SAGD Cogeneration: Towards Lower Carbon Power & Oil Sands Production

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Canada's Greenhouse Gas (GHG) Emissions & Targets

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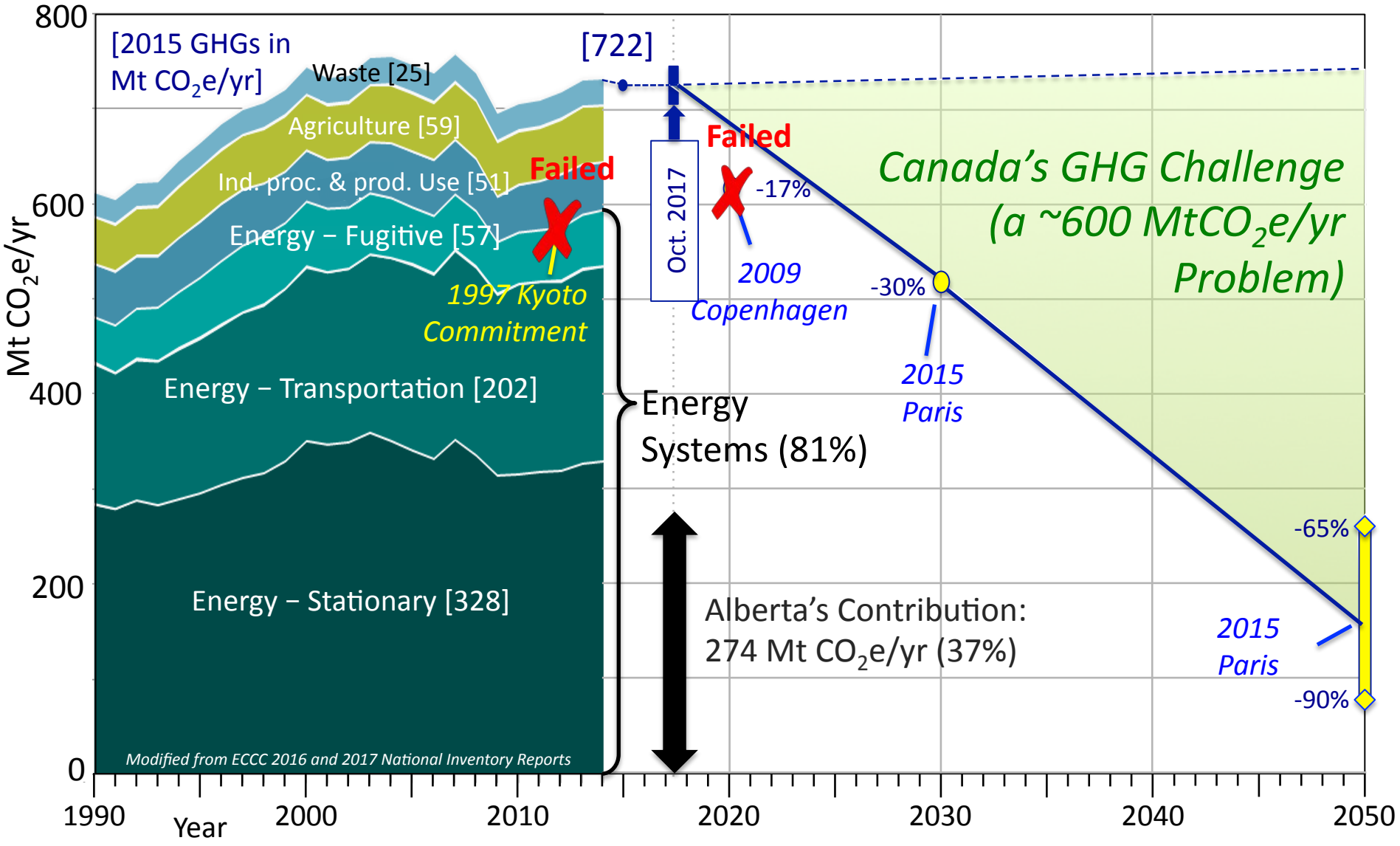
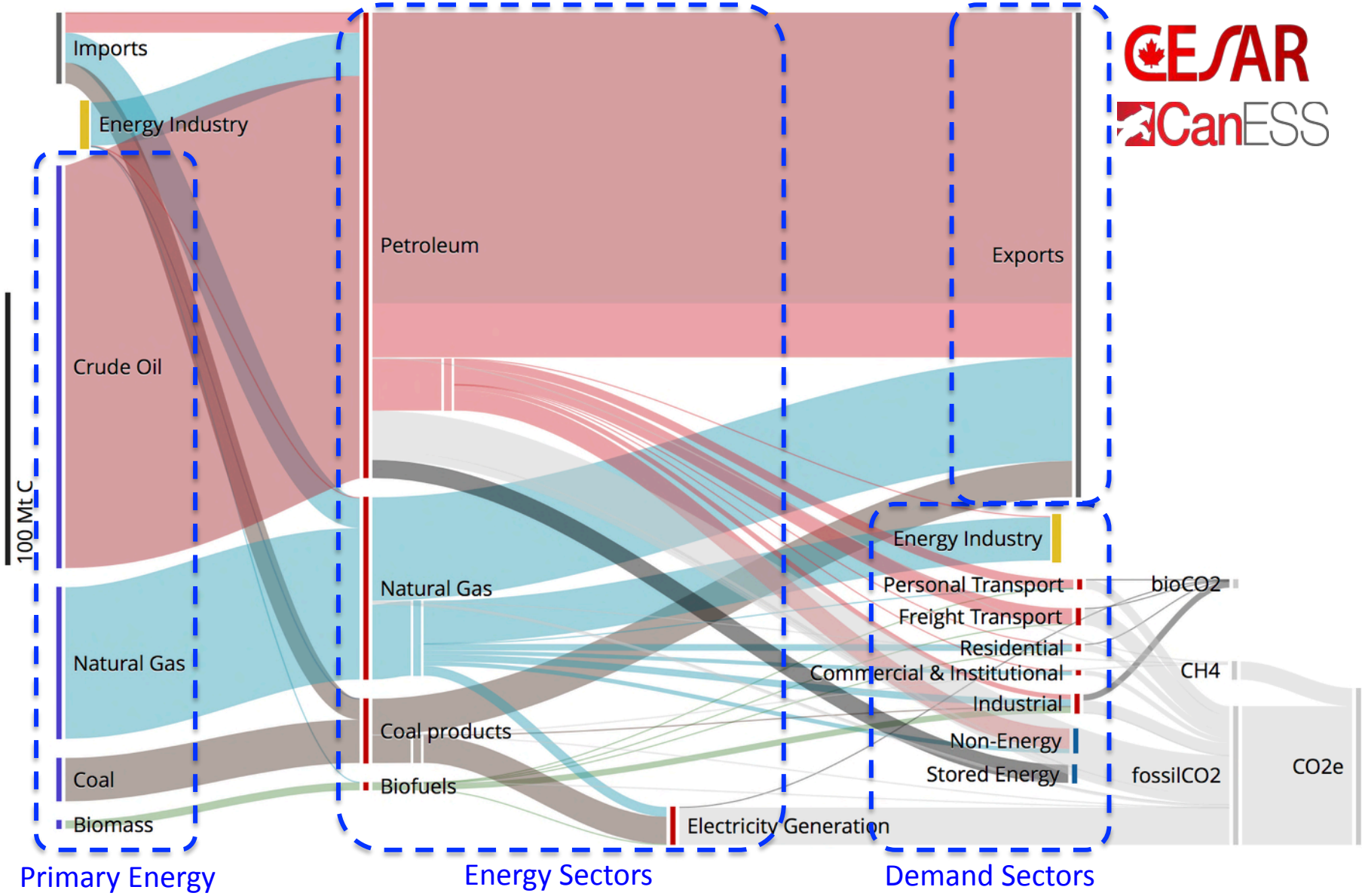


The Flow of Carbon Through the Energy Systems of Alberta in 2013



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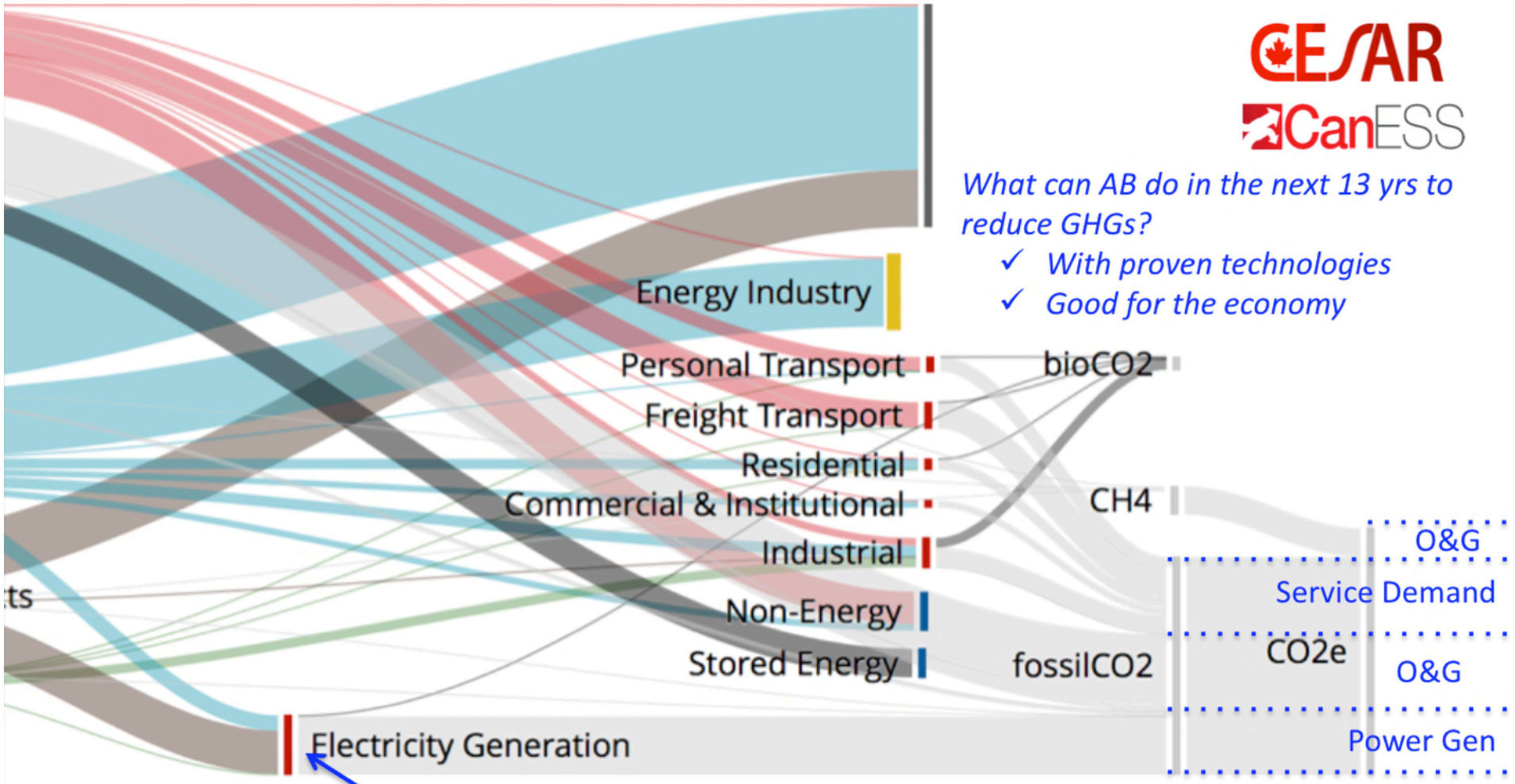


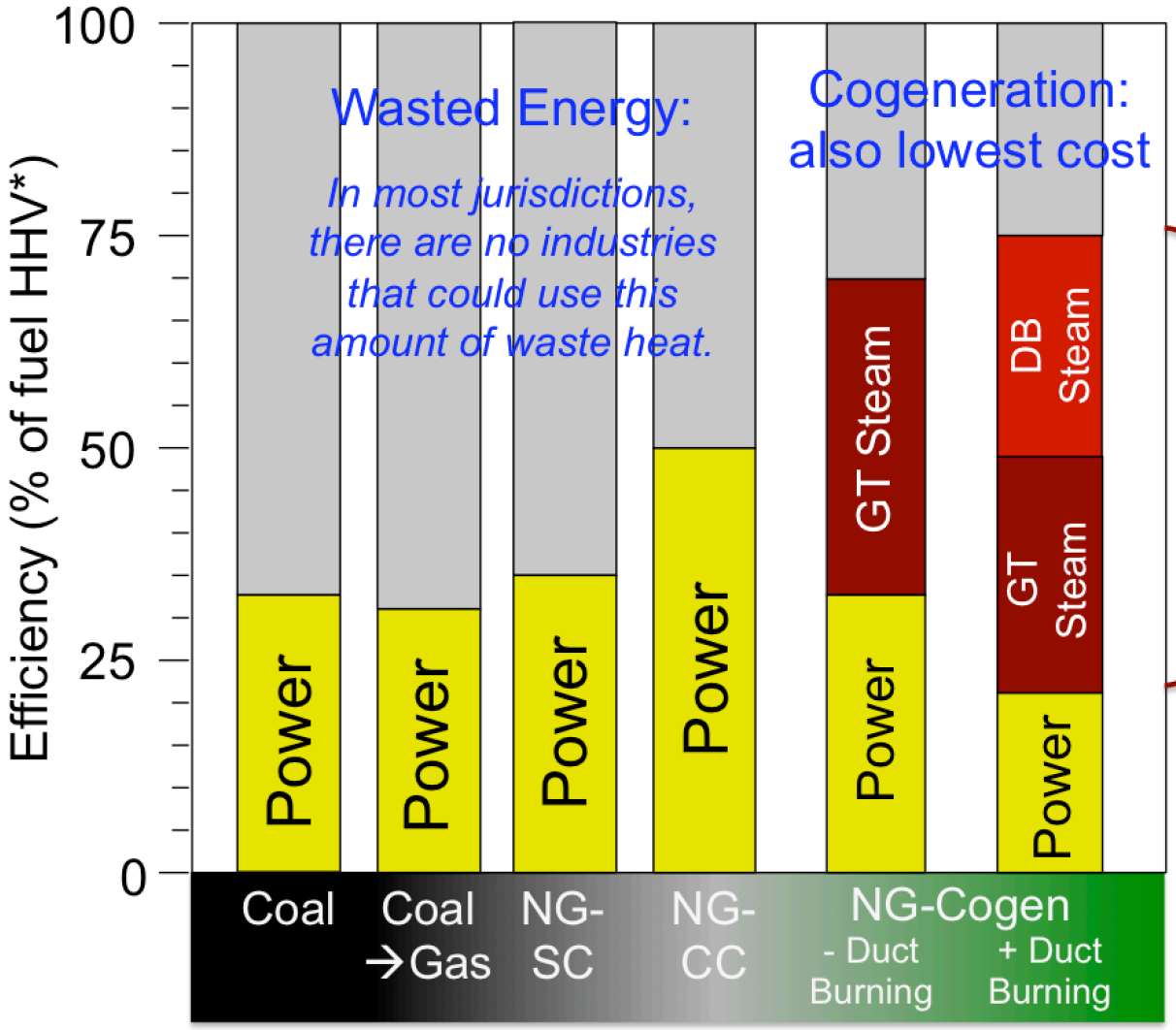
What can AB do in the next 13 yrs to reduce GHGs?

- ✓ *With proven technologies*
- ✓ *Good for the economy*

Inefficient!

(50% to 70% of fuel energy lost as heat)

The Inefficiency of Thermal Power Generation

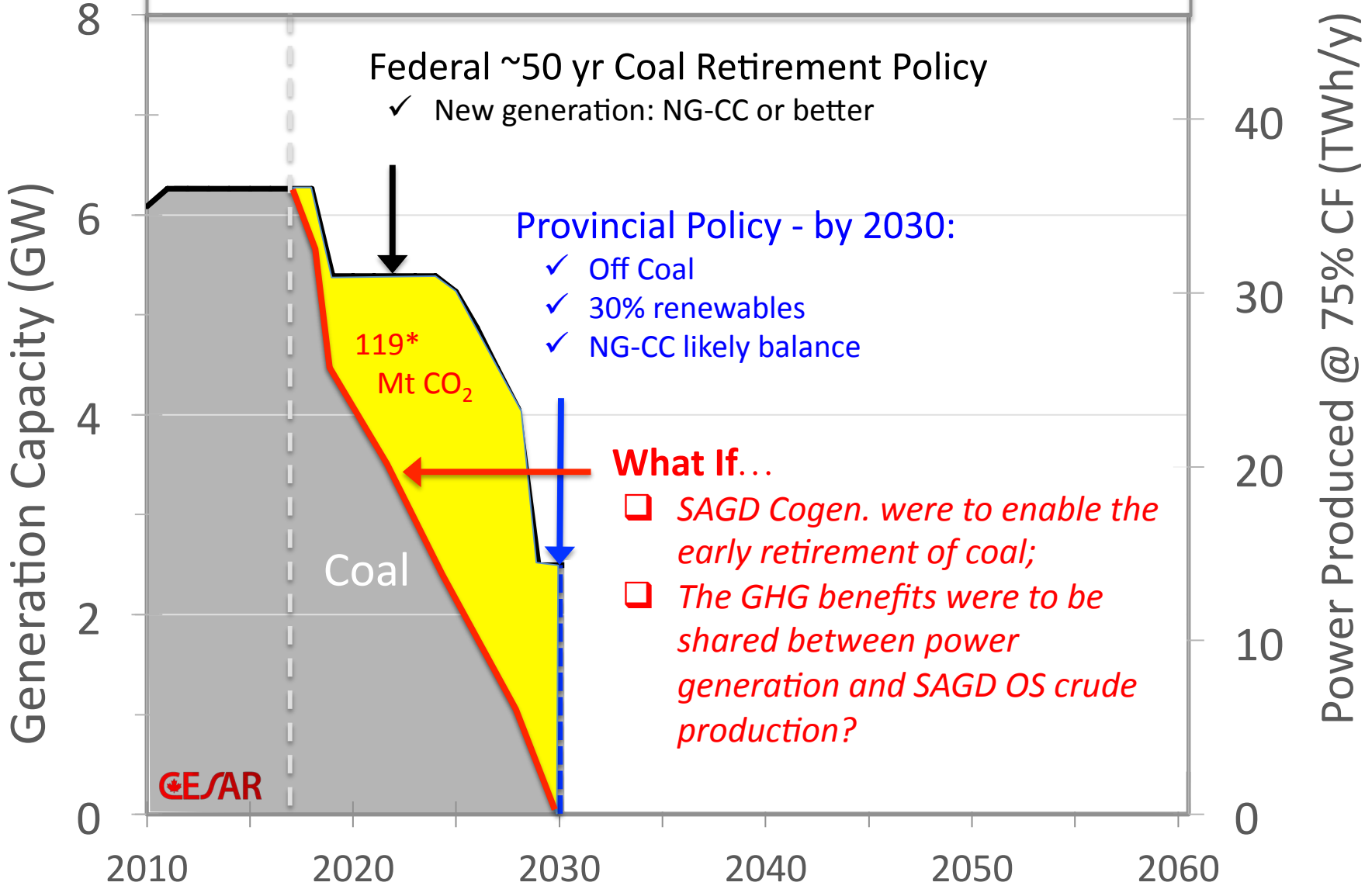


DB, duct burning; GT, gas turbine; HHV, higher heat value; NG, Natural gas; SC, single cycle; CC, Combined cycle

Cogeneration of heat & power can increase fuel use efficiency to 75% or more if one has an appropriate heat demand.

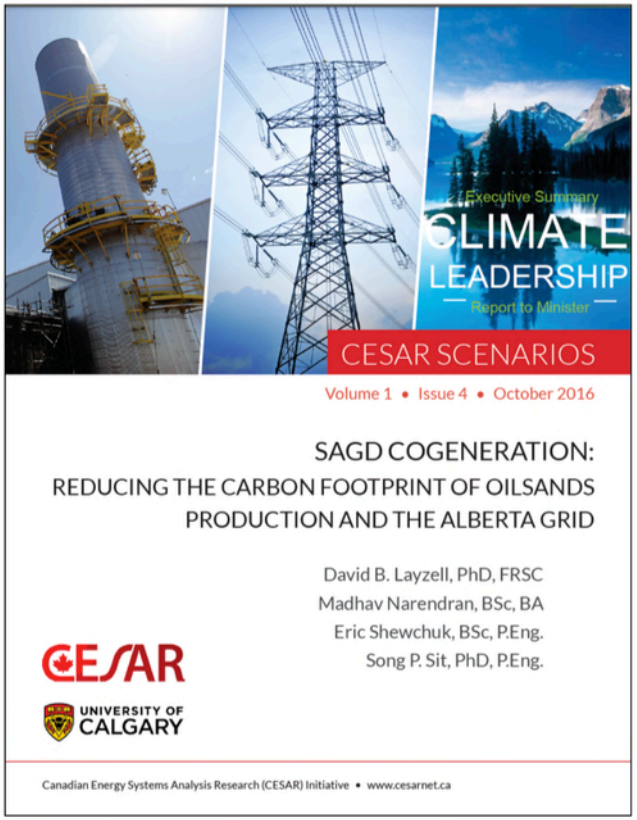
With Steam Assisted Gravity Drainage (SAGD), AB has the heat demand

Alberta Coal Plant Retirement



***Assumes:** Coal generation (@ 1008 kg CO_2/MWh) replaced with NG-Cogen or NG-CC (@ 390 kg CO_2/MWh)*

Two Reports:



Free download from: www.cesarnet.ca

Facility Perspective

- ❑ Target Audience: SAGD Operators
- ❑ Techno/economic/environmental analysis showing that a 'standard' 33,000 bpd SAGD facility could efficiently use all the heat from two 85 MW gas turbines and put ~150 MW on the grid

Provincial Perspective

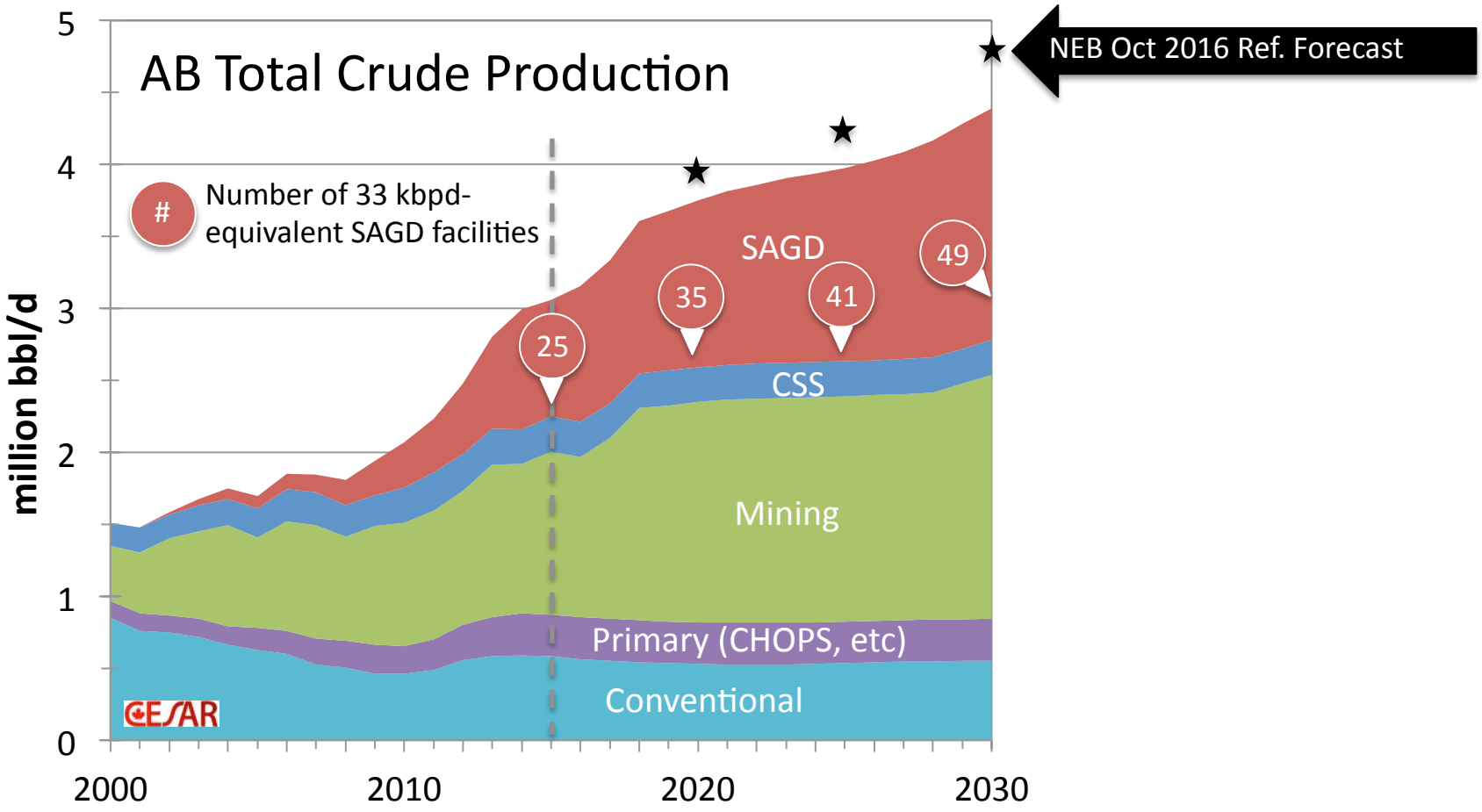
- ❑ Modelled Five Energy Scenarios to 2030 for all SAGD + all Electrical Grid in Alberta

- ➢ S1: 2014 Policy
- ➢ S2: Current Policy (~30% renewables, coal retire @2030)

Early Coal retirement:

- ➢ S3: w/NGCC
- ➢ S4: w/SAGD Cogen Max
- ➢ S5: w/SAGD Cogen Rnw

Oil Production Forecast



The Five Scenarios…

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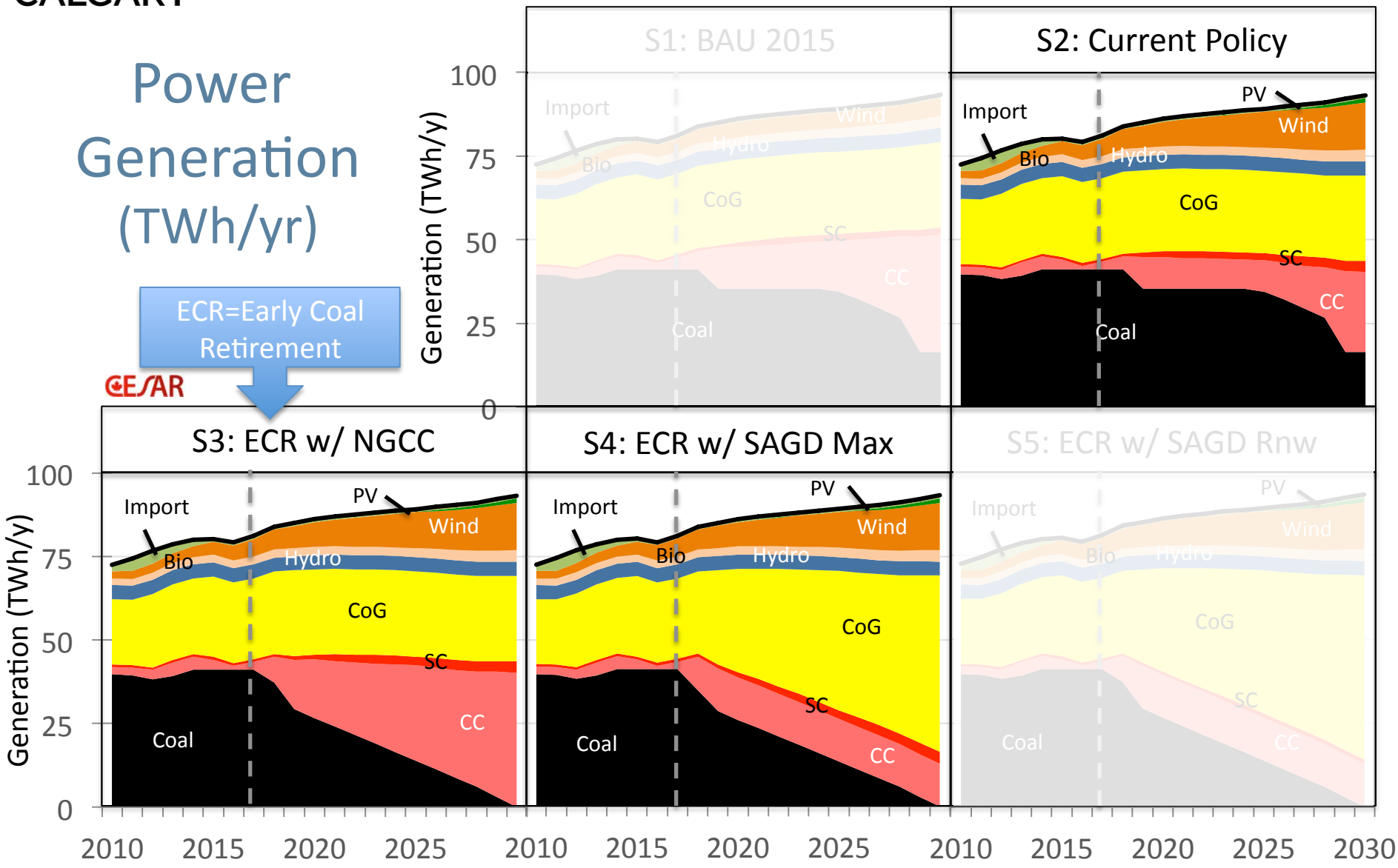
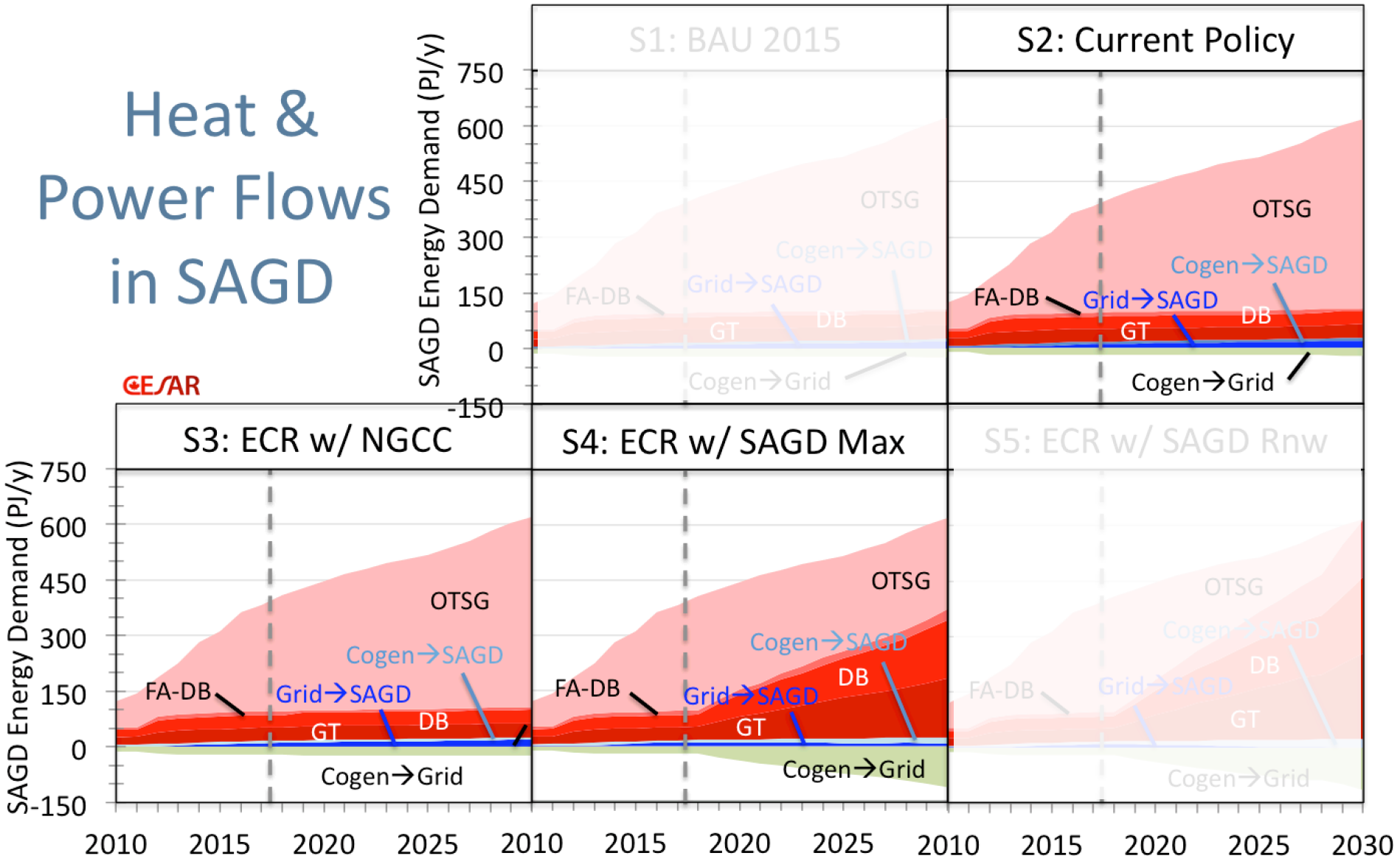
Power Generation (TWh/yr)

ECR=Early Coal Retirement



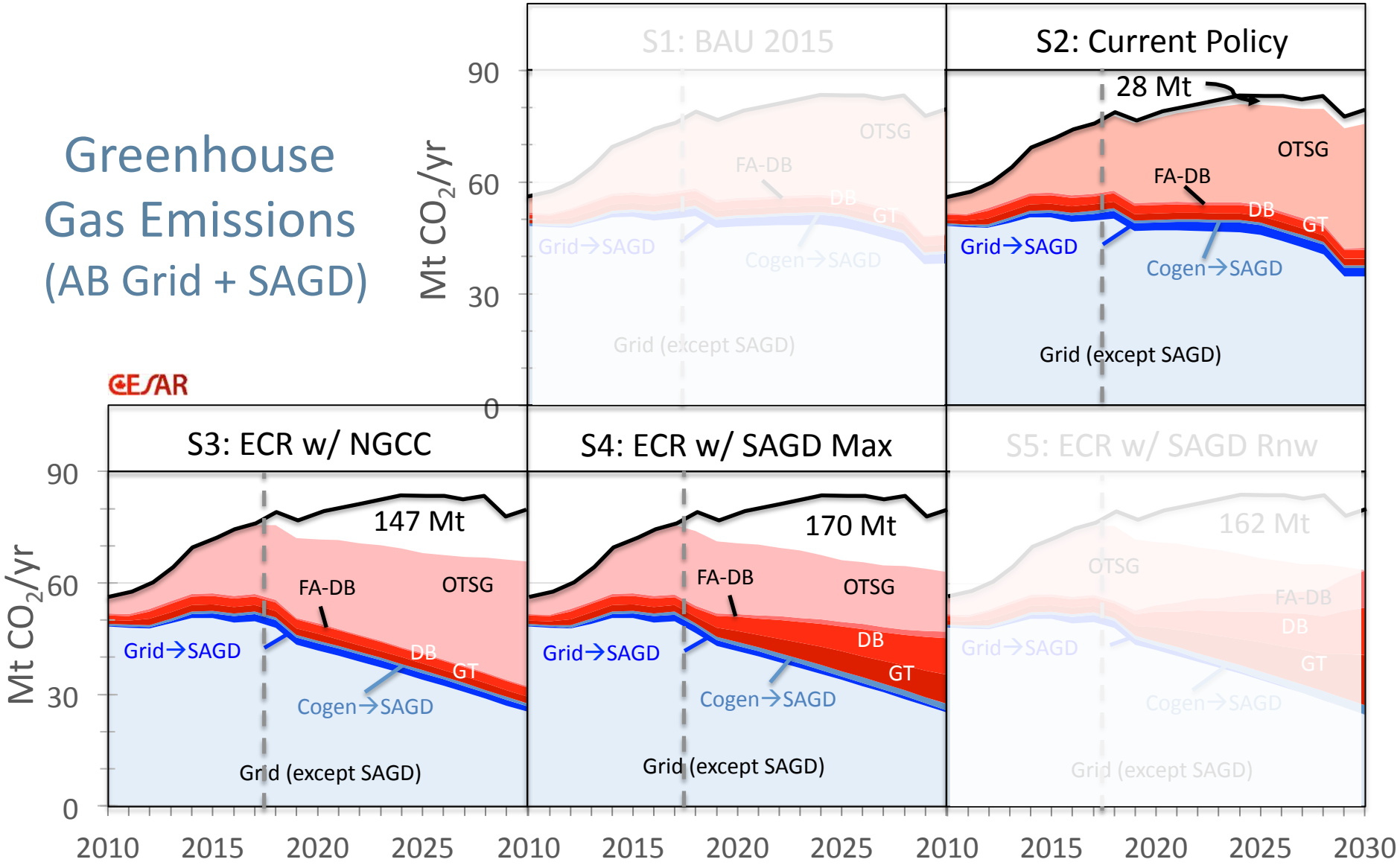
The Five Scenarios…

Heat & Power Flows in SAGD

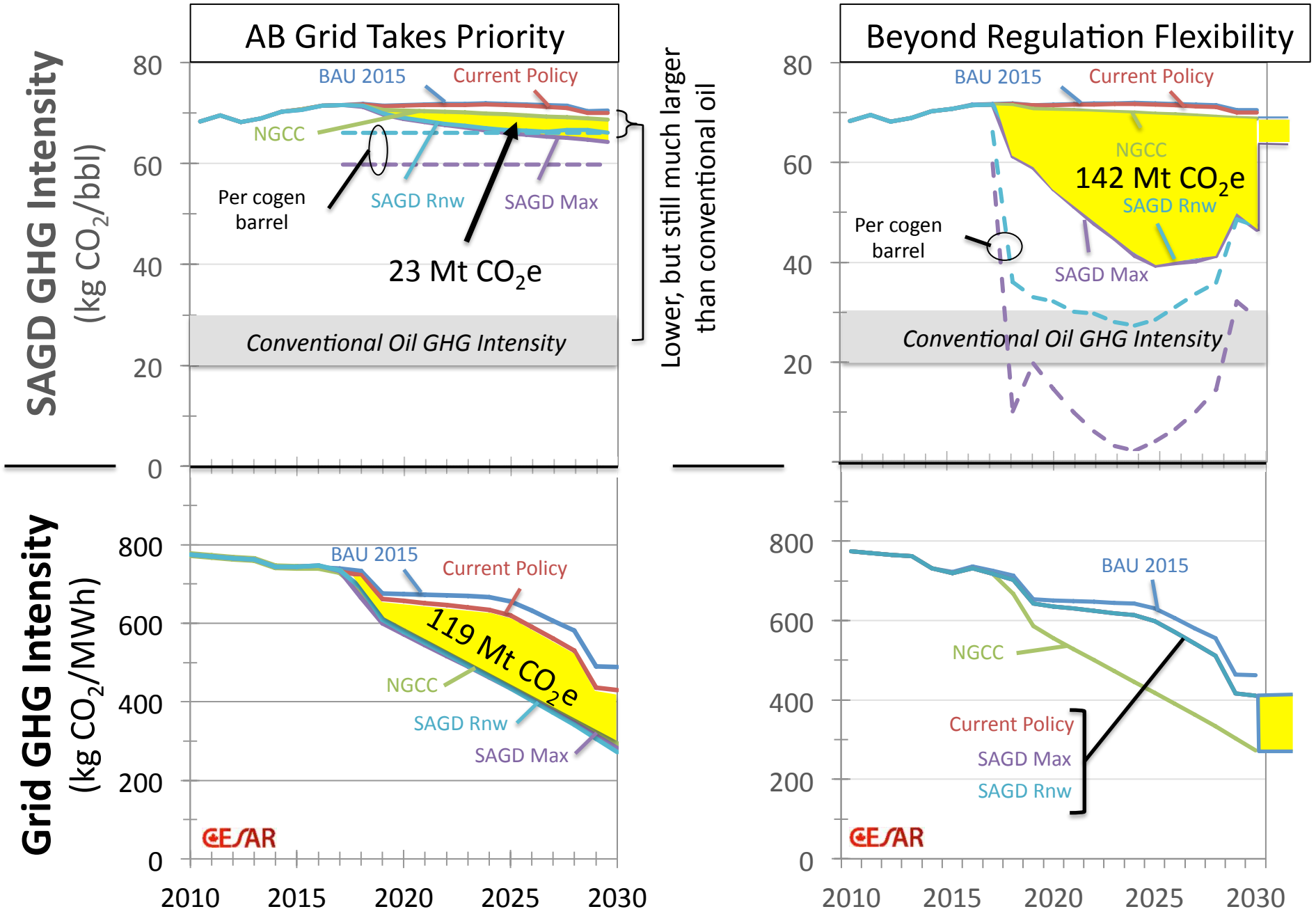


The Five Scenarios…

Greenhouse Gas Emissions (AB Grid + SAGD)



The Allocation of GHG Emission Reductions



Conclusions

Industrial Scale (e.g. SAGD) Cogeneration:

- *Improve energy efficiency in the use of natural gas fuels;*
- *Achieve ~142 Mt CO_2e of additional emissions reductions between now and 2030;*
- *Constrain AB electricity prices;*
- *Could enable SAGD operations to decrease C intensity of oil sands production to equal conventional oil:*
  - ✓ *OS production more important to the AB/Cdn economy than the GHG intensity of the AB Grid*
- Industrial Cogen. Coalition has been established in AB to ensure new capacity market recognizes this opportunity

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Thank you

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Madhav Narendran (Electrical Engineering & Economics)
& Manfred Klein (Mechanical Engineer)

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The Five Scenarios…

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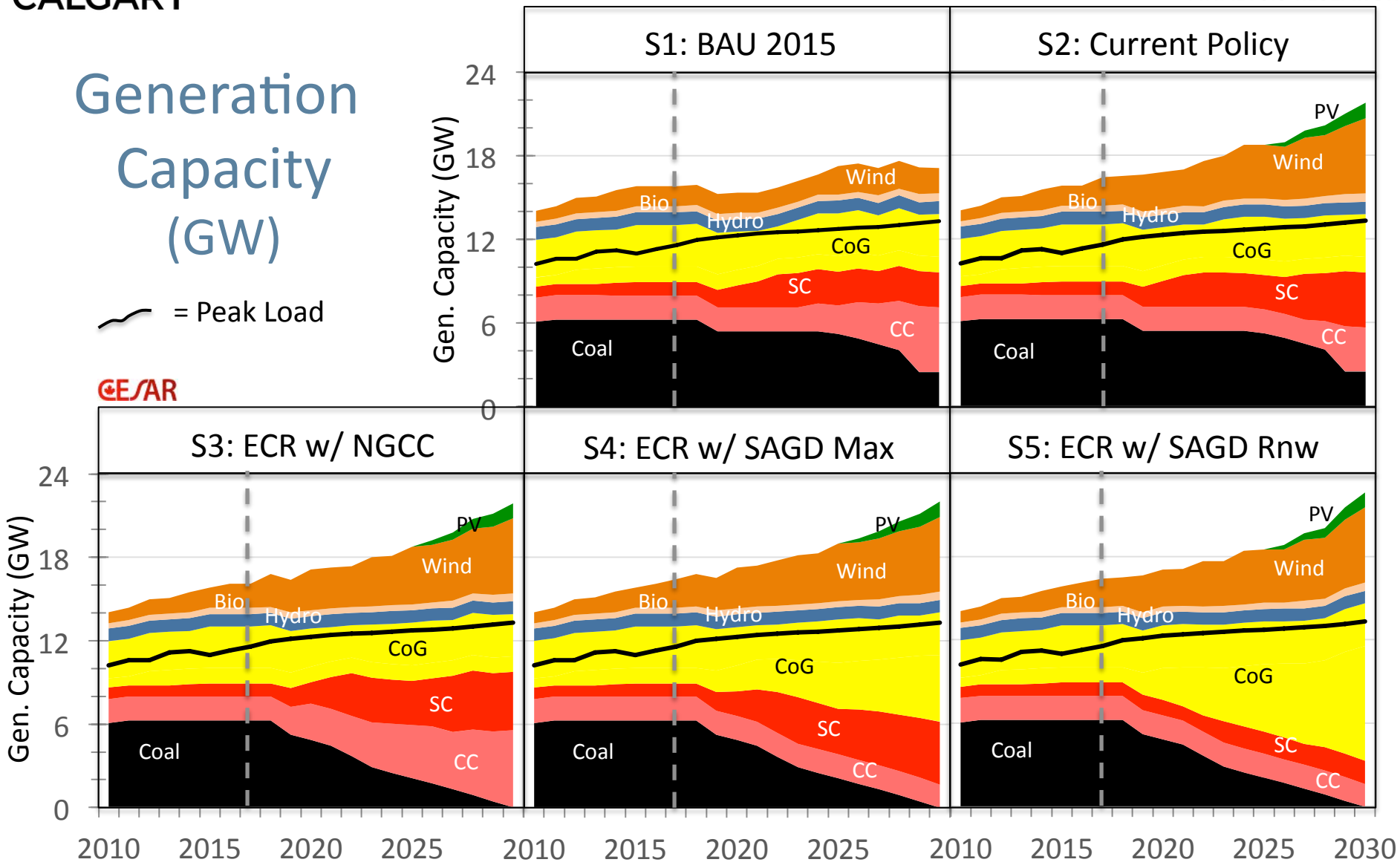
Generation Capacity (GW)

= Peak Load



The Five Scenarios…

SAGD Electricity Production and End Use