ITEM #:	**9**
DATE:	**12-20-22**
DEPT:	**Administration**

COUNCIL ACTION FORM

SUBJECT: **WASTE-TO-ENERGY OPTIONS STUDY FINAL REPORT**

BACKGROUND:

Most of the municipal solid waste (MSW) in Story County is transported to the City's Resource Recovery Plant (RRP), which has been in operation since 1975. Recyclable materials are removed from the waste through processing, and lighter, combustible materials are shredded into refuse-derived fuel (RDF), which is transferred to the Power Plant and used as a supplemental boiler fuel in conjunction with natural gas.

The current co-firing process has operational limitations. Since the RDF cannot be effectively stored long-term, one of the Power Plant's units must be in near constant operation to dispose of the RDF as it is produced. This limits the electric utility's ability to take full advantage of market energy at times when rates are low. There are also corrosion and maintenance issues with the storage and combustion of the RDF.

On April 27, 2021, the City Council awarded a contract to Enviro-Services & Constructors, Inc. d/b/a RRT Design and Construction (RRT) to complete a Waste-to-Energy Options Study. **The purpose of the study was to evaluate credible options for disposing MSW in a waste-to-energy system that could satisfy the county's solid waste disposal needs for 2023 and beyond.** These options would serve as a reliable solution for waste disposal and allow the City of Ames to perform as a leader/innovator in the Waste to Energy Industry, focusing on providing community wide sustainability with minimum impact to the environment.

The study involved developing projections regarding the quantity and characteristics of MSW for the county into the future, and evaluating five staff-identified options for waste-to-energy systems to dispose of that waste into the future. **For each option, the consultant was asked to evaluate capital costs, operational and maintenance costs, environmental impacts and permitting, externalities (such as truck traffic, odor, and noise), and the timeline to design and construct. The ability to provide redundant systems and re-use existing components was also to be evaluated. Additionally, the consultant was asked to identify the impacts of each option on the existing diversion programs (glass and food waste).**

The documents being provided to the City Council for review in this packet are:

1) This Council Action Form, which contains a summary of key findings from the study

2) A copy of the presentation to be delivered by RRT on December 20

3) The Waste-to-Energy Options Study Final Report

4) Appendices to the Final Report

In addition to outlining the information to be presented by the consultants, this Council Action Form includes a request for the City Council to authorize staff to further explore two additional options related to waste-to-energy. This request is detailed later in this document.

SUMMARY OF KEY STUDY FINDINGS:

Staff initially requested that the consultants evaluate five options. Additional analysis was undertaken to further divide these options into the seven following scenarios:

1. Utilize the existing Resource Recovery and Power Plant as is (Base Case used for comparison)

2A. Utilize the existing Resource Recovery Plant and construct a new dedicated refuse-derived fuel (RDF) unit at the Power Plant with Unit 8 serving as a backup unit

2B. Modify the Resource Recovery Plant to produce larger, 20" RDF, (currently 4") and construct two new dedicated RDF units at the Power Plant (does not rely on Unit 8 as a backup)

3A-1. Construct a new Resource Recovery Plant at the Coal Yard, and construct a new dedicated refuse-derived fuel (RDF) unit at the Power Plant with Unit 8 serving as a backup unit

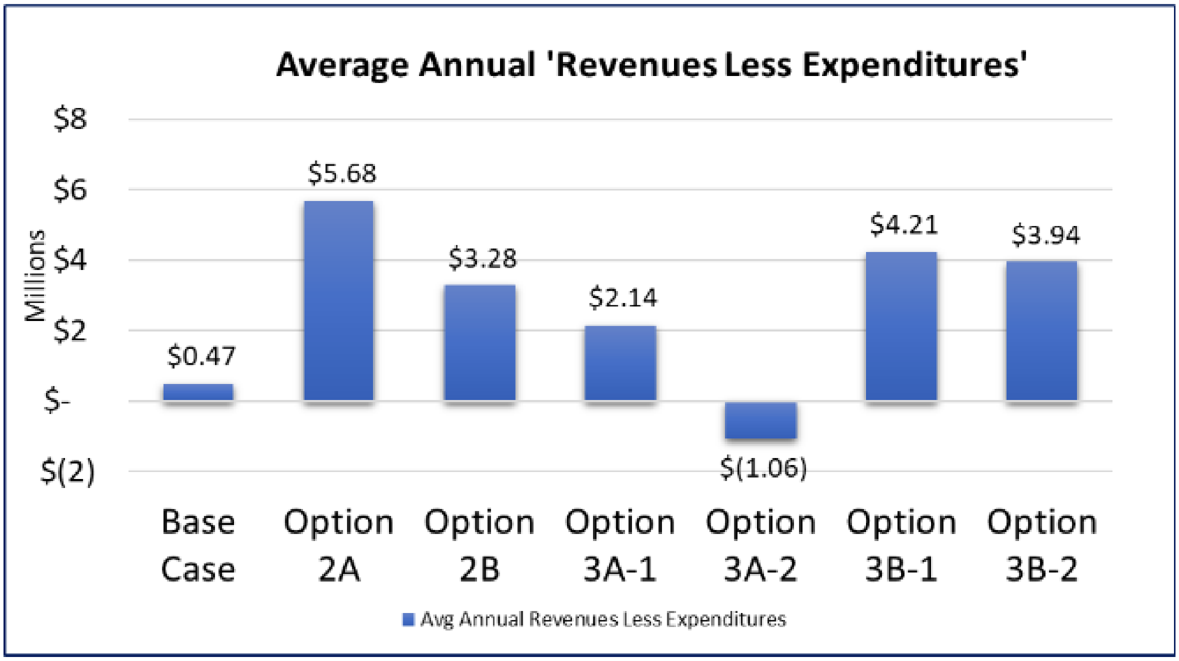
3A-2. Construct a new Resource Recovery Plant and construct two new dedicated RDF units producing steam to an industrial host at a new greenfield site

3B-1. Construct two new MSW mass burn units (no pre-processing) at the Coal Yard site

3B-2. Construct two new MSW mass burn units (no pre-processing) producing steam to an industrial host at a new greenfield site.

After finalizing the options, the consultants evaluated the technical aspects of each option, including feasibility, performance, availability/redundancy, environmental impacts, technology options, and capital/operating/maintenance costs. The costs developed were then used to prepare a comprehensive financial model. The financial model, which has been provided to City staff, allows for adjustments to be made to key assumptions, including natural gas costs, waste volumes, recovery/reject rates, purchased power costs, and other variables.

Using the base set of assumptions prepared for the final report, the model indicates the following average annual net Revenues less Expenditures after capital and debt service:



The chart above assumes $5/dekatherm (dth) natural gas prices (including delivery), escalating at 1% annually. Further analysis was conducted to determine the impact of lower or higher natural gas prices on the financial viability of each option:

Table 1: Average Annual 'Revenue less Expenses' Sensitivity to Gas Prices [$M]

Base Case Gas Price	Base Case	Option 2A	Option 2B	Option 3A-1	Option 3A-2	Option 3B-1	Option 3B-2
$4.00/dth	$4.6	$6.3	$3.3	$2.8	($1.6)	$4.2	$3.6
$5.00/dth	$0.5	$5.7	$3.3	$2.1	($1.1)	$4.2	$3.9
$6.00/dth	($3.7)	$5.1	$3.3	$1.5	($0.6)	$4.2	$4.3
$7.00/dth	($7.8)	$4.5	$3.3	$0.9	($0.1)	$4.2	$4.7
$8.00/dth	($12.0)	$3.9	$3.3	$0.2	$0.4	$4.2	$5.1

This table indicates that increasing natural gas prices make the Base Case, Option 2A, and Option 3A-1 less financially attractive, while improving the outlook for Option 3A-2 and Option 3B-2, and having no impact on Option 2B or 3B-1.

For comparison, the City's current contract for the natural gas consumed in the Power Plant provides gas supplies at $3/dth, which staff views as a highly competitive rate. This contract expires at the end of calendar year 2023. By that time, a new long-term gas supply contract will need to be secured.

In late summer 2022, staff observed natural gas spot market prices reaching $8/dth. Prices have since eased, but there remains uncertainty about what the future prices of natural gas will be. If natural gas supplies are $8/dth and the Power Plant operates as-is (Base Case Scenario), the fuel cost adjustment charged to utility customers on a per-kWh basis is estimated by staff to increase by 4 cents. **Natural gas prices in this range would make the base case scenario far less attractive compared to an option in which natural gas consumption is substantially lowered.**

A summary of the capacity and characteristics of the seven evaluated options is provided below in Tables 3 and 4:

Table 3: Summary Comparison of Evaluated Options (1 of 2)

	Option No.						
	1	2A	2B	3A-1	3A-2	3B-1	3B-2
Option Description	Base Case (As Is)	New RDF Unit & Nominal RRP Improvements	New 20" RDF Units & New RRP	New RDF Unit & New RRP	New RDF Units & New RRP	New MSW Combustion Units	New MSW Combustion Units
Location	Existing Buildings	Existing Buildings	Existing Buildings	New Facility @ Coal Yard	New Facilites @ Industrial Site	New Facilities @ Coal Yard	New Facilities @ Industrial Site
Feedstock RDF/MSW	<4"RDF	<4"RDF	20" RDF	<4"RDF	<4"RDF	MSW	MSW
Backup Unit	Existing Unit 7	Existing Unit 8	New Unit 10	Existing Unit 8	New Unit 10	New Unit 10	New Unit 10
Max CONTINUOUS MSW Processing Capacity of System [tons]	49,005	66,150	66,150	66,150	66,150	66,150	66,150
Net Present Value from 2026 to 2044 w/Capital Inv and Debt Service [$Millions]	$6.6	$65.8	$37.6	$23.7	($13.9)	$49.1	$46.1
Avg. Annual (Costs)/Revenue including O&M and Capital Financing [k$] (2026-2044)	$473	$5,677	$3,279	$2,144	($1,059)	$4,211	$3,942
Avg Annual Bypassed Waste to Landfill Over System Capacity (TPY) (2025 - 2044)	10,428	0	0	0	0	0	0
Avg MSW Process Rejects (including bulk rejects) (TPY) (2025 - 2044)	15,240	16,166	6,395	6,888	6,888	594	594
Avg Annual Ash to Landfill (TPY) (2025 2044)	2,720	3,435	6,245	4,112	4,112	11,532	11,532
Avg Total Equiv. GHG (CO2) (TPY) at Design Conditions (2025-2044) (from Table 12)	253,024	135,220	126,116	143,481	136,192	122,829	130,292

Table 4: Summary Comparison of Evaluation Options (2 of 2)

		Technical Features and Additional Considerations						
		Option No.						
		1	2A	2B	3A-1	3A-2	3B-1	3B-2
RRP Summary		Existing	Existing with small improvements	Rough Shred only	S-O-A RRP	S-O-A RRP	None	None
Primary Combustion Unit(s)		Existing Unit 8	One New 125 TPD RDF Unit 9	Dual "Large RDF" Units 9 & 10	One new RDF Unit 9	Dual RDF Units 9 & 10	Dual MSW Units 9 &10	Dual MSW Units 9 & 10
Backup Combustion Unit		Existing Unit 7	Existing Unit 8	Unit 9/10	Existing Unit 8	Unit 9/10	Unit 9/10	Unit 9/10
Steam Turbine		Existing 7/8	Refurbished ST5	Refurbished ST5	Refurbished ST5	New ST9	Refurbished ST5	New ST9
Steam Sales		NO	NO	NO	NO	YES	NO	YES
AVERAGE AMOUNT TO LANDFILL BY MASS (2025-2044)	Excess Beyond System Capacity	17.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Bulky Rejects	2.9%	3.5%	3.5%	3.5%	3.5%	1.0%	1.0%
	RRP Process Rejects	22.6%	23.6%	7.2%	8.0%	8.0%	0.0%	0.0%
	Ash	4.6%	5.8%	10.5%	6.9%	6.9%	19.3%	19.3%
Landfill Diversion Total % [mass]		52.4%	67.1%	78.8%	81.6%	81.6%	79.7%	79.7%
Landfill Diversion Total % [volume][1]		56.3%	72.1%	87.8%	87.5%	87.5%	96.2%	96.2%
Design Storage Mass (tons)	at RRP inlet	400+	400+	400+	400+	400+	~400 (MSW pit/floor)	~400 (MSW pit/floor)
	at RDF Bin	200	200	400	400	400	n/a see above	n/a see above
Bin Storage Duration with Lead or Single Unit Off-line in CY2044		~16	~8	~7	~7	~7	~5	~5
RRP Staffing (FTE)		17.5	17.5	8.5	9.1	16	2	2
PP staffing (FTE)		41	41	41	41	43	46	48
Total Staffing		58.5	58.5	49.5	50.1	59	48	50

[1] Based on 10 lb/cuft average density of MSW and 70 lb/cuft density of ash

One component of the analysis that may be of particular interest to the City Council is the impact of the different options on CO2 and other Greenhouse Gas emissions. The CO2 and equivalent greenhouse gas impacts are detailed in the table below:

Table 12: Net GHG Annual CO2 Emissions Based on Avg. Annual Waste Flows[26]

Option	1	2A	2B	3A-1	3A-2	3B-1	3B-2
CO_2 from Combustion of Non-Biogenic Fraction of Waste (TPY)	15,070	19,133	22,368	22,904	22,763	22,000	22,000
CO_2 from Combustion of Natural Gas (TPY)	221,760	24,283	0	24,283	0	0	0
Equivalent CO_2 from Landfilling of By-Passed Waste (TPY)	16,194	2,718	5,639	6,283	6,291	776	776
CO_2 from Replaced Fossil-Based Power (TPY)	0	89,086	98,109	90,012	107,138	100,053	107,516
Total Equivalent CO_2 Emissions (TPY)	**253,024**	**135,220**	**126,116**	**143,481**	**136,192**	**122,829**	**130,292**

RRT has consulted with suppliers and contractors to develop capital cost estimates for each option. The construction cost estimates provided by RRT are estimated to be within +/- 25% accuracy as of February 2022. **The total design and construction costs for each option range from $115.82 million to $228.74 million, as detailed in the table below:**

CITY OF AMES - WTE OPTIONS CAPITAL COST ESTIMATE SUMMARY						
	(in millions of US Dollars - Feb 2022)					
	Option 2A	**Option 2B**	**Option 3A-1**	**Option 3A-2**	**Option 3B-1**	**Option 3B-2**
	4"RDF	20" RDF	4"RDF	4"RDF	MSW	MSW
DESCRIPTION	5/6 building	Coal Yard	Coal Yard	Industrial Site	Coal Yard	Industrial Site
RRP Equipment Capital Costs	$0.95	$5.65	$5.75	$5.75	$0.32	$0.32
RDF Storage Costs	$0.32	$-	$3.21	$2.59	$-	$-
RRP Building & Equip Installation Costs	$0.59	$2.00	$8.14	$8.69	$-	$-
PP Major Equipment	$66.708	$79.73	$68.16	$108.22	$80.21	$82.26
PP Installation, parts, materials & labor	$14.429	$31.35	$23.03	$35.04	$31.35	$42.18
Metal Ash Recovery (MSW options only)	$-	$-	$-	$-	$3.30	$3.30
Pipe Rack	$-	$2.70	$2.70	$0.26	$2.70	$0.26
Land Acquisition	$-	$-	$-	$1.00	$-	$0.90
Subtotal	**$82.99**	**$121.42**	**$111.00**	**$161.56**	**$117.88**	**$129.22**
Pre-Construction Services, Engineering	$5.07	$7.24	$7.16	$9.99	$6.30	$8.19
Constr. Mgmt., 3rd Party Testing, Commissioning	$13.78	$19.75	$19.64	$28.23	$20.42	$23.54
Subtotal	$101.83	$148.41	$137.79	$199.77	$144.59	$160.95
Contingency (15% equip, 25% labor)	$13.98	$20.41	$20.09	$28.97	$21.04	$23.91
TOTAL 2022	**$115.82**	**$168.82**	**$157.88**	**$228.74**	**$165.63**	**$184.86**

FURTHER ANALYSIS:

Among the evaluated options (excluding the "as-is" Option 1), City staff has evaluated the cost of the least costly option (Option 2A – minor modifications to the RRP with a dedicated RDF unit at the Power Plant) to determine the potential impacts to rates and fees if such a project was pursued. According to the study, Option 2A involves an estimated capital cost of $115,820,000. City staff estimates that the principal and interest payments over 20 years would total $183,914,212.50, or an average payment of $9,195,710.63 per year.

It is estimated that the utilization of a dedicated RDF boiler could save the Electric utility approximately $8,000,000 per year. This is the net savings after reducing the consumption of natural gas and adding back the cost of purchased power that is no longer being produced in the Power Plant.

There are three potential funding streams that could be used to finance the principal and interest payments owed to construct a project:

1) Tipping fees collected from garbage haulers and residents at the Resource Recovery Plant (currently $62.50/ton),

2) Per capita charges collected from the jurisdictions that participate in the Resource Recovery System based on population (currently $10.50 per person), or

3) Electric utility rates (cost increases/decreases relating to the cost of fuel used to generate electricity are captured in the Energy Cost Adjustment, which can either be a credit or charge reflected on monthly bills).

Increases to tipping fees are passed on to customers through garbage hauling fees paid to private providers, typically on a monthly basis. Increases to the per capita charge are passed on to property owners through property taxes. The table below illustrates the potential impacts to users subject to the charges depending on which funding stream—or combination of funding streams—is used to finance the bond payments:

Financing Scenario For Lowest Cost Option (2A)	IMPACTS TO GARBAGE FEES		IMPACTS TO PROPERTY TAXES			IMPACTS TO ELECTRIC BILLS
	Tipping Fee Per Ton (FY 22/23 $62.50)	Residential Garbage Fee Increase (est. per mo.)*	Per Capita Charge (FY 22/23 $10.50)	Tax Rate Increase (per $1,000 taxable val.)**	Property Tax Increase ($200,000 res. property)***	Residential Electric Bill Incr./(Decr.) (estimated per mo.)****
100% Tipping Fee	$ 231.47	$ 35	$ 10.50	0	$ 0	($16.00)
100% Per Capita	$ 62.50	$ 0	$ 110.56	2.66	$ 287.97	($16.00)
50% Tipping Fee AND 50% Per Capita	$ 154.19	$ 20	$ 60.53	1.33	$ 143.99	($16.00)
25% Tipping Fee AND 25% Per Capita AND 50% Electric Rates	$ 115.56	$ 11	$ 35.31	0.67	$ 72.53	($ 6.80)
100% Electric Rates	$ 62.50	$ 0	$ 10.50	0	$ 0	$ 2.39

* Assuming a typical residential customer currently pays a provider $20/month for garbage collection, consisting of $7.50 in fixed costs (37.5%) and $12.50 in tipping-related costs (62.5%)

** Increases shown are for Ames taxpayers only, and are in addition to the current City total levy of $9.83 per $1,000 of taxable valuation

*** A $200,000 residential property has a taxable value of $108,260 in FY 2022/23 after the rollback is applied. The City's FY 2022/23 tax rate is 9.8294 per $1,000 of taxable value

**** Assuming a $100 residential electric bill. Accounts for any increases in purchased power, any decreases in natural gas purchases, and any increases in debt service. Each scenario (except when 100% funded by electric rates) provides a reduction in the average monthly residential electric utility bill

If a project was pursued to substantially modify the waste-to-energy system, it would be staff's hope to identify grant funding that would help defray the construction cost. Any reduction in the amount that would need to be financed from bonds would reduce the potential fee or property tax increases or add to the

savings generated for electric customers, depending on the method used to pay back the bonds.

ADDITIONAL ANALYSIS RECOMMENDED:

In addition to the alternatives presented in the study, staff has had initial discussions regarding two further waste-to-energy system concepts that are worthy of consideration. These concepts were not envisioned at the time the consultant was retained for the Waste-to-Energy Options Study, and therefore these concepts were not evaluated as part of the final report. These concepts are:

Combustion Turbine #2 Heat Recovery Steam Generator (HRSG) Concept

The City's Electric Utility operates two combustion turbines (CTs) at the Dayton Avenue substation. CT #2 was installed in 2005 and is capable of generating 29 megawatts of electricity. These CTs operate by firing fuel oil to rotate a turbine, which is connected via a shaft to a generator. With some infrastructure modifications, the units could be converted to operate using natural gas. These units are used at times of peak electric demand, for backup when other infrastructure has failed, and to meet the utility's obligation to have generation capacity equal to 110% of its historical peak electric load.

Both existing CTs are a simple-cycle design, meaning the heat generated from the combustion process is exhausted to the atmosphere; only the rotational energy of the turbine is used to generate electricity. This contrasts with a "combined-cycle" process, where the energy from the exhaust gas heat of combustion is extracted and used to increase the total power output of the unit, thereby decreasing the cost to produce energy.

The generator component of CT #2 has a greater potential capacity than the turbine that turns it. **Staff believes it may be possible to move CT #2 near the current Power Plant, construct a waste-to-energy boiler and steam generator as envisioned in Option 2A, and use the exhaust gas heat from CT #2 to generate additional steam and produce more electricity.** The generator could also be turned using the existing combustion turbine, either independently or at the same time as the waste-to-energy boiler is operating.

This arrangement has several advantages: 1) The capital cost of constructing a generator can be eliminated 2) the generation capacity added to the Electric Utility would be substantially greater than outlined in all the options, resulting in a lower cost per MW in construction costs, 3) the Electric Utility would increase its capacity in advance of the next increase in the electric peak, and 4) the operational cost of CT #2 would decrease.

More study is necessary to determine the technical and financial feasibility of this potential project. Therefore, staff issued a Request for Proposals for a detailed evaluation to be undertaken by an engineering firm. Five proposals were received. An evaluation team was formed to review proposals and score on qualifications; price was not a factor in scoring the proposals.

After evaluating the proposals, staff determined that the proposal from Sargent & Lundy, LLC, Chicago, IL, demonstrated the best project understanding and presented the best qualified professionals for the project.

FIRM	RANK	PRICE
Sargent & Lundy, LLC, Chicago, IL	1	$69,500
Stanley Consultants, Inc., Des Moines, IA	2	$75,000
Lutz, Daily, & Brain, LLC, Overland Park, KS	3	$78,900
Zachry Engineering Corporation, Omaha, NE	4	$99,500
The Energy Group Company, Inc., Des Moines, IA	5	$172,000

Staff is requesting that the engineering firm Sargent & Lundy, LLC, Chicago, Illinois be retained to provide an evaluation of this Combustion Turbine #2 Heat Recovery Steam Generator Concept. This evaluation is expected to take four months. Savings in the amount of $86,267 are available from the Waste to Energy study and the Power Plant Wastewater Treatment CIP projects for this project.

Potential Partnership with Lincolnway Energy

Staff has held preliminary discussions with Lincolnway Energy regarding the possibility of a partnership to construct a new waste-to-energy facility near its plant in Nevada. Lincolnway Energy uses a substantial amount of steam in its process to manufacture ethanol. Representatives of the company indicated to City staff that they are interested in exploring the use of a waste-to-energy system to generate that steam, in a scenario similar to Option 3A-2 or 3B-2. Steam produced from a waste-to-energy process, as opposed to the steam Lincolnway Energy currently generates from natural gas boilers, would have advantages for the marketability of the ethanol produced.

In this potential concept, electricity would not be generated, as in the existing waste-to-energy process. Therefore, the costs to construct and operate a turbine, generator, and electrical grid interconnection equipment would not be incurred, unless it was necessary to do so for a backup process at times when Lincolnway Energy is not able to take steam.

If this potential partnership was pursued, a variety of details would need to be further discussed with Lincolnway Energy (and Alliant Energy, which is the electric and natural gas provider in that area), such as the ownership and operating responsibility for the equipment, the source of the waste material to be converted, and the extent of the City's involvement in the overall system.

Staff would like to hold further discussions with Lincolnway Energy before the City Council takes final action regarding a preferred option. Staff would then return to the City Council at a future date with a more detailed analysis of the advantages and disadvantages of a partnership option.

ALTERNATIVES:

1. Adopt a motion to:

   a. Accept the Waste-to-Energy Options Study Final Report as presented by RRT

   b. Approve a contract with Sargent & Lundy, LLC, Chicago, Illinois, in the amount not to exceed $69,500 to evaluate the feasibility of a Combustion Turbine #2 Heat Recovery Steam Generator Concept.

   c. Support continued discussions with Lincolnway Energy regarding the feasibility of a partnership to develop a waste-to-energy facility, and return a report to the City Council analyzing the advantages and disadvantages of such a partnership.

2. Engage RRT to perform additional analysis related to the Waste-to-Energy Options Study.

3. Accept the report, identify a preferred option, and direct staff to develop a plan for implementation.

4. Accept the report and continue to operate as designed today.

CITY MANAGER'S RECOMMENDED ACTION:

The Waste-to-Energy Options Study contains valuable insights regarding the potential options before the City Council and possible consequences.

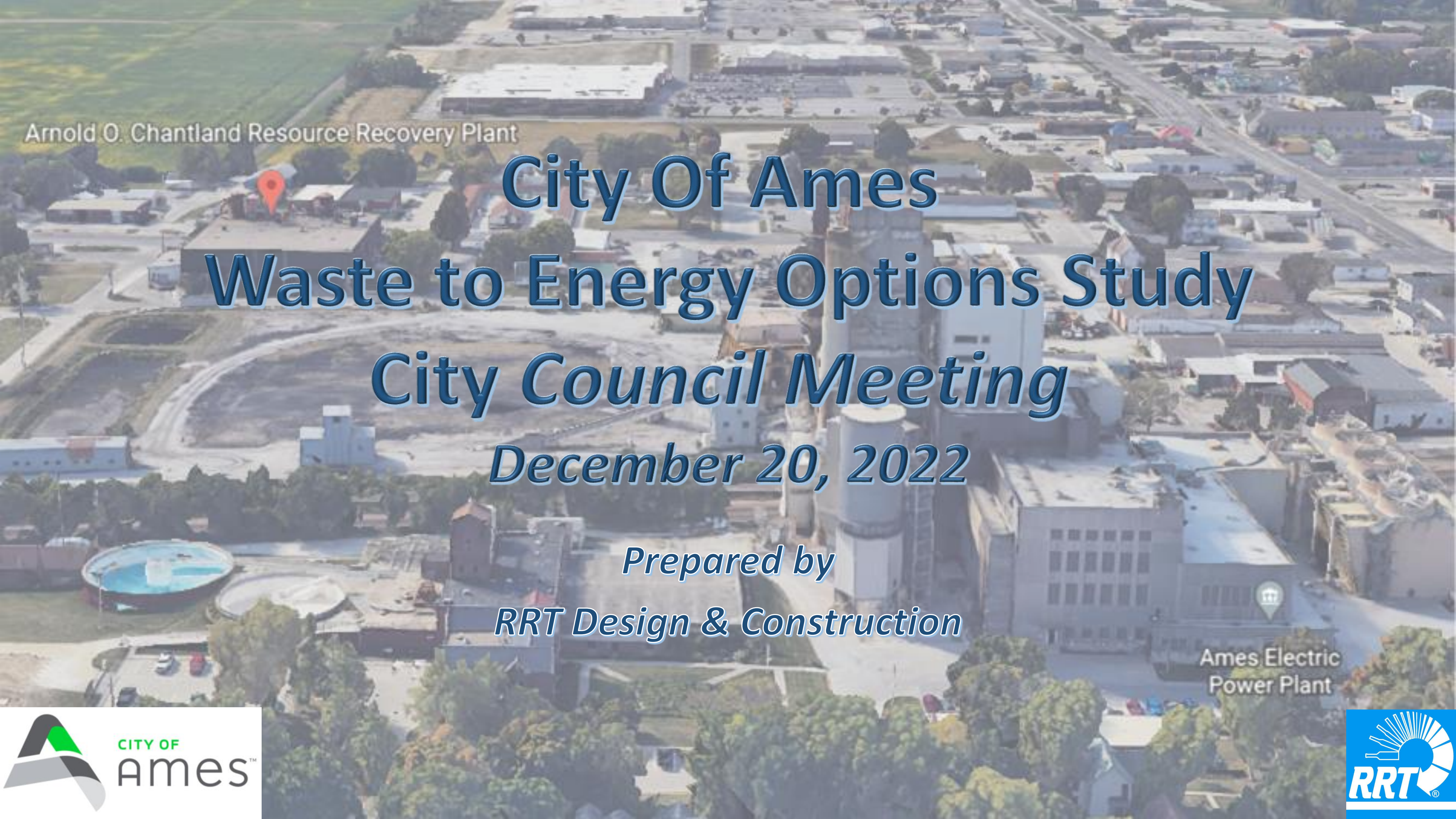
First, the study makes clear that each of the potential options comes with substantial costs – in terms of either capital expenses or the opportunity cost of maintaining the status quo. These costs have a significant impact on property taxes, garbage disposal fees, or electric rates.

Second, one of the most consequential factors in deciding the value of pursuing system modifications is whether it can be expected that the cost of natural gas will remain relatively low, or whether gas prices will increase to a level that makes the combustion of refuse-derived fuel in the Power Plant financially untenable.

Finally, staff continues to be troubled by the potential for volatility in construction and materials prices. Although the consultants indicate confidence that the estimates are valid based on current market conditions, construction bids for a project would not be solicited until many months from now, by which time additional cost increases could occur. Based on the substantial construction costs estimated, even a small percentage increase in bid prices could result in significant additional expenses.

Given these consequences, it seems prudent to staff to explore the two additional potential projects described in this report: 1) the Combustion Turbine #2 Heat Recovery Steam Generator feasibility study and 2) the potential for a partnership with Lincolnway Energy. These two alternative paths could provide the opportunity for substantial capital cost savings compared to the options evaluated in the Waste-to-Energy Options Study.

Therefore, it is the recommendation of the City Manager that the City Council adopt Alternative No. 1a-c, as described above.



City Of Ames
Waste to Energy Options Study
City *Council Meeting*

December 20, 2022

Prepared by

RRT Design & Construction

CITY OF
Ames

RRT

AGENDA

15 MIN — Introduction

- Introduction of Project Team (City & RRT)
- RRT Firm Background
- WTE Study Objectives

45 MIN — Presentation Topics

- Existing Facilities Considerations
- Options Evaluated in the Study
- Financial Summary
- Emissions and Environmental Impact
- Permitting
- Schedule
- Options Comparison

30 MIN — Q & A

CITY OF Ames™

RRT®

About RRT

RRT Design & Construction

Solid waste planning, engineering and construction since 1989

Over 450 projects executed

Extensive experience with municipally owned solid waste processing facilities

Over 40 power facilities across US

Some of our clients:

RRP Ames, IA

Covanta Energy Durham York, Canada

City of Red Wing, MN

Perham Resource Recovery Facility, MN

Our team: 40+ years WTE industry experts

Passionate staff

Nat Egosi   Brett Wolfe

John Sasso   Steve Goff

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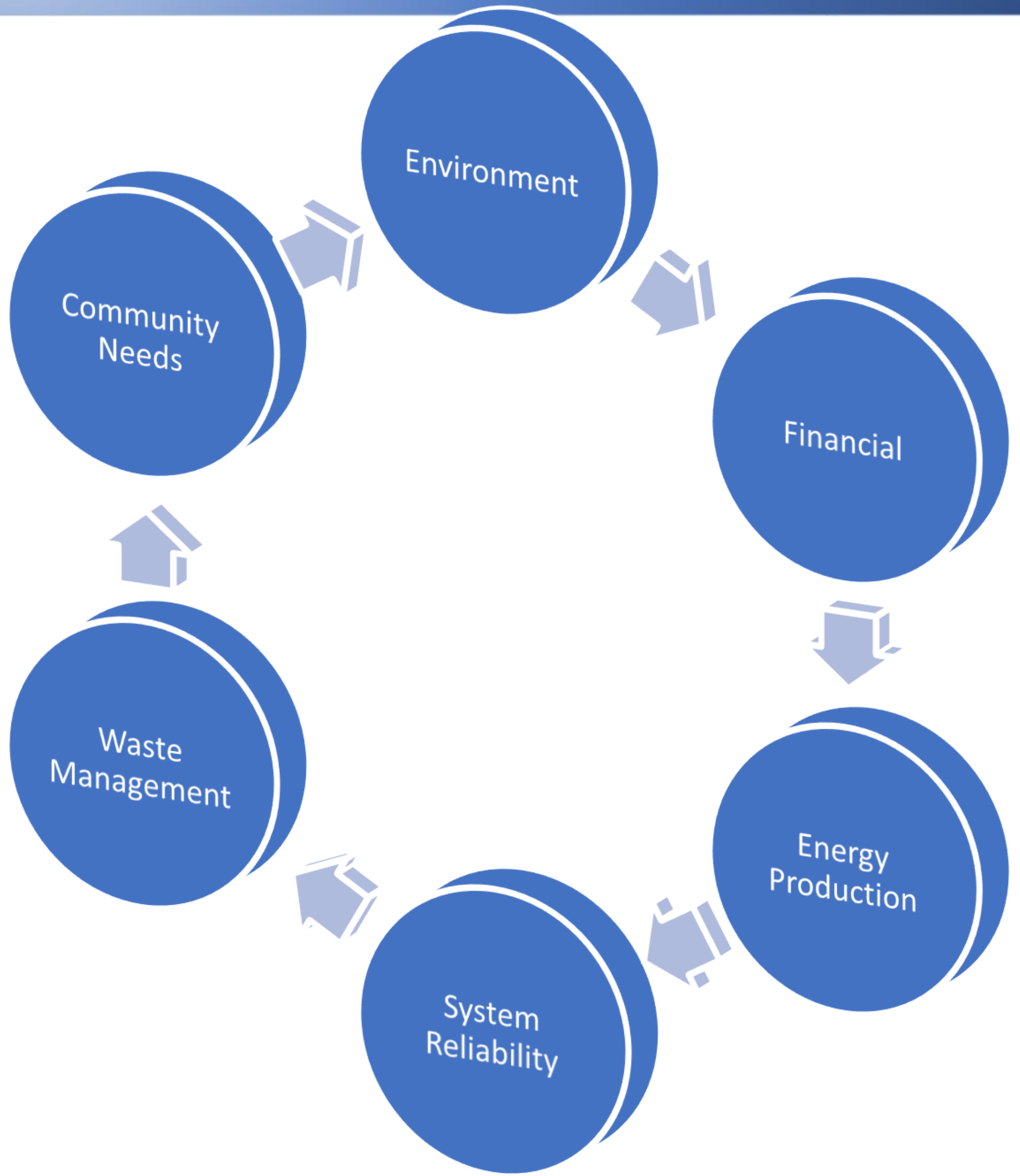
WTE Options Study Objectives & Goals

- Population growth: 82,000 by 2040
- Environmental stewardship
- Landfill avoidance with increasing tonnage
- Reduce greenhouse gas impact

- 5 Waste-To-Energy (WTE) options + 2 sub-options
- Alternatives to landfilling
- Only information, no recommendations



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Existing City Waste-to-Energy System

Arnold O. Chantland Resource Recovery Plant (RRP portion)

- Operating Since 1975
- 52,000 TPY MSW available to process to refuse derived fuel (RDF)
- Serves 12 cities in Story County, ISU and Story County

Ames Power Plant (PP portion)

- Combusting 32,000 TPY (max.) of RDF annually
- Municipal electric utility 28,000 metered customers
- 30% RDF co-fired with 70% Natural Gas by weight per air permit
- On average ~40% of Ames electric energy use is produced by PP

CITY OF Ames™

Existing City Waste-to-Energy System

Issues

- ~2,700 TPY of MSW currently directed to landfill due to WTE limitations
- Tonnage to landfill grows to 17,000 TPY in 2044 if 1.1% growth rate is realized
- Requirement to burn natural gas is large contributor to GHG emissions
- Market energy available in the region at lower costs and lower GHG emissions
- MISO requires COA to have under contract the capacity to meet ~110% of COA historic electric demand

Existing Waste-to-Energy System

- Nominal 200 tons/day (M-F) of municipal solid waste (MSW) received
  - Converted to 4” RDF
- 12-14 tons RDF/hour throughput
- 200 tons RDF storage bin (~ 1.5 days of PP needs)
- 33,800 TPY of waste diverted from landfill
- WTE preferred by EPA over landfilling as better environmental approach

CITY OF Ames™

RRT®

Existing Waste-to-Energy System

- (2) RDF/natural gas co-fired boilers totaling 98 MW (65 MW + 33 MW) consuming up to 30% RDF with 70% Natural Gas by weight (permit limit)
  - Thru 2024 City of Ames PP produces electricity at approximately $56/MWh ($5/dth gas burner tip)

The balance of COA electricity use comes from

- The grid (contract wind, solar, other fossil generation)
  - Average Grid price of electricity: $30/MWh on-peak and $17/MWh off-peak
- (2) oil-fired combustion turbines (off-site) (45 MW total)

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Options Evaluated in the Study

Technical Evaluation → Feasibility → Performance → Availability/ Redundancy → Environmental Impact → Boiler Technology options → Capital Cost → O&M Cost

- 5 Options, 2 sub-options including Base Case

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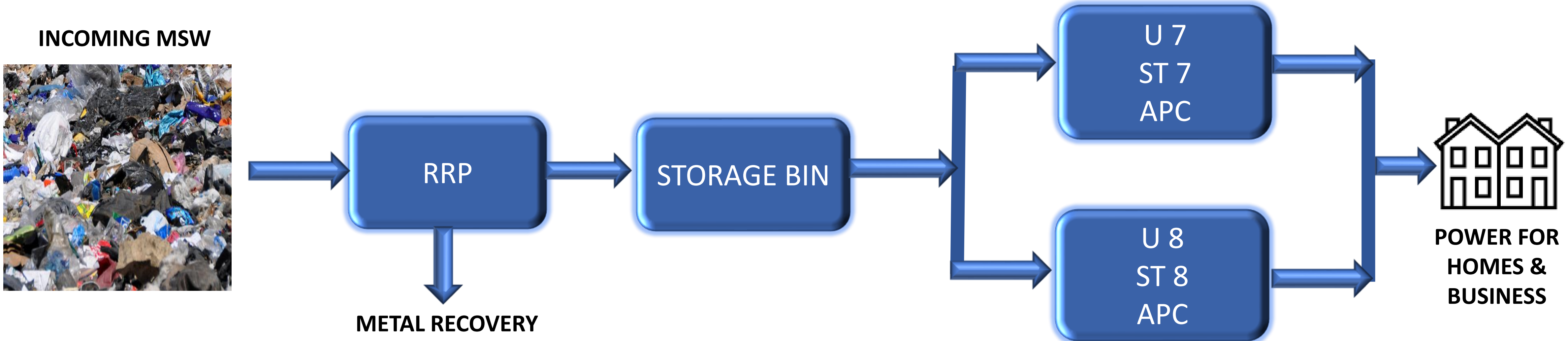
Options Evaluated in the Study

- Option 1: RRP and PP as-is (Base Case)
- Option 2A: RRP with minor upgrades and new RDF combustion unit in existing PP
- Option 2B: Modified RRP (20”RDF) with two new RDF combustion units at coal yard
- Option 3A-1: New RRP and one new RDF combustion unit at coal yard
- Option 3A-2: New RRP and two new RDF combustion units at greenfield site
- Option 3B-1: Two new MSW mass-burn combustion units at coal yard
- Option 3B-2: Two new MSW mass-burn combustion units at greenfield site

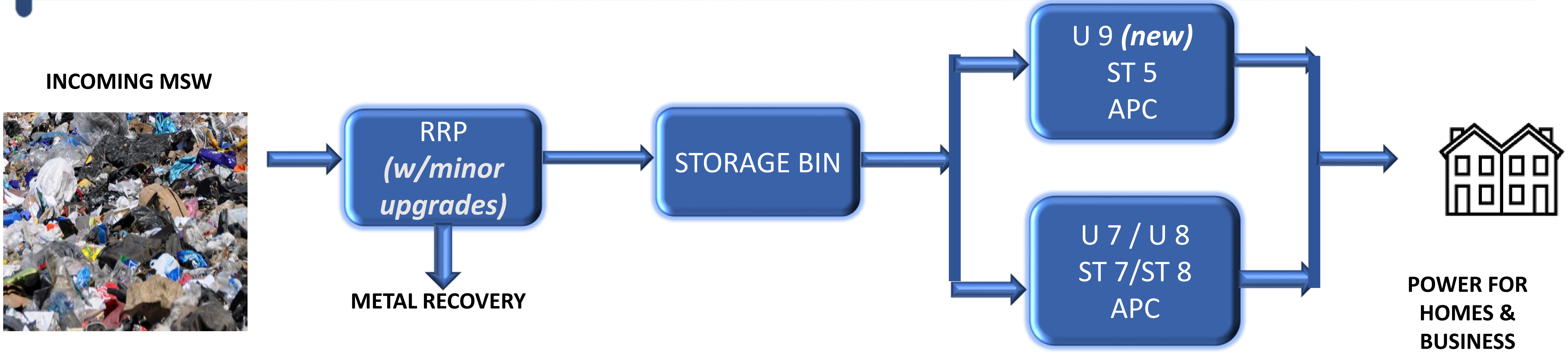
Option 1 Base Case



- RRP
- RDF Bin
- Unit 7 & Unit 8
- Steam Turbine 7 & 8
- Air Pollution Control (APC)

AS IS

Option 2A



- Minor RRP upgrades for improved metals recovery
- Existing RDF storage bin
- New RDF combustion unit – Unit 9
- Unit 7 and 8 as back-up
- Steam turbine 5 refurbished

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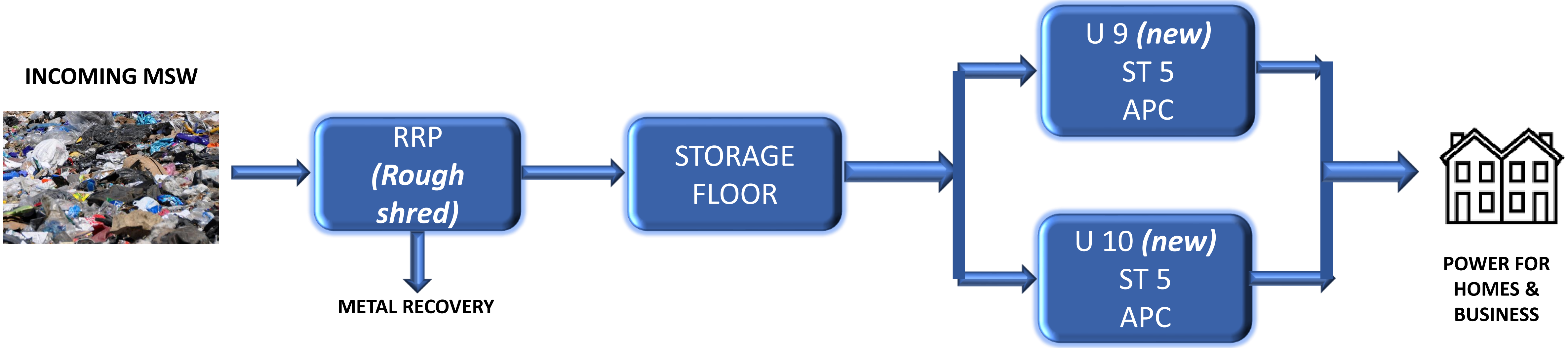
Option 2B



- New RRP equipment for a rough shred (20” minus) RDF
- New RDF storage
- Two new combustion units (units 9 and 10)
- Steam turbine 5 refurbished

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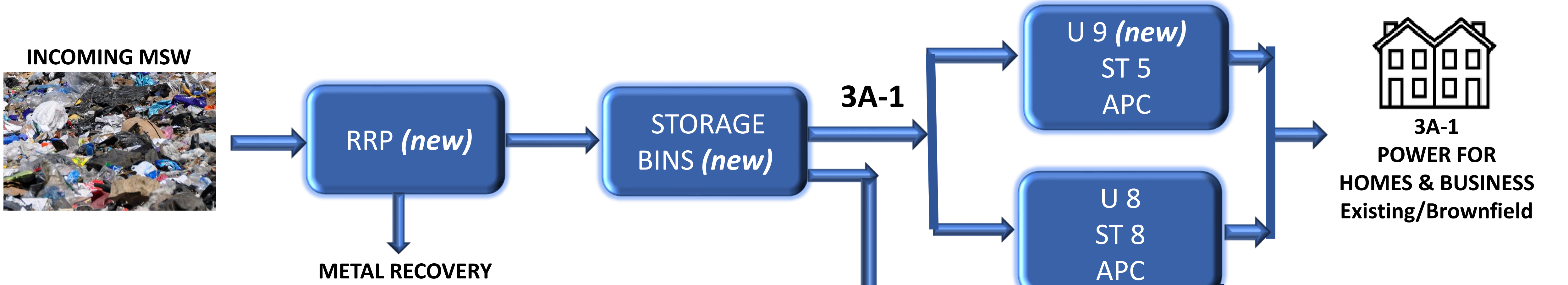
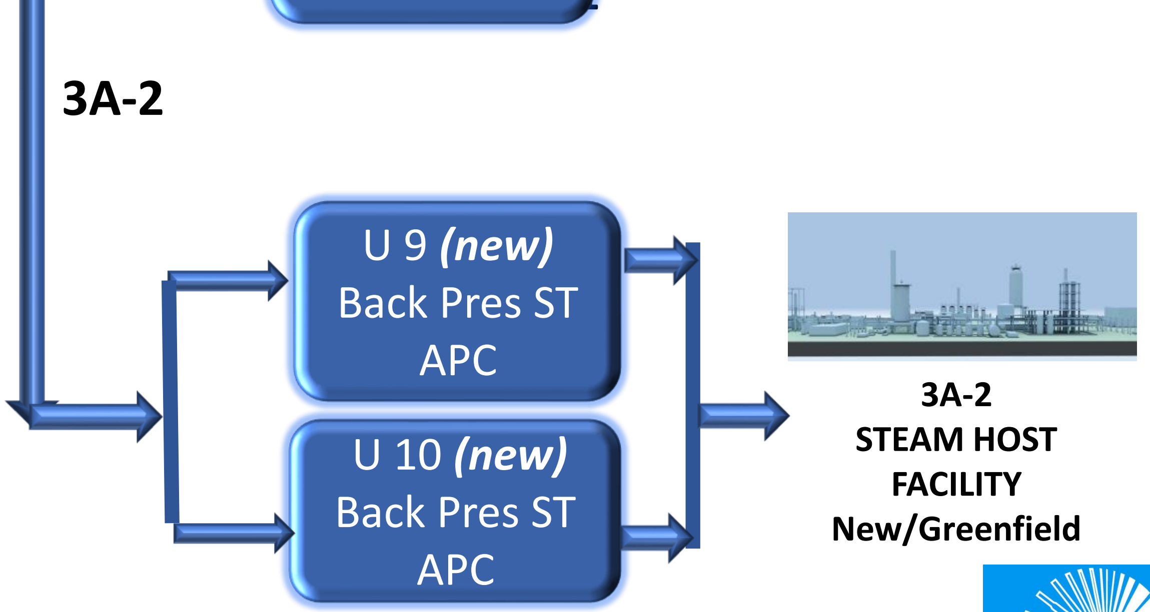
Option 3A (3A-1 or 3A-2)

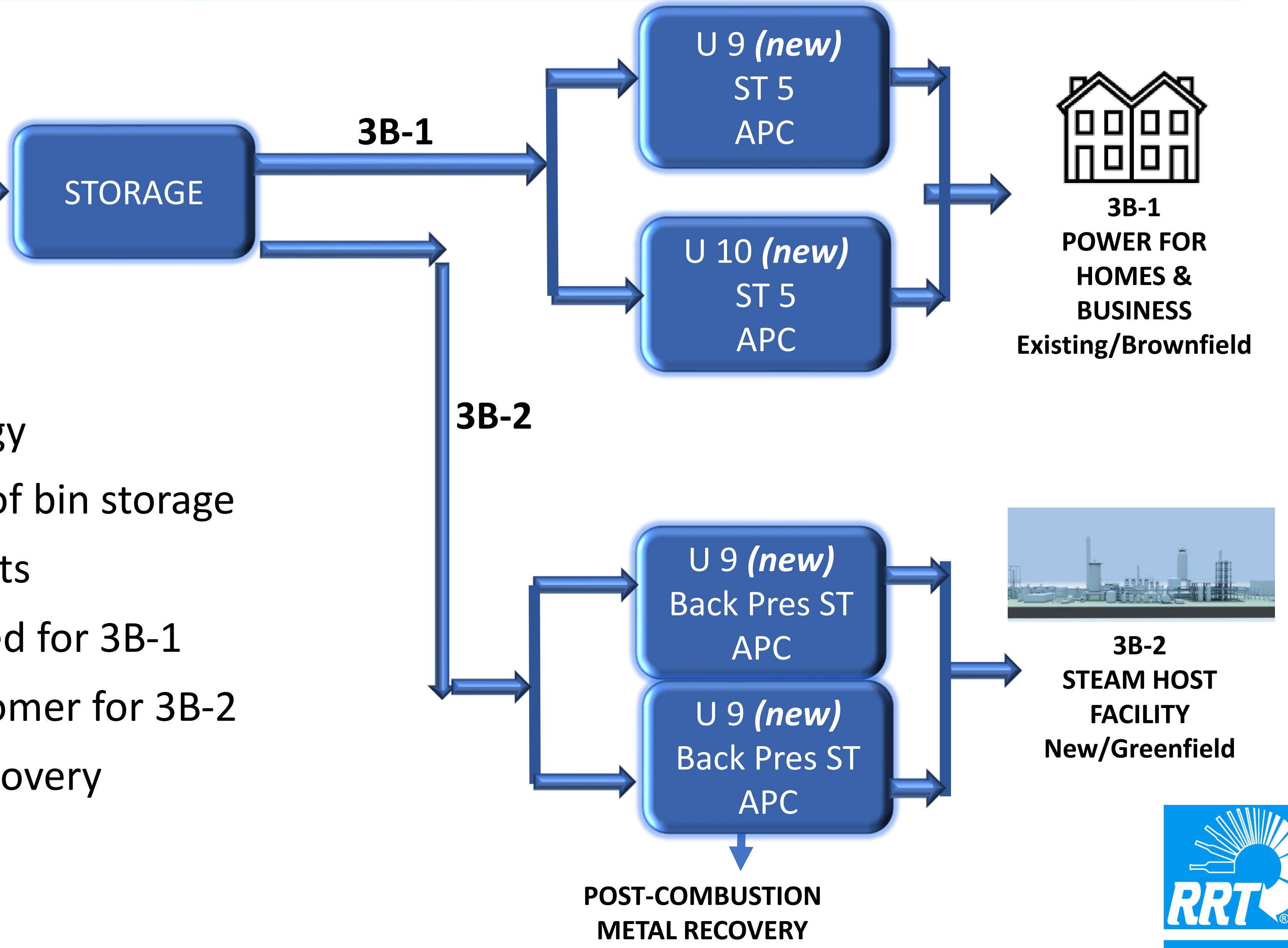




- New State-of-the-Art RRP
- New RDF Bins: (1) bin for 3A-1; (2) bins for 3A-2
- New combustion units:
  - (1) unit for 3A-1 and Unit 8 back-up
  - (2) units for 3A-2
- Steam turbine 5 refurbished for 3A-1
- New industrial steam customer for 3A-2

Option 3B (3B-1 or 3B-2)

INCOMING MSW



- MSW mass-burn technology
- MSW floor storage in lieu of bin storage
- New MSW combustion units
- Steam turbine 5 refurbished for 3B-1
- New industrial steam customer for 3B-2
- Post-combustion metal recovery

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TECHNICAL OPTIONS SUMMARY

	1	2A	2B	3A-1	3A-2	3B-1	3B-2
RRP Summary	Existing	Existing with minor improvements	Rough shred only	S-O-A RRP	S-O-A RRP	None	None
RDF Size	<4"	<4"	<20"	<4"	<4"	MSW	MSW
Storage	200-ton RDF bin	200-ton RDF bin	200-ton RDF (new)	400-ton RDF dual bins (1 new)	400-ton RDF dual bins (new)	400-ton Intake floor (new)	400-ton Intake floor (new)
Primary Combustion Unit(s)	Existing Unit 8	One 125 TPD RDF unit (new)	Dual RDF units (new)	One RDF unit (new)	Dual RDF units (new)	Dual MSW units (new)	Dual MSW units (new)
Backup Combustion Unit	Existing Unit 7	Existing Unit 8	Unit 9/10 (new)	Existing Unit 8	Unit 9/10 (new)	Unit 9/10 (new)	Unit 9/10 (new)
Main PP Location	Existing	Adjacent to existing	Adjacent to existing	Adjacent to existing	Greenfield	Adjacent to existing	Greenfield
Steam Turbine	Existing 7/8	Refurbished ST 5	Refurbished ST 5	Refurbished ST 5	New back-pressure ST 9	Refurbished ST 5	New back-pressure ST 9
Electric/Steam Sales	Electric	Electric	Electric	Electric	Steam	Electric	Steam

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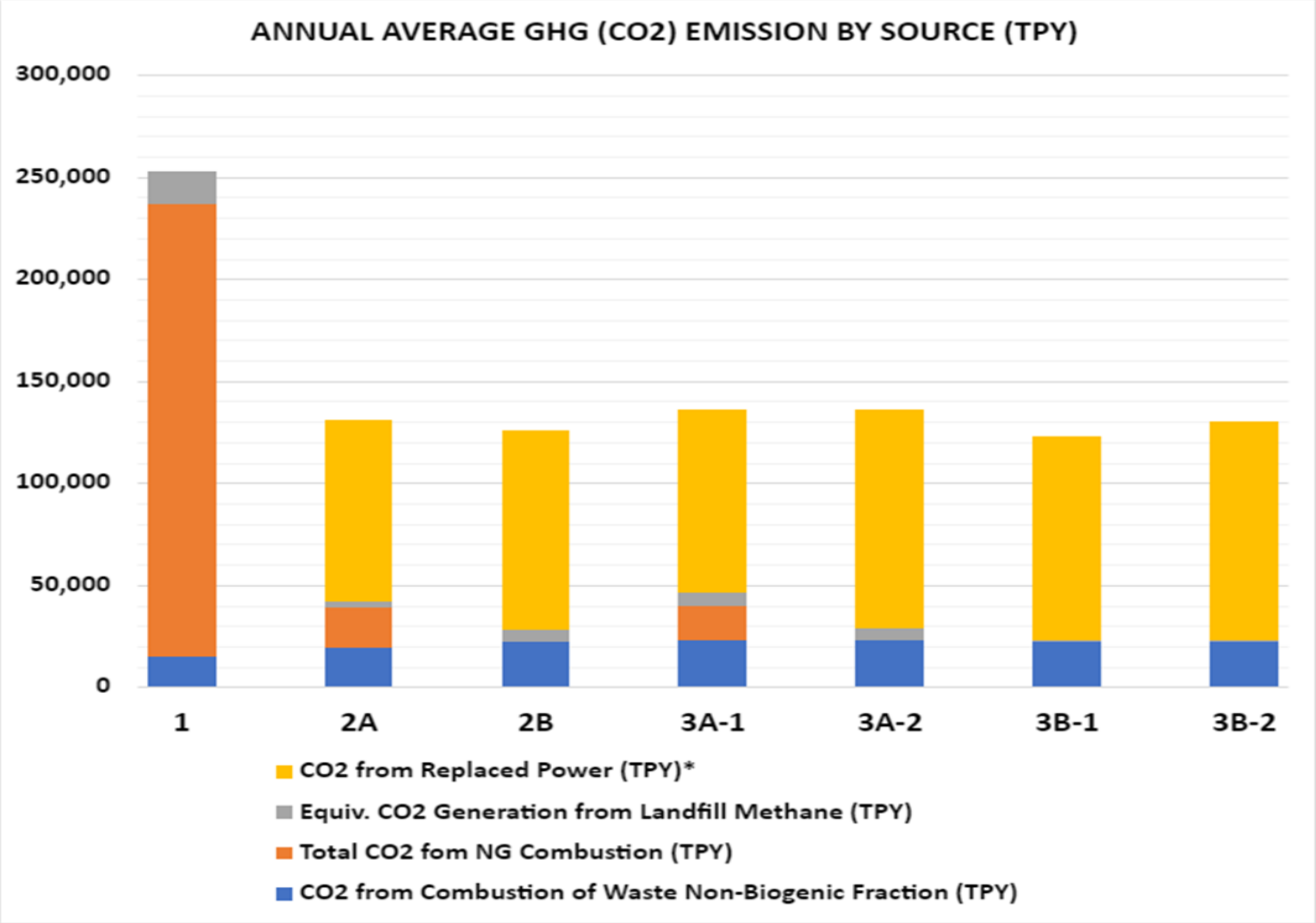
Pause for Options/ Technology Questions?

GHG and Emission Impacts

All options will result in >50% reduction in GHG emissions over Option 1 due to reduction of NG firing

APCs for all options meet EPA emission standards for PM, NOx, SO2



*Based on 611.11 lbmCO2/MWh for Iowa, 2020, USEPA eGRID

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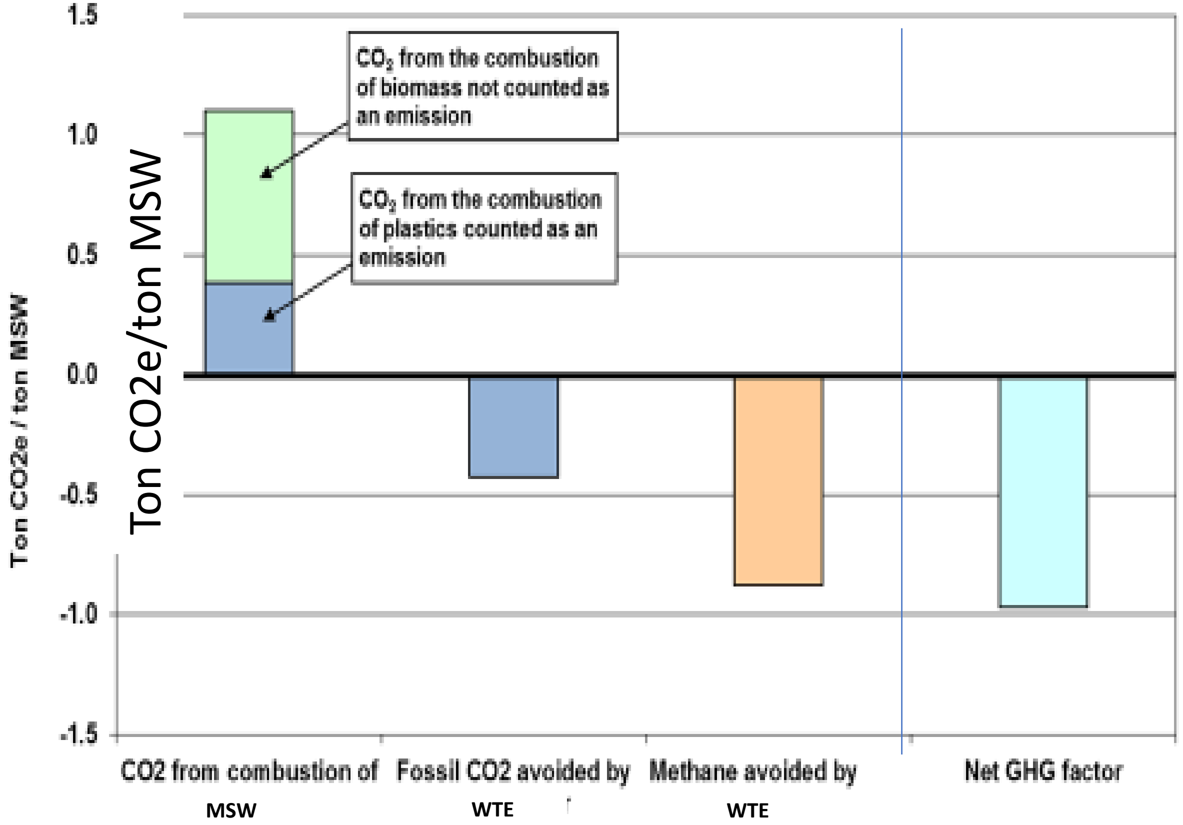
The GHG Value of WTE

1 ton of MSW diverted from landfill to WTE => net reduction in GHG of 1 ton of CO2 equivalent



"... MSW combustors actually reduce the amount of GHGs in the atmosphere compared to landfilling. The savings are estimated to be about 1.0 ton of GHGs saved per ton of MSW combusted."

U.S. EPA, Energy Recovery Webpage, http://www.epa.gov/wastes/nonhaz/municipal/wte/airem.htm#7

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Pause for Environmental Questions?

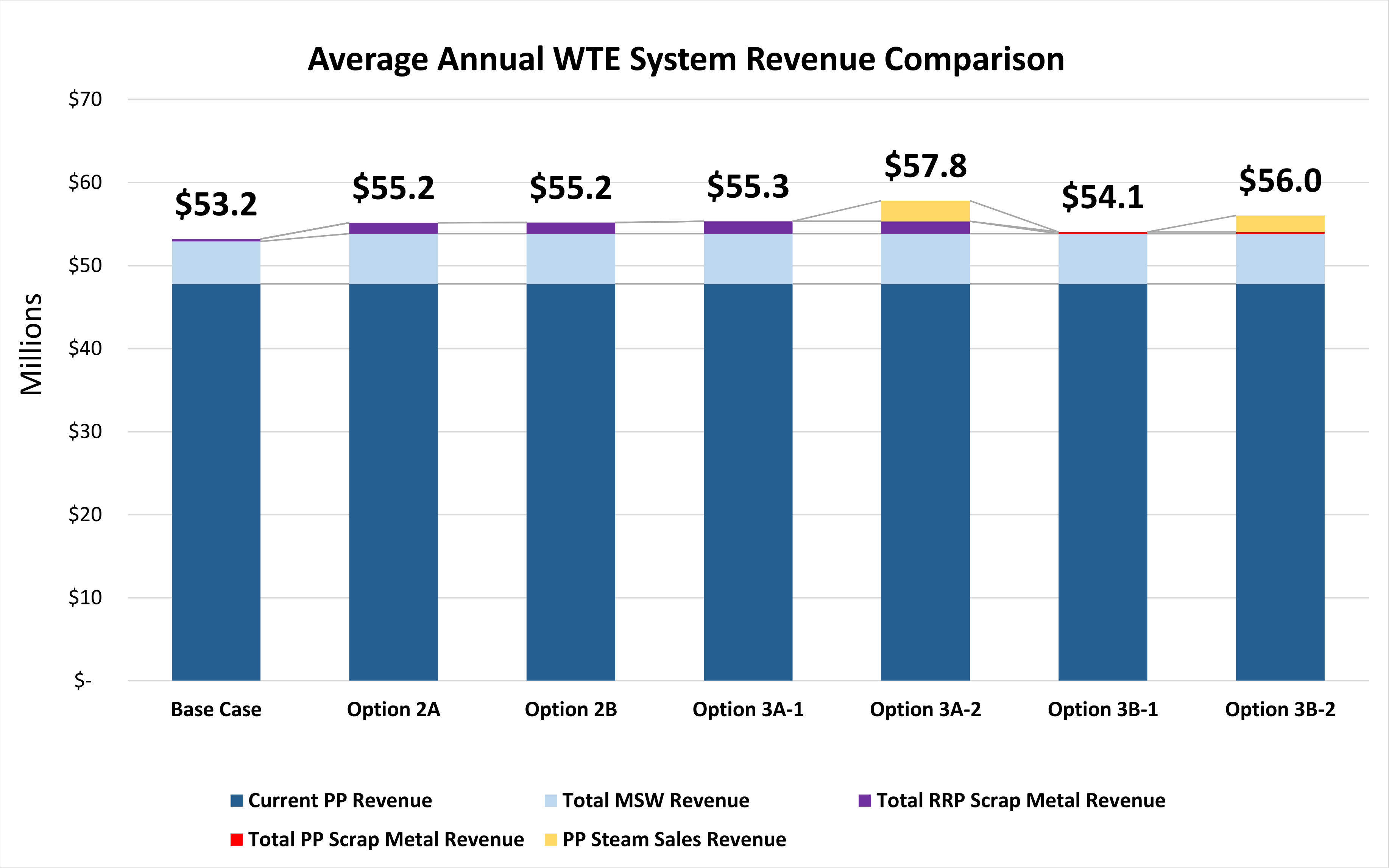
Financial Model Summary

- Approach to model development
- Tool for City to use in future evaluations
- Capital costs for new option
- Adaptable model for sensitivity analyses
- Financial results of 5 cases and 2 sub-options
- Average annual costs (variable, fixed, debt for new options)
- Net Present Value (NPV) comparison based on $5/dth gas (burner tip)
- Internal Rate of Return (IRR) comparison

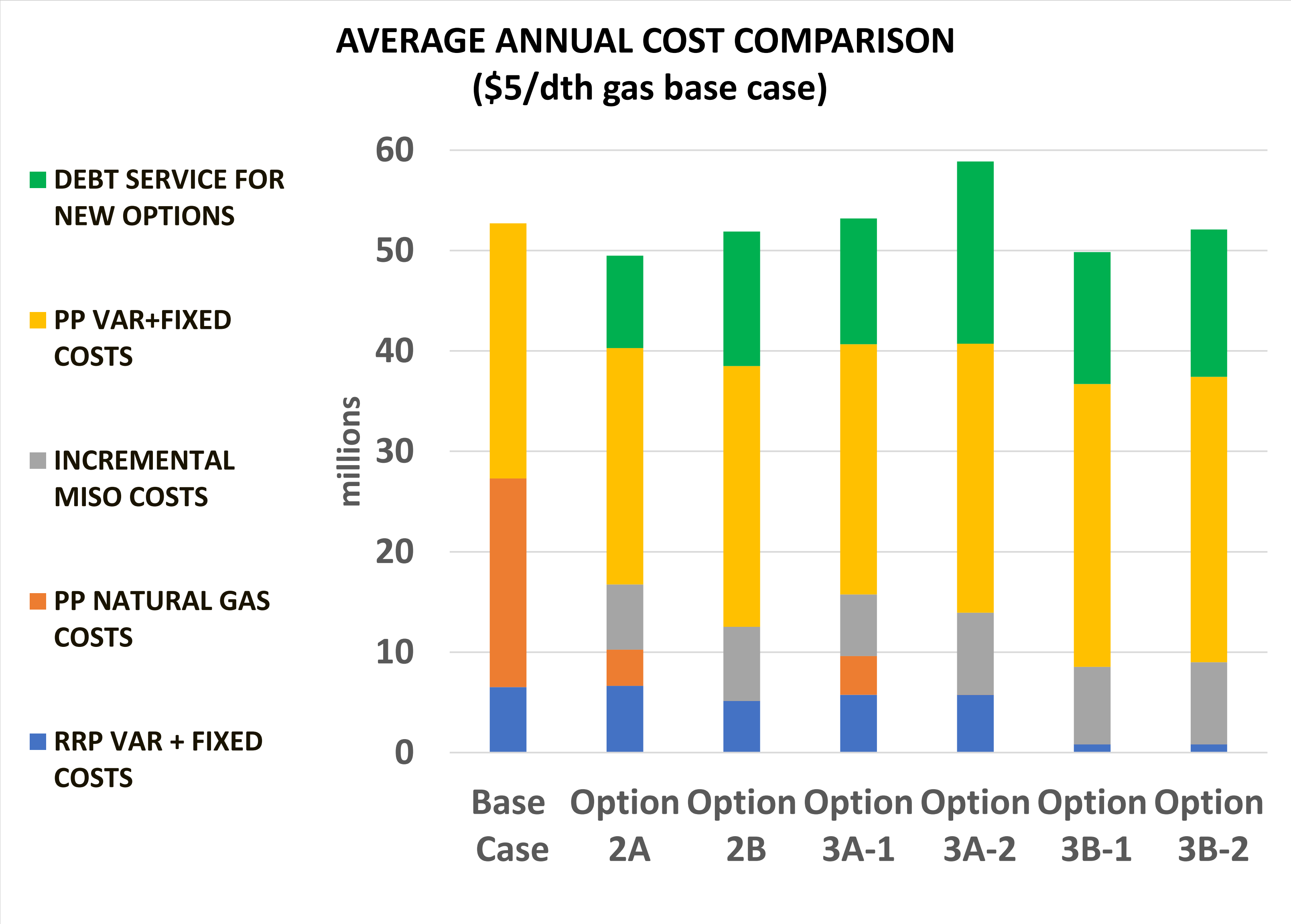
Capital Costs of Evaluated Options

	(in millions of US Dollars - Feb 2022)					
	Option 2A	**Option 2B**	**Option 3A-1**	**Option 3A-2**	**Option 3B-1**	**Option 3B-2**
	4"RDF	20" RDF	4"RDF	4"RDF	MSW	MSW
	5/6 building	Coal Yard	Coal Yard	Industrial Site	Coal Yard	Industrial Site
RRP Costs	2	8	14	14	0	0
Power Plant Costs	81	109	97	146	118	128
Engineering, Constr Mgmt, Commissioning etc.	19	27	27	39	27	33
Contingency (15% equip, 25% labor)	14	20	20	29	21	24
TOTAL 2022	**$116**	**$164**	**$158**	**$229**	**$166**	**$185**
Escalation to 2025 @ 2.13%	**$123**	**$171**	**$165**	**$239**	**$173**	**$193**

Revenue Comparison



Operating Cost Comparison



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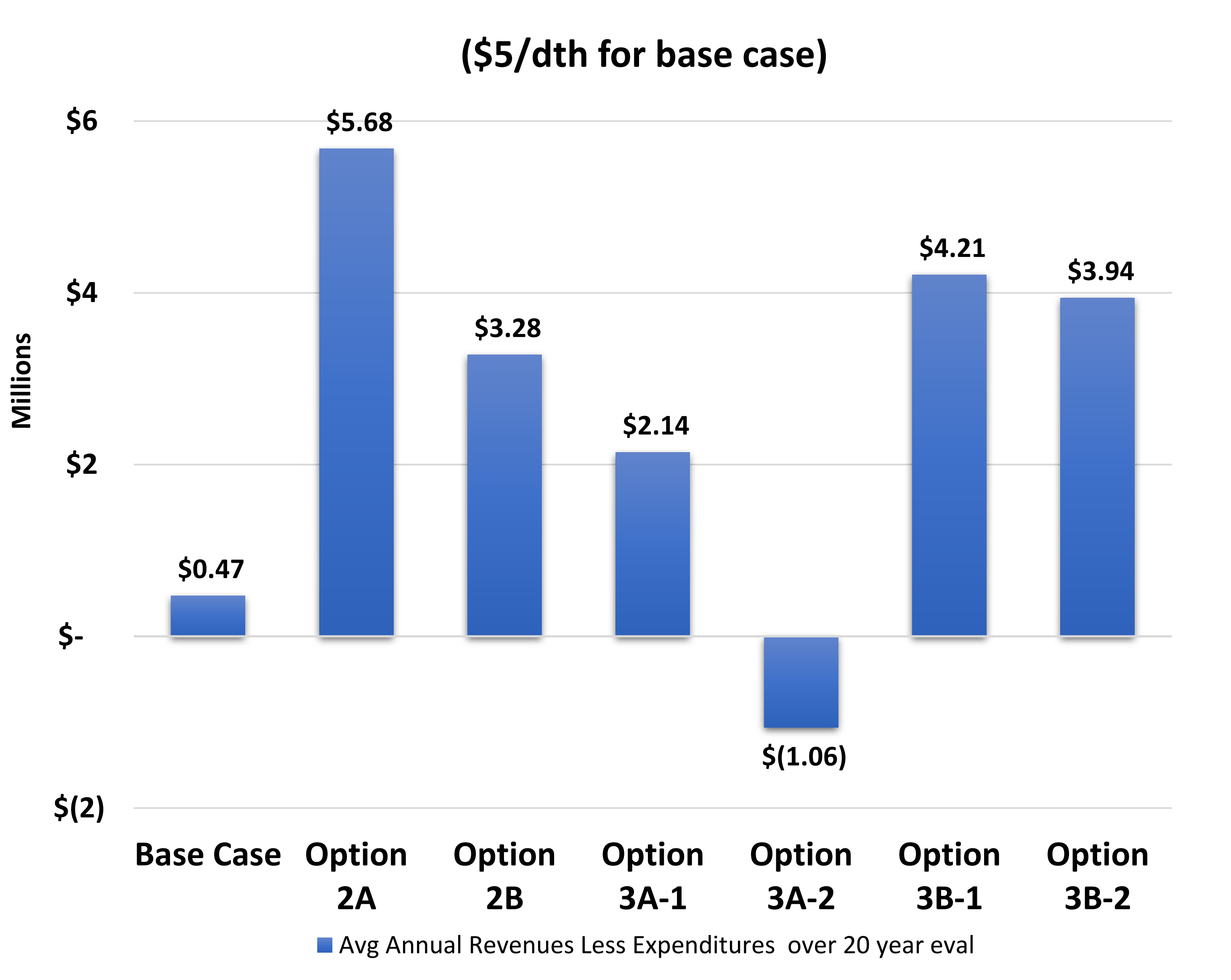
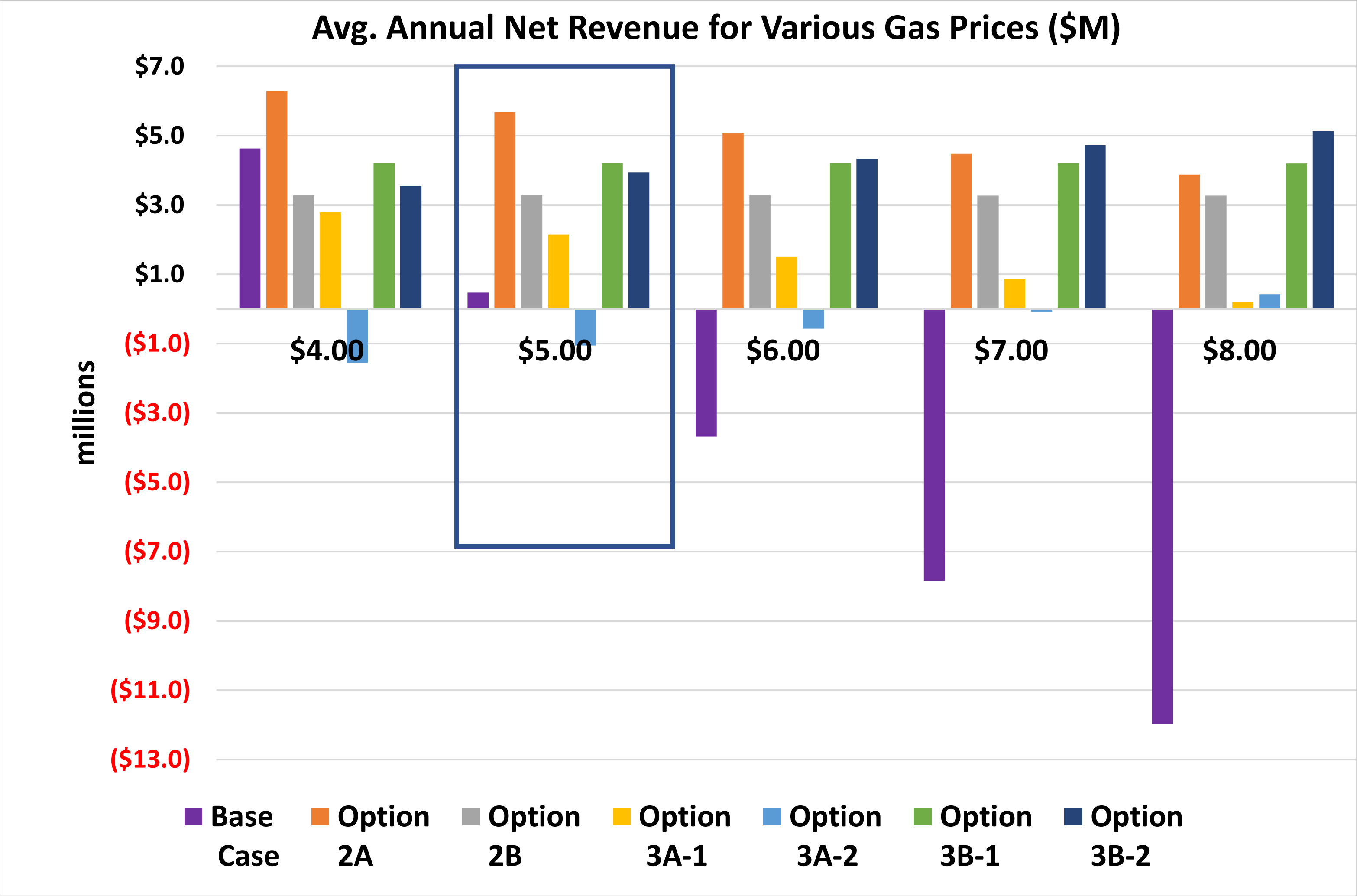
'Revenue Less Expenditures' Comparison

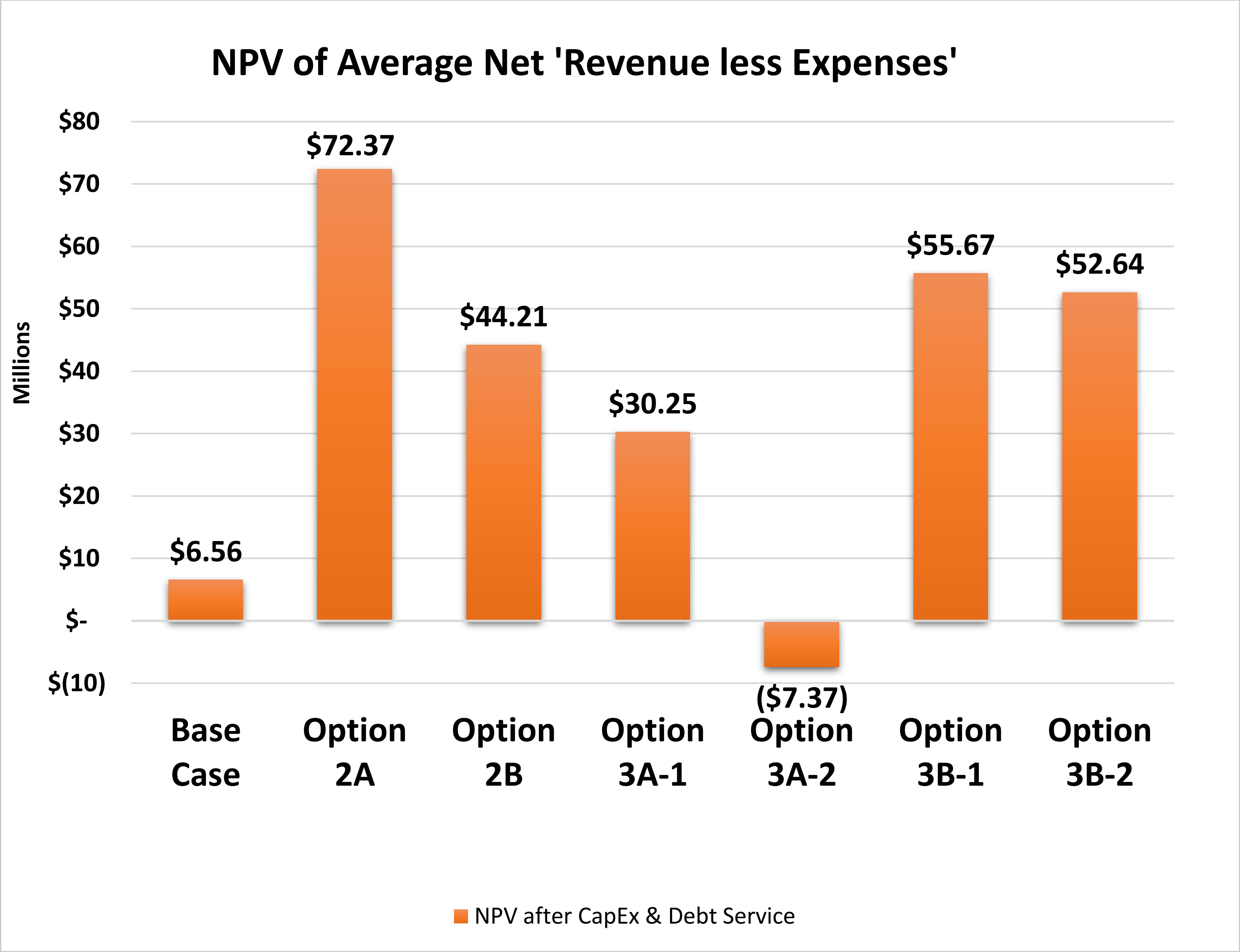


Gas Price Sensitivity

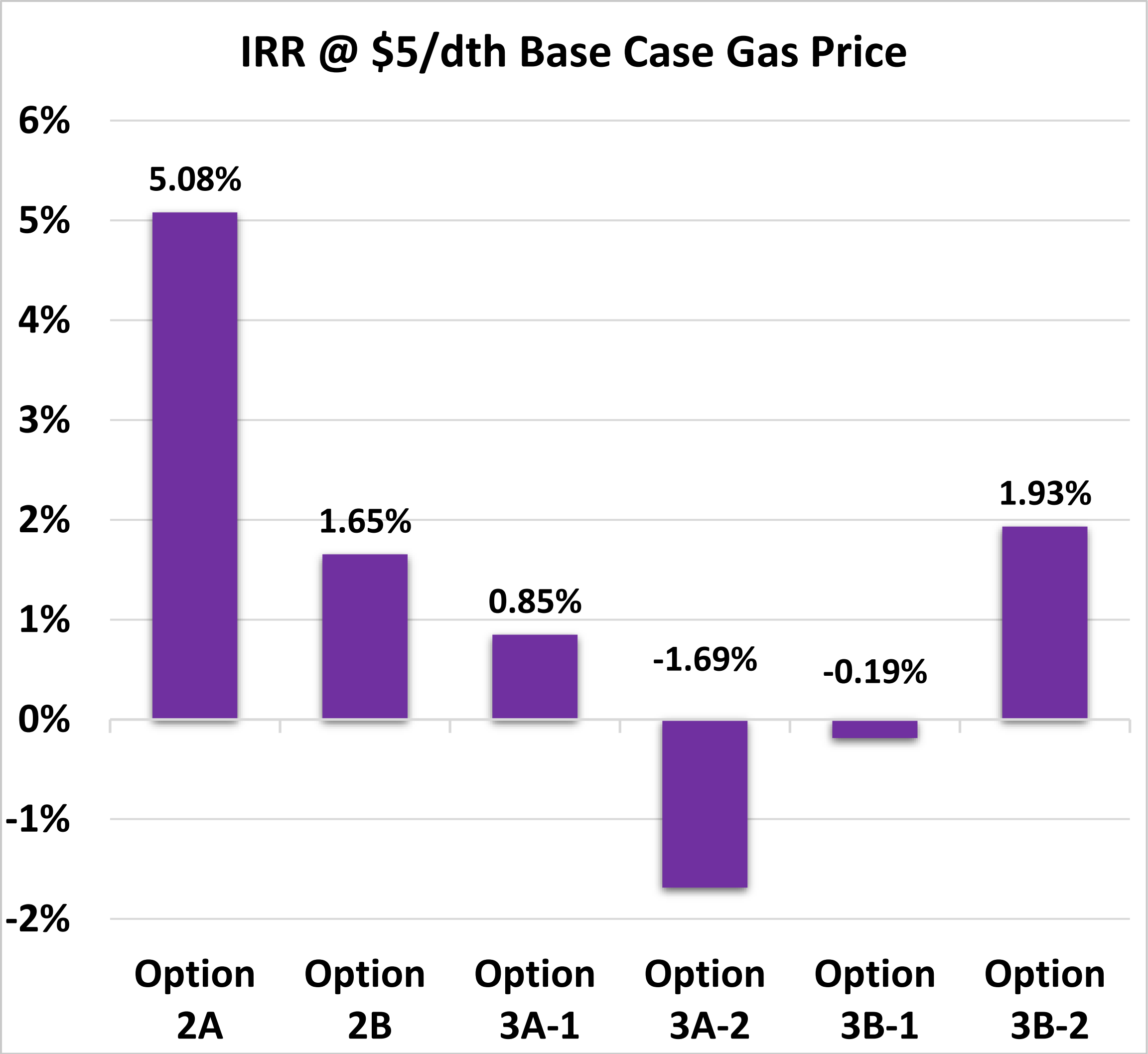
- Results are sensitive to natural gas prices



20-Year NPV Analysis



IRR of 20-year Cash Flows



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Pause for Financial Questions?

Permitting

State of Iowa DNR

- Title V Air Permit
- Solid Waste Permit
- Construction permits, including operating requirements
- Ash disposal

Local Permits

- Construction standards
- Code compliance (fire, electric, odor, traffic, noise etc.)

Other City Program Impacts

Curbside Recycling

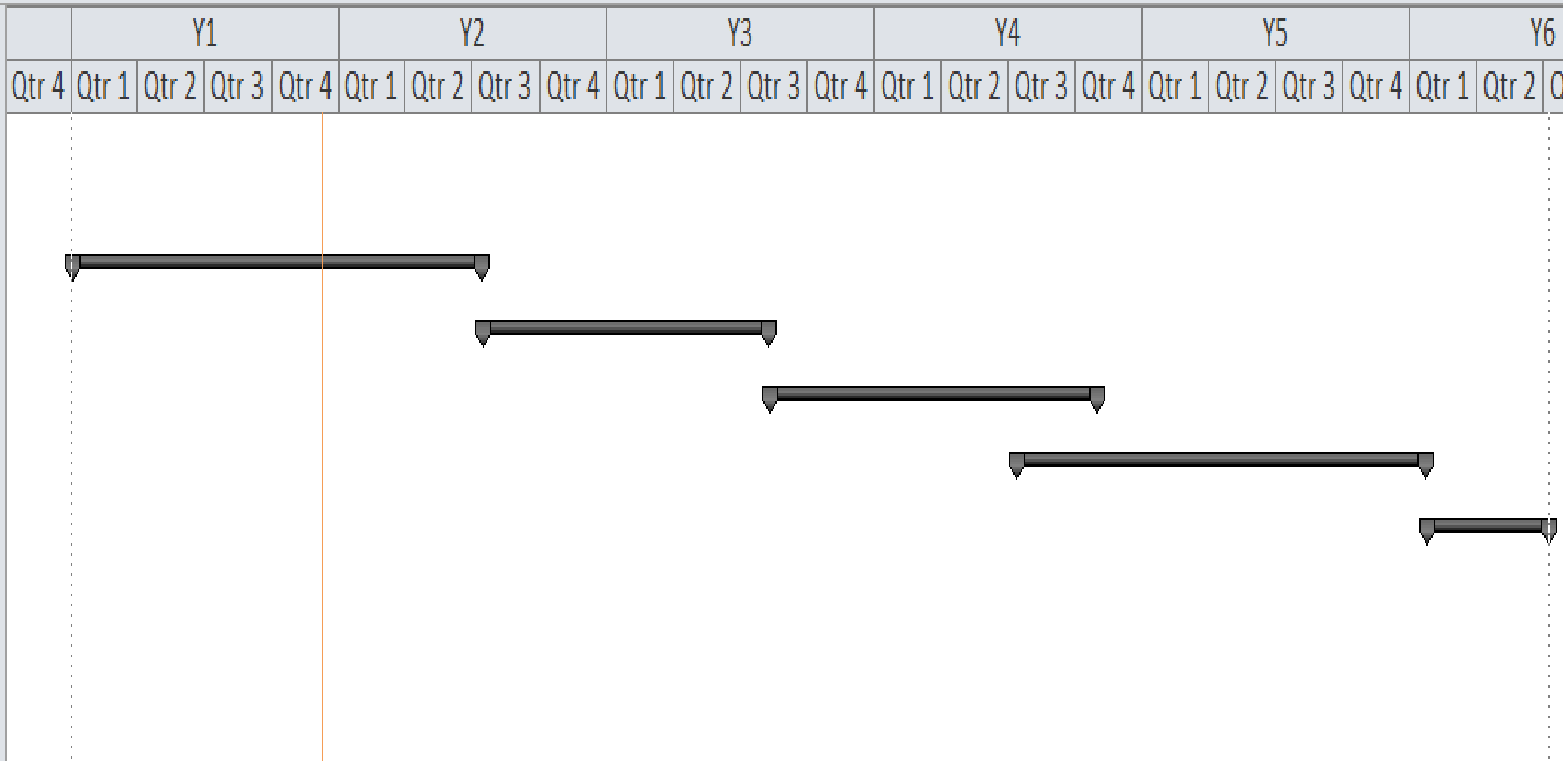
Organics Diversion

Outreach & Education

Development Impacts

Schedule

Task Name	Duration
Final City of Ames Eval of Options & Selection of Engineer	0 days
ENGINEERING & EQUIP SELECTION	**400 days**
DETAILED ENGINEERING	**280 days**
EQUIPMENT FABRICATION	**320 days**
CONSTRUCTION/COMMISSIONING	**400 days**
SCHEDULE FLOAT	**120 days**
***NOTE: Permitting activity and duration will need to be determined by the City and coordinated with the above project delivery schedule	



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Further Questions?

The RRT Teams wants to wish the City of Ames

Restful and joyful holidays, and best wishes for 2023

We appreciate the opportunity and enjoyed working with you