Oil Sands Can Help Address Climate Change

David B. Layzell, PhD, FRSC
Director, CESAR
Professor, U Calgary

Madhav Narendran, BEng (Electrical) & BA (Economics)
ES Modeler, CESAR

Eric Shewchuk, P.Eng.
Energy Systems Modeler, CESAR
Electrical Engineer, Candor Engineering Ltd.

Song P. Sit, PhD, P.Eng.
Senior Associate, CESAR
Principal, GHG Reduction Consultancy

INTRODUCTION

Thermal power generation is inefficient, typically discarding 50% or more of the energy in the fuel (Fig 1).

Most jurisdictions in the world do not have an industrial heat demand capable of using this waste heat.

However, the oil sands technology known as **Steam Assisted Gravity Drainage (SAGD)**, gives Alberta an opportunity to replace its coal fired power generation with a more climate-friendly, cost-effective source of base-load power.

This study [Ref 2] explores three scenarios to achieve the early retirement of coal-fired power generation over the next 14 years (Fig. 2).

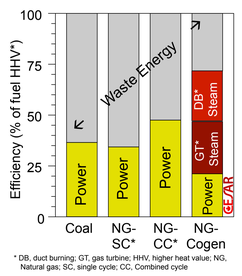

Fig. 1. Efficiency of power generation technologies

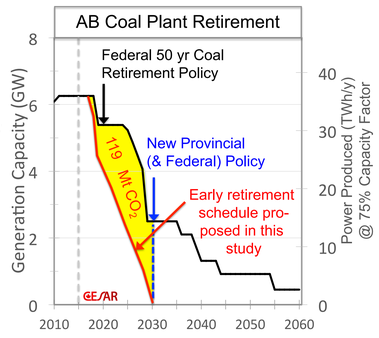

Fig. 2. Proposed schedule for early coal retirement

METHODS

Using the modeling process summarized in Fig.3, energy flows and greenhouse gas emissions were calculated for five scenarios (S1-S5, Fig. 4) that considered all SAGD production and power generation in Alberta to 2030. See ref [1] and [2] for details.

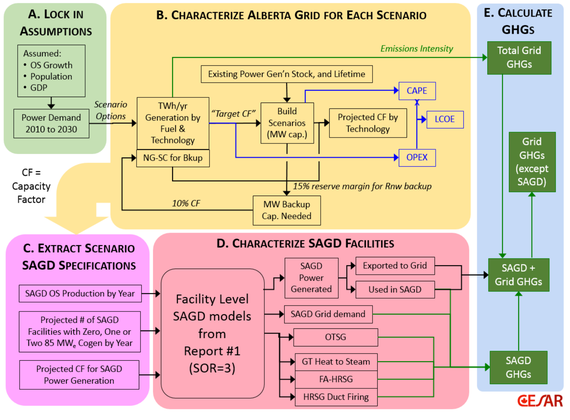

Fig. 3. Process flow used to model five scenarios (S1-S5, Fig. 4) for Alberta power generation and SAGD production to 2030

RESULTS

The Scenarios:

Power Generation:
- Assumed for each scenario

Built Capacity:
- NG-Single cycle (SC) at 10% CF built to maintain 15% reserve margin

SAGD Energy Flows:

GHG Emissions:
- For all SAGD and power generation in AB; Cogen @ 390 kg CO_2/MWh

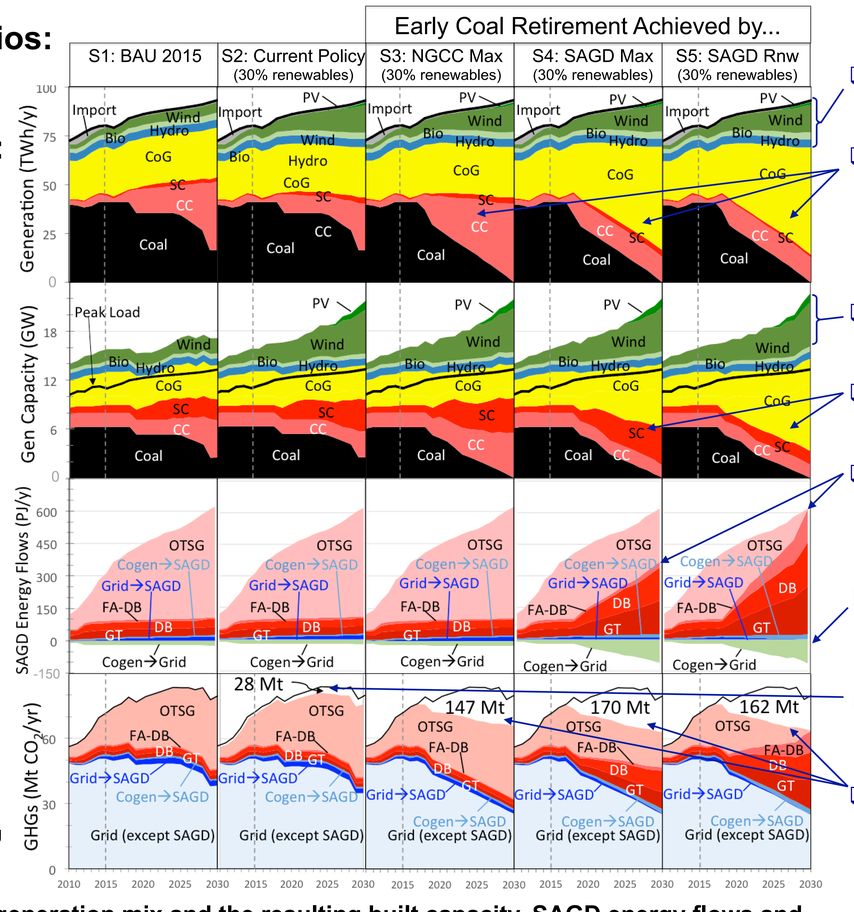

Fig. 4. Assumed generation mix and the resulting built capacity, SAGD energy flows and total GHG emissions for five scenario models that encompass the electrical grid and SAGD oil sands production in Alberta. See [2] for details.

NOTE:

- 30% renewables in S2-S5
- NG combined cycle (CC, S3) or Cogeneration (CoG, S4 & S5) were used to make up for early retirement.
- Increase in capacity due to renewables
- In S5, Cogen not NG-SC backs renewables
- By 2030, steam from Cogen provides 60% (S4) or 100% (S5) of SAGD needs
- In S4 & S5, by 2030 SAGD cogen provides 31 TWh/y to public grid
- The 30% renewable target reduces GHGs by 28 $MtCO_2$.
- Early coal retirement, reduces GHG by an additional 119 to 142 $MtCO_2$, but ***the largest emission reductions occur when cogen is used.***

DISCUSSION & CONCLUSIONS

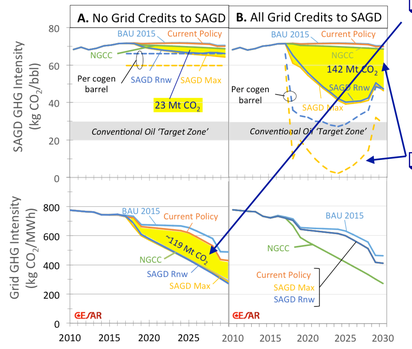

Fig. 5. Proposed schedule for early coal retirement

- Under existing policies, most GHG benefits of SAGD cogen flow to the public grid.
- However, transitional credits for early coal retirement could give SAGD oil sand crude a GHG intensity that is ≤ conventional oil.

The effect of the five scenarios on the GHG intensity of both oil sands crude production and the public grid are shown in Fig. 5.

Using SAGD Cogen generates the greatest GHG benefits (142 Mt CO_2), but the majority of the GHG benefits (119 Mt CO_2) are assigned to the Alberta public grid, and there are only small improvements in the GHG intensity of oil sands crude (Fig. 5A).

To incentivize SAGD cogen deployment to assist in early coal retirement, SAGD operators could be given the opportunity to transitionally assign grid GHG reductions to oil sands crude production, thereby reducing the GHG intensity of cogen-produced oil to be equal to or less than conventional oil.

Details behind these scenario models, and the pros and cons of this policy option are explored in more detail in references [1] and [2].

REFERENCES

[1] Layzell DB, Shewchuk E, Sit SP, Klein, M. 2016. Cogeneration options for a 33,000 BPD SAGD facility: Greenhouse gas and economic implications. CESAR Scenarios Vol. 1, Issue 3: 1-54.

[2] Layzell DB, Narendran M, Shewchuk E, Sit SP. 2016. SAGD Cogeneration: Reducing the carbon footprint of oilsands production and the Alberta grid. CESAR Scenarios Vol. 1, Issue 4: 1-36.

ACKNOWLEDGEMENTS

Financial support for this work was gratefully received from the Edmonton Community Foundation, Candor Engineering Ltd., AIEES, MEG Energy, Suncor Energy, Cenovus Energy and Nexen Energy ULC.

We greatly appreciate the contributions of Bas Straatman, Mark Lowey, and Benjamin Israel in the production and dissemination of the final product.

For further info, contact : dlayzell@ucalgary.ca