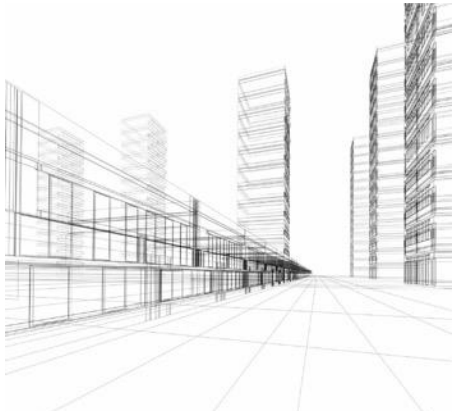


Gateway to the Rockies
HINTON

FEED Project Review

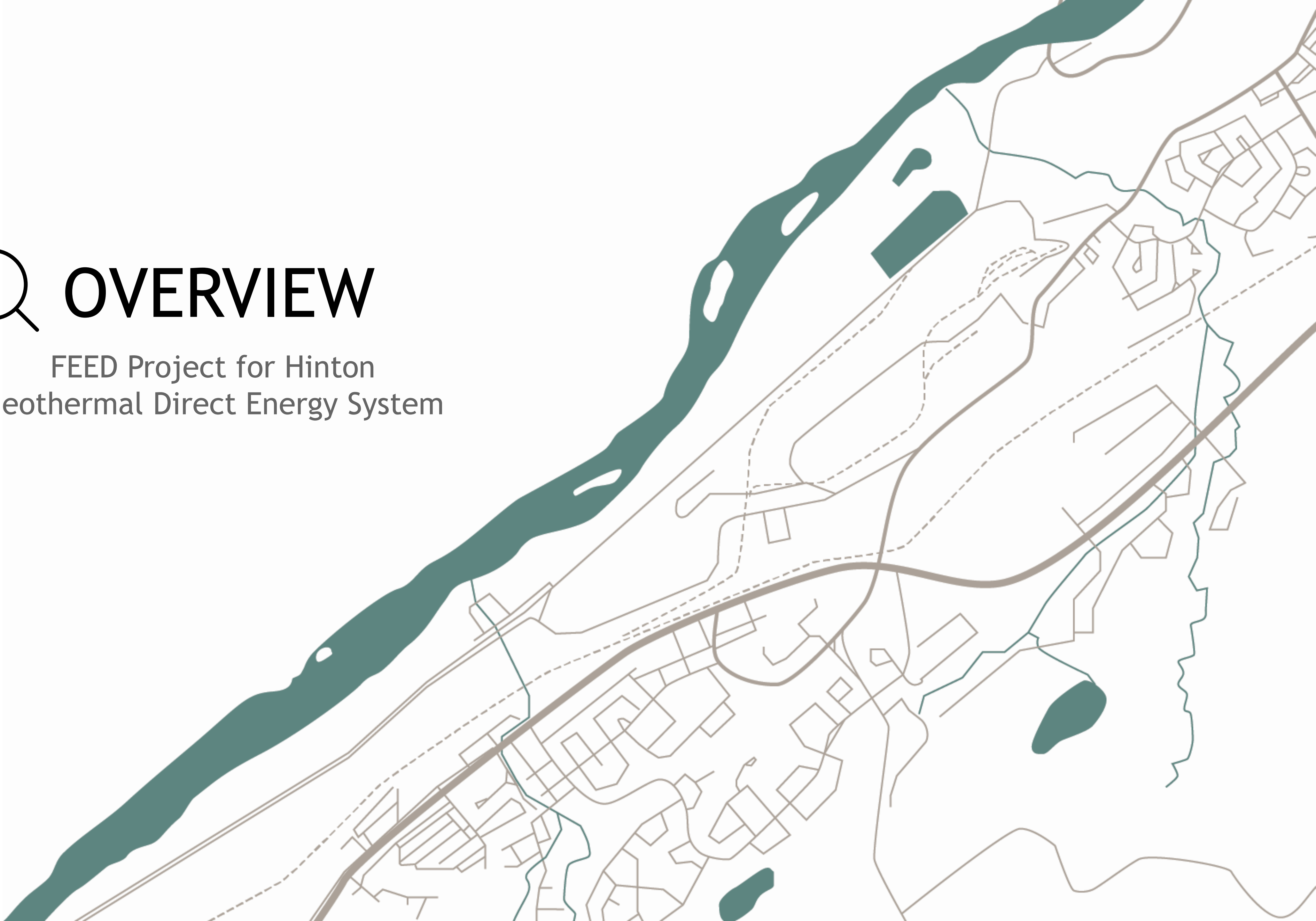
Hinton Geothermal District Energy System

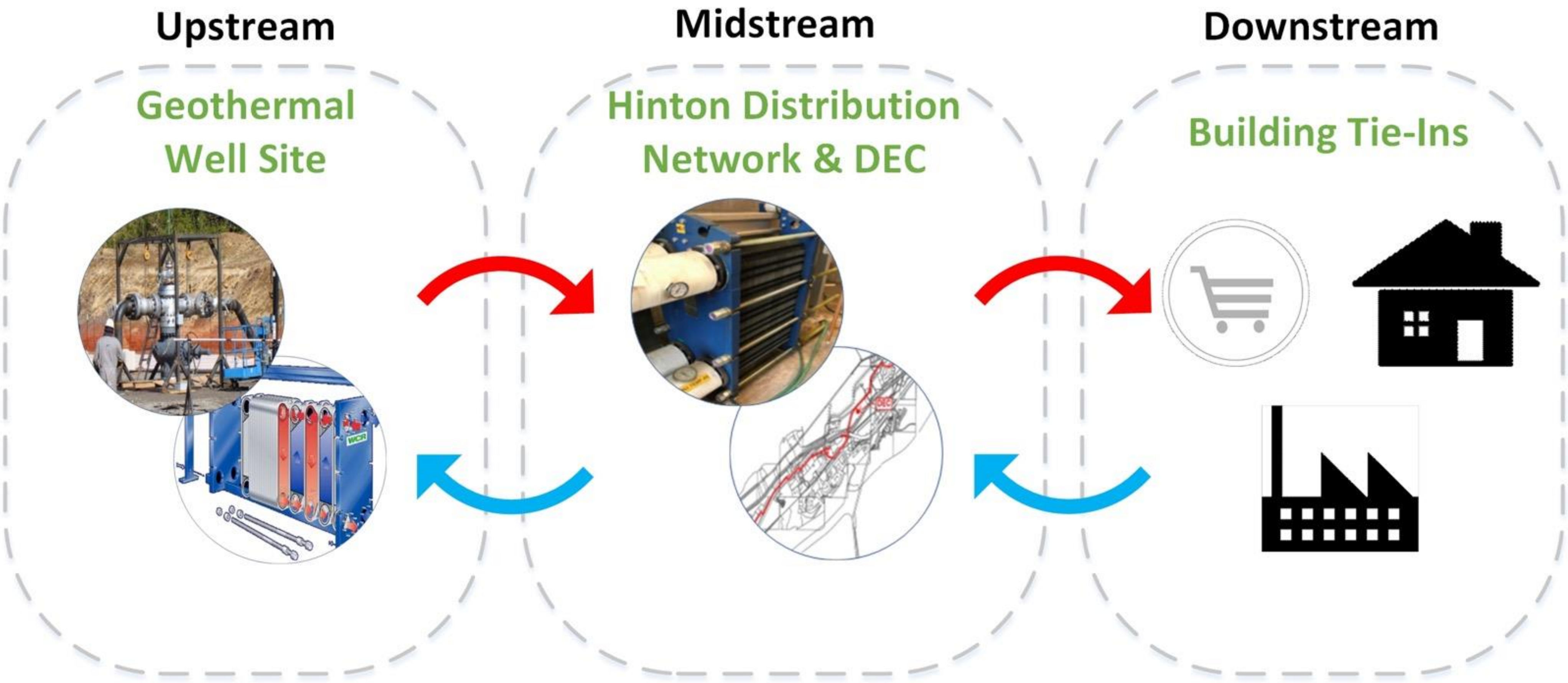
November 2018

EPOCH
ENERGY DEVELOPMENT

OVERVIEW

FEED Project for Hinton
Geothermal Direct Energy System





DISTRICT ENERGY SYSTEM OVERVIEW

OVERVIEW

PROJECT PROCESS FLOW

	Pre-FEED	FEED	Detailed Engineering	Construction
Phase:	Pre-FEED	FEED	Detailed Engineering	Construction
% Cost:	1%	5-8%	20%	75%
Estimate Accuracy:	±50% Class 5	±30% Class 3	±10% Class 1	

OVERVIEW

KEY MESSAGES & CHALLENGES

UPSTREAM

- Complex geology & unable to obtain O&G wells
- Scope change from repurposing wells to drilling wells

MIDSTREAM

- Design considerations: low heat load density, elevation change
- Scope change from full system (53 buildings) to optimized (38 buildings)

DOWNSTREAM

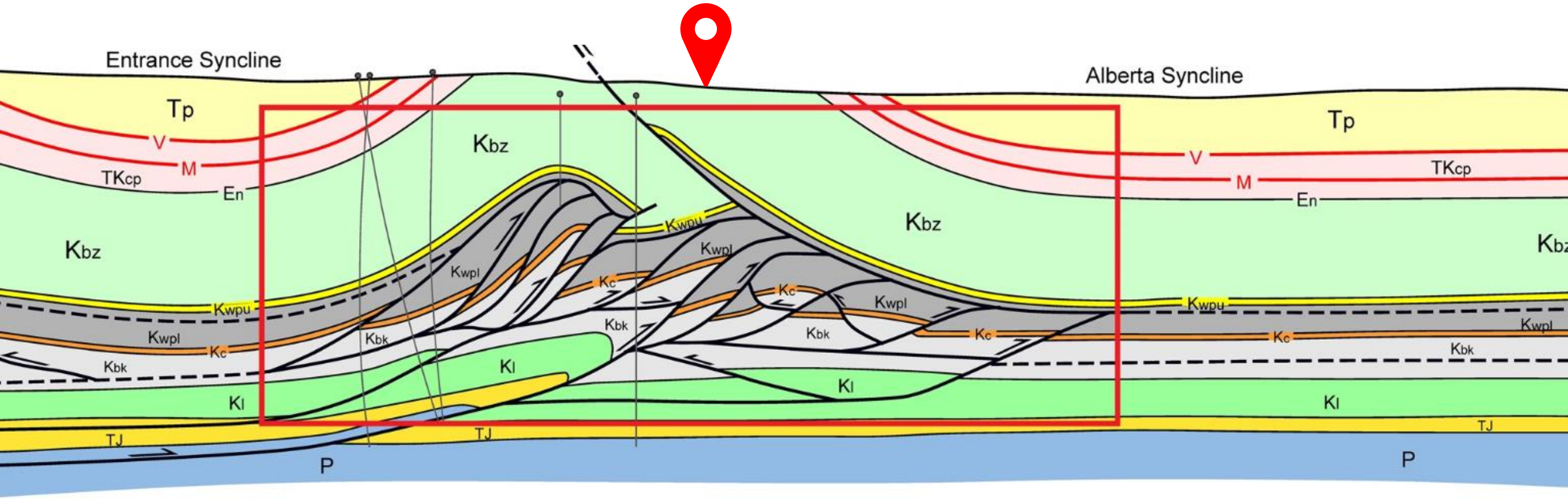
- Limited access to buildings & information
- More engagement required with end-users to increase buy-in

FINANCIAL ANALYSIS

- A geothermal-supplied DES not feasible; other heat source possible

⊤ UPSTREAM

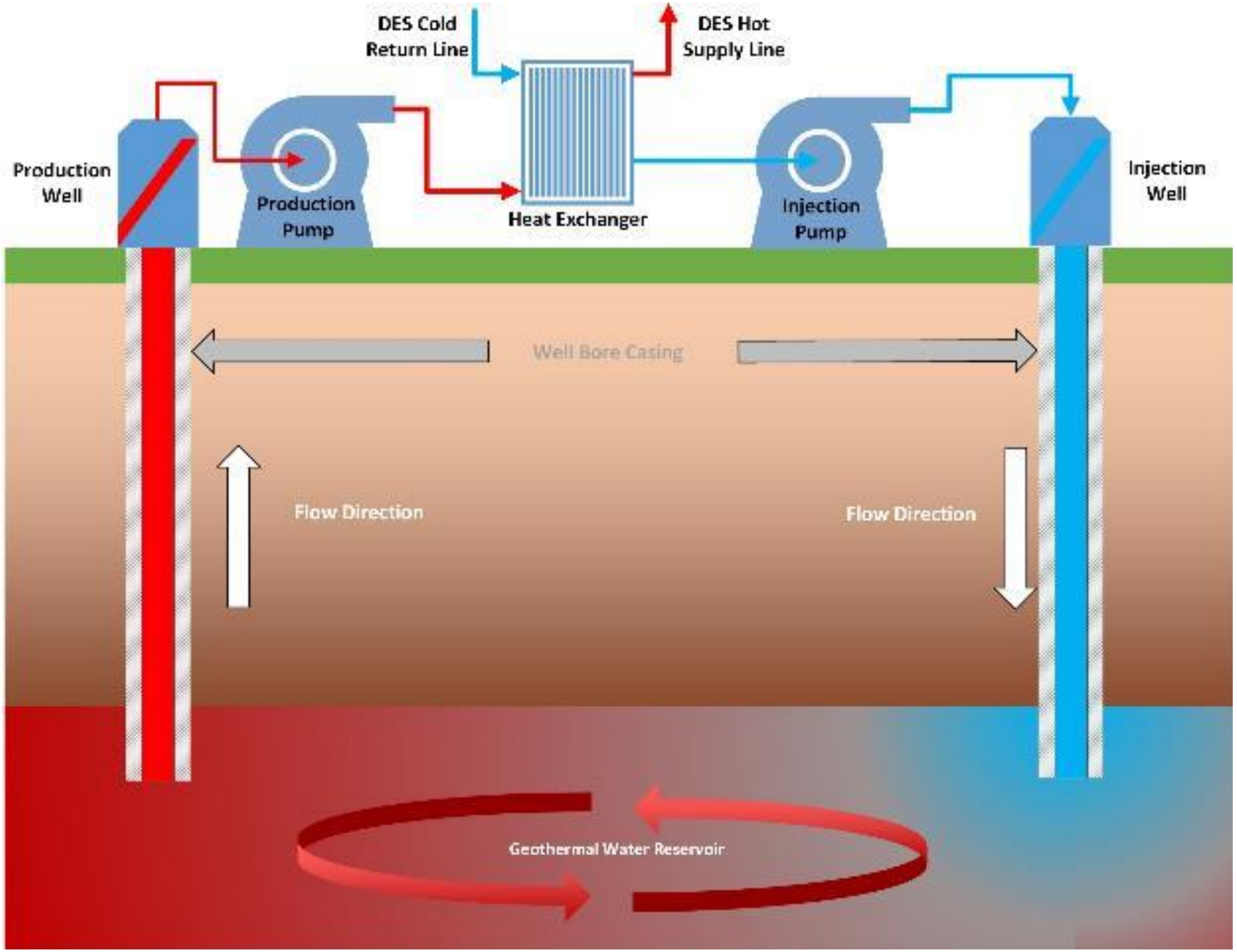
Geothermal Resource Production
via Repurposing Oil & Gas Wells



UPSTREAM

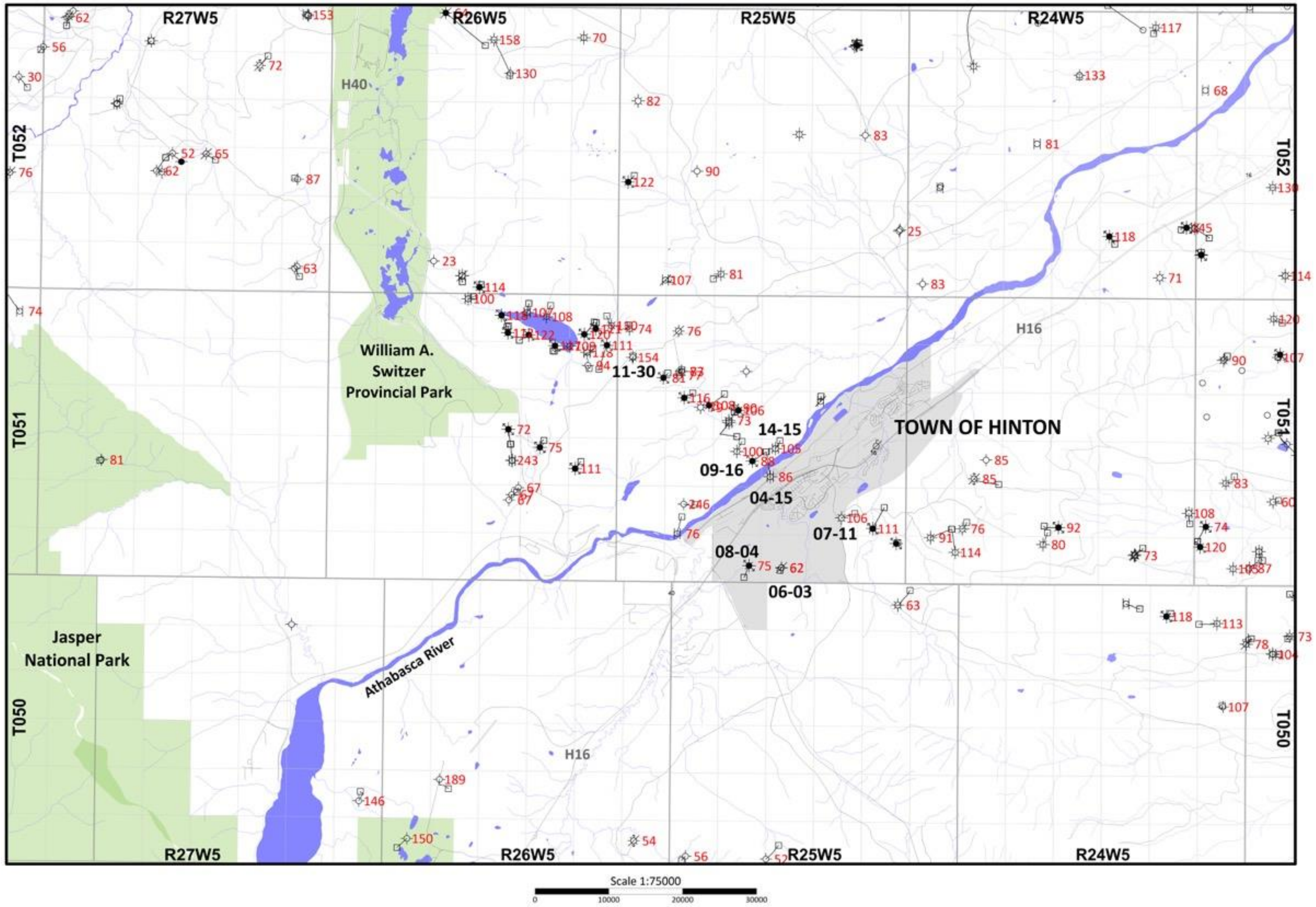
IDEAL GEOTHERMAL CONFIGURATION

Example of a production and injection well pair



UPSTREAM

GEOLOGICAL ASSESSMENT

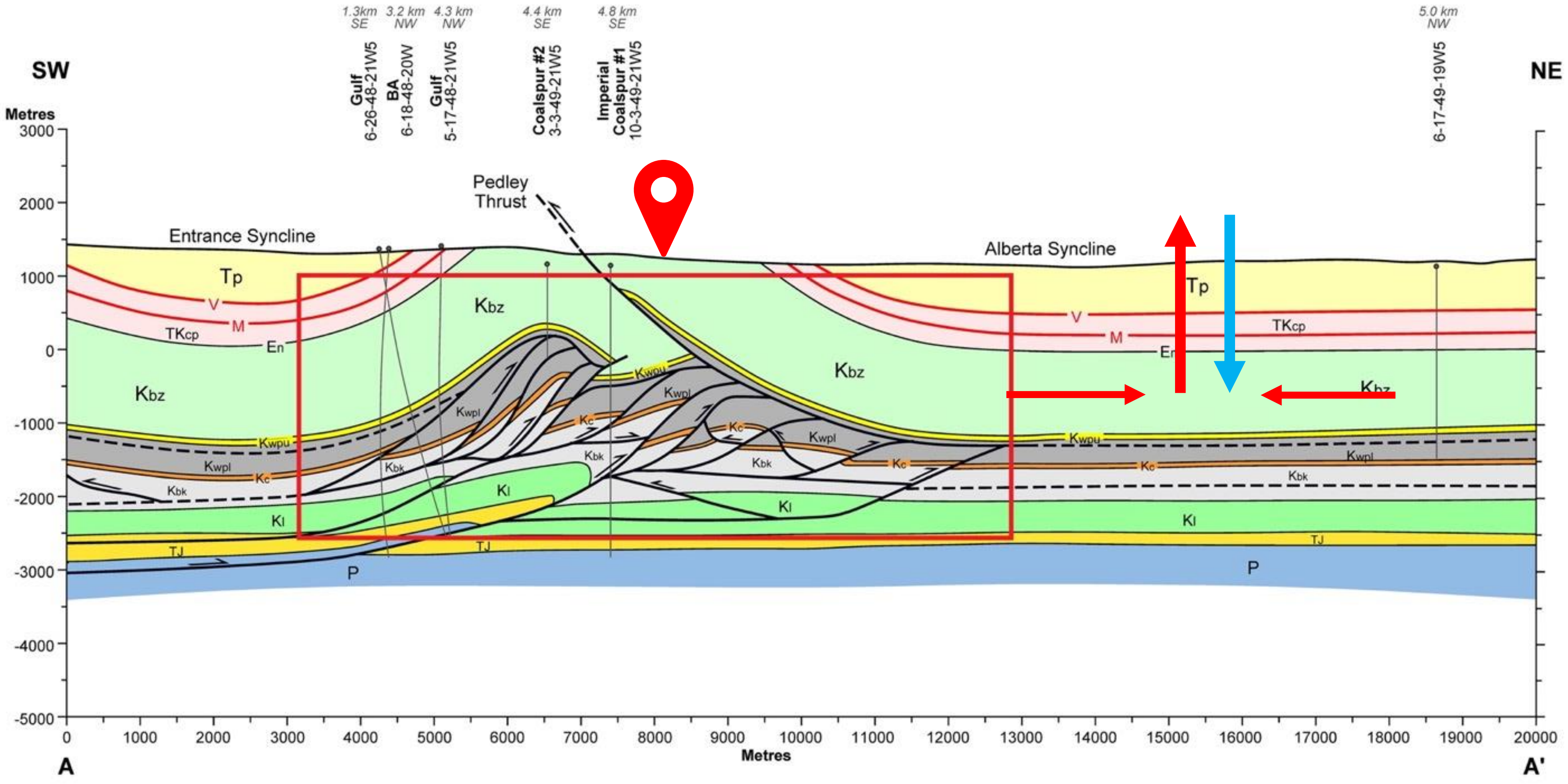


- Immense knowledge gain
  - 98 wells studied; drilling, completion, production logs
  - Focused on ~17km radius around Hinton; research area extended much farther

UPSTREAM

RESERVOIR CHARACTERISTICS

Representative structural cross-section near Hinton



UPSTREAM

RESERVOIR CHARACTERISTICS

- Very high temperatures, very deep down
- Multiple sour (H_2S) zones
- Lack of porosity, permeability, areal extent, water saturation, flow rates
- Little to no communication between wells
- Drastic pressure variation with depth → slow, expensive drilling
- Risky high pressure zone

→ High potential if power considered; heat alone not feasible

UPSTREAM

WELLS:
3 OPTIONS

❌ Repurposing existing O&G wells

- No zones with suitable geology to support fluid flow requirements
- Existing deep wells with high temperatures far away
- Wells not available from current owners

UPSTREAM

WELLS:
3 OPTIONS

❌ Repurposing existing O&G wells

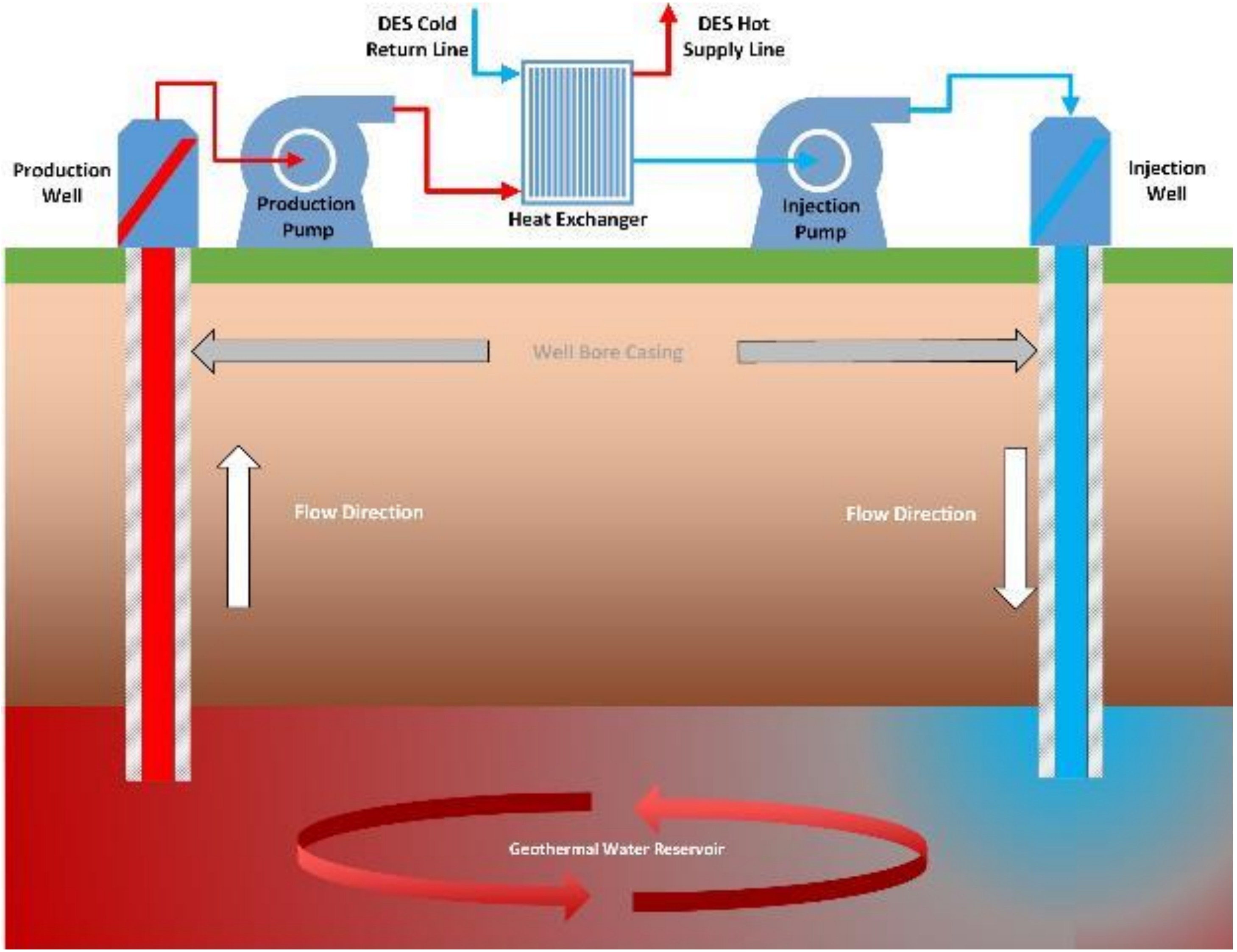
- No zones with suitable geology to support fluid flow requirements
- Deep wells with high temperatures far away
- Wells not available from current owners

Drill: pair of wells (2 wells: 1 production/1 injection)

- Severe loss of fluids into formations and faults
- Lack of communication between wells
- Risky subsurface drilling environment

UPSTREAM

SCOPE CHANGE: DRILL NEW WELL



Example of a production and injection well pair

UPSTREAM

WELLS:
3 OPTIONS

Repurposing existing O&G wells

- No zones with suitable geology to support fluid flow requirements
- Deep wells with high temperatures far away
- Wells not available from current owners

Drill: pair of wells (2 wells: 1 production/1 injection)

- Severe loss of fluids into clay formations
- Lack of communication between wells
- Risky subsurface drilling environment

UPSTREAM

WELLS:
3 OPTIONS

❌ Repurposing existing O&G wells

- No zones with suitable geology to support fluid flow requirements
- Deep wells with high temperatures far away
- Wells not available from current owners

❌ Drill: well pair configuration (2 wells: 1 production/1 injection)

- Severe loss of fluids into clay formations
- Lack of communication between wells
- Risky subsurface drilling environment

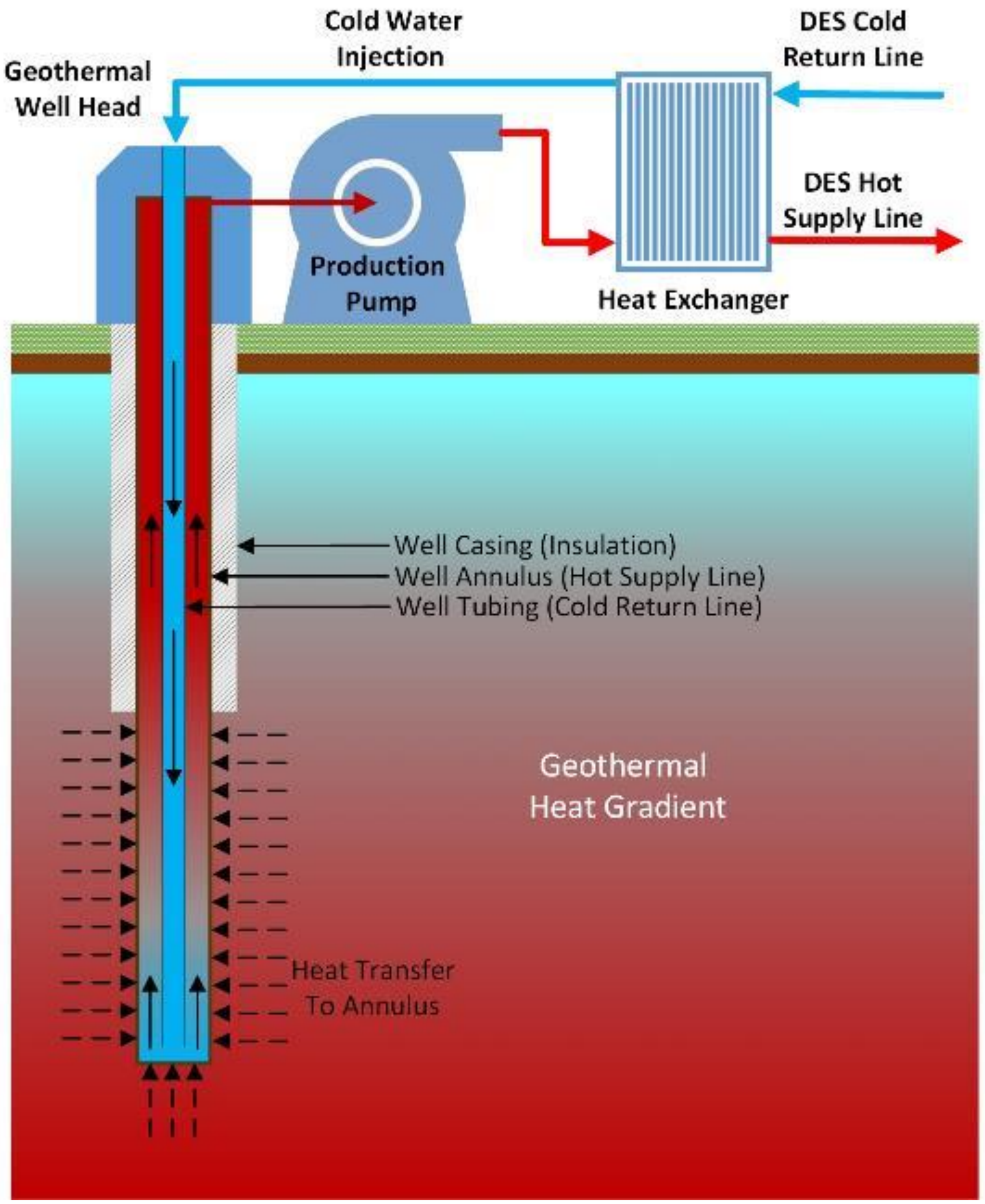
Drill: single well, closed-loop circulation

- Vertical depth: 3,650m, Horizontal leg: 500m, Total length: 4,300m
- $6 million; 10-20x more expensive than repurposing
- Multiple proposed configurations
- Modeled for optimal heat extraction per unit cost

UPSTREAM

SCOPE CHANGE: DRILL NEW WELL

Best-case single well, closed-loop circulation



UPSTREAM

WELLS:
3 OPTIONS

✗ Repurposing existing O&G wells

- No zones with suitable geology to support fluid flow requirements
- Deep wells with high temperatures far away
- Wells not available from current owners

✗ Drill: well pair configuration (2 wells: 1 production/1 injection)

- Severe loss of fluids into clay formations
- Lack of communication between wells
- Risky subsurface drilling environment

✓ Drill: single well, closed-loop circulation

- Vertical depth: 3,650m, Horizontal leg: 500m, Total length: 4,300m
- $6 million; 10-20x more expensive than repurposing
- Multiple proposed configurations
- Optimized factors to get the most heat for the least amount of money

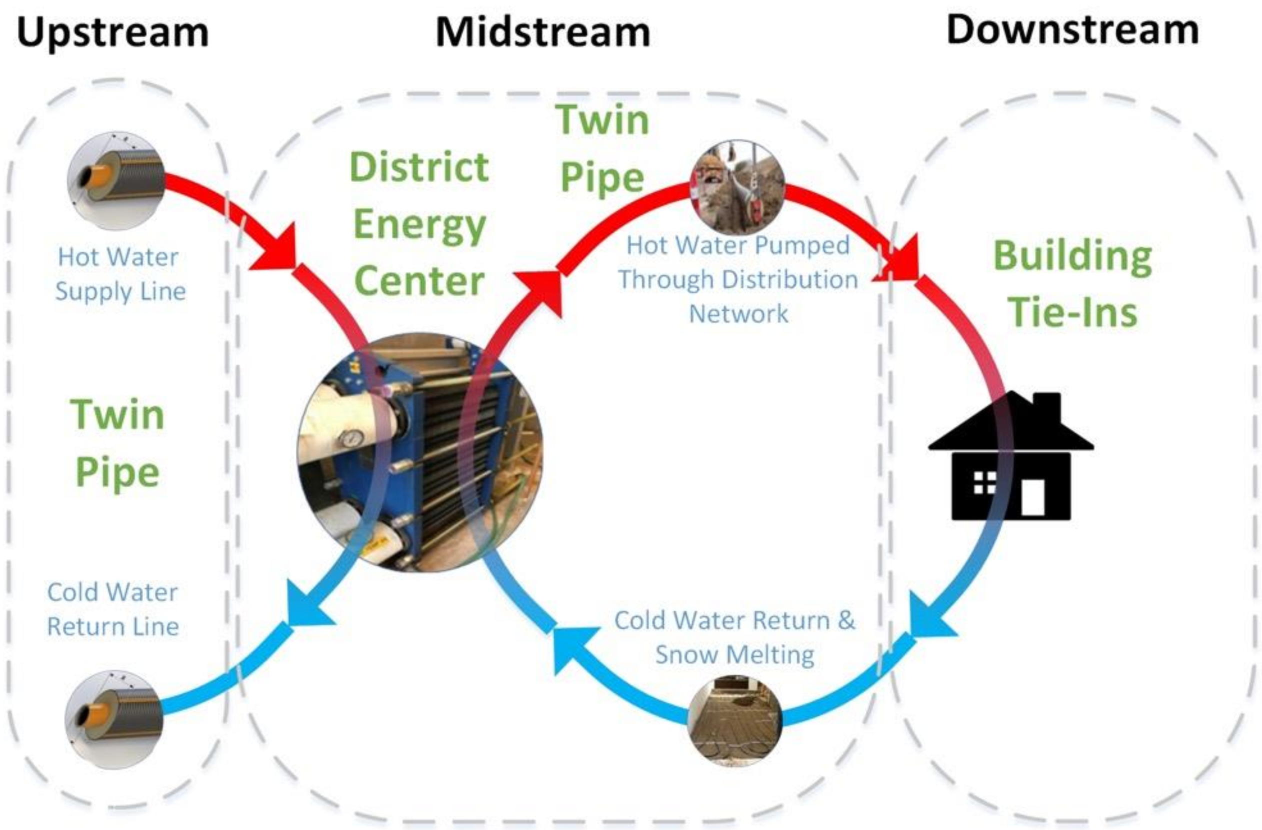
Drilling a new well is viable, but much more expensive than repurposing

MIDSTREAM

District Energy Infrastructure

MIDSTREAM

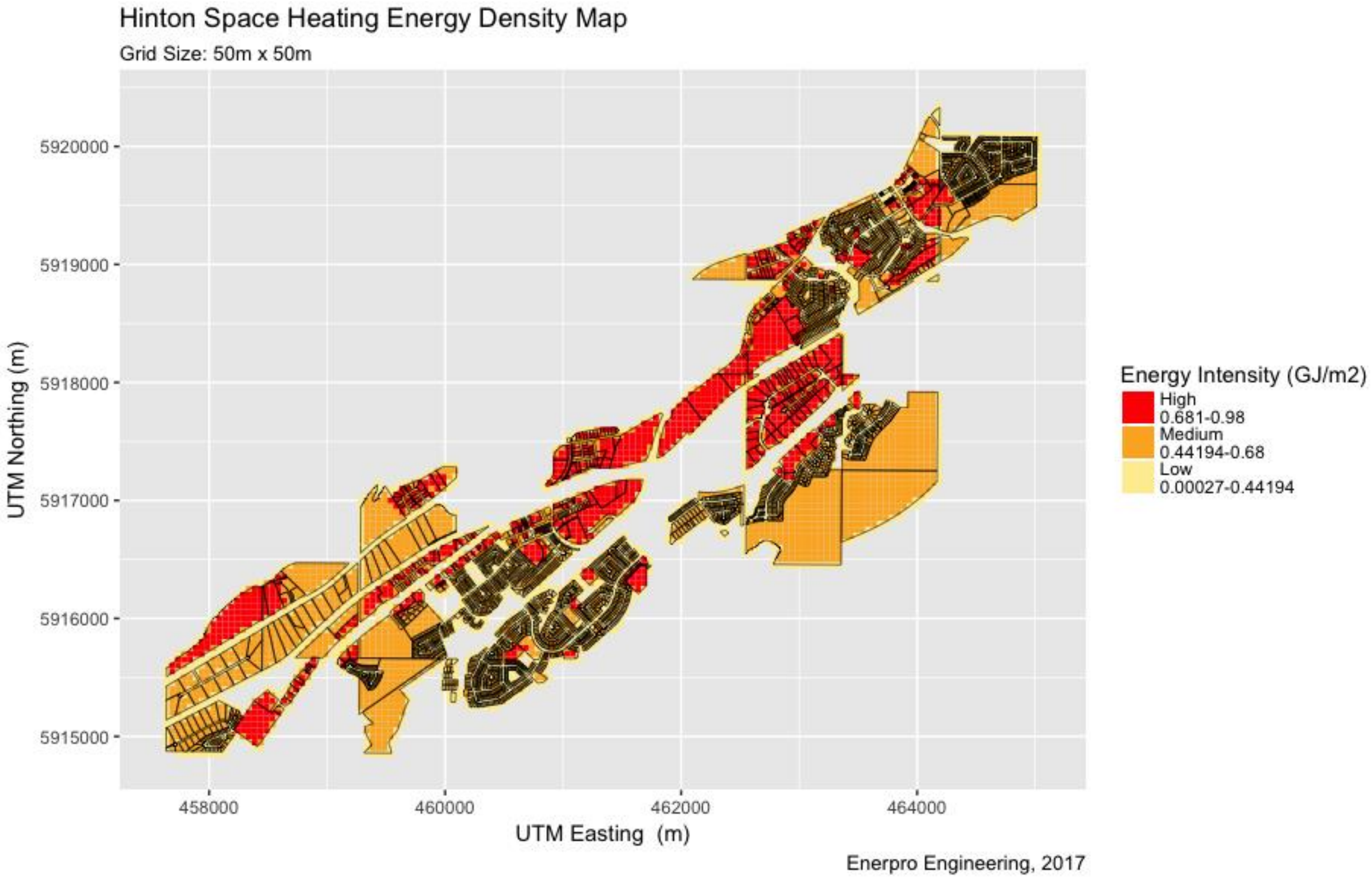
MIDSTREAM SUMMARY



- Heat source agnostic (geothermal, biomass, waste heat, etc.)
- DES design
  - Complete design with all 53 potential consumers
  - Optimized design with 38 consumers; eliminates unprofitable areas
- Lack of access to buildings and information forced assumptions

MIDSTREAM

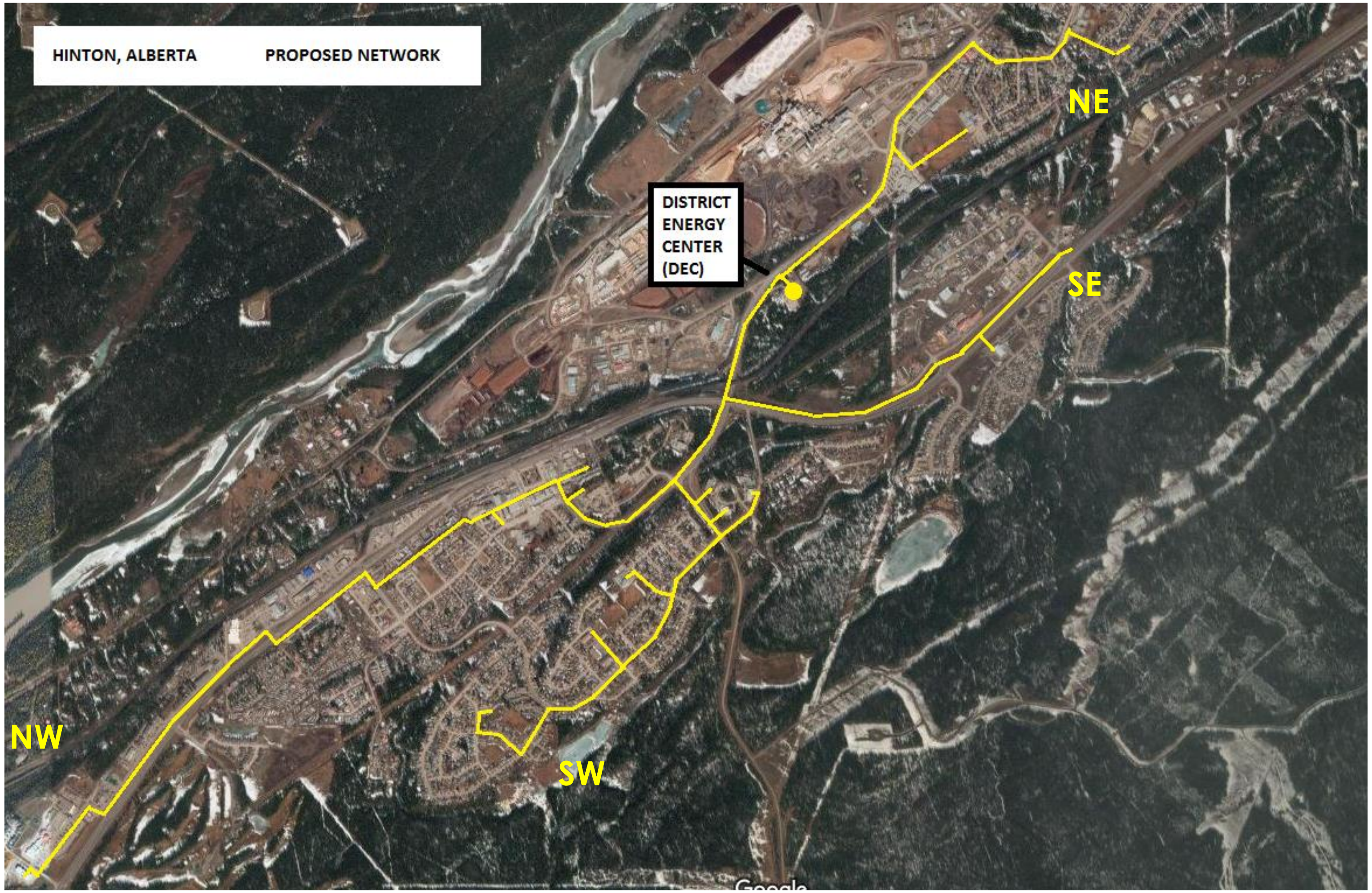
DESIGN FACTORS



MIDSTREAM

COMPLETE DES SYSTEM DESIGN

Town of Hinton Complete DES layout



- All 53 consumers
- 10 iterations
- Obstacles: dispersed heat load, lack of profitability, elevation change
- $21 million: $4.6M for DEC, $17M for pipeline network

MIDSTREAM

OPTIMIZED DES SYSTEM DESIGN

Town of Hinton Optimized DES layout

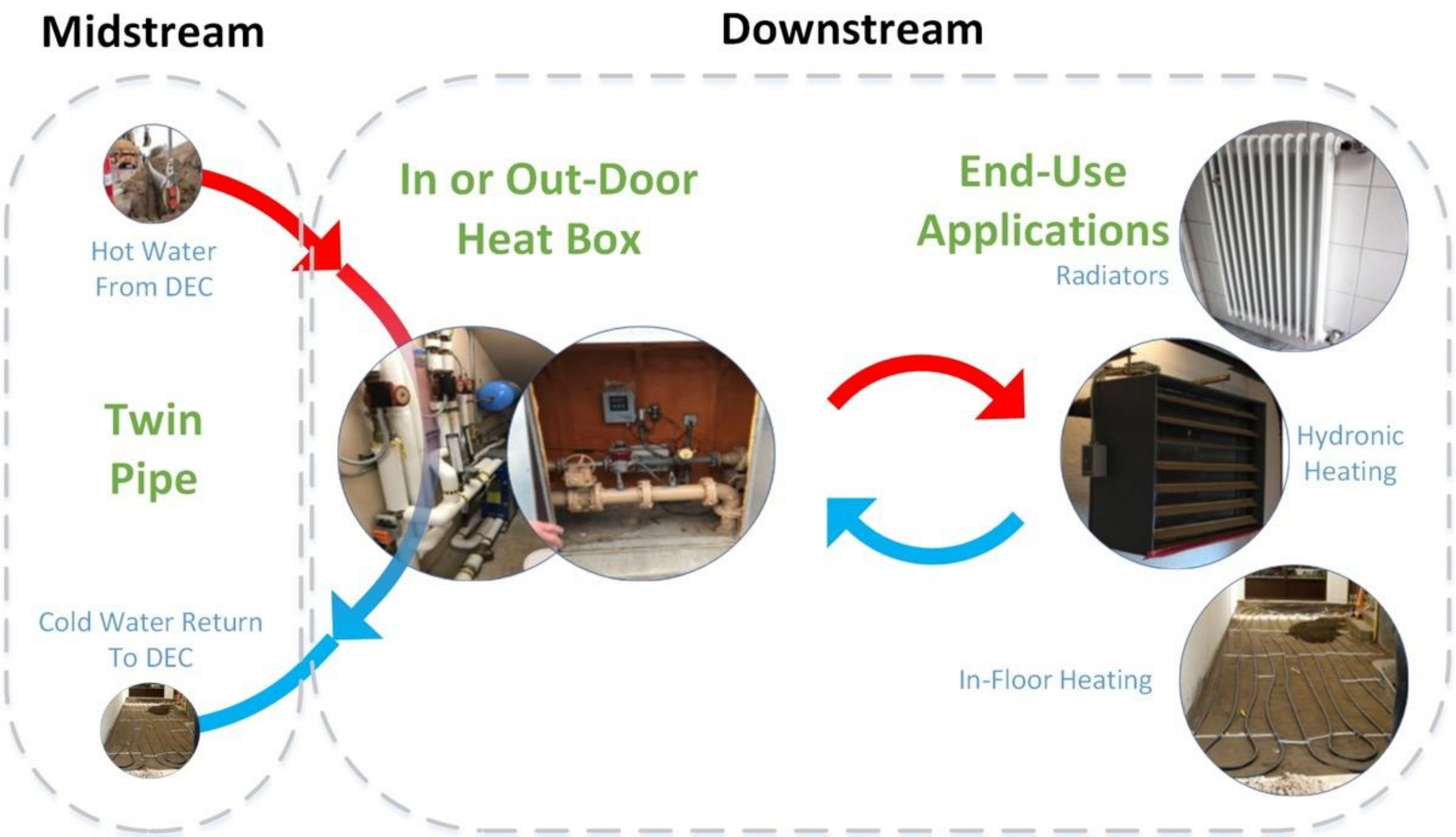
- 11th iteration: optimized to eliminate unprofitable areas
- 38 consumers
- $13.4 million: $3M for DEC, $10.8M for pipeline network

DOWNSTREAM

Building Interconnection

DOWNSTREAM

DOWNSTREAM SUMMARY



- **Evaluated feasibility of 53 prospective buildings**
  - Quality of in-place heating systems
  - Existing infrastructure
- **Identified potential retrofits & associated costs**

DOWNSTREAM

DOWNSTREAM COSTS

Cost estimates

Estimated Cost to Tie-in		Estimated Cost to Convert to Hydronic	
Low	High	Low	High
$5,600	$37,000	$130,000	$1,600,000

Total (Complete system design - 53 buildings)	
$763,089	$15,048,887

DOWNSTREAM

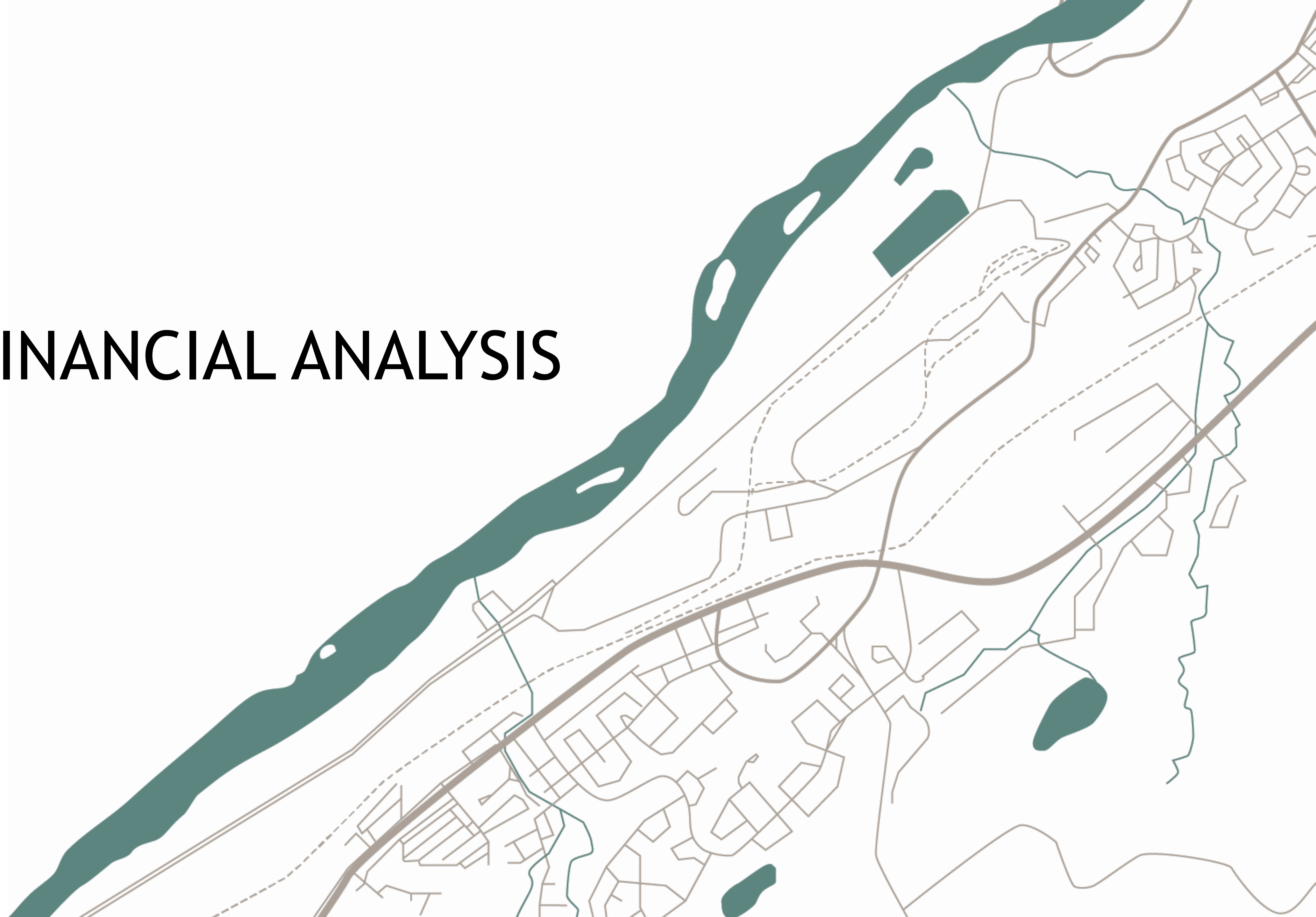
HEAT EXCHANGER

Example Downstream infrastructure

Example installed heat exchanger in a mechanical room

Example heat exchanger building enclosure outside
→ Used if no room inside building

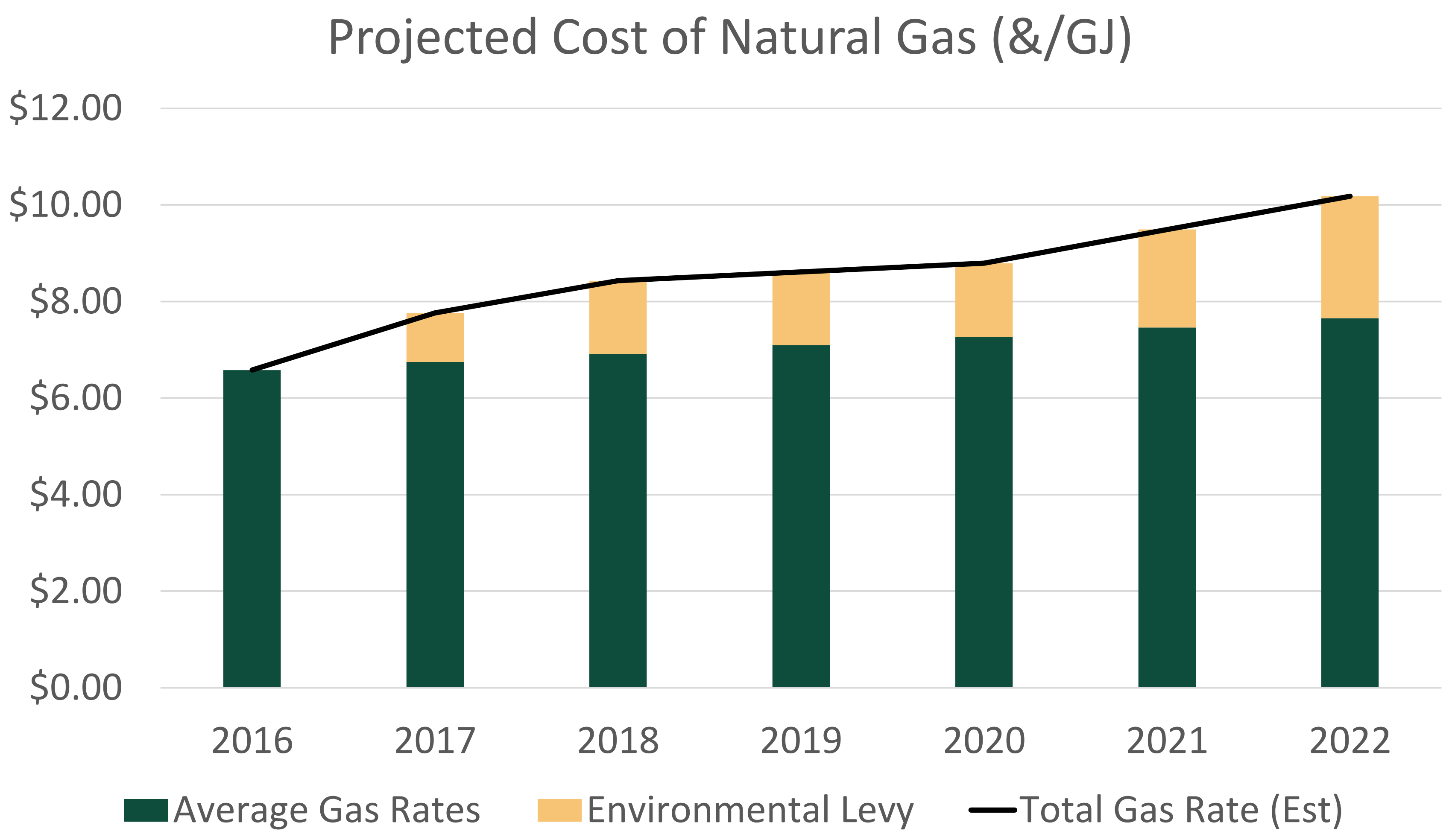
FINANCIAL ANALYSIS



FINANCIAL

NATURAL GAS

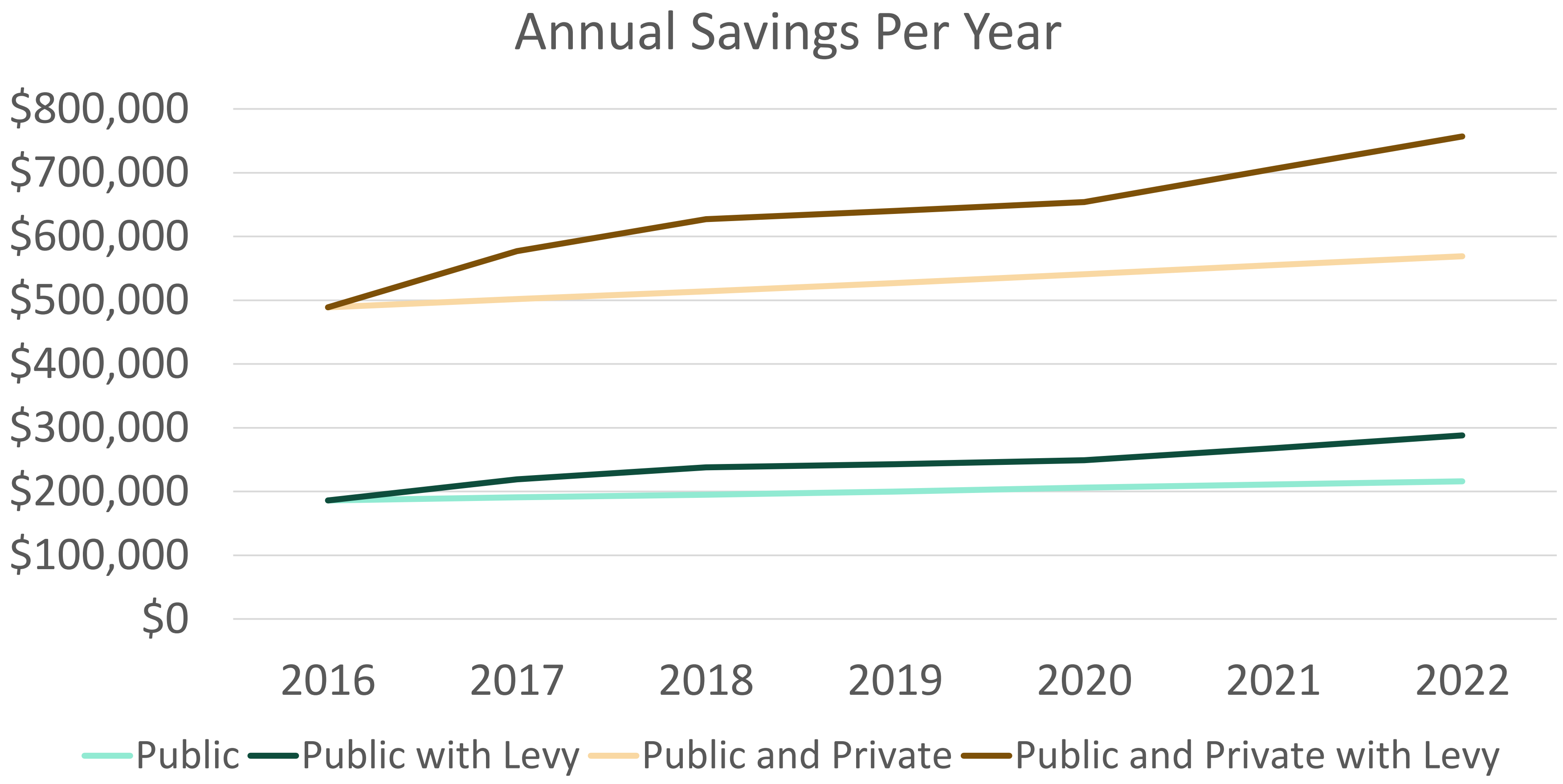
Projected cost of natural gas



FINANCIAL

ANNUAL SAVINGS

- Projected annual savings per year



FINANCIAL

UPSTREAM & DOWNSTREAM FINANCIALS

Summary of Upstream Costs

New Well	$6,300,000
Pipeline	$3,000,000
Total	$9,300,000

25-30 year payback period

Summary of Downstream Costs – Optimized System

Tie-in Costs	$560,000
Building Modifications	$5,000-$300,000/building*

**cost borne by building owner*

FINANCIAL

MIDSTREAM FINANCIALS

Assumptions

- Interest: 4%
- Price: $10/GJ
- Funded by subsidies or grants: 0%
- Operations & Maintenance: $500,000/year

Summary of Midstream Costs – Optimized System

District Energy Centre	$2,600,000
District Energy System	$10,800,000
Energy Transfer Stations	$1,582,000
Operation & Maintenance	$500,000/year

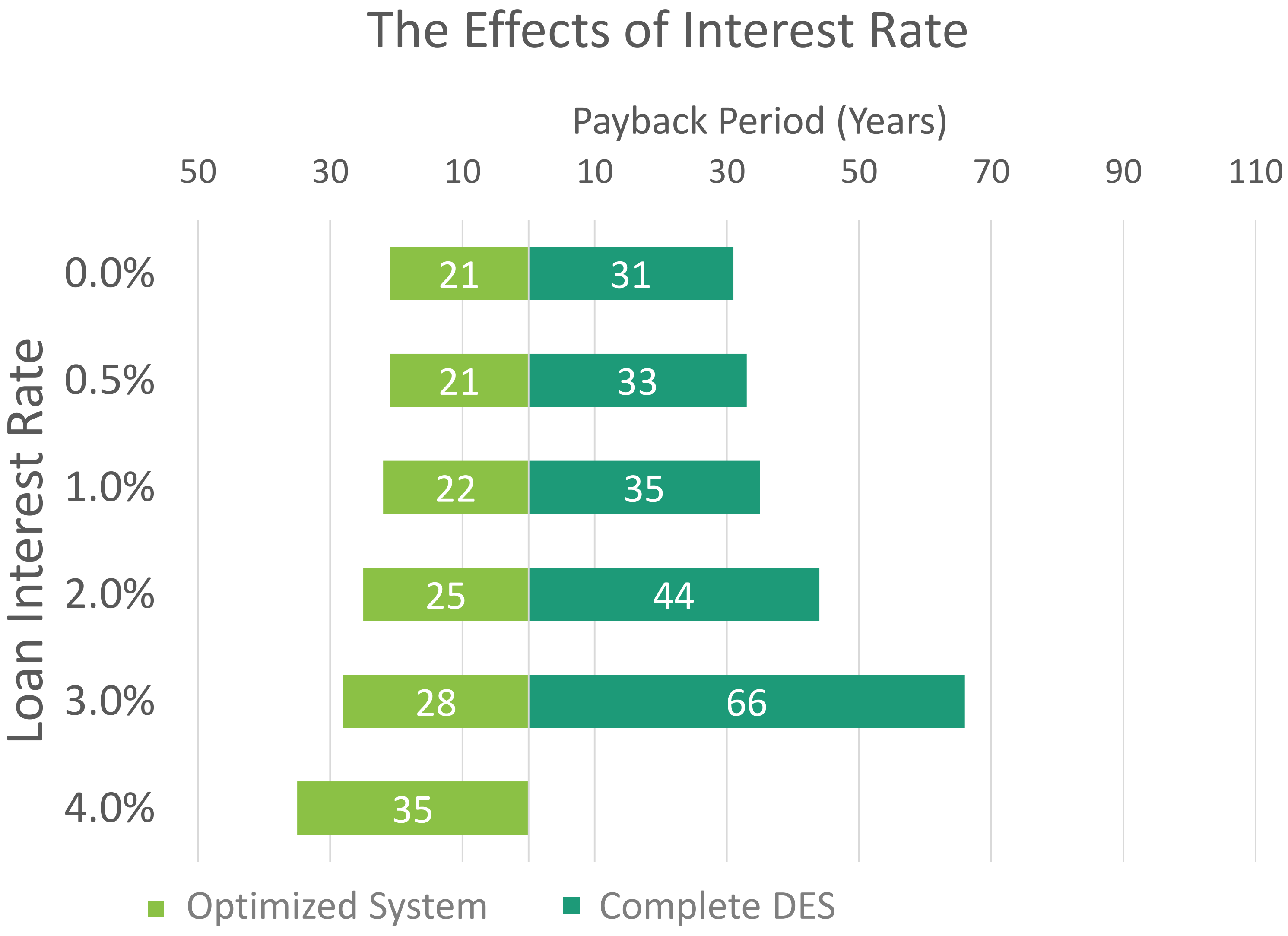
Effect of Cost Saving Measures

- Interest: 2%
- Price: $10/GJ
- Capital Reduction: 30%
- Yields 15 year payback

FINANCIAL

MIDSTREAM SENSITIVITY ANALYSIS

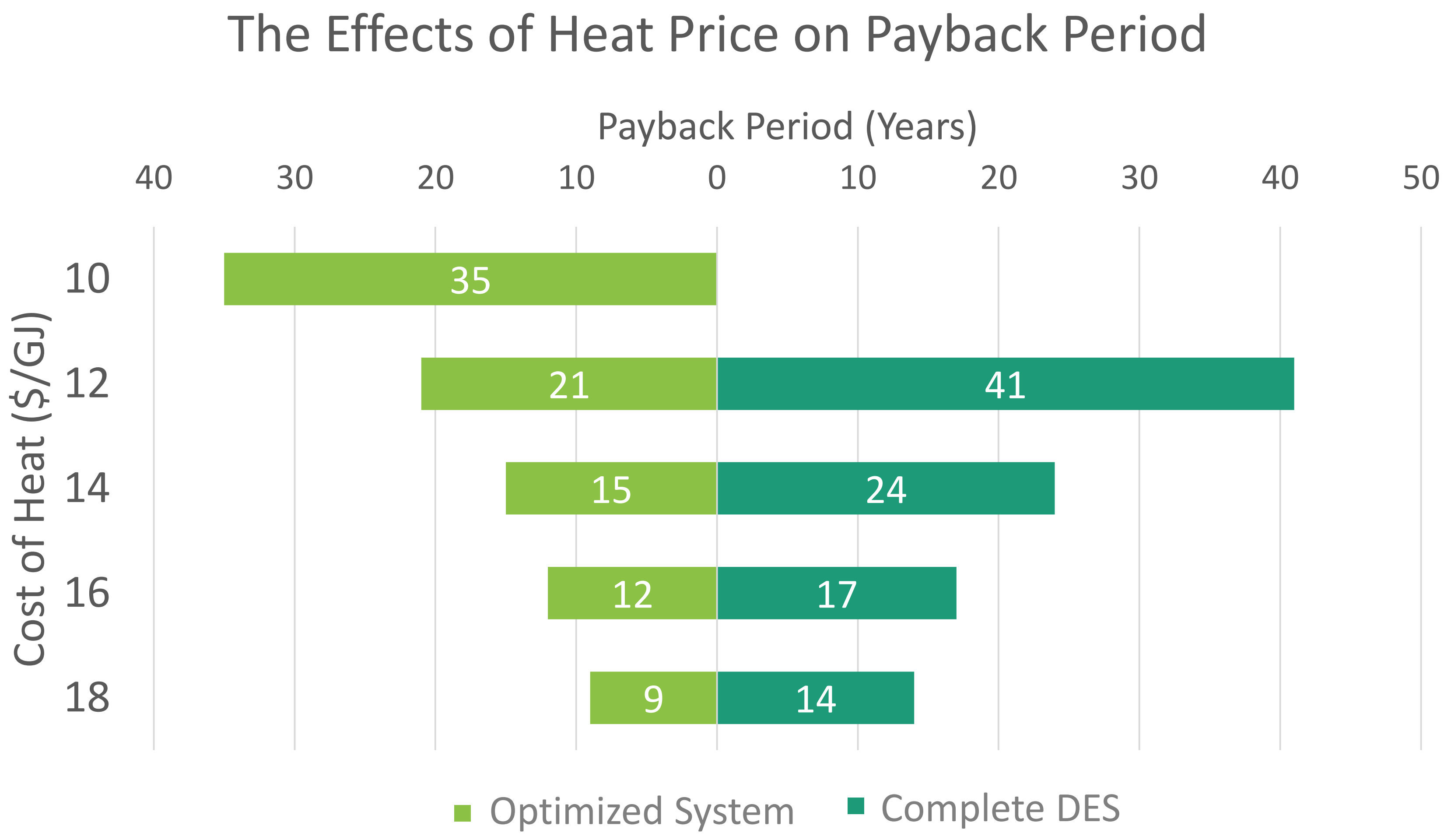
Effect of Interest Rate



FINANCIAL

MIDSTREAM SENSITIVITY ANALYSIS

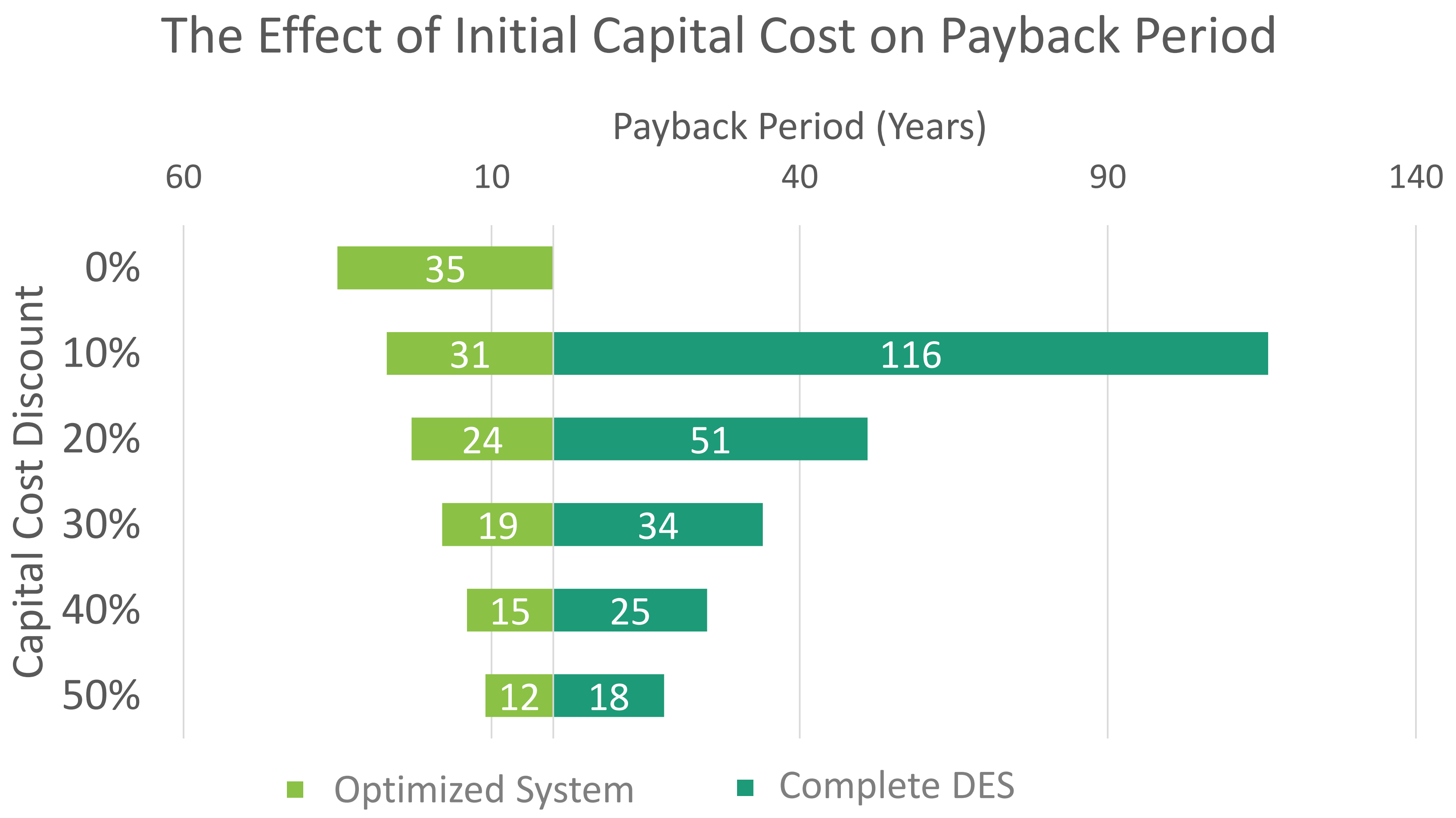
Effect of Heat Price on Payback Period



FINANCIAL

MIDSTREAM SENSITIVITY ANALYSIS

Effect of Initial Capital Cost on Payback Period



RECOMMENDATIONS

RECOMMENDATIONS & CONCLUSIONS

- A study on a combined geothermal heat & power plant.
- Increase energy density in the Hinton downtown core.
- Confirm building specifics and increase consumer engagement & participation.
- Identify alternative viable heat source.
- Process developed to evaluate other potential municipalities & heat sources

QUESTIONS?

Hinton Geothermal Project

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