Assessing the Role of Cogeneration for Carbon Management of Oil Sands Operations in Alberta

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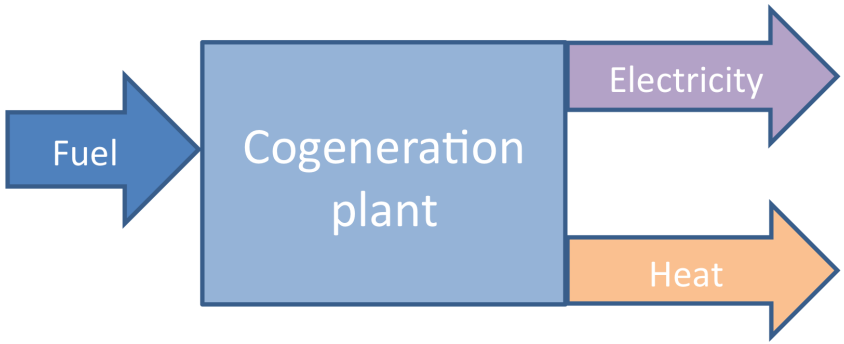
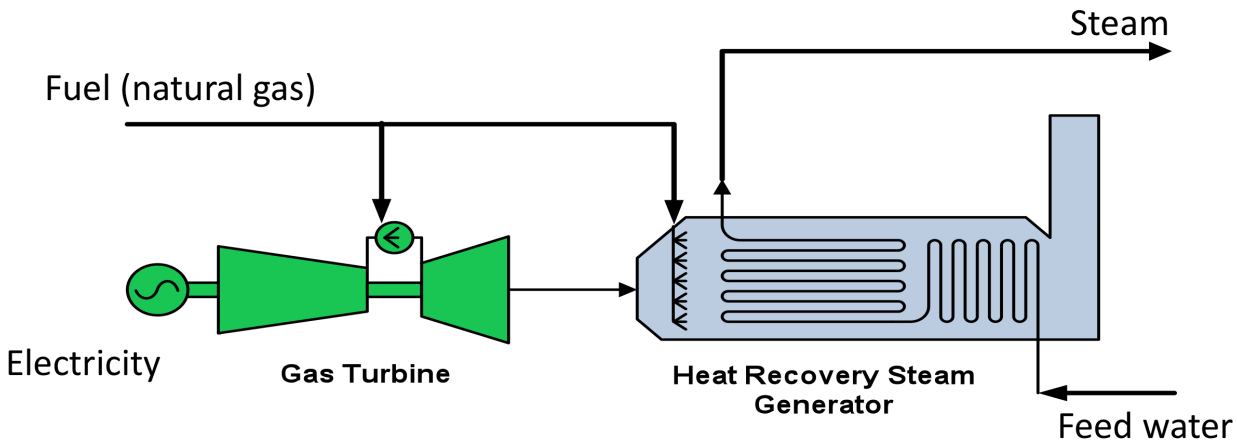
Introduction

- Oil sands sector: a dominant electricity and natural gas consumer
- Cogeneration: an option to reduce CO_2 emissions in oil sands and electricity sectors
- Investments on cogeneration: influenced by fuel price volatilities, transmission access, and carbon management policies
- We investigate the effect of carbon management policies on cogeneration investments

Cogeneration

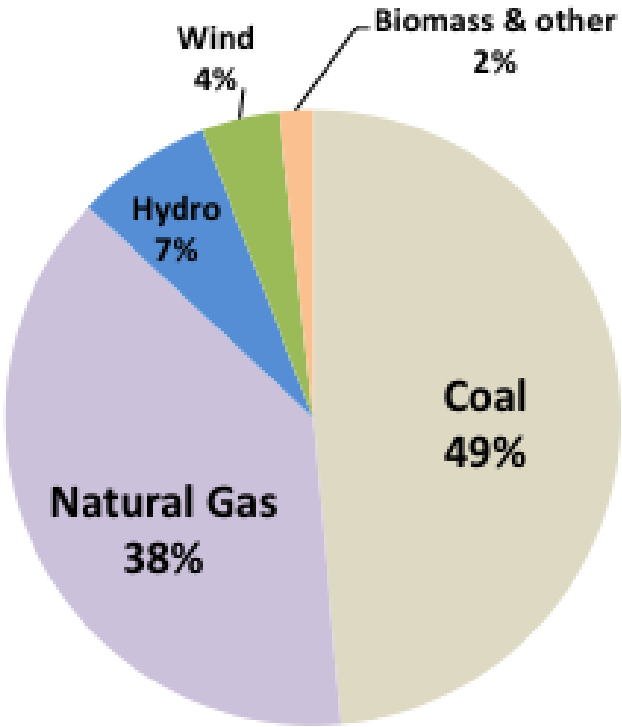
▷ Process of capturing and using waste heat while generating electricity



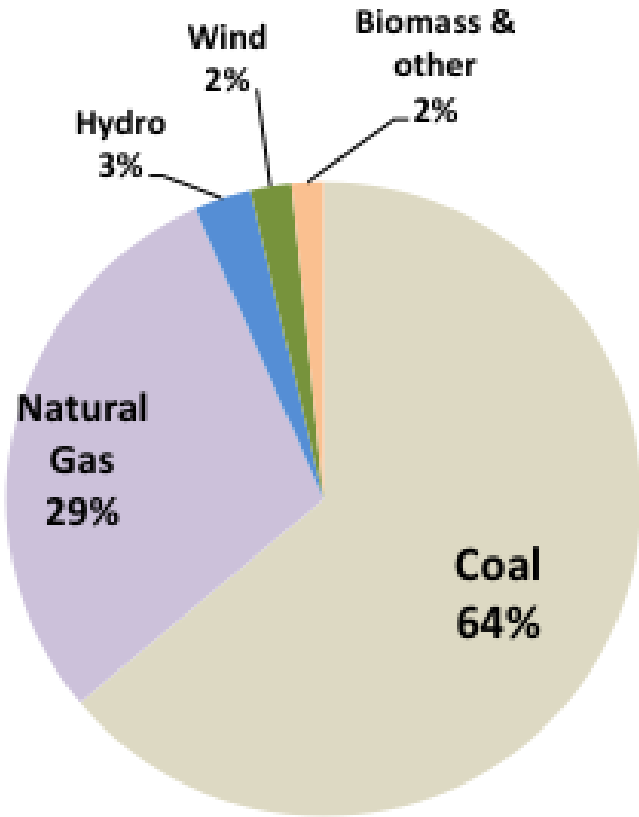


Overall fuel efficiency is very high (2x)

Alberta Electricity Generation Mix

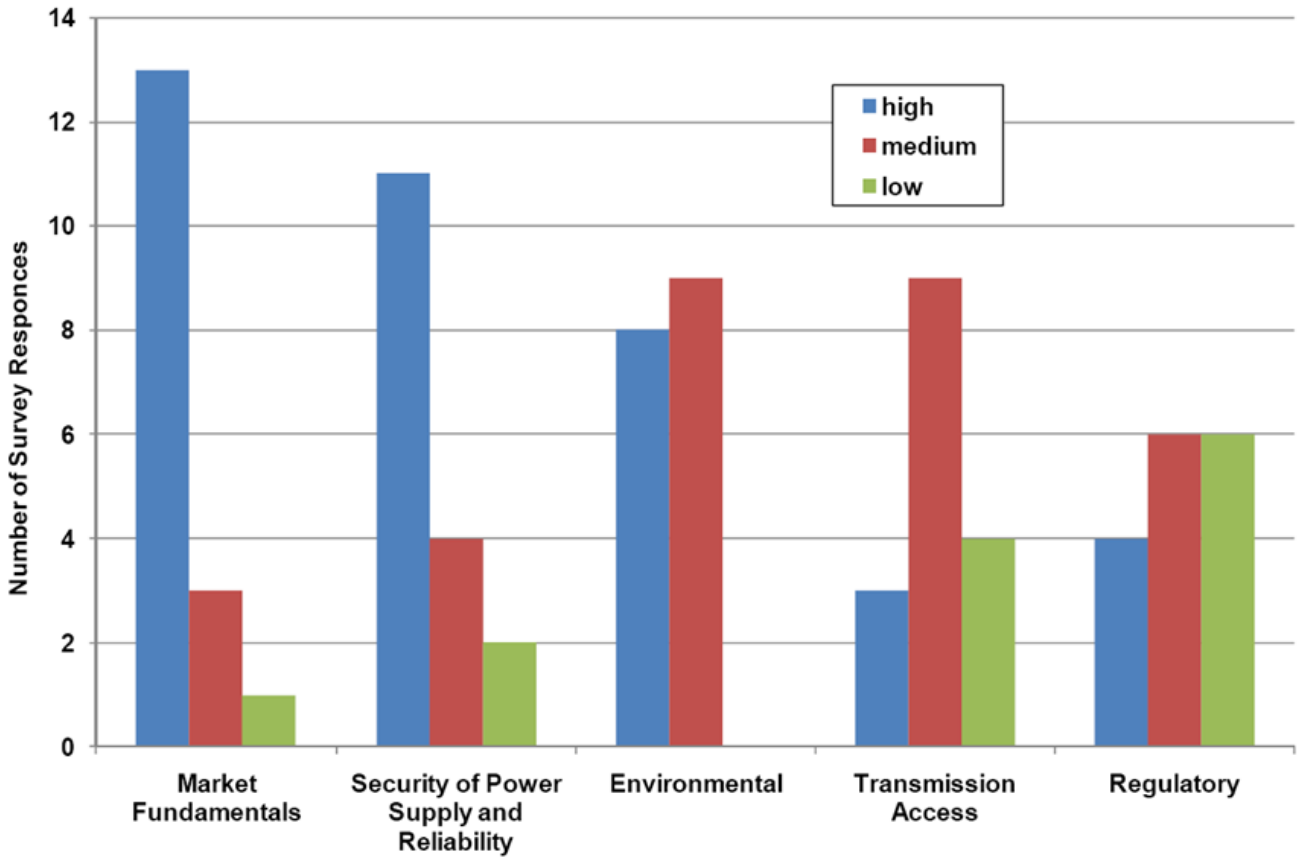


Generation Capacity:
12,142 MW
(2007)



Electricity Production:
69,213 GWh
(2007)

Factors Influencing the Decision to Build Cogeneration



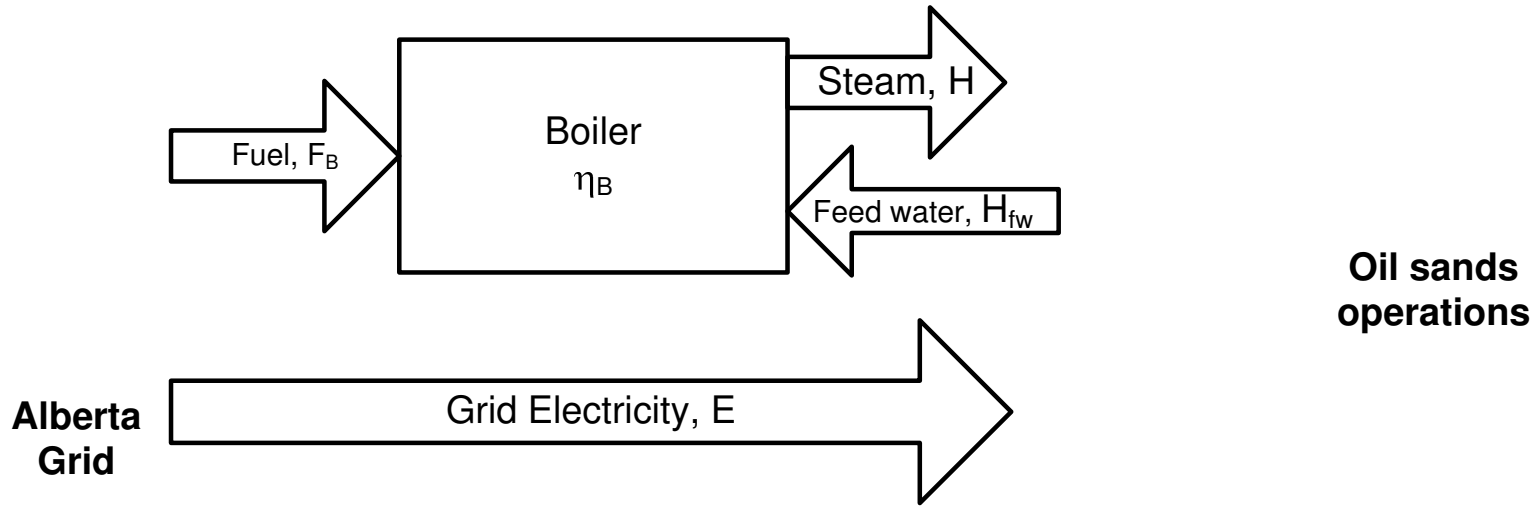
Source: The Oil Sands Developers Group (2010)

Alberta Specified Gas Emitters Regulation (SGER)

- Requires the major GHG emitters in the province to reduce their emissions
- Facilities are required to reduce the GHG intensity by 12%
- Sets an implicit cap on carbon price in the province ($15/tCO2)
- Cogeneration receive special consideration
- For cogeneration facilities, emissions associated with electricity are excluded from emission reduction obligations

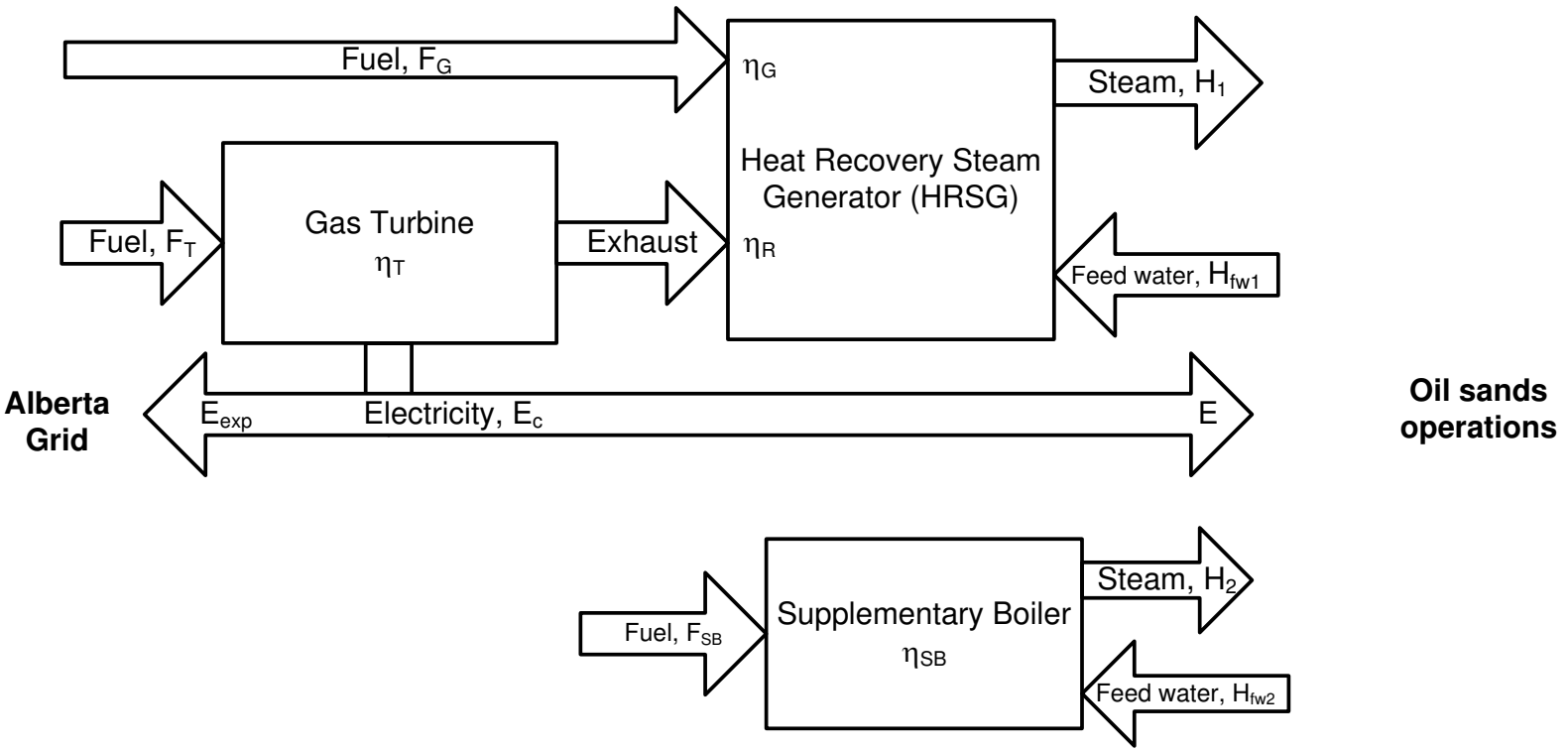
Illustrative Example: 30,000bbl/day

Baseline Case

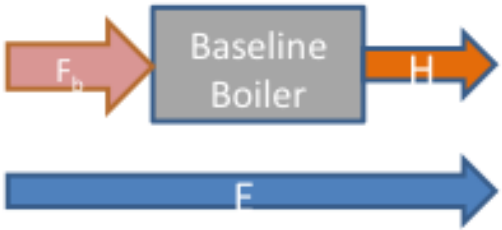


Illustrative Example: 30,000bbl/day

Cogeneration Case



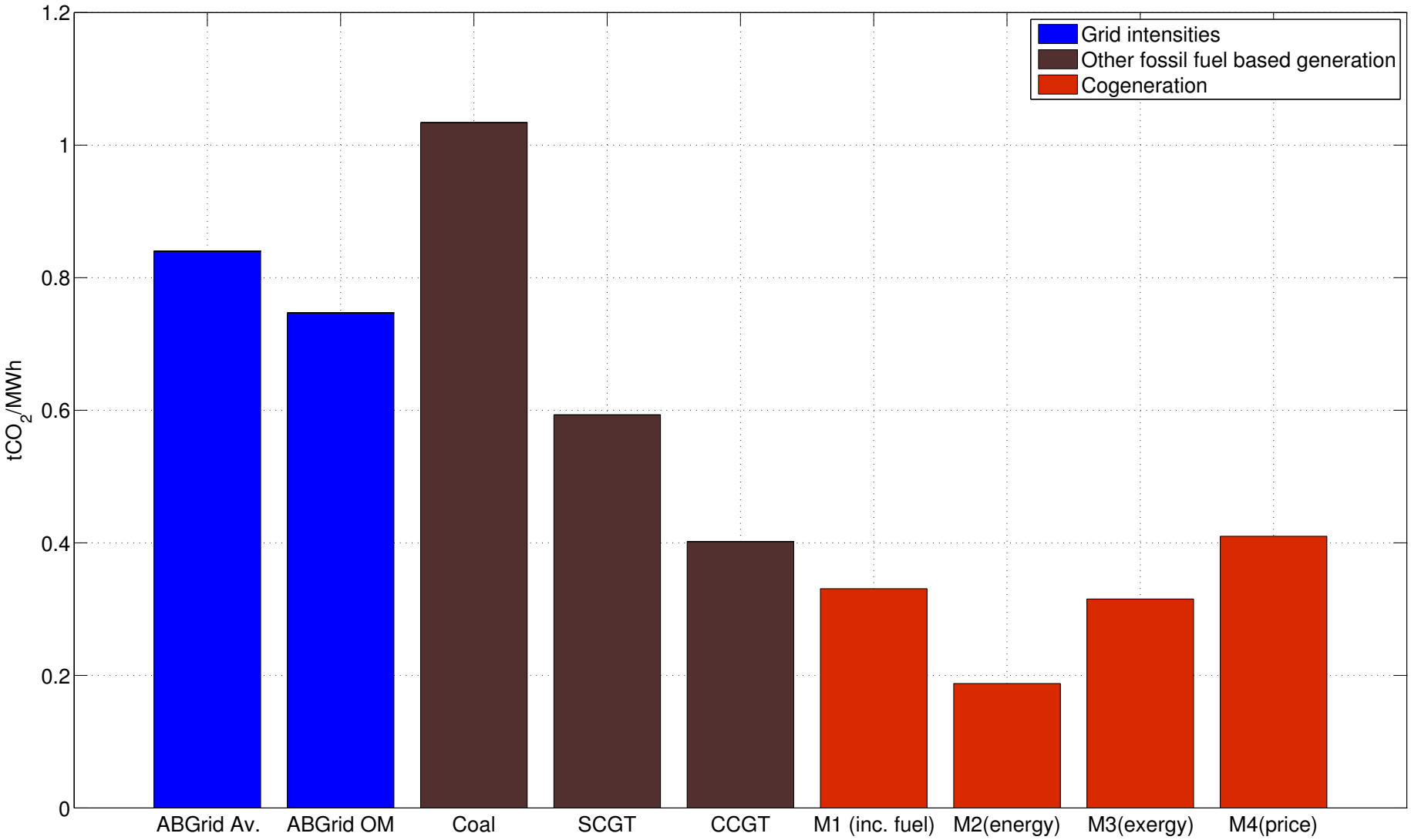
Fuel/Emission Allocation



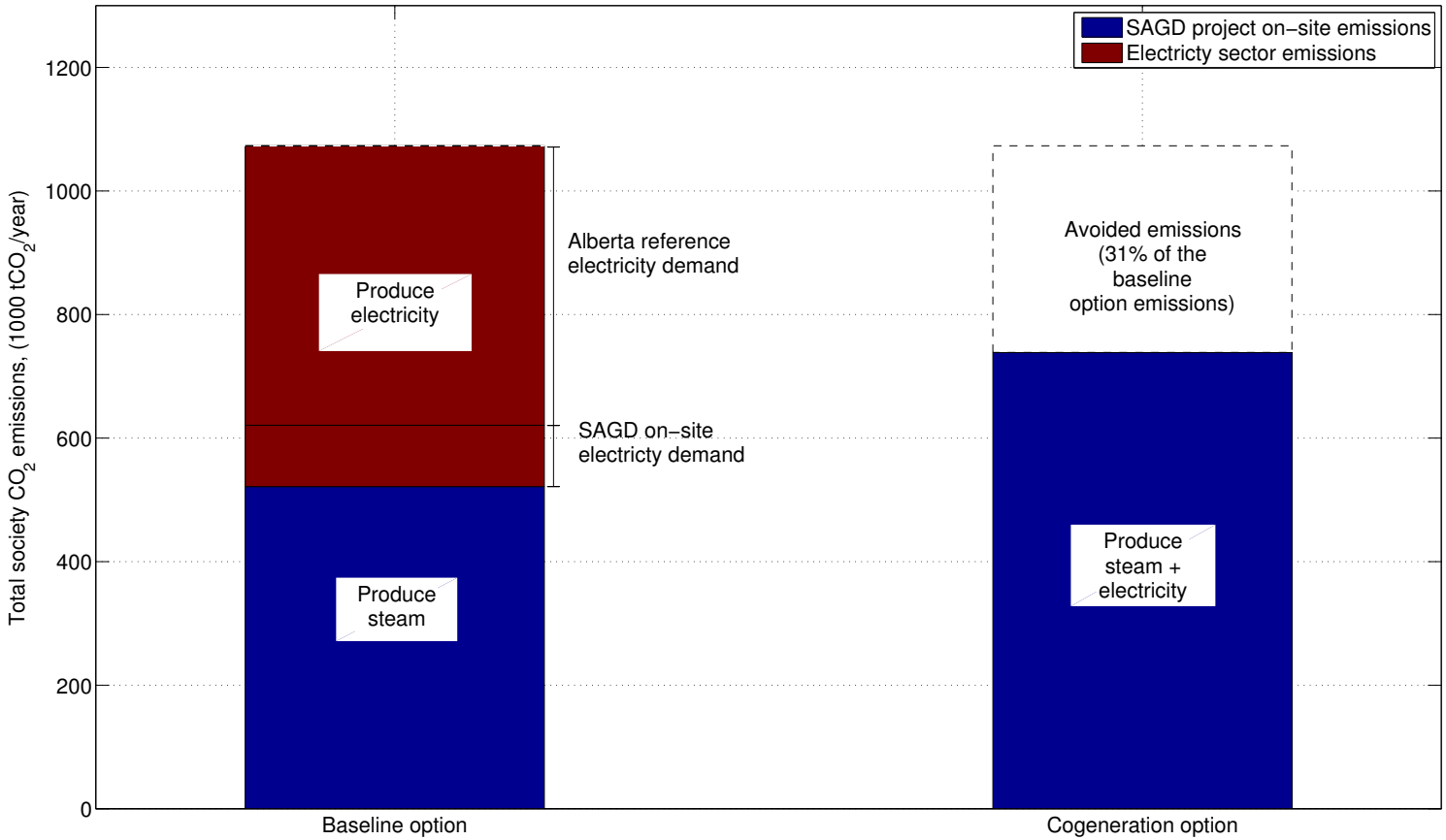
- $ECP_{M1} = \frac{F_c - F_b}{E_c}$ *(Incremental fuel)*
- $ECP_{M2} = \left(\frac{E_c}{E_c + H}\right) \cdot F_c \cdot \frac{1}{E_c}$ *(Energy)*
- $ECP_{M3} = \left(\frac{E_c}{E_c + x \cdot H}\right) \cdot F_c \cdot \frac{1}{E_c}$ *(Exergy)*
- $ECP_{M4} = \left(\frac{p_e \cdot E_c}{p_e \cdot E_c + p_h \cdot H}\right) \cdot F_c \cdot \frac{1}{E_c}$ *(Price)*

ECP - Energy chargeable to power

CO_2 Intensities of Electricity



CO_2 Emissions of the Two Options



Offset Credits

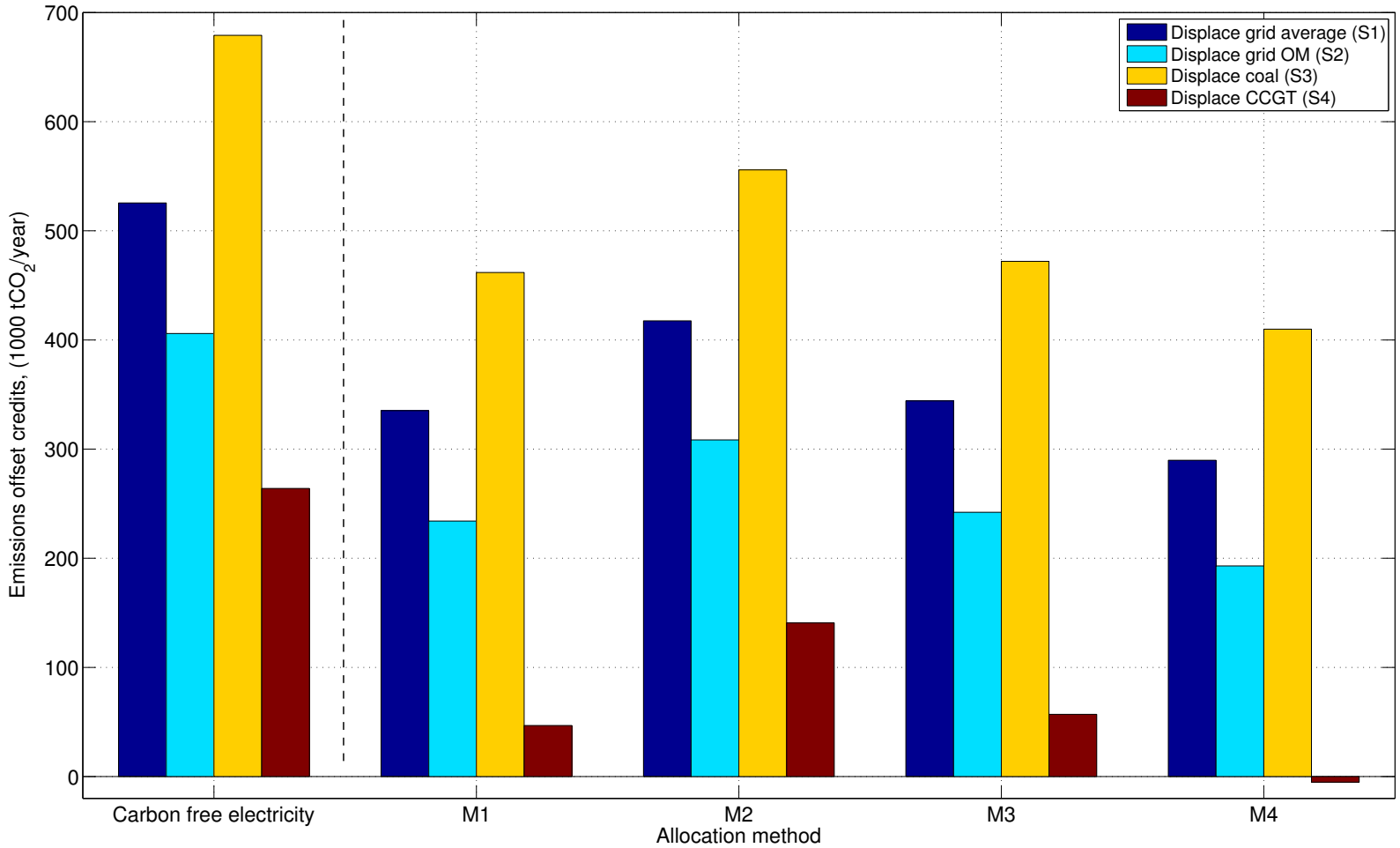
$$Offset\ credits = E_C \cdot (I_{offset} - I_{cgn})$$

Options for I_{cgn} and I_{offset}

I_{cgn}
0
$ECP_{M1} \cdot I_{ng}$
$ECP_{M2} \cdot I_{ng}$
$ECP_{M3} \cdot I_{ng}$
$ECP_{M4} \cdot I_{ng}$

I_{offset}
I_{gridav} (offset grid average)
I_{gridom} (offset grid operating margin)
I_{coal} (offset coal fired electricity)
I_{ccgt} (offset CCGT)

Offset Credits



SGER: Obligations for a Facility with Cogeneration

Baseline emission intensity, $\mathbf{BEI} = \frac{(\mathbf{TAE_{base}} - \mathbf{G_{Tbase}}) + \mathbf{D_{Hbase}}}{\mathbf{P_{base}}}$

Net emissions intensity, $\mathbf{NEI} = \frac{\mathbf{TAE} - \mathbf{D_E}}{\mathbf{P}}$ *where*, $\mathbf{D_E} = \mathbf{I_{ccgt}} \cdot \mathbf{E_C}$

where, P - total production in the compliance year

$$\mathbf{Obligation} = \mathbf{NEI} \cdot \mathbf{P} - (1 - \mathbf{t}) \cdot \mathbf{BEI} \cdot \mathbf{P}$$

positive obligations: *submit compliance options*
negative obligations: *apply for performance credits*

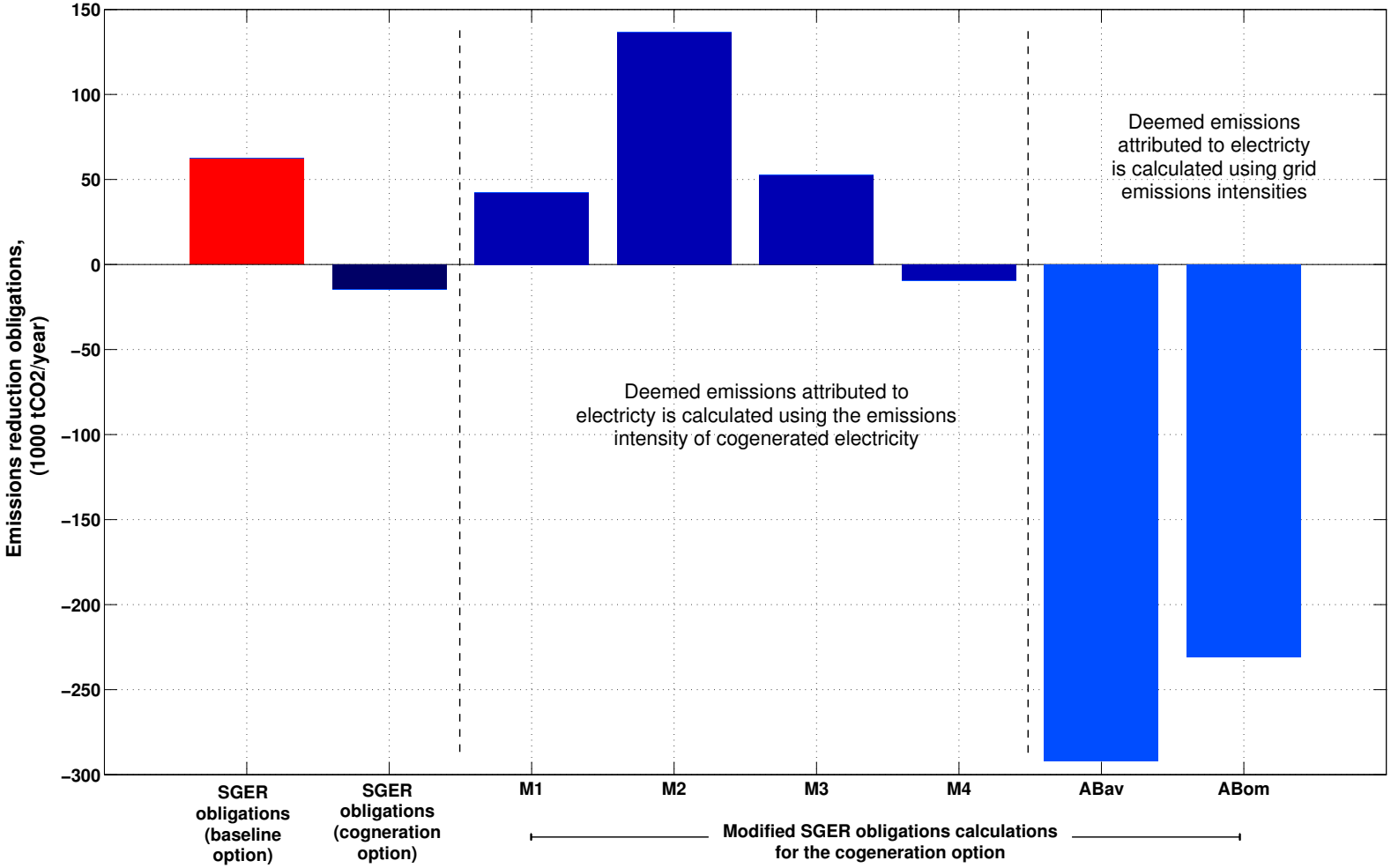
Alternative Methods

Use the emission intensity factor of cogenerated electricity to calculate D_E. Then NEI is calculated as follows:

$$\mathbf{NEI} = \frac{\mathbf{TAE} - \mathbf{E_c} \cdot \mathbf{I_{cogen}}}{\mathbf{P}} \quad \textit{or} \quad \mathbf{NEI} = \frac{\mathbf{TAE} - \mathbf{E_c} \cdot \mathbf{I_{offset}}}{\mathbf{P}}$$

$I_{cogen} = EPC \cdot I_{ng} \Longrightarrow$ emission reduction obligations depend on the allocation method.

Emission Reduction Obligations



Conclusions

- Cogeneration presents an effective option to reduce carbon emissions in Alberta and the most significant emissions reductions will be observed in the electricity sector
- Cogeneration investments are likely to respond to emission offset credits
- Incentives provided by Alberta's current carbon management policy are not sufficient to influence cogeneration investments
- Key challenges in carbon management policy making:
  - GHG emission intensity of cogenerated electricity
  - GHG emission intensity of displaced electricity
  - Need for stakeholder agreement on the accounting procedure