, such as the Federal Renewable Fuel Standard, and state-based low carbon fuel standards in California and Oregon.

Overview of Opportunities and Challenges



Based on findings from previous work phases and stakeholder feedback, ICF will develop:

- Comprehensive project report, including methodology and results.
- Deliberative presentation slide deck, including methodology and results.
- Opportunity for MPSC to review and provide input during drafting process.

Final Report

Study Timeline

Schedule

Report Outline: December 2021 (posted)

Final Report

Draft: late May / early June

Final Report: August / September

Stakeholder Meetings

Meeting 1: January 10

Meeting 2: Summer 2022

Completion date: September 2022

Stakeholder Comments

Michigan’s Prosperity Regions

Michigan's Prosperity Regions

Michigan's Prosperity Regions were created as part of the Regional Prosperity Initiative, led by the Michigan Economic Development Corporation in 2013.

ICF seeks to present the RNG potential in a way that is accessible.

Challenge:

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- County-level: Too many (83 Counties); get lost in detail

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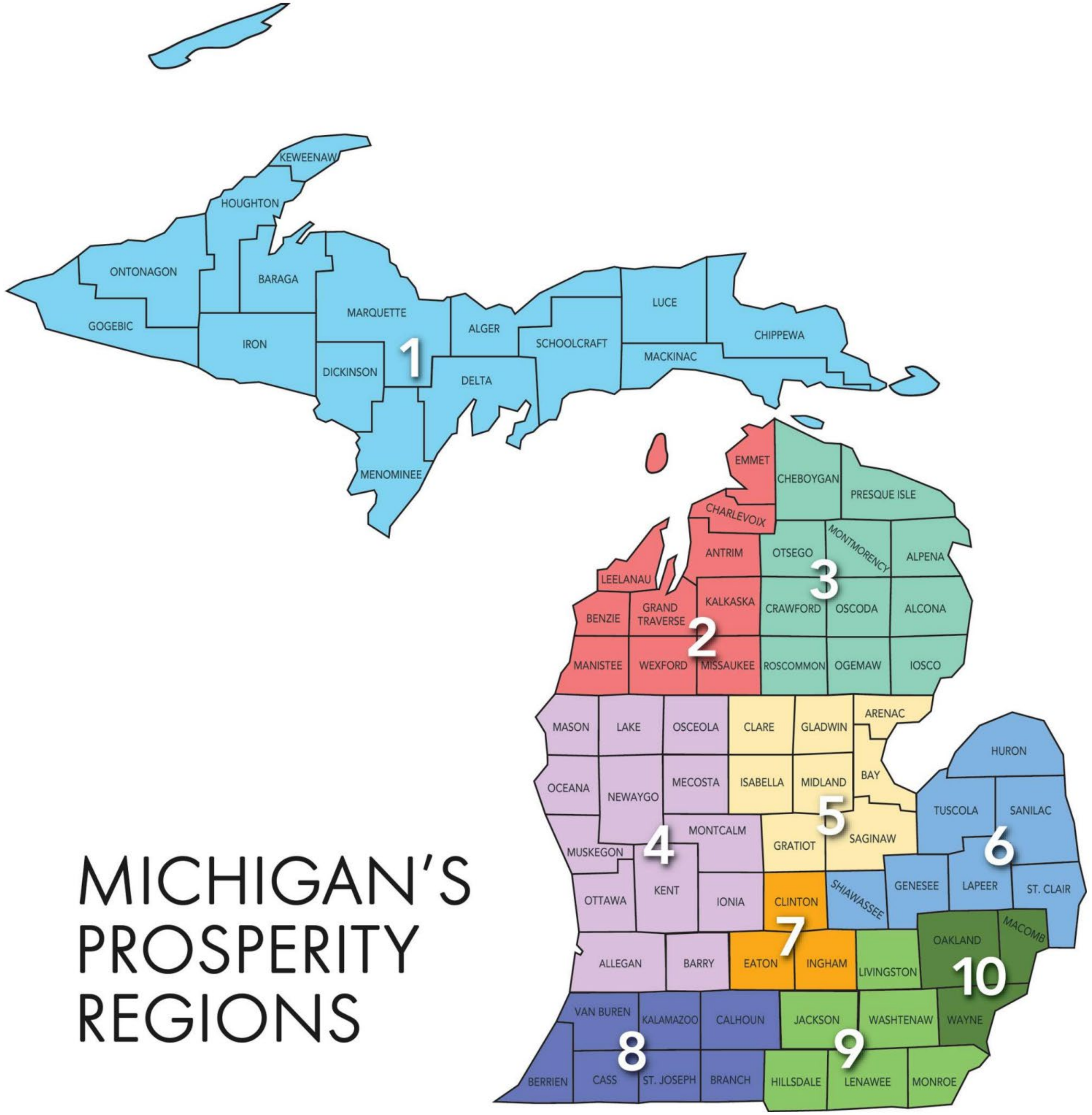

Stakeholder Comments on Prosperity Regions

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About ICF

ICF (NASDAQ:ICFI) is a global consulting and digital services company with over 7,000 full- and part-time employees, but we are not your typical consultants. At ICF, business analysts and policy specialists work together with digital strategists, data scientists and creatives. We combine unmatched industry expertise with cutting-edge engagement capabilities to help organizations solve their most complex challenges. Since 1969, public and private sector clients have worked with ICF to navigate change and shape the future.