Actions to achieve Canada's 2030 GHG target of 524 Megatonnes CO2e

Alberta Renewable Energy Alliance

Submission to

Climate Technology Task Force

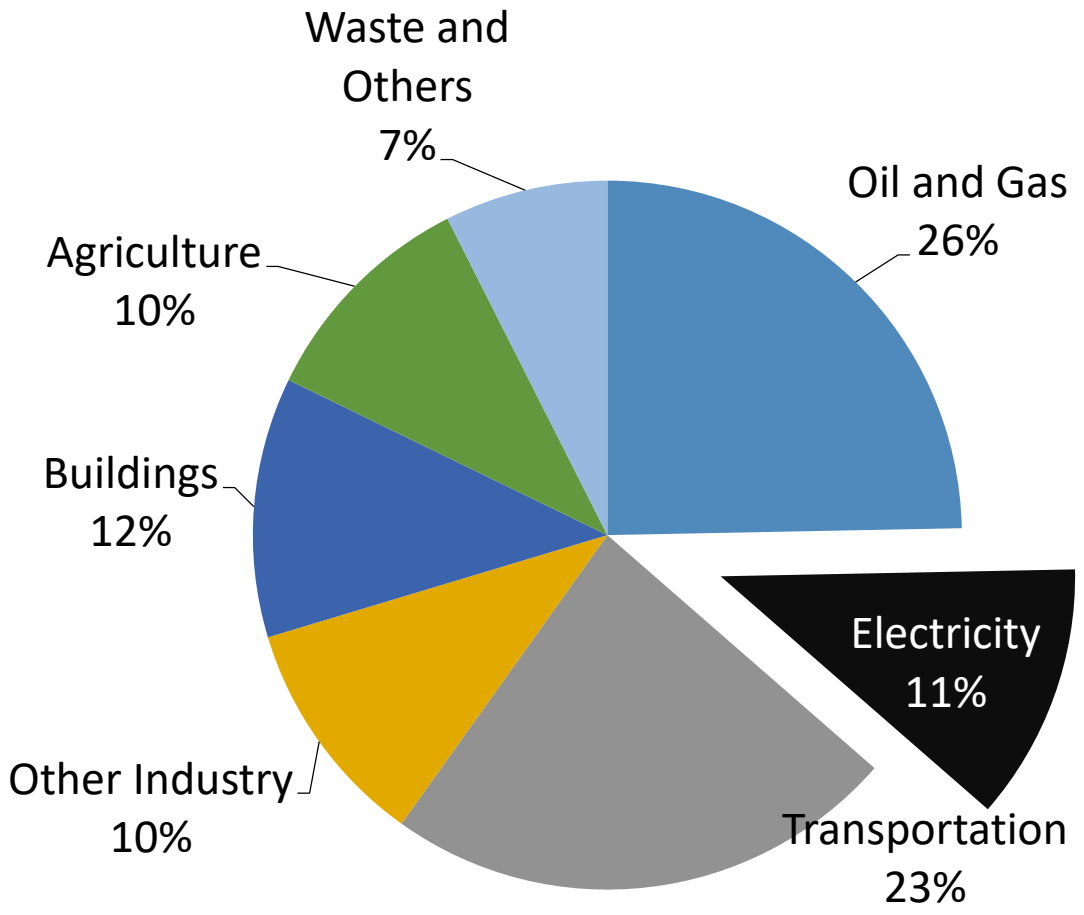
October 31, 2016

A Roadmap to 2030

- Canada's should meet its Paris Commitment of 524 MT CO2e by 2030 (as a minimum).
- Alberta should do its fair share and meet a Goal of 200 MT CO2e by 2030.
- These goals should be reviewed annually in plans to ensure that there is measurable progress toward targets for years 2020, 2025 and 2030.
- To meet 2030 goals we must focus specifically on major emission sectors.
- We must devise sector specific strategies to achieve our goals.

Canadian GHG emissions – By Economic Sector

85 Million Tonnes CO2e arise from **electricity generation** annually

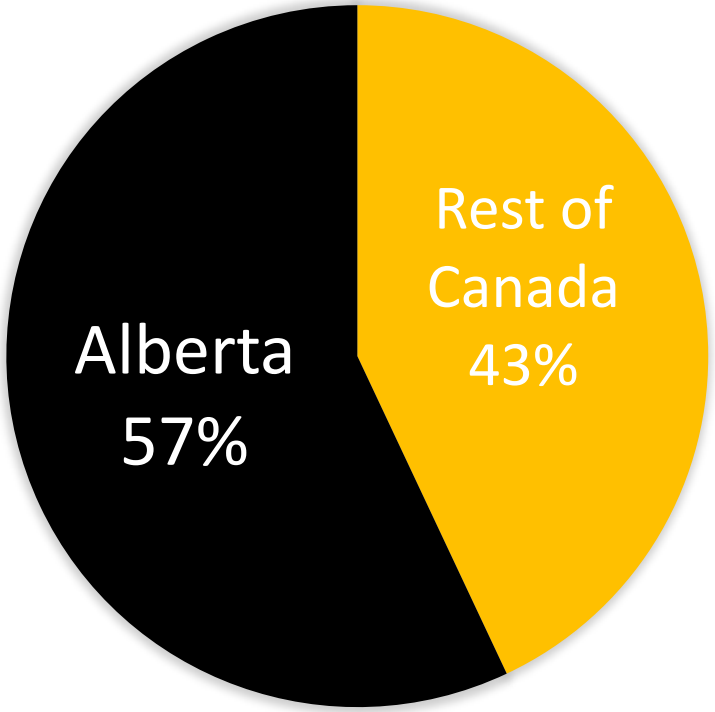


Source: Environment Canada and Climate Change (2016) National Inventory Report 1990–2014: Greenhouse Gas Sources and Sinks in Canada.

Alberta emits

57% of Canada's GHG emissions from electricity generation

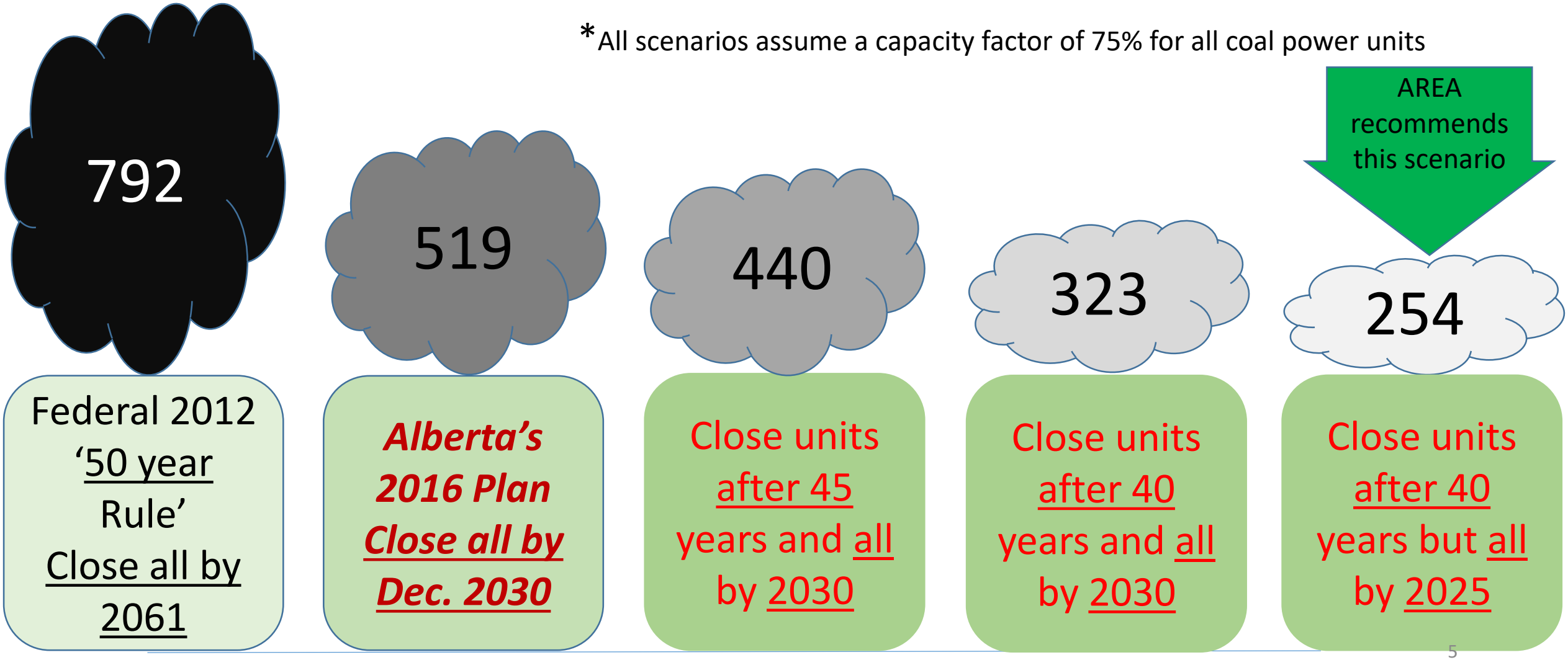
2014 CONTRIBUTION OF GHG EMISSIONS FROM ELECTRICITY GENERATION



Source: Environment Canada and Climate Change (2016) National Inventory Report 1990–2014: Greenhouse Gas Sources and Sinks in Canada.

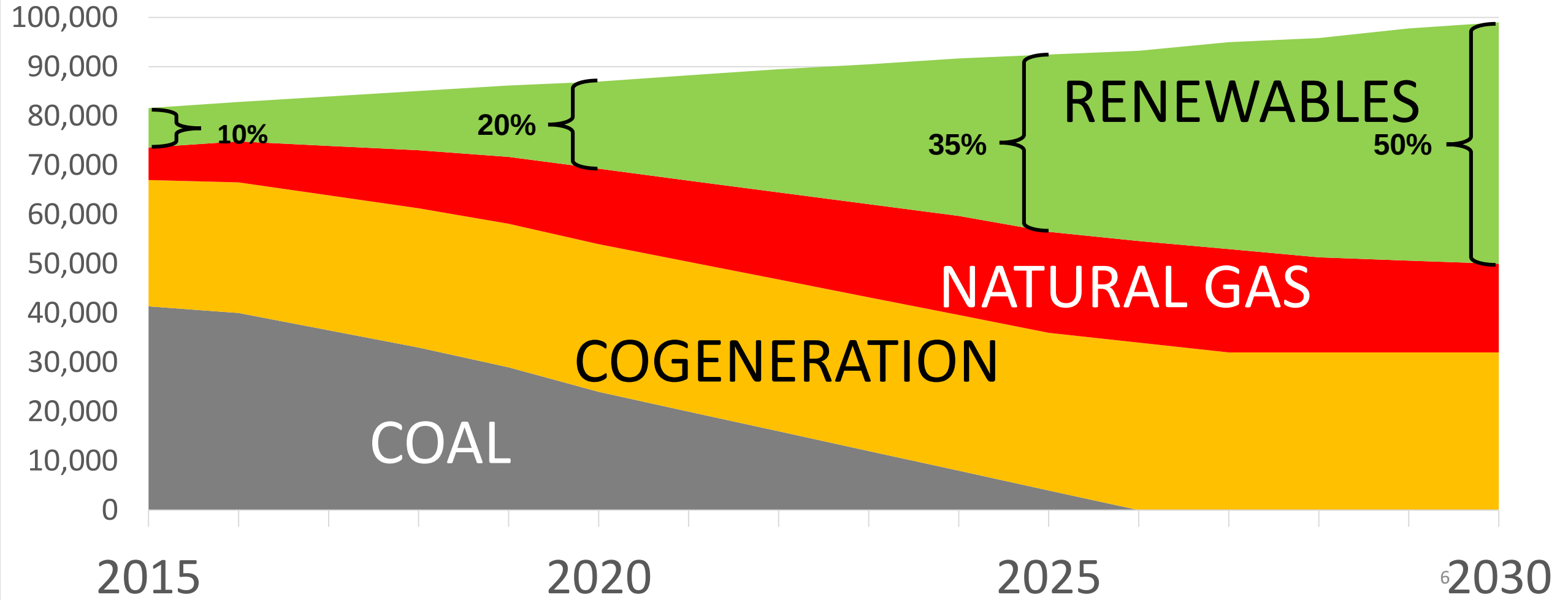
Alberta's GHG emissions ***from coal*** (2016 to 2030) assuming various coal unit closure scenarios* (Million Tonnes CO2e)

*All scenarios assume a capacity factor of 75% for all coal power units

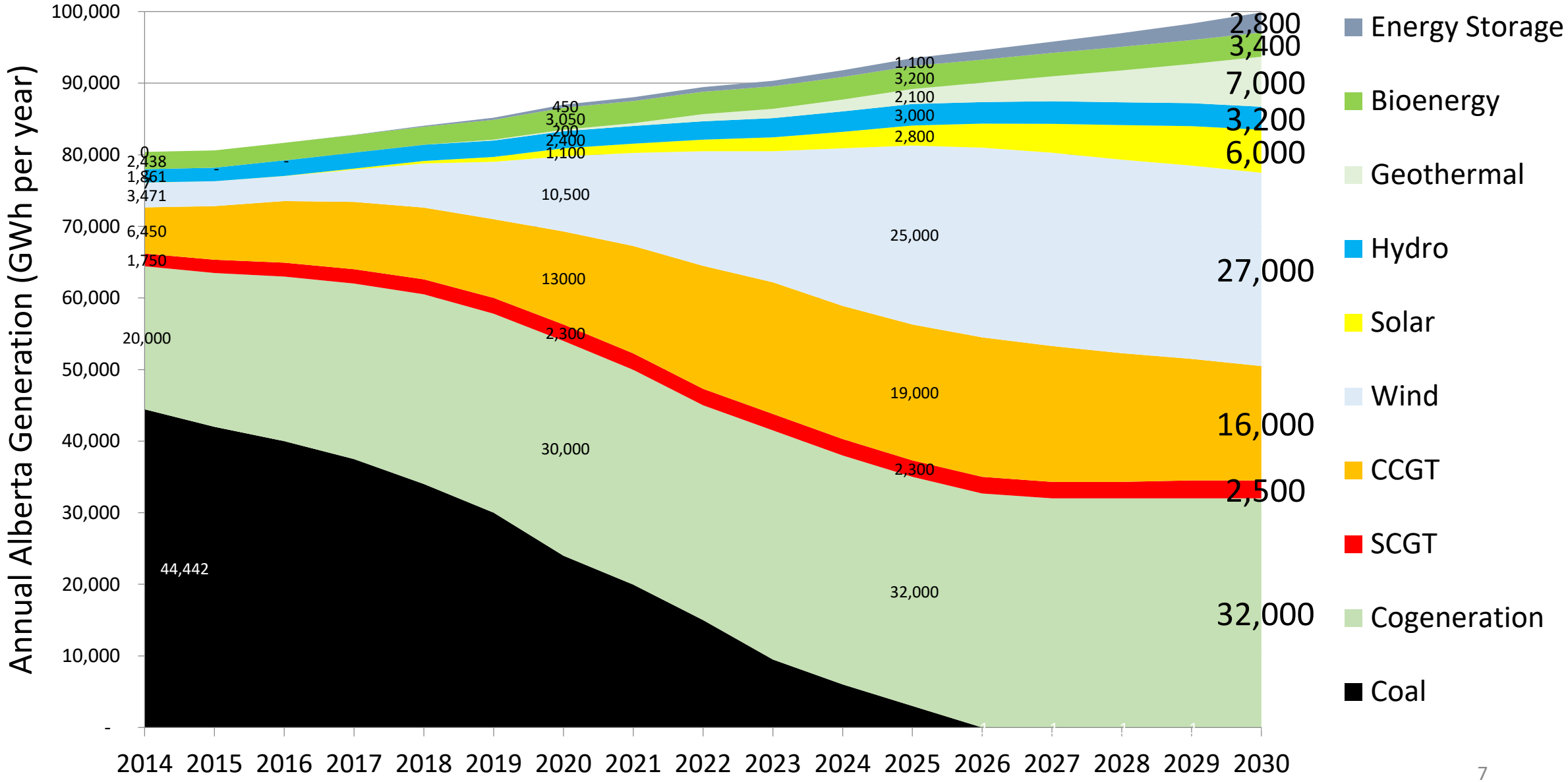


AREA's Recommended Mix of Hydrocarbon and Renewable Generation in Alberta 2015 to 2030

(GWh per year)

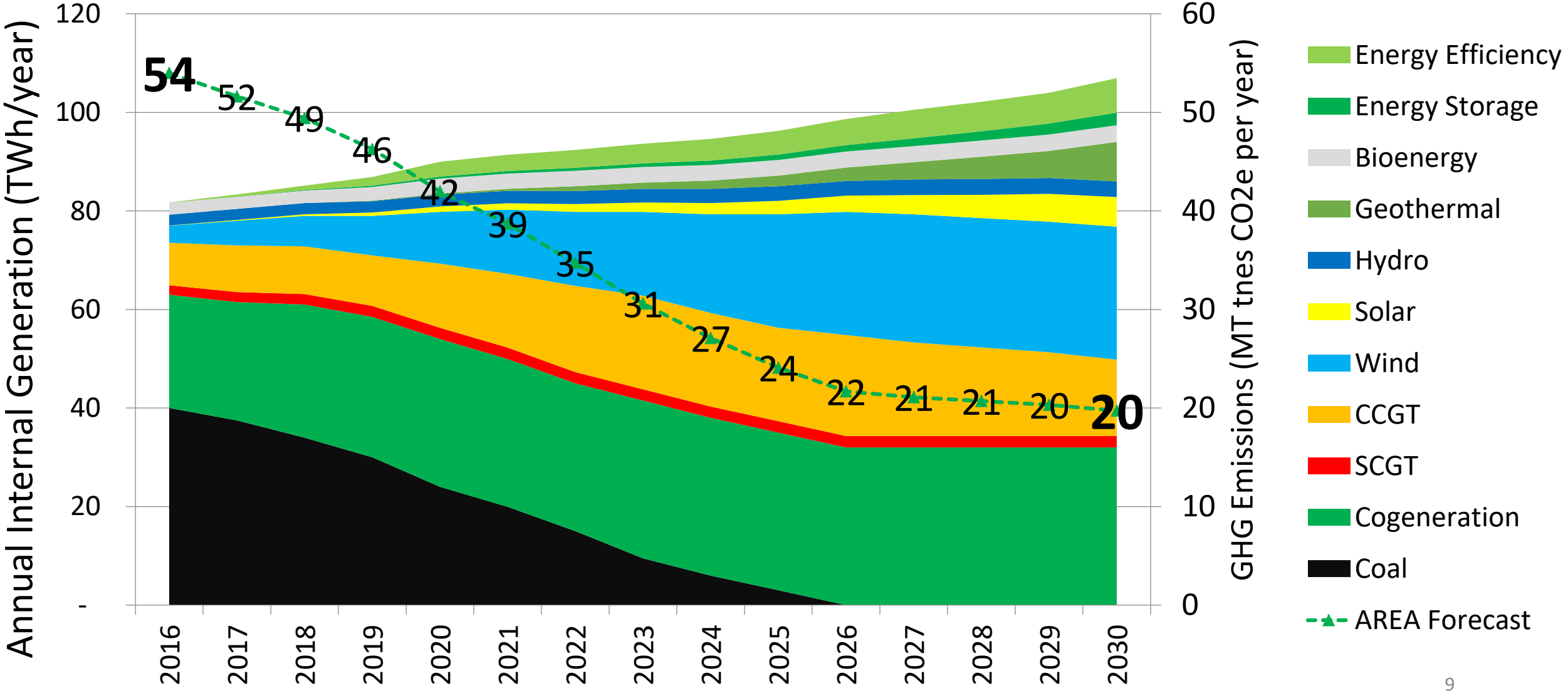


AREA's Forecast for Renewable Generation in Alberta by 2030
Total Generation is assumed to be 99,500 GWh per year



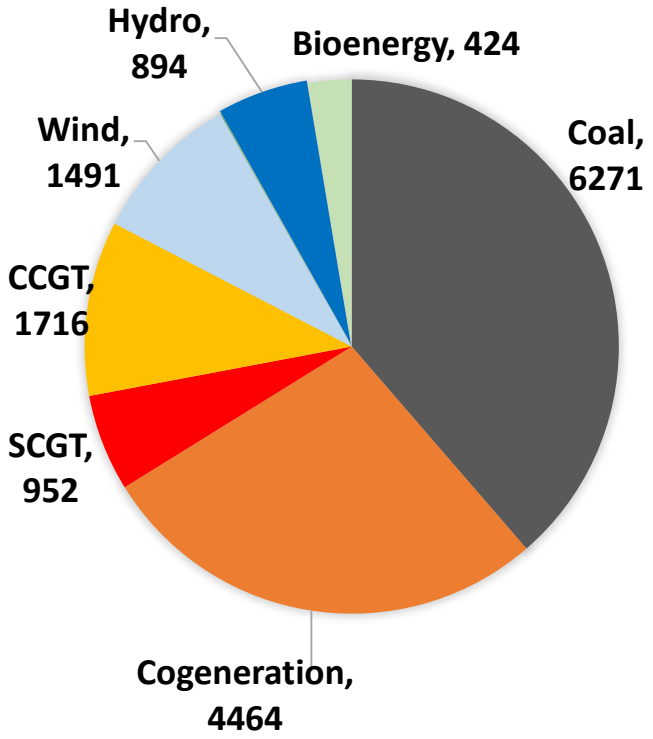
How will taking coal offline within ten years and replacing required generation with 50% renewable energy reduce GHG emissions?

Electricity Generation GHG Emissions Can Be Reduced 63%
From 54 MT to 20 MT by 2030
Cumulative Emissions 2016 to 2030 = 501 MT CO2e

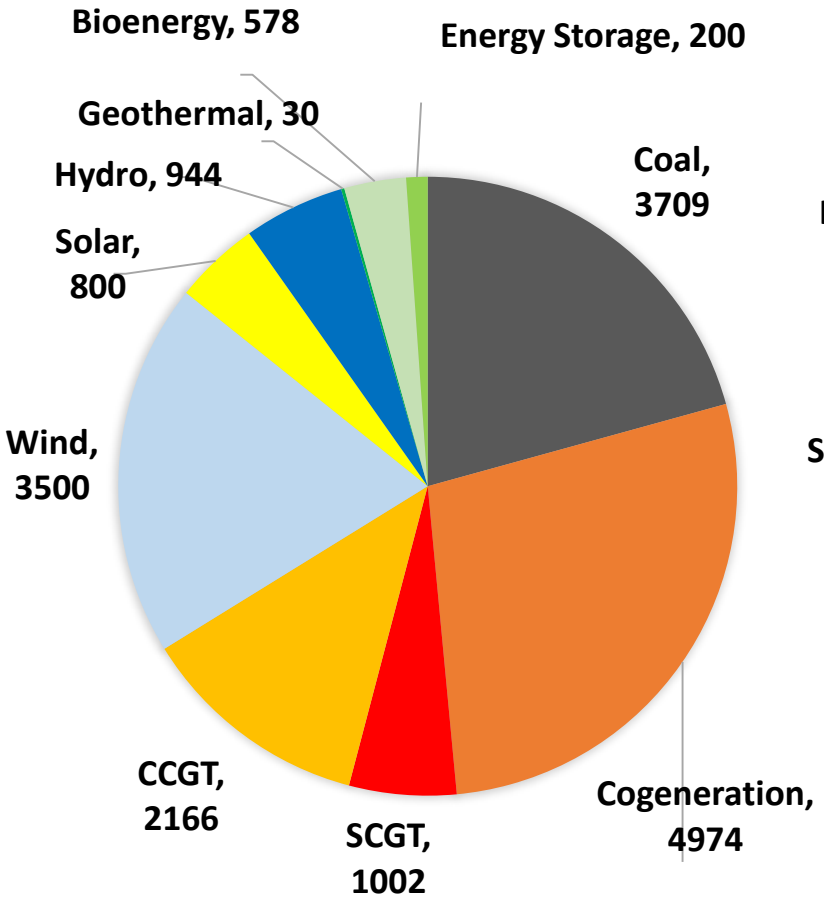


AREA's recommended Capacity Mix (2020 and 2030)

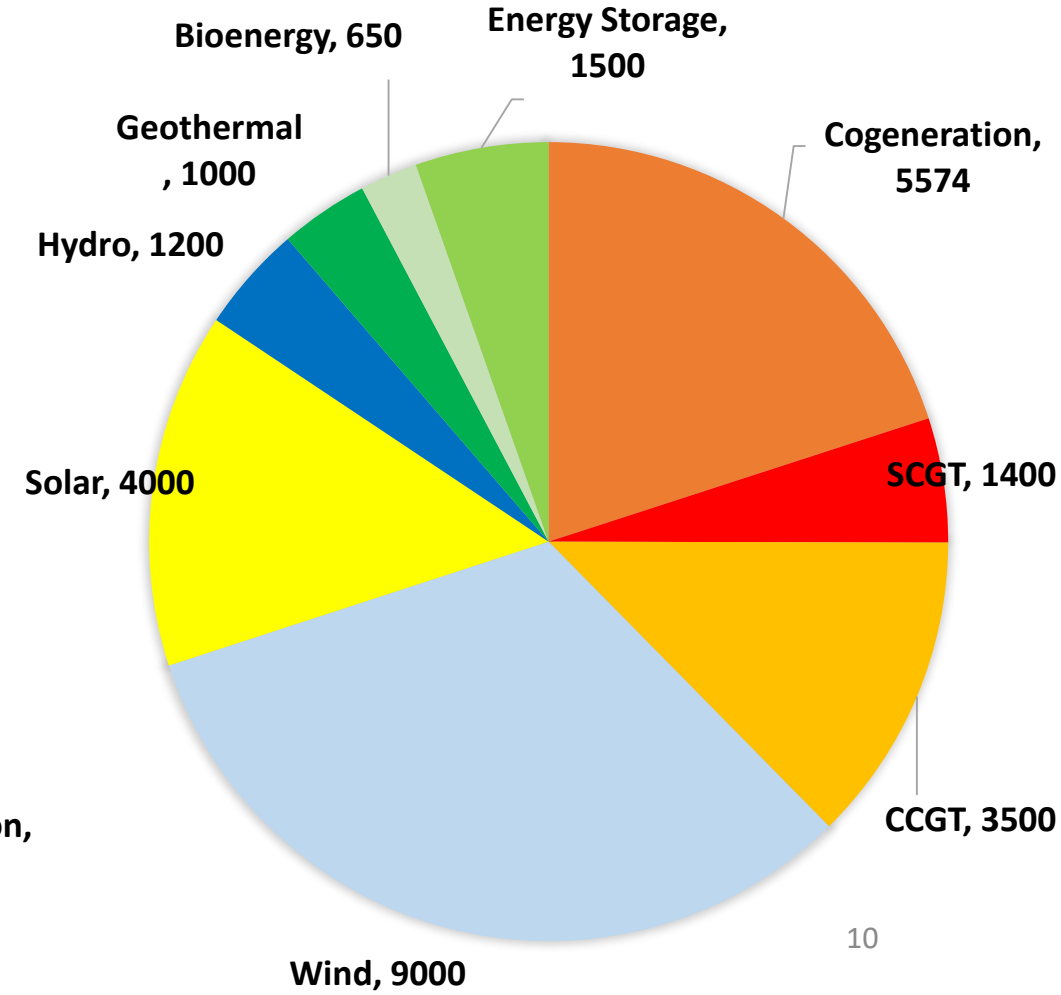
AESO's Installed Capacity in 2015 (16,224 MW)



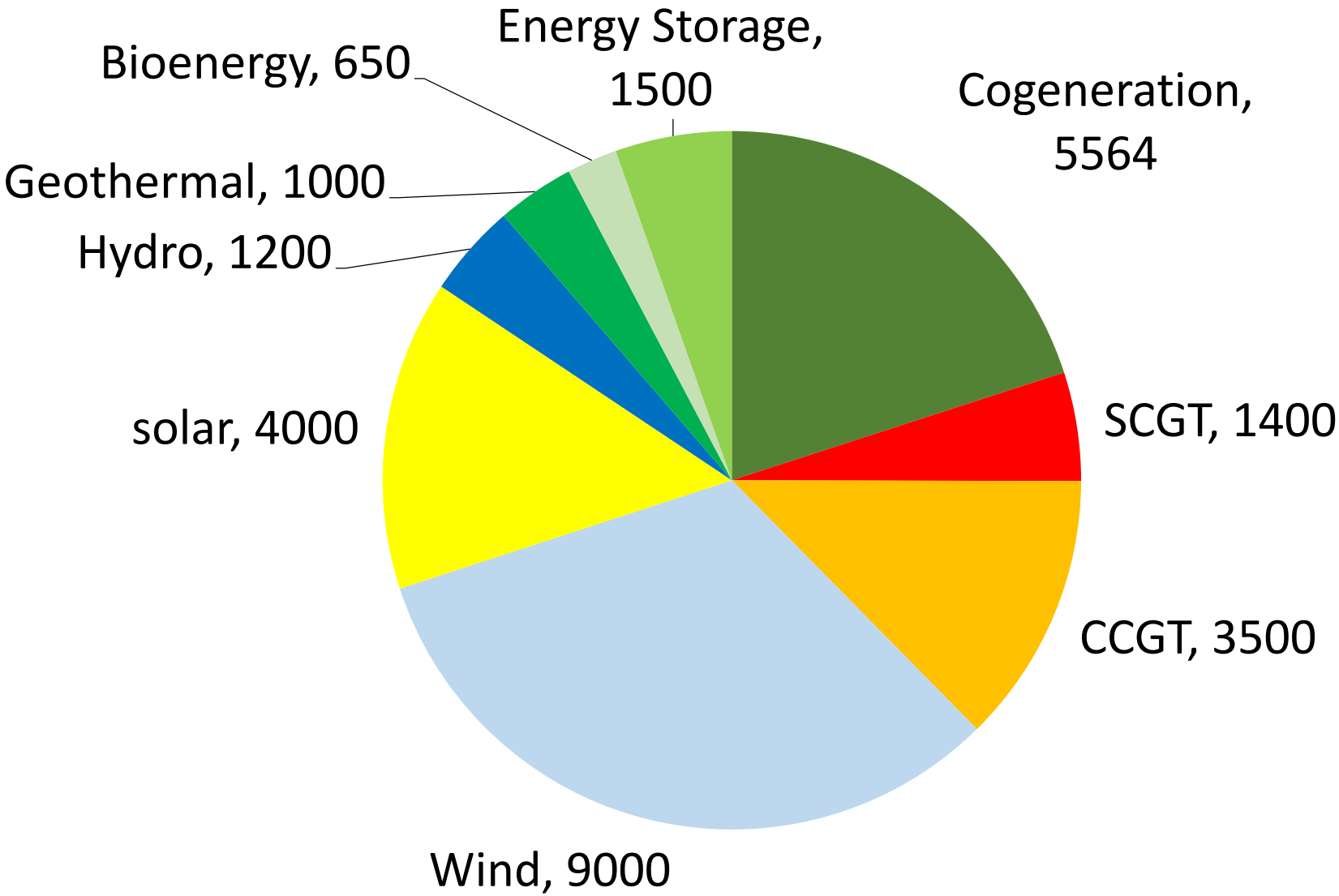
AREA's Recommended Capacity by 2020 (17,903 MW)



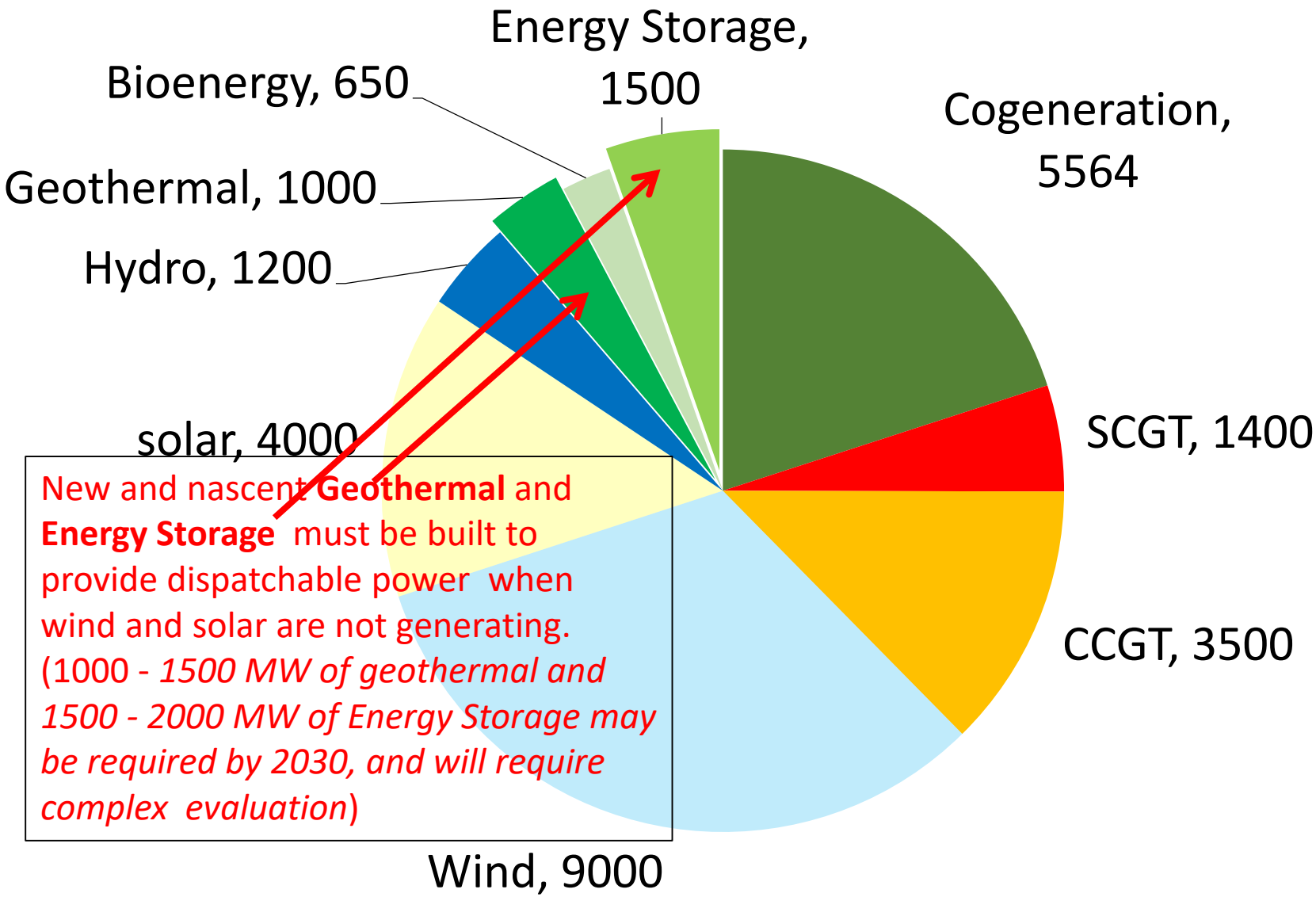
AREA's Recommended Capacity by 2030 (27,814 MW)



AREA's Recommended Capacity Mix for Alberta in 2030
not including 900 MW imported hydro
(27,814 MW)

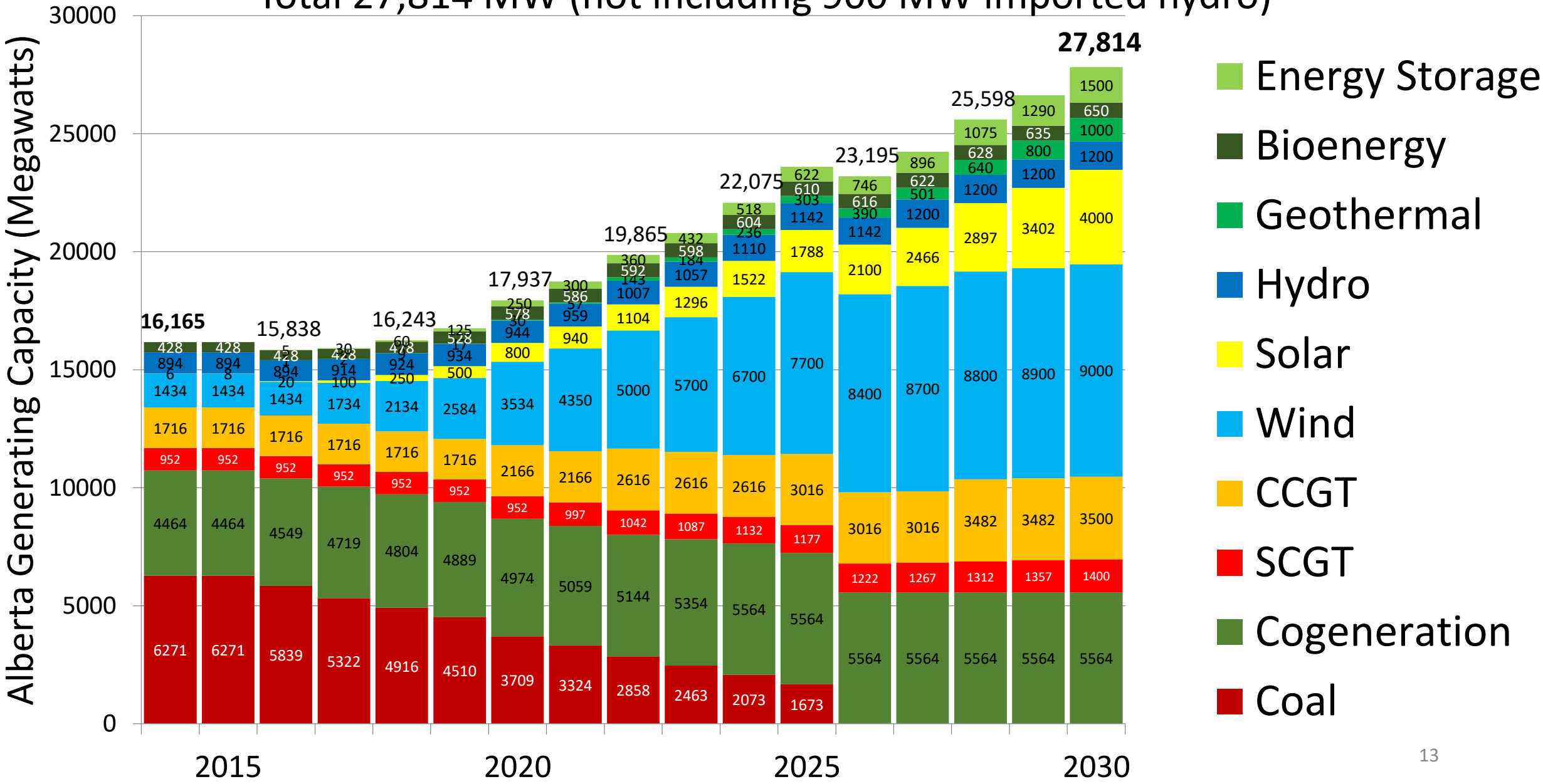


Dispatchable Capacity for Alberta in 2030
not including 900 MW imported hydro
(14,814 MW)

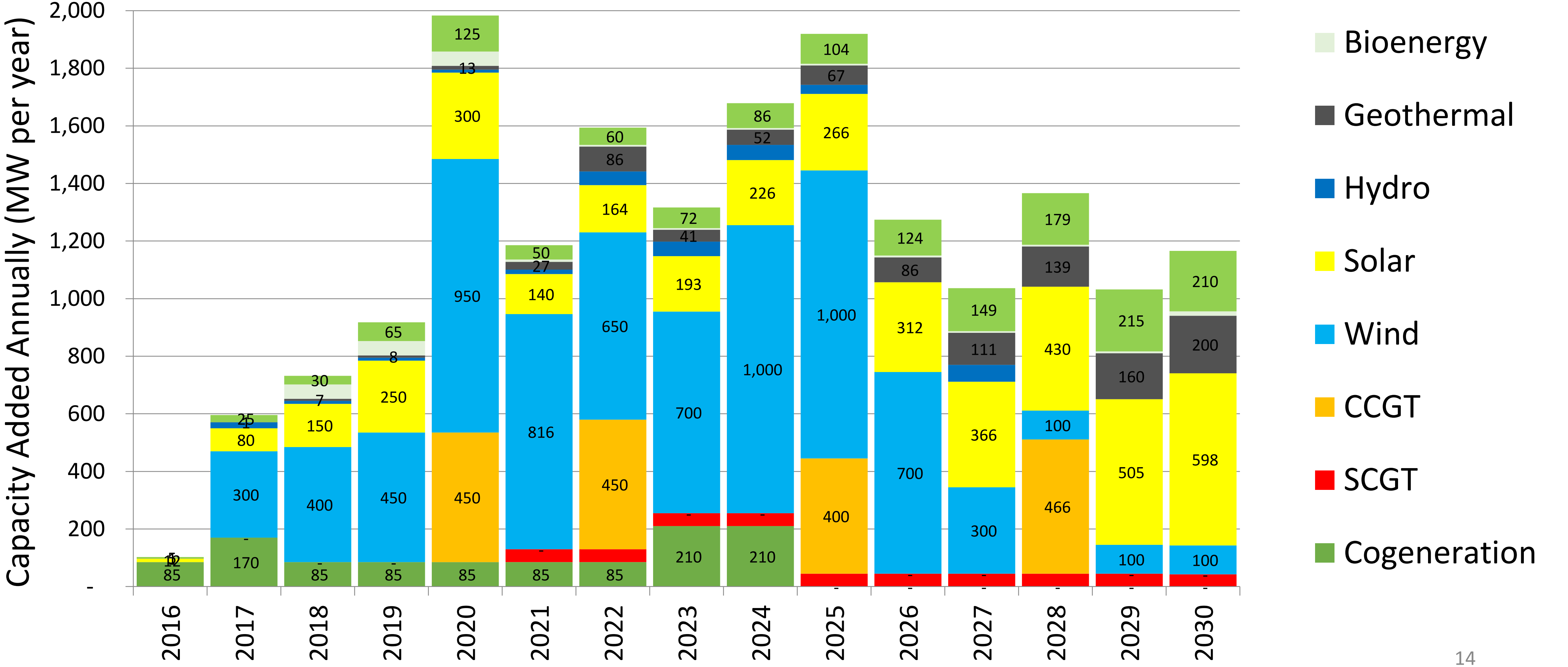


AREA's Recommended Capacity Buildout for Alberta 2016 to 2030

Total 27,814 MW (not including 900 MW imported hydro)



AREA's Recommended **Capacity** of Natural Gas and Renewables **added Annually**
to replace 6,300 MW of coal-fired electricity
and to achieve 50% renewable **generation** by 2030
Total added from 2016 to 2030 = 17,500 MW
Gas = 2,900 MW Renewables = 14,600 MW



WHAT ABOUT COSTS?

- To what?

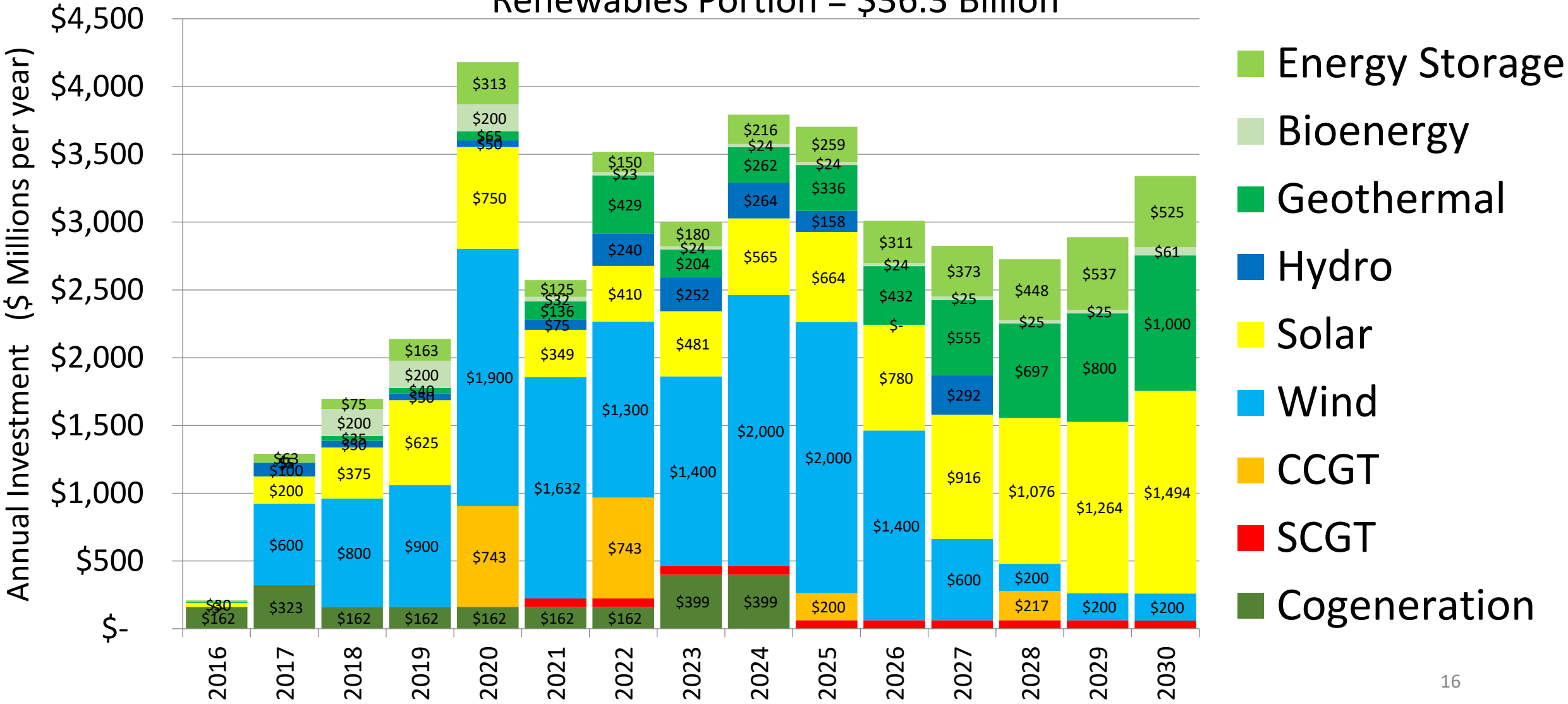
- the Economy?

  OR

- the Environment?

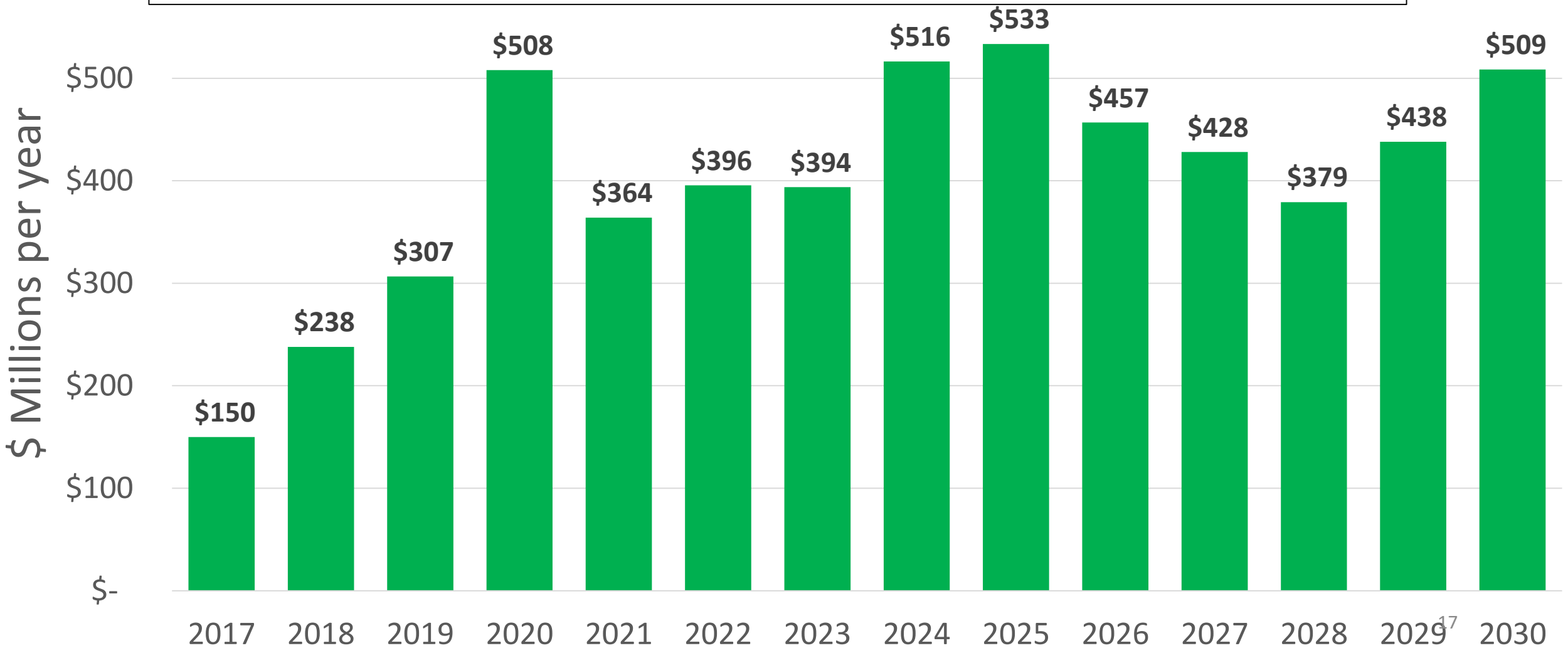
- Consider Costs as *Investment Opportunities*

AREA's Estimated **Investment** Required for Cogeneration, SCGT & CCGT gas, repowered coal and Renewable Power to add 17.5 GW from 2016 to 2030 = $41 Billion Renewables Portion = $36.3 Billion



Leveraged* Investment for Renewable Energy Projects
Total Project Funding 2017 to 2030 = $5.6 Billion
($million per year)

* Assumed leverage Investment ratio = 5.5:1 (similar to CCEMF)



Renewable Energy **Job Opportunities*** in Alberta 2016 to 2030

(*applying IRENA metrics for direct & indirect jobs per MW)

RENEWABLE TECHNOLOGIES ADDED BY 2030	ADDED CAPACITY BY 2030 (MW)	CAPACITY FACTOR	UNIT COST ($ / kW)	INVESTENT OPPORTUNITY ($ MILLIONS)	*DIRECT & INDIRECT JOBS PER MW	FORECAST NEW DIRECT & INDIRECT JOBS
Solar	4,000	16%	$2,500	$ 10,000	12.2	48,846
Wind	7,500	33%	$2,000	$ 15,000	2.5	18,724
Small Hydro	300	35%	$5,000	$ 1,500	5.5	1,650
Bioenergy	250	60%	$4,000	$ 1,000	3.6	898
Geothermal	1,000	85%	$5,000	$ 5,000	12.1	12,121
Energy Storage	1,500	20%	$2,500	$ 3,750	6.0	9,000
TOTAL	**14,550**			**$ 36,250**		**91,239**

Incentives to foster investment should embrace:

- Value adjusted RECs (Renewable Energy Certificates) generated within Alberta and awarded higher but differential premiums for:
  - Low emissions;
  - Proximity to load;
  - Ability to deliver during peak day loads;
  - Ability to be dispatched on short notice.

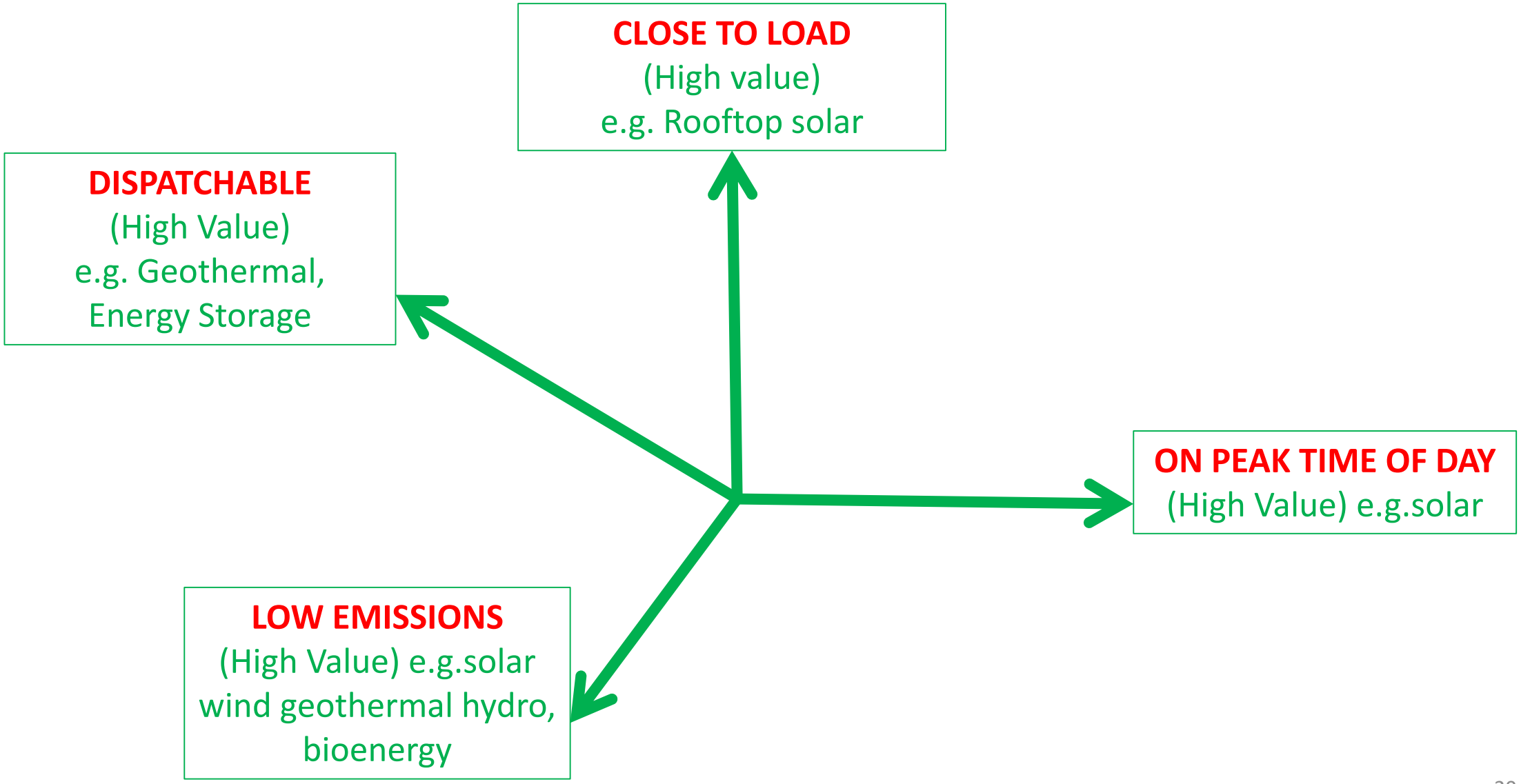
  OR

- Differential Carbon Offsets (related to SGER but **not restricted** to the single current offset number of 0.59 tne CO_2e / MWh)

  Note:

  1. *Either RECs or Offsets may be claimed but NOT BOTH in order to prevent double counting;*
  2. *Duration for incentives/PPAs should be reduced from 20 years to 10 years to mitigate against risks in long term obligations.*

Four factors that should differentiate the value of RECs should be evaluated for Alberta's electricity market.



How many direct, indirect and induced jobs will be lost in Alberta* when coal power is curtailed ?

**Applying the jobs loss estimates of ACCCE:*

Low Estimate

Coal Fleet Capacity = 6,299 MW

- Direct Operating Jobs lost = 819
- Indirect & Induced Jobs lost = 1,781

- Total Job Impact = 2,600

High Estimate

Coal Fleet Capacity = 6,299 MW

- Direct Operating Jobs lost = 1,008
- Indirect & Induced Jobs lost = 2,338

- Total Job Impact = 3,346

Which are the sectors that offer the best opportunities for GHG reduction in **Alberta** by 2030 ?

Sector	NIR 2014 Sectoral GHG Emissions (Megatonnes)	AREA's 2030 Forecast GHG Emissions (Megatonnes)	Percent Change
Agriculture and Waste (Methane)	25	15	-40%
Buildings (Energy Efficiency / Demand Reduction)	16	12	-25%
Manufacturing	25	26	4%
Transportation (Hybrids & EVs)	30	19	-37%
Electricity (Curtail Coal with 50% Renewable Generation)	47	17	-64%
Oil & Gas (Control Fugitive Emissions)	66	22	-67%
Oil Sands (30% less GHG emissions per barrel)	66	89	35%
TOTAL	274	200	-27%

To meet our Climate Action Commitments in Alberta

The Federal, Provincial (Alberta) and Municipal governments should do the following urgently, by using Federal Infrastructure funds, and monies from the Alberta Climate Change and Emissions Management Fund:

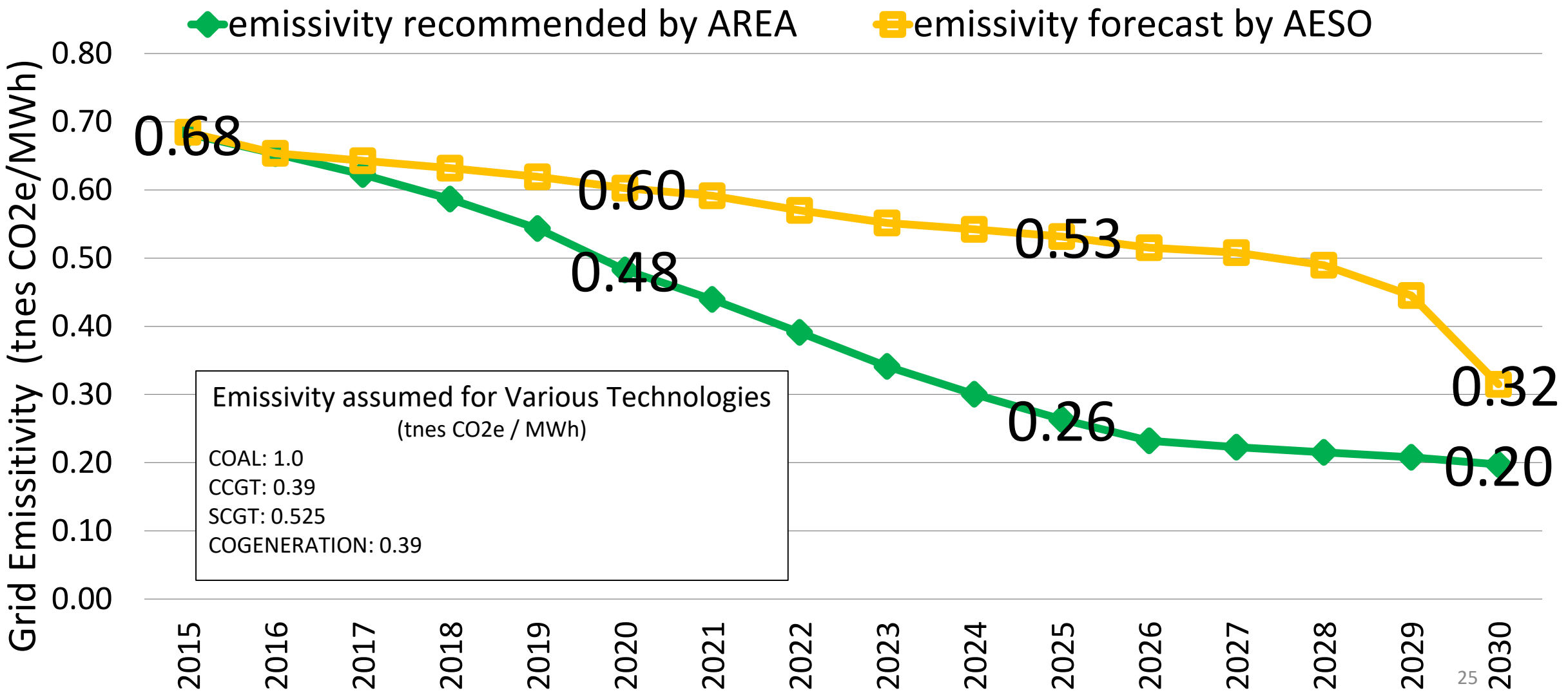
Establish an agency that will provide:

- zero to low interest **loans** to residential and commercial investors who wish to install energy conserving items and renewable energy systems such as solar, combined heat and power and geo-exchange systems in their homes and businesses;
- **rebates** to those investors who implement energy conservation and renewable energy to permit payback of those investments within a reasonable period of time, i.e., one to 10 years;
- **grants** to training institutions such as SAIT and NAIT to provide programs for tradespeople to learn the skills required to install the energy conserving items and renewable energy systems;
- **grants** to oil and gas companies that set up divisions within their organizations that broaden the corporate mandate of hydrocarbon production to embrace renewable energy production and retain and retrain staff in this transition period.

Tens of thousands of good jobs are available, starting now.

An Emissivity Target for 2030 should be established for the Alberta Grid that approaches the current low emissivity of the Canadian Electricity Grid of 0.15 tnes CO_2e per MWh

Recommended Emissivity of Alberta Electricity Grid (including Behind the Fence Generation) tnes CO2e / MWh



ALBERTA RENEWABLE ENERGY ALLIANCE

VISION

AREA envisions an Alberta where power is supplied entirely by renewable and ecologically sound sources.

MISSION

AREA advances the deployment of renewable power through educational events, political advocacy, and support for installations.

http://www.abrenewableenergy.ca

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Appendix

An Explanation of Capacity (MW), Generation (MWh) & Capacity Factor (%)

- Capacity is the amount of power (commonly expressed in Megawatts) that a generating unit can produce under specific conditions.
  1 megawatt (MW) is one million watts.
- Generation is the amount of electricity a generator produces over a specific period of time (commonly expressed in Megawatt hours).
  - 1 megawatt (MW) operating for one hour will generate 1 MWh
  - 1megawatt (MW) operating for one year will generate 8,760 MWh
- The Capacity Factor of a power plant is the ratio of its actual output over a period of time, to its potential output if the plant were to operate at full capacity continuously over the same period of time.
  - The capacity factor is frequently measured over a period of one year;
  - For example, if a 5 MW (Megawatt) wind turbine generates 15,000 MWh in one year, its capacity factor can be calculated as 15,000 MWh / 5 MW / 8,760 hours per year = 34.2 %
  - For example, if a 5 kW (kilowatt) solar array generates 6,570 kWh in one year, its capacity factor is 6,570 kWh / 5 kW / 8,760 hours per year = 15.0 %

Where are the priority areas for GHG reduction in **Canada** by 2030 ?

- Reduce fugitive emissions from Oil & Natural Gas by 70%;
  - *(Canada has committed to reducing fugitive emissions by 45% by 2025)*
- Reduce Emissions from Electricity Generation by 67%;
- Reduce Emissions from Solvent Use by 50%;
- Reduce Emissions from Waste Disposal by 30%;
- Reduce Emissions from Crop Residue & Manure by 30%;
- Reduce Fuel Consumed for Oil & Gas Production by 25%;
- Reduce Emissions from Road Transportation by 15%

Where are the priority areas for GHG reduction in **Alberta** by 2030 ?

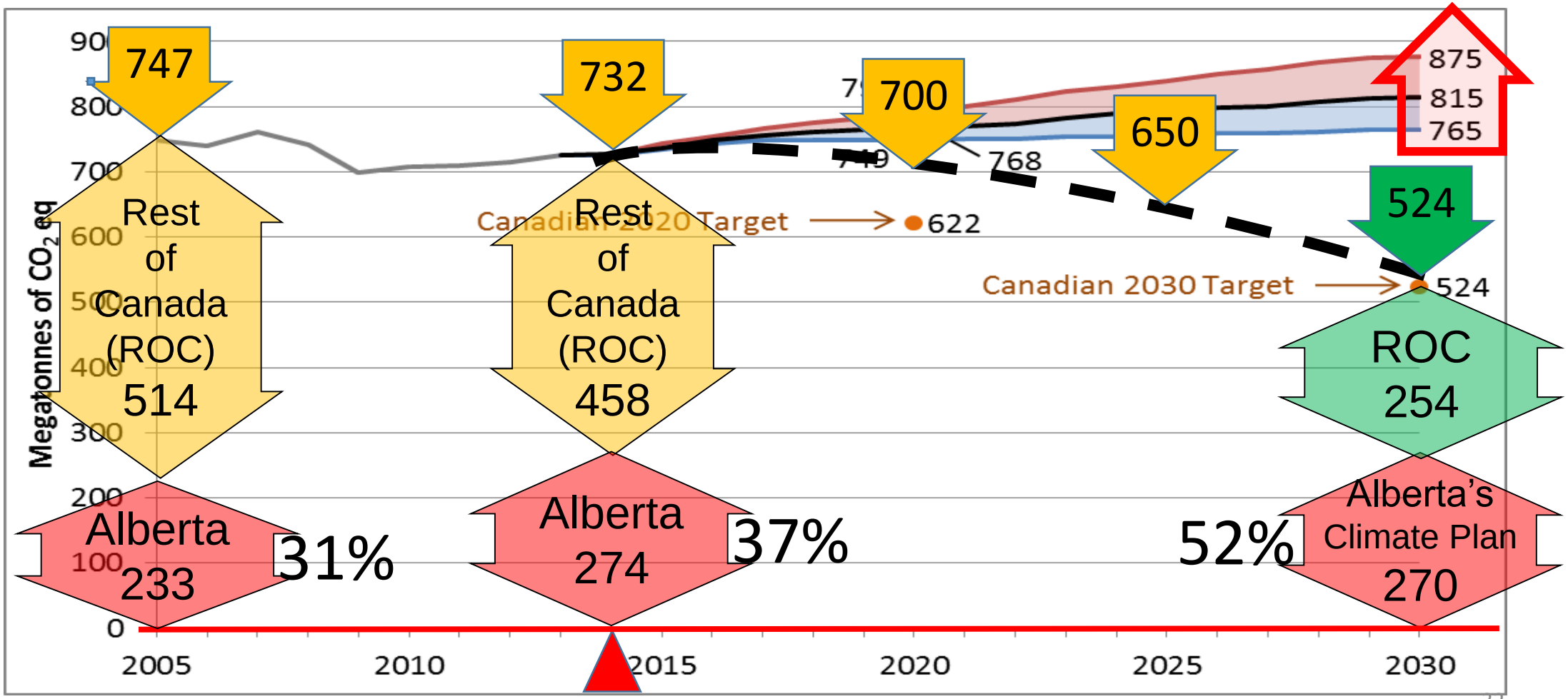
- Reduce fugitive emissions from Oil & Natural Gas by 67%;
- Reduce Emissions from Electricity Generation by 64%;
- Reduce Emissions from Agriculture & Waste (methane) by 40%;
- Reduce Emissions from Transportation by 37%;
- Reduce Emissions from Buildings (improve EE) by 25%;
- Reduce electricity demand by 15%;
- Phase out coal by 2025 (in one decade);
- Close coal units that have operated for 40 years;
- Increase renewable generation from current 10% to 20% by 2020; 35% by 2025; and 50% by 2030

GHG Emissions Reduction in Alberta

- What is Alberta targeting to accomplish by 2030?

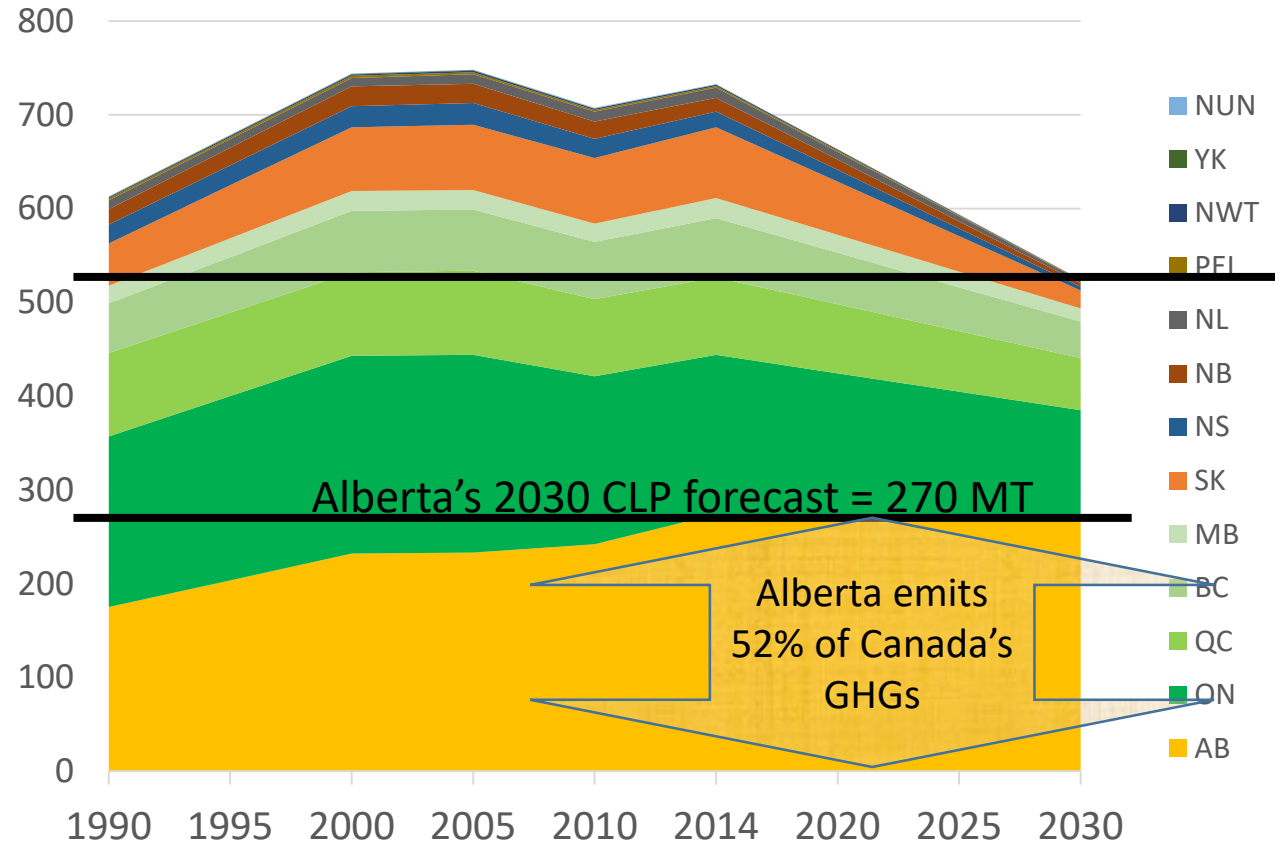
Canada's GHG target was confirmed in 2015 at Paris COP21

Our 2030 National target is 524 Megatonnes CO2e
= 30% below 2005 levels of 747 MT

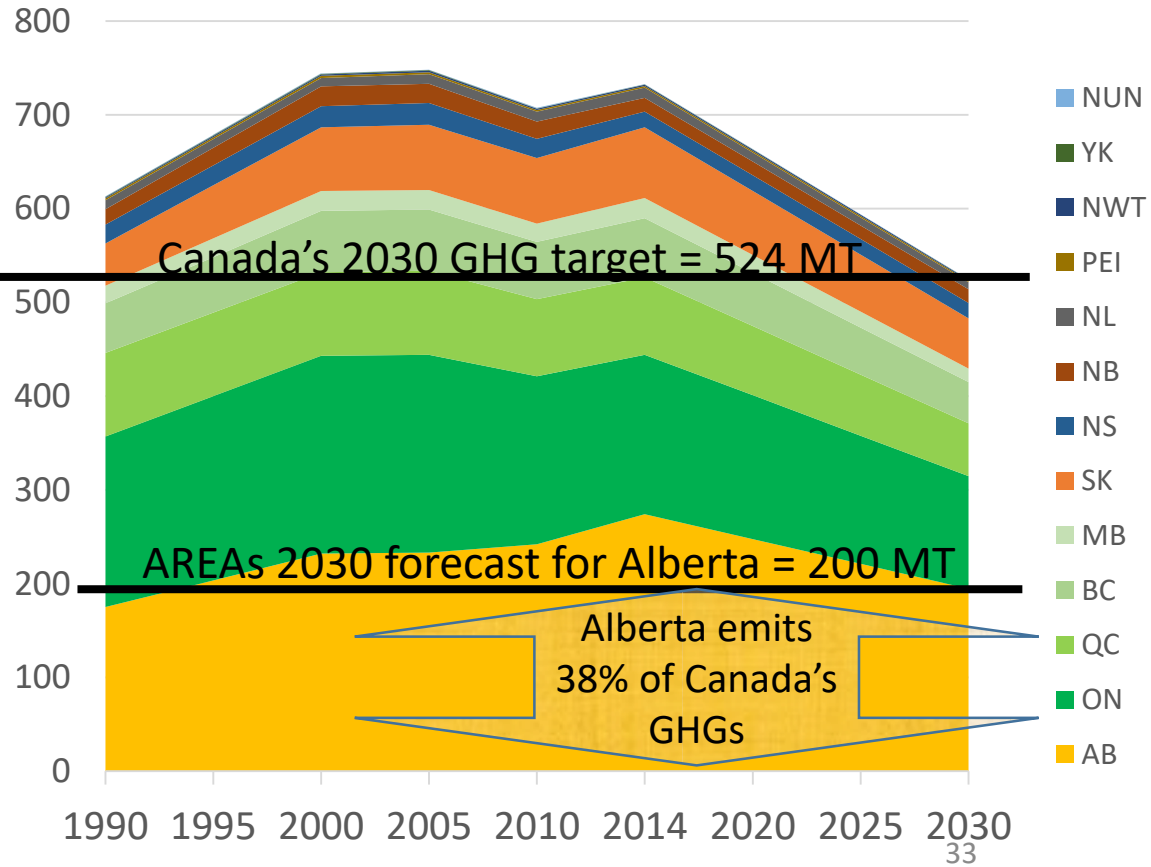


Alberta should reduce current GHG emissions of 274 MT by 28% to 200 MT by 2030 to help meet Canada's goal of 524 MT.

Alberta's CLP Climate Leadership Plan



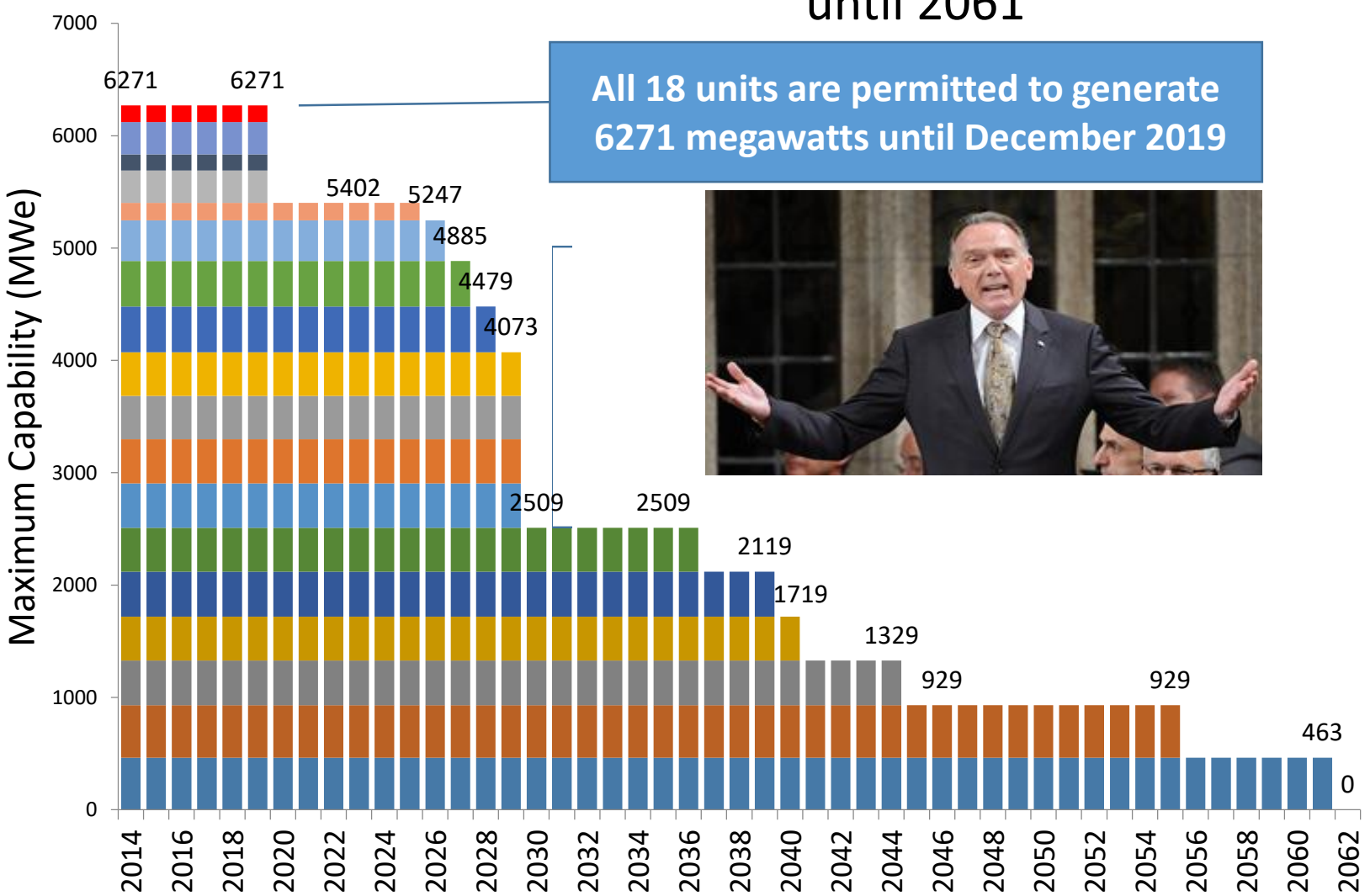
Alberta's Fair Reduction Obligation



AREA's Recommended Provincial GHG Reductions to achieve Canada's 2030 Target

Province	GHG emissions (MT CO2e / year)		Actual % GHG change from 2005 to 2014	AREA's Recommended % GHG reduction from 2014 by 2030	AREA's Recommended Provincial GHG targets for 2030 (MT CO2e)	Comments to justify varying Provincial reduction percentages
	2005	2014				
NL	10	11	4%	-30%	7.4	
PEI	2.1	1.8	-13%	-17%	1.5	have already reduced 13%
NS	24	17	-29%	-1%	16	have virtually met 2030 target
NB	21	15	-27%	-3%	15	have virtually met 2030 target
QC	90	83	-8%	-32%	56	previously committed to 56 MT
ON	211	170	-19%	-32%	115	previously committed to 115 MT
MB	21	22	4%	-33%	14	previously committed to 14 MT
SK	70	75	8%	-27%	55	
AB	233	274	18%	-27%	200	
BC	65	63	-4%	-33%	42	previously committed to 38 MT
YK	0.5	0.3	-42%	0%	0.3	have met 2030 target
NWT	1.7	1.5	-8%	-26%	1.1	have already reduced 8%
NUN	0.3	0.3	-23%	-11%	0.2	have already reduced 23%
TOTAL	**747**	**732**			**524**	

The 2012 Federal Coal Regulation Sanctioning 50 year 'Useful' Lifetime allowed Alberta Coal Power to operate until 2061



Alberta Energy Brochure

Phase-out of coal-fired emissions in Alberta

Alberta's Electricity Sector Today

In 2014, 55 per cent of Alberta's electricity was produced from 18 coal-fired generators.

Coal-fired electricity produces high levels of greenhouse gas (GHG) emissions and air pollutants which impact air quality and impact human health. In 2013, the electricity sector accounted for 17 per cent of Alberta's total GHG emissions — the majority from coal-fired generation.

Federal coal phase-out regulations

Under existing federal regulations, coal-fired power plants are required to meet performance standards to lower GHG emissions or retire when they reach 50 years of operation. Strict standards are set for facilities to become as efficient as natural gas generation. In Alberta, 12 coal-fired generating units are expected to retire before 2030.

Coal production in Alberta:

There are eight coal mines operating in Alberta, five mines produce coal for Alberta's electricity sector.

Coal mines for power generation

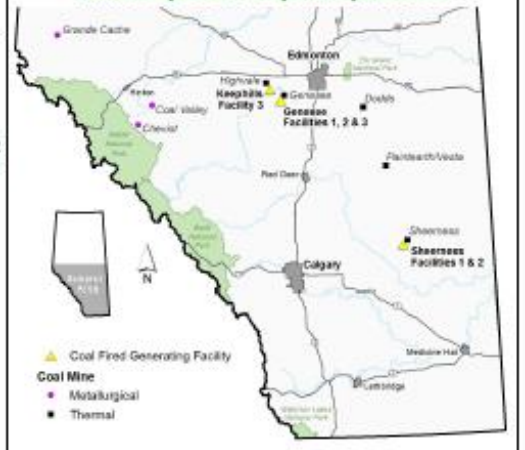
- Thermal coal is predominantly used for electricity generation.
- Five coal mines produced 23.3 million tonnes of coal for coal-fired electricity power plants in 2014.

Coal mines for export

- Alberta produced approximately 2 million tonnes of metallurgical coal from three mines in 2014.
- The coal was exported for steel making and other purposes.

Alberta's focus on zero emissions by 2030 do not affect metallurgical mines or export mines.

Current coal-fired generating units and coal mines expected to operate past 2030



alberta.ca
March 2016

Alberta Government

Coal Units, Owners and Associated Mines in Alberta

Federal regulation of coal-fired emmissions
- Coal-fired units meet performance standards at end-of-life (approx. 50 years) or shut down.

Alberta's action to phase-out coal-fired emissions
- Zero pollution from coal-fired generation by 2030.

Coal-fired generation unit and owner	Mine and Owner	2016	2030	2061
Keephills 3 Capital Power and TransAlta	Highvale TransAlta			2061
Genesee 3 Capital Power and TransAlta	Genesee Westmoreland Coal Company			2055
Genesee 1 Capital Power	Genesee Westmoreland Coal Company			2044
Sheerness 2 ATCO Power and TransAlta	Sheerness Westmoreland Coal Company			2040
Genesee 2 Capital Power	Genesee Westmoreland Coal Company			2039
Sheerness 1 ATCO Power and TransAlta	Sheerness Westmoreland Coal Company			2036
Keephills 2 TransAlta	Highvale TransAlta		2029	
Keephills 1 TransAlta	Highvale TransAlta		2029	
Battle River 5 ATCO Power	Paintearth and Vesta Westmoreland Coal Company		2029	
Sundance 6 TransAlta	Highvale TransAlta		2029	
Sundance 5 TransAlta	Highvale TransAlta		2028	
Sundance 4 TransAlta	Highvale TransAlta		2027	
Sundance 3 TransAlta	Highvale TransAlta		2026	
Battle River 4 ATCO Power	Paintearth and Vesta Westmoreland Coal Company		2025	
Sundance 2 TransAlta	Highvale TransAlta	2019		
HR Milner Maxim Power	Coal Valley Westmoreland Coal Company	2019		
Sundance 1 TransAlta	Highvale TransAlta	2019		
Battle River 3 ATCO Power	Paintearth and Vesta Westmoreland Coal Company	2019		

Focus of Alberta's action to zero emissions

LEGEND
Expected Closure Date
20XX
20XX

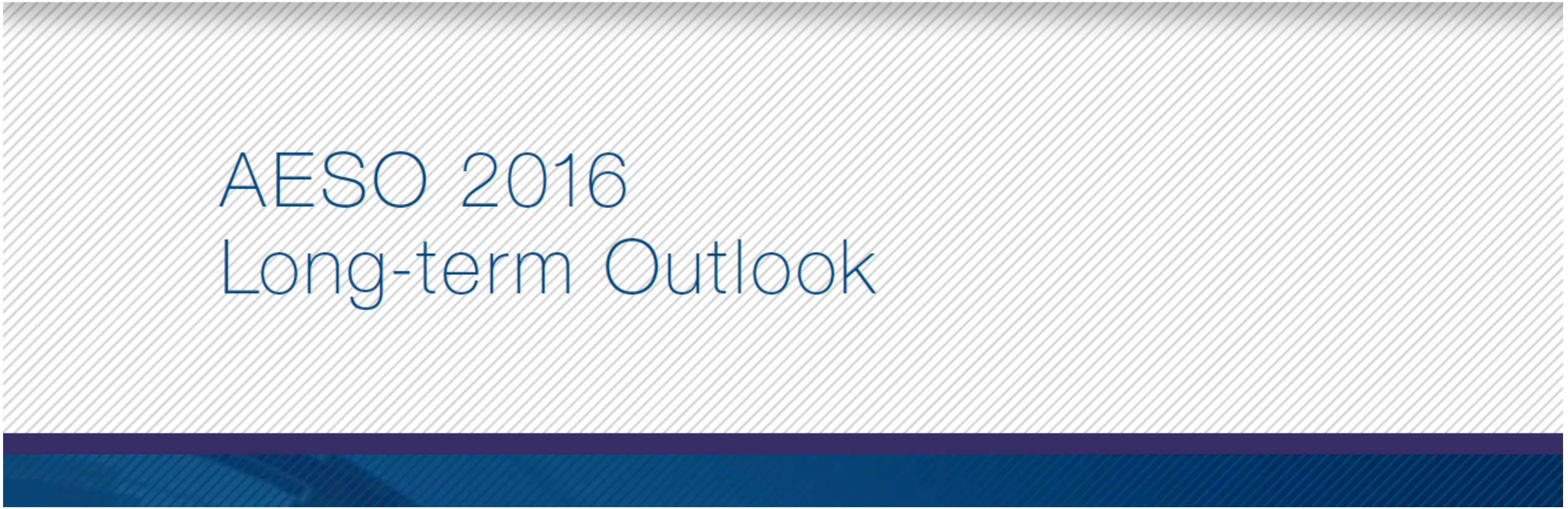
In 2016 the Alberta government required the closure of coal power by December 2030

Export coal mines not used for electricity generation in Alberta: Not affected by phase-out of coal-fired emissions

Coal Valley Mine (Westermoreland) Hinton
Cardinal River Mine/ Cheviot (Teck Coal) – Hinton
Grande Cache Coal Mine (Grande Cache Coal) – Grande Cache

*All facilities are required to meet air quality regulations and performance standards.

What has AESO Proposed ? (May, 2016)



From AESO Long Term Outlook (May 2016)

Figure 7 summarizes the generation additions and retirements by generation technology for key study years.

FIGURE 7: Generation capacity mix comparison

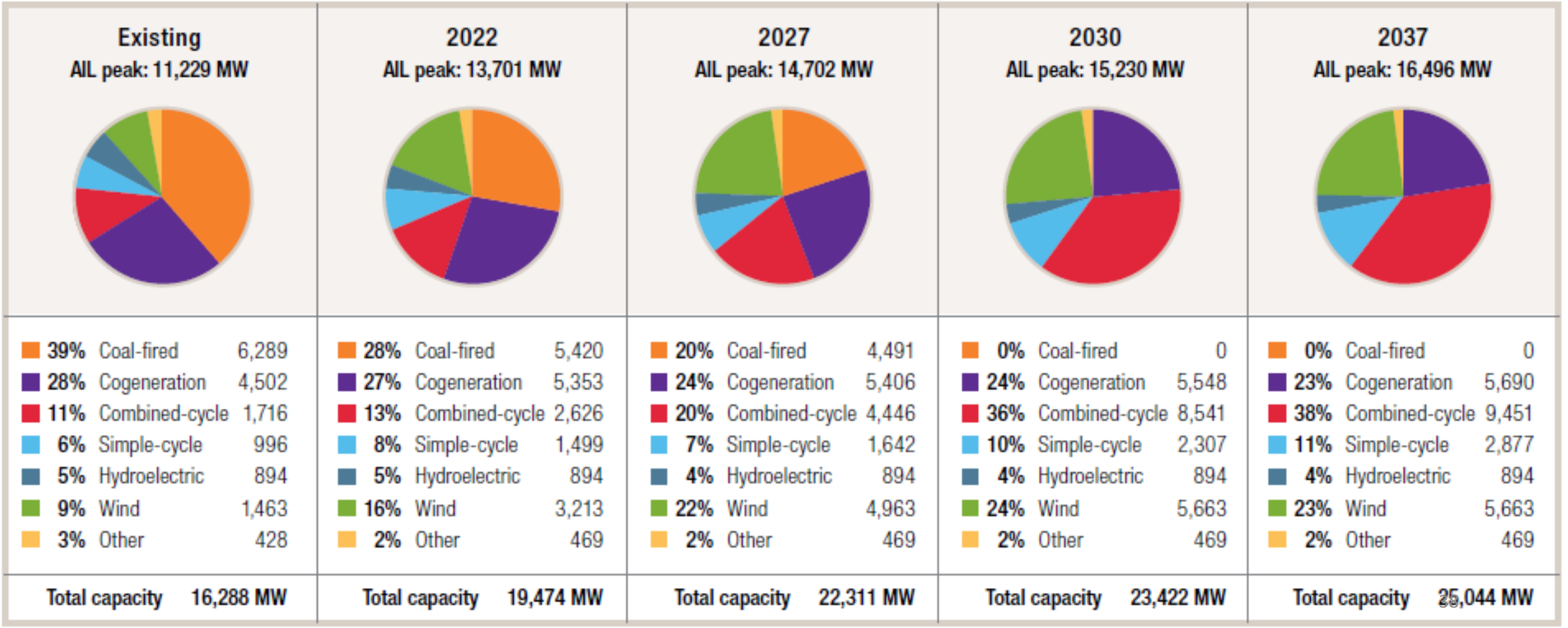
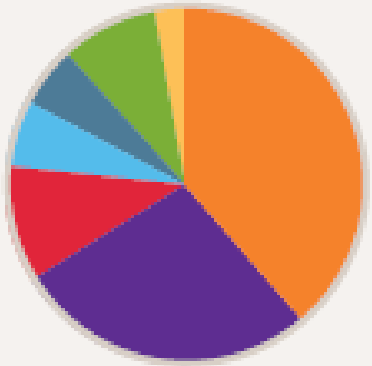
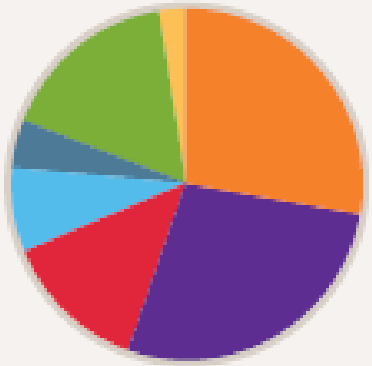
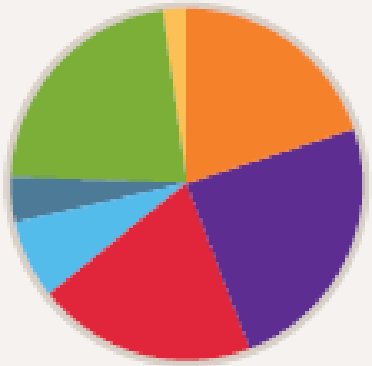
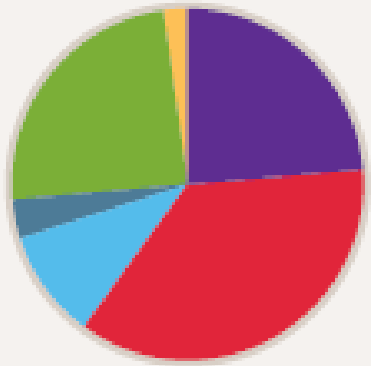


FIGURE 7: Generation capacity mix comparison

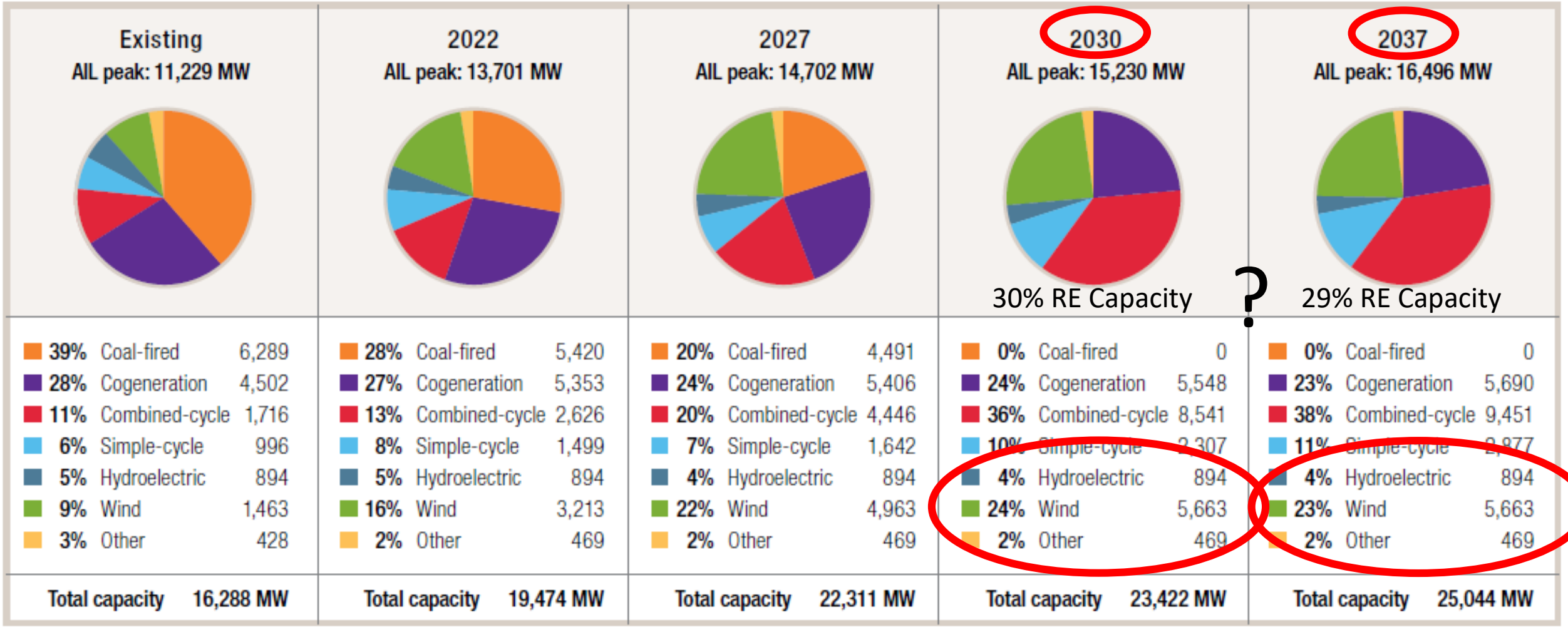
Existing AIL peak: 11,229 MW			2022 AIL peak: 13,701 MW			2027 AIL peak: 14,702 MW			2030 AIL peak: 15,230 MW		
											
39%	Coal-fired	6,289	28%	Coal-fired	5,420	20%	Coal-fired	4,491	0%	Coal-fired	0
28%	Cogeneration	4,502	27%	Cogeneration	5,353	24%	Cogeneration	5,406	24%	Cogeneration	5,548
11%	Combined-cycle	1,716	13%	Combined-cycle	2,626	20%	Combined-cycle	4,446	36%	Combined-cycle	8,541
6%	Simple-cycle	996	8%	Simple-cycle	1,499	7%	Simple-cycle	1,642	10%	Simple-cycle	2,307
5%	Hydroelectric	894	5%	Hydroelectric	894	4%	Hydroelectric	894	4%	Hydroelectric	894
9%	Wind	1,463	16%	Wind	3,213	22%	Wind	4,963	24%	Wind	5,663
3%	Other	428	2%	Other	469	2%	Other	469	2%	Other	469
Total capacity		16,288 MW	Total capacity		19,474 MW	Total capacity		22,311 MW	Total capacity		23,422 MW

17% RE Capacity 2016

30% Renewable *Capacity* by 2030

Why would AESO plan the same renewable capacity in 2037 as in 2030 ?

FIGURE 7: Generation capacity mix comparison

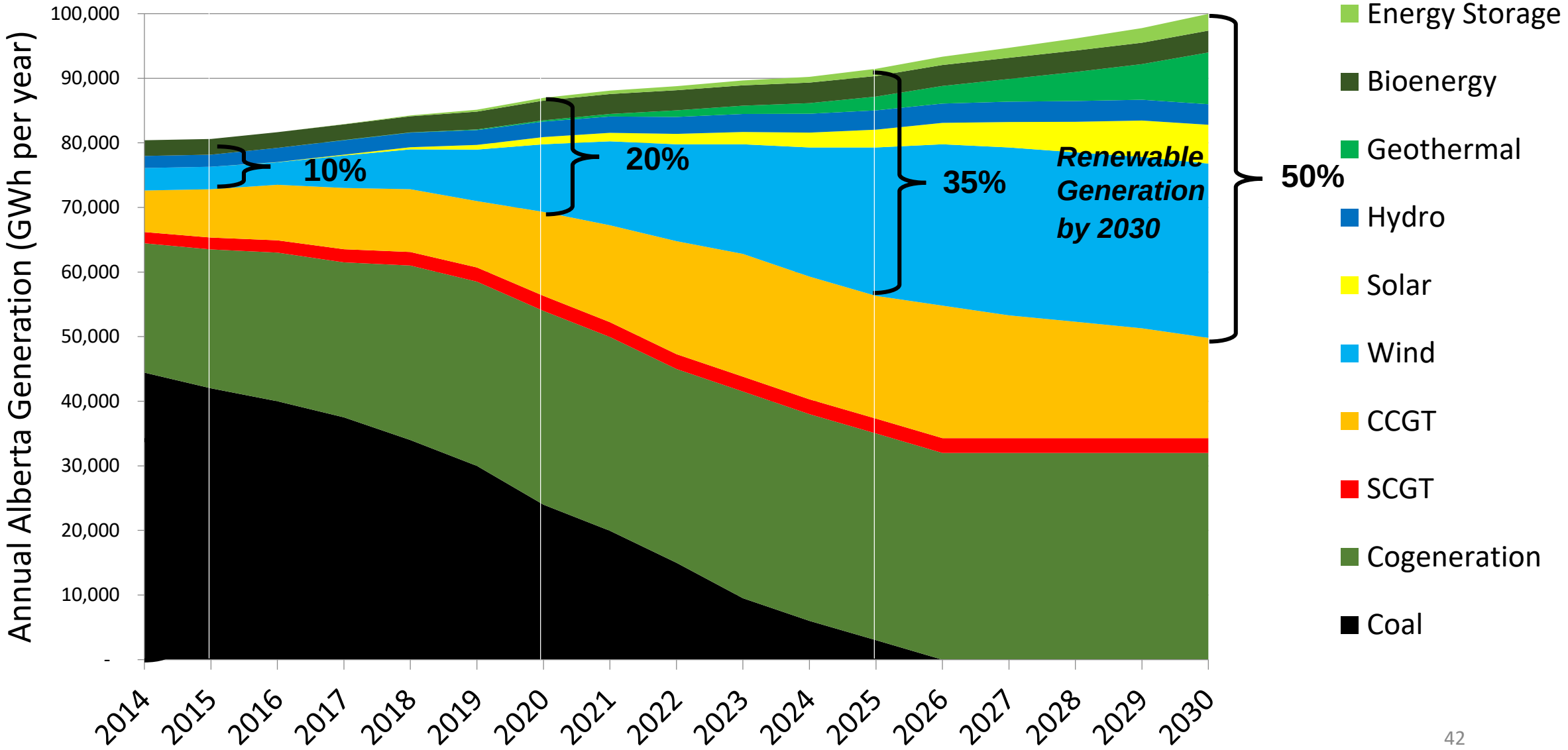


Existing AIL peak: 11,229 MW			2022 AIL peak: 13,701 MW			2027 AIL peak: 14,702 MW			2030 AIL peak: 15,230 MW			2037 AIL peak: 16,496 MW		
39%	Coal-fired	6,289	28%	Coal-fired	5,420	20%	Coal-fired	4,491	0%	Coal-fired	0	0%	Coal-fired	0
28%	Cogeneration	4,502	27%	Cogeneration	5,353	24%	Cogeneration	5,406	24%	Cogeneration	5,548	23%	Cogeneration	5,690
11%	Combined-cycle	1,716	13%	Combined-cycle	2,626	20%	Combined-cycle	4,446	36%	Combined-cycle	8,541	38%	Combined-cycle	9,451
6%	Simple-cycle	996	8%	Simple-cycle	1,499	7%	Simple-cycle	1,642	10%	Simple-cycle	2,307	11%	Simple-cycle	2,877
5%	Hydroelectric	894	5%	Hydroelectric	894	4%	Hydroelectric	894	4%	Hydroelectric	894	4%	Hydroelectric	894
9%	Wind	1,463	16%	Wind	3,213	22%	Wind	4,963	24%	Wind	5,663	23%	Wind	5,663
3%	Other	428	2%	Other	469	2%	Other	469	2%	Other	469	2%	Other	469
Total capacity		16,288 MW	Total capacity		19,474 MW	Total capacity		22,311 MW	Total capacity		23,422 MW	Total capacity		25,044 MW

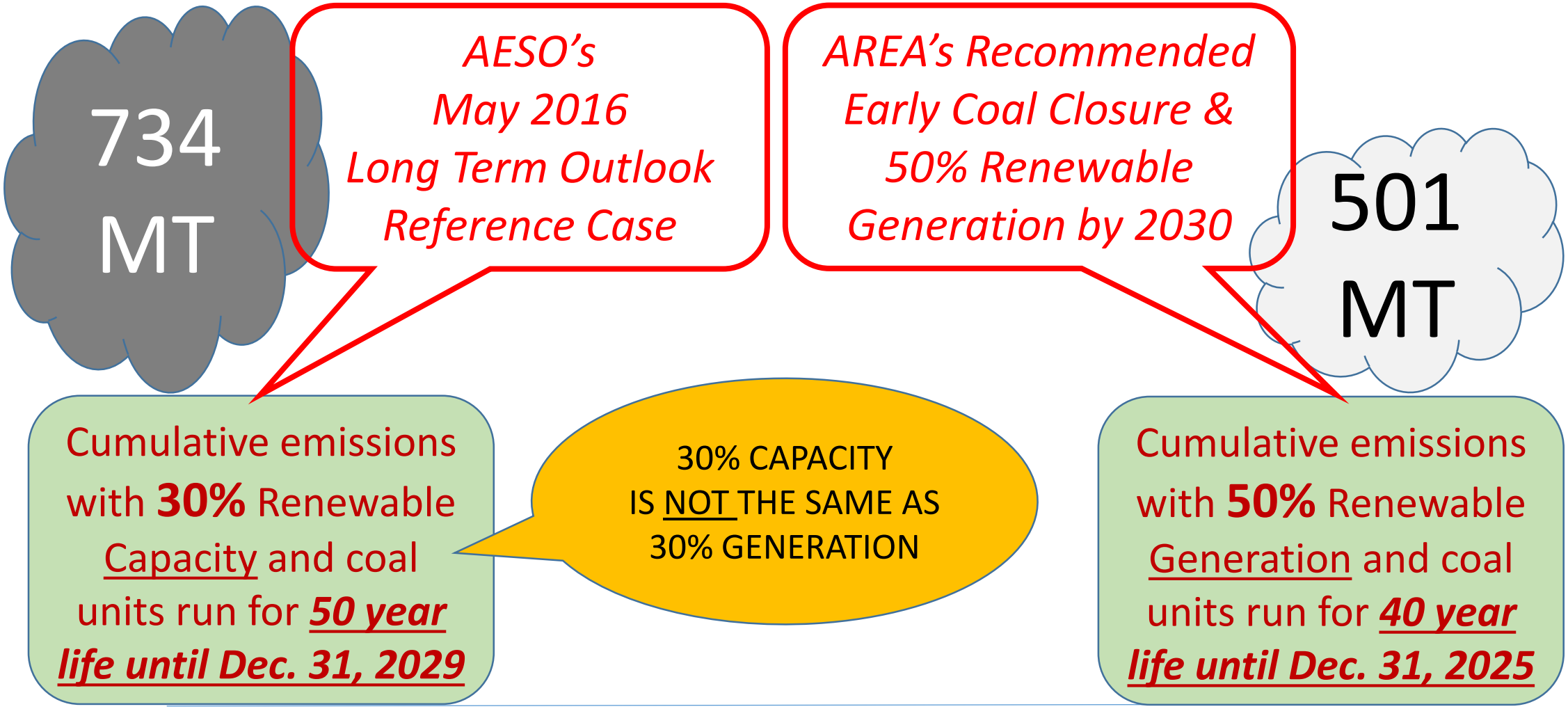
30% RE Capacity ? 29% RE Capacity

What should the Renewable **generation** mix in Alberta look like in five year steps?

AREA's Forecast for Generation in Alberta 2016 to 2030
If coal generation is suspended by 2025
(99,500 GWh per year) not including imports



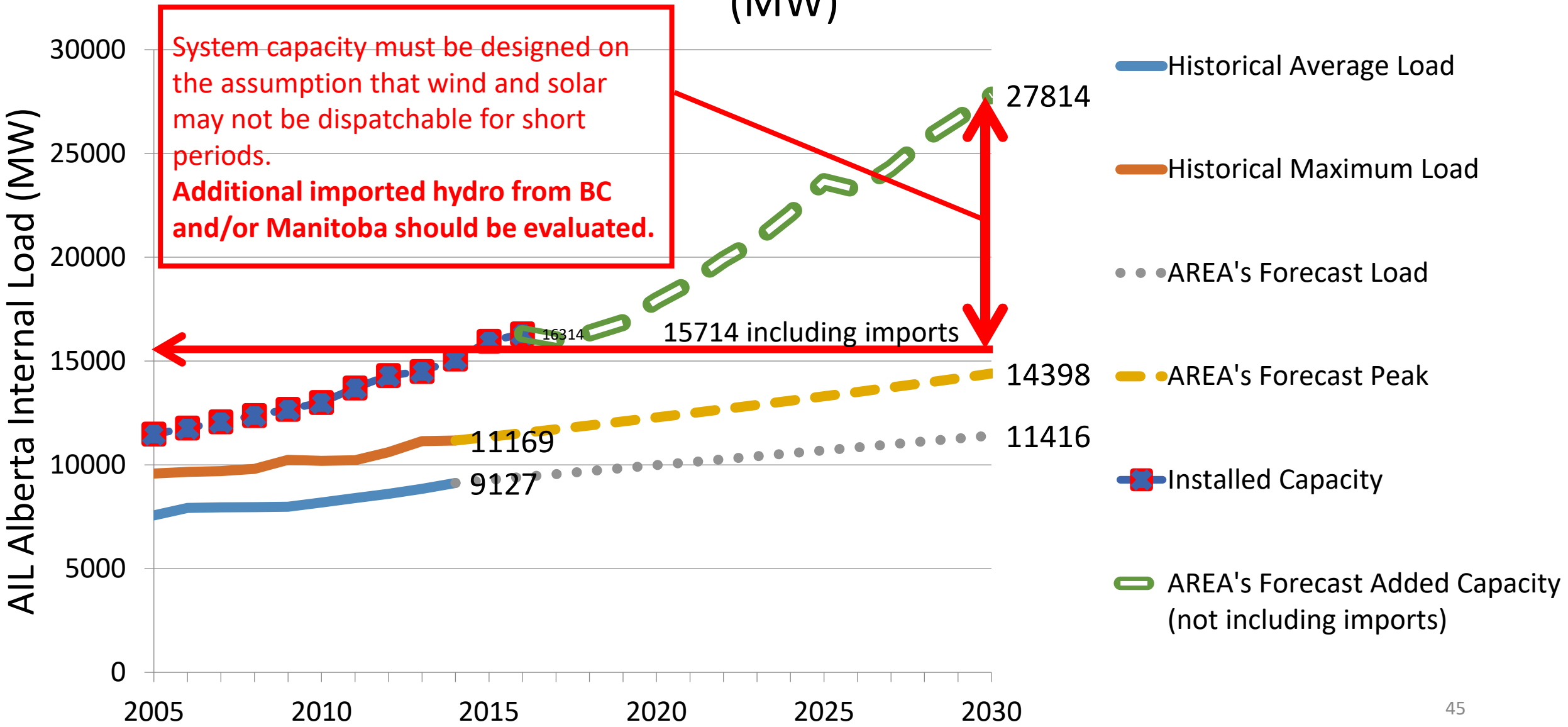
Alberta's 15 year (2016 to 2030) Cumulative Electricity GHG emissions comparing AESO's LTO and AREA's Recommendations (MT CO2e)



What Capacity Mix in MW is required in Alberta to achieve:

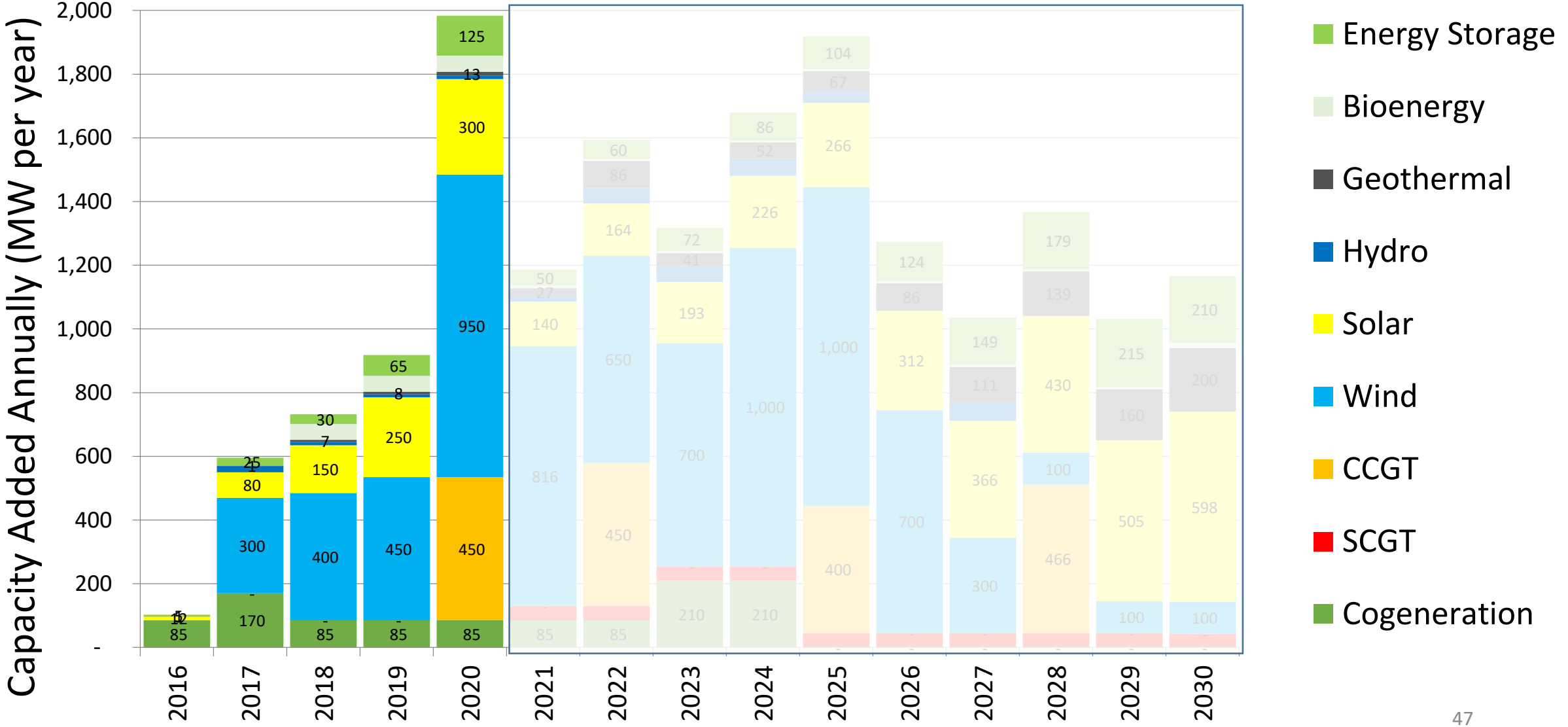
20% Renewable Generation in 2020; and
50% Renewable Generation in 2030 ?

Historical and AREA's Forecast Alberta Electrical Loads 2005 to 2030 (MW)



What Capacity should be added in the interim period to 2020 ?

AREA's Recommended **Capacity** of Natural Gas and Renewables **added Annually**
to replace 2,587 MW (nine units) of coal-fired electricity in Alberta
and reach 20% renewable generation by 2020
Total added from 2016 to 2020 = 4,330 MW Gas = 960 MW Renewables = 3,370 MW



The Climate Change and Emissions Management Fund has leveraged investment of $2.3 Billion at 5.5:1 which equates to a percentage of 15.6 % of total investment.
(CCEMC Annual Report 2014/2015)

CCEMC ACHIEVEMENTS TO DATE

109
Number of projects

$359.7 MILLION
CCEMC investment

$2.3 BILLION
Total value of projects

5.5:1
Investment leverage

12.7 MEGATONNES BY 2020
Estimated GHG reductions in Alberta - equivalent to removing more than 2.5 million cars from the road

12,000 PERSON YEARS OF FTE EMPLOYMENT
Estimated employment impact of CCEMC supported projects in Alberta between 2011 and 2016, according to the Conference Board of Canada

$1.95 BILLION
Forecast total economic benefit of CCEMC projects for Alberta between 2011 and 2016, according to the Conference Board of Canada

WHAT ABOUT JOBS?

- A burgeoning new renewable energy sector would provide diversified job opportunities.

2016 IRENA Annual Report on Jobs in Renewable Energy

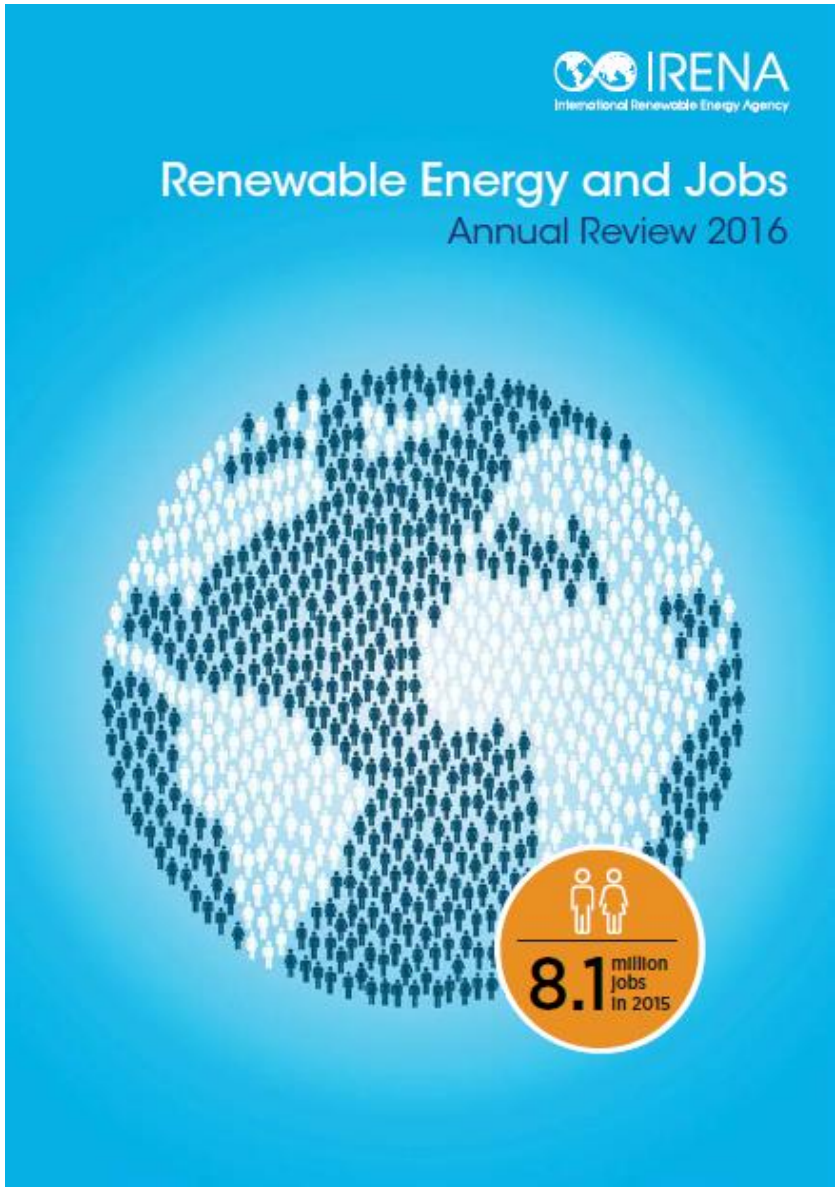
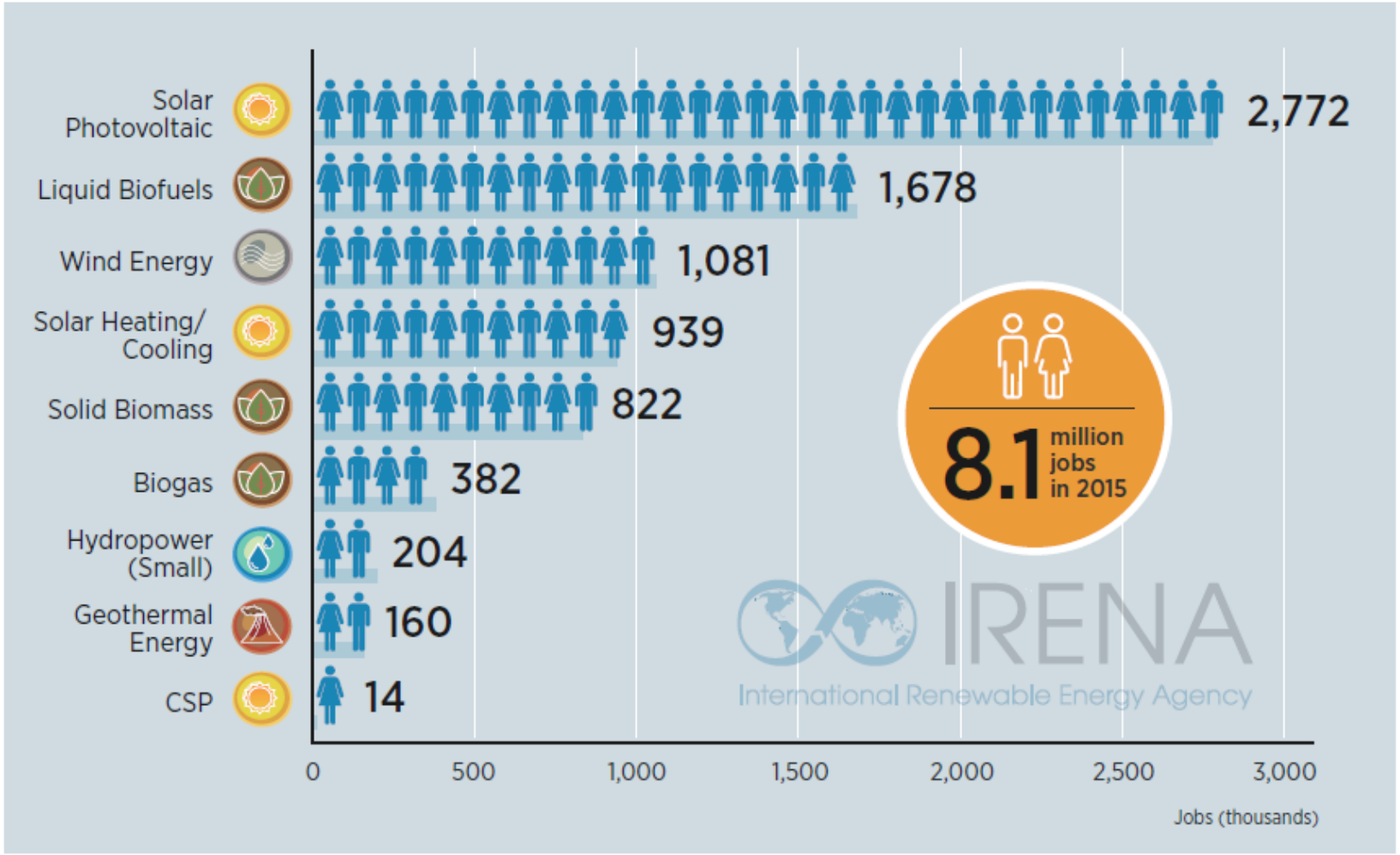


FIGURE 1: RENEWABLE ENERGY EMPLOYMENT BY TECHNOLOGY



WHAT ABOUT JOBS?

- What effect will coal power closures have on jobs?

Reference: ACCCE (American Coalition for Clean Coal Electricity, October 1, 2012)

ACCCE
AMERICAN COALITION FOR CLEAN COAL ELECTRICITY

JOB LOSSES DUE TO COAL PLANT SHUTDOWNS

EPA regulations have been cited as a factor in the announced closure of 205 coal units, representing more than 31,000 megawatts (MW) of coal-fueled generating capacity in 26 states. These closures are current as of the end of September. We conservatively estimate that coal plant shutdowns will cause the loss of 13,000 – 17,000 jobs.

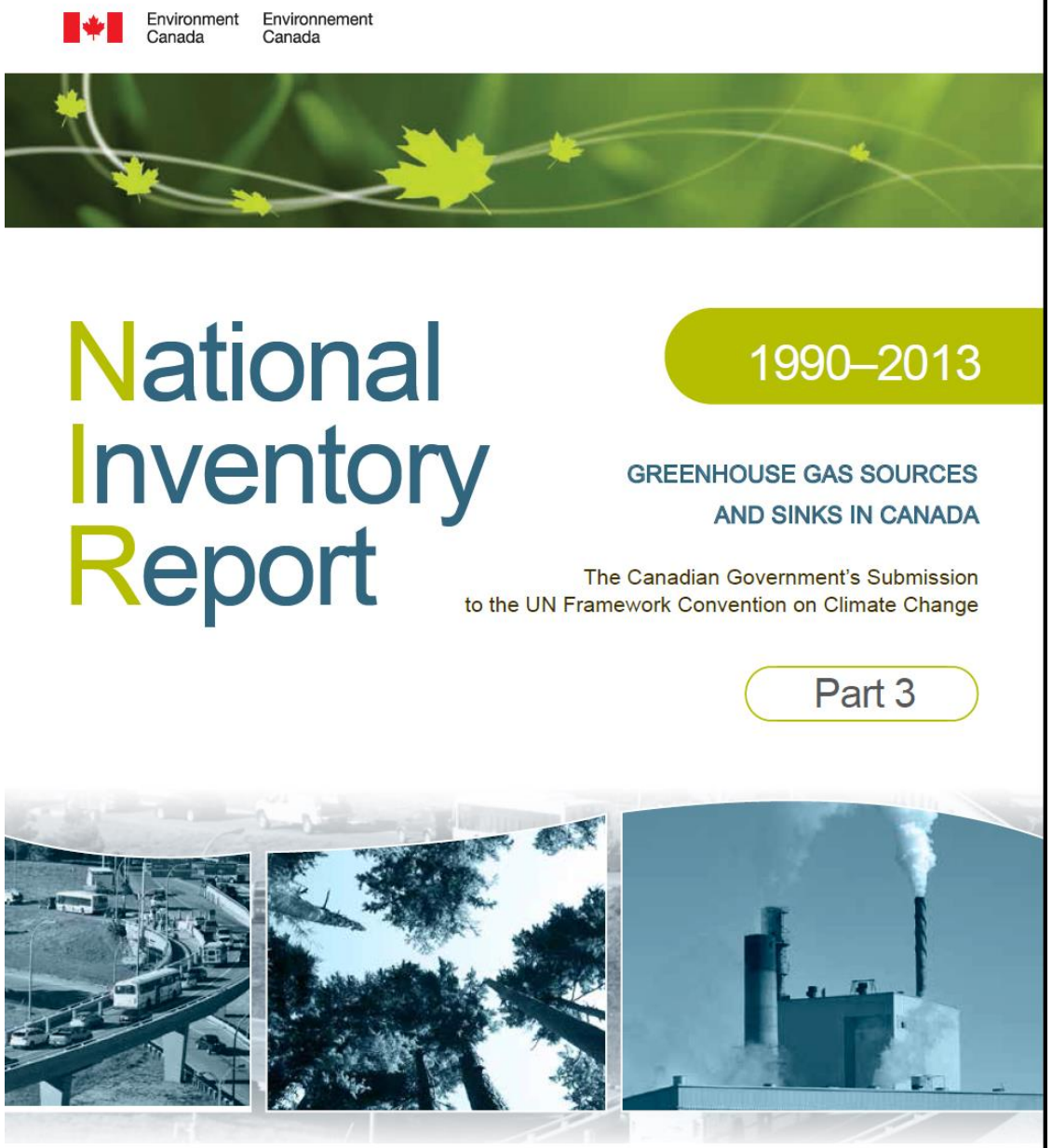
RESULTS Using this methodology, ACCCE estimates 4,000 to 5,000 direct job losses due to announced coal plant shutdowns. To estimate other job losses, we use state-based employment multipliers from the U.S. Bureau of Economic Analysis.[2] The state multipliers give the total of direct, indirect, and induced job losses for every job lost at a coal plant. Based on these state multipliers, the estimated direct losses of 4,000 to 5,000 jobs caused by coal plant shutdowns would lead to total job losses (direct plus indirect and induced job losses) from currently-announced coal plant retirements of 12,700 to 16,600 jobs.

Where do GHG reduction opportunities lie in Canada and Alberta?

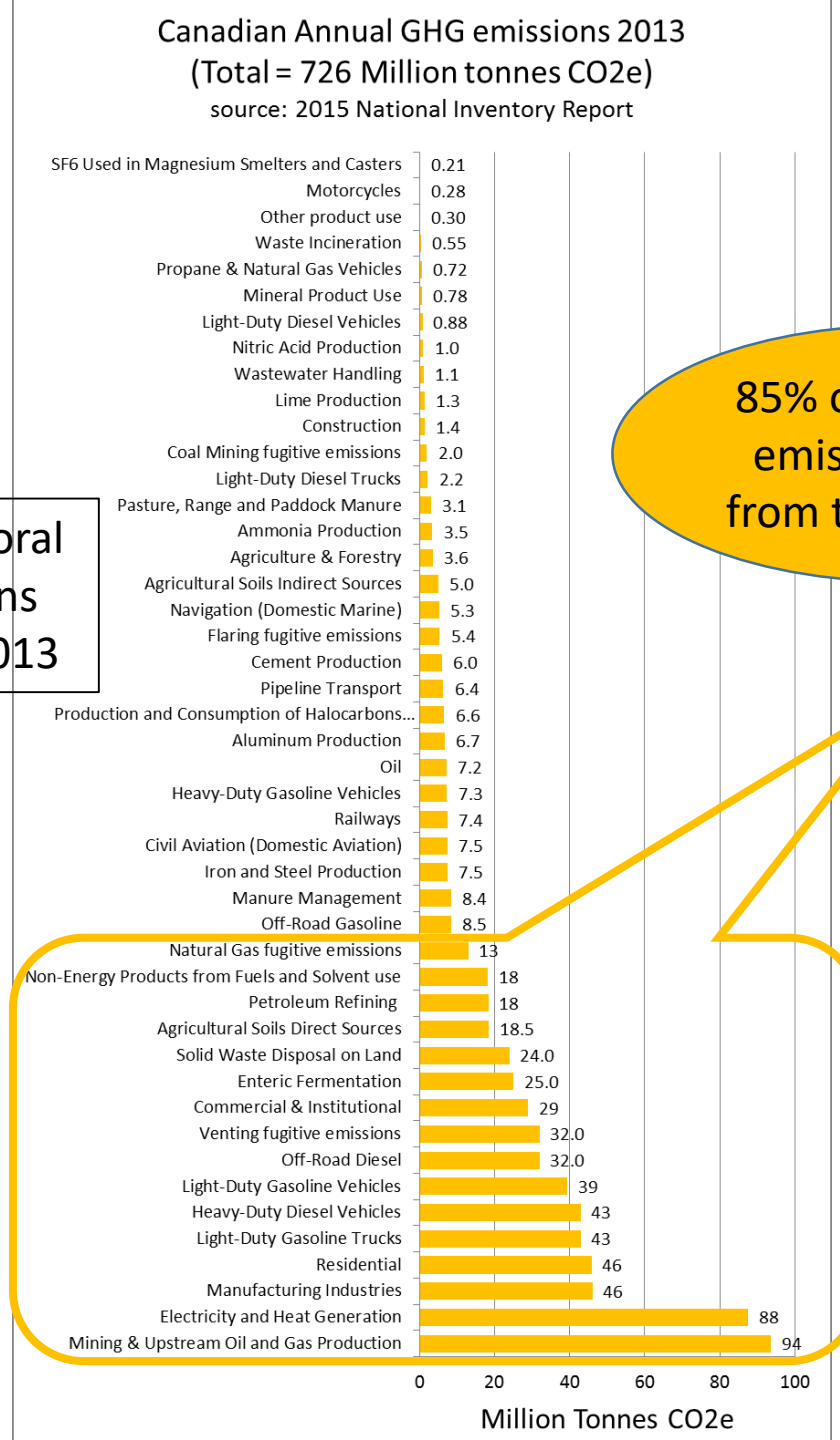
NIR 2015

Canada is required under the UN Framework Convention on Climate Change to submit an annual report on GHG emissions from all sectors within Canada. This NIR (National Inventory Report) 2015 was released in May of 2015 and reported on emissions from 1990 to 2013.

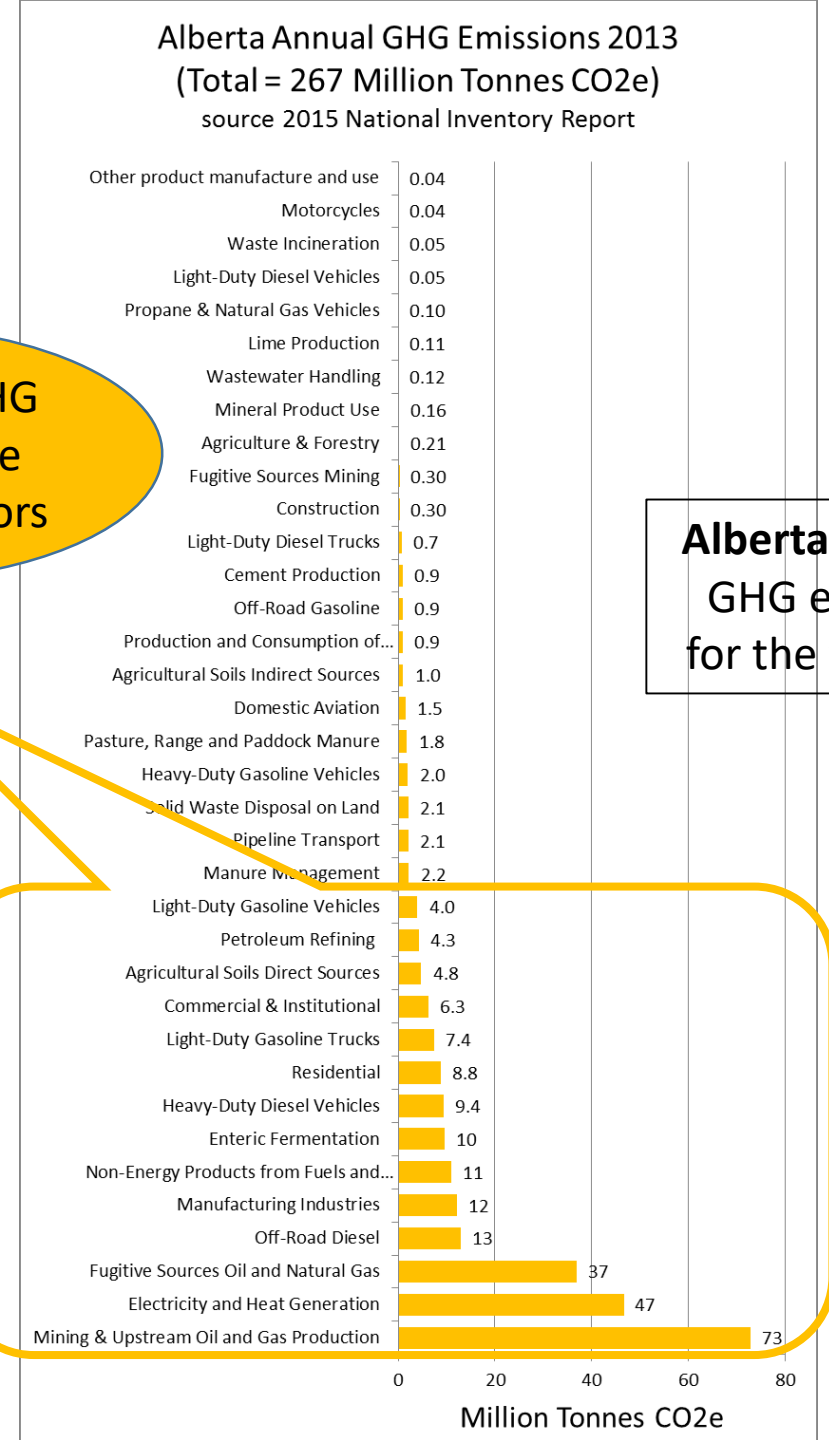
NIR 2015 formed the rationale for Canada's 2015 INDC commitment to reduce GHGs by 30% below 2005 GHG levels.



Canada's Sectoral GHG emissions for the year 2013

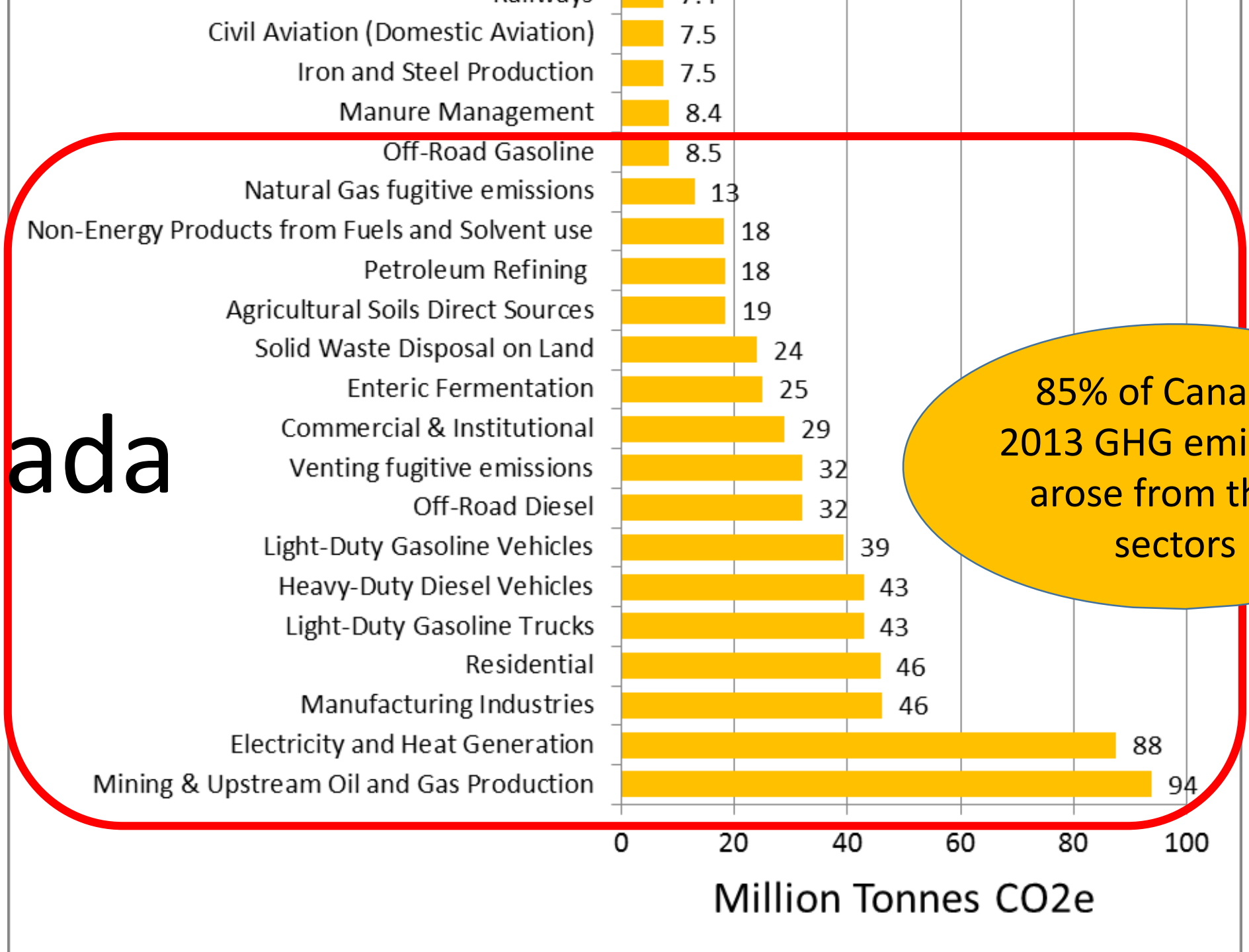


85% of 2013 GHG emissions arose from these sectors



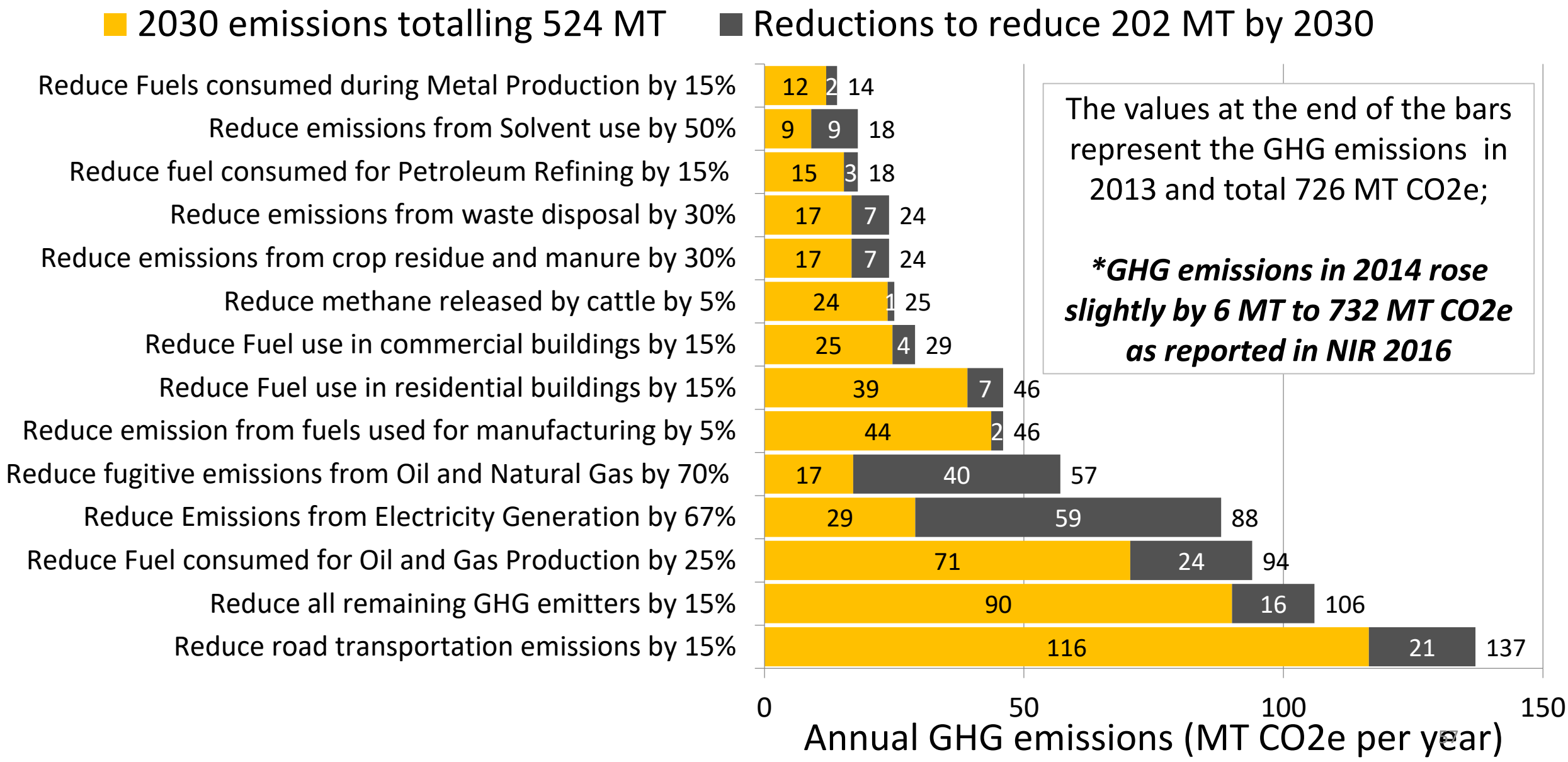
Alberta's Sectoral GHG emissions for the year 2013

Canada



85% of Canada's 2013 GHG emissions arose from these sectors

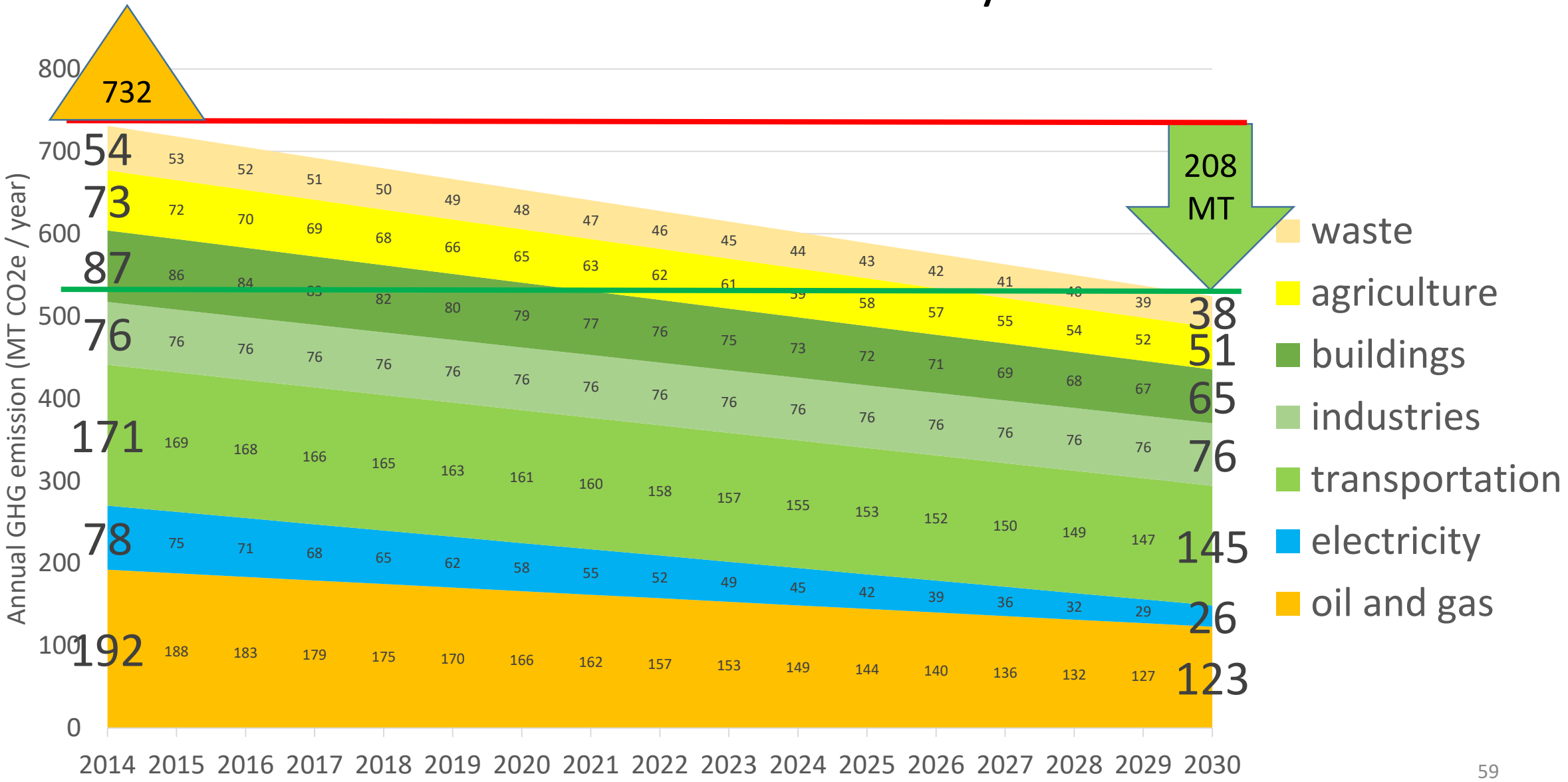
Canada's 2013 GHG emissions* can be reduced by 202 MT to achieve Canada's Paris commitment of 524 MT by 2030



Where are the priority areas for GHG reduction in **Canada** by 2030 ?

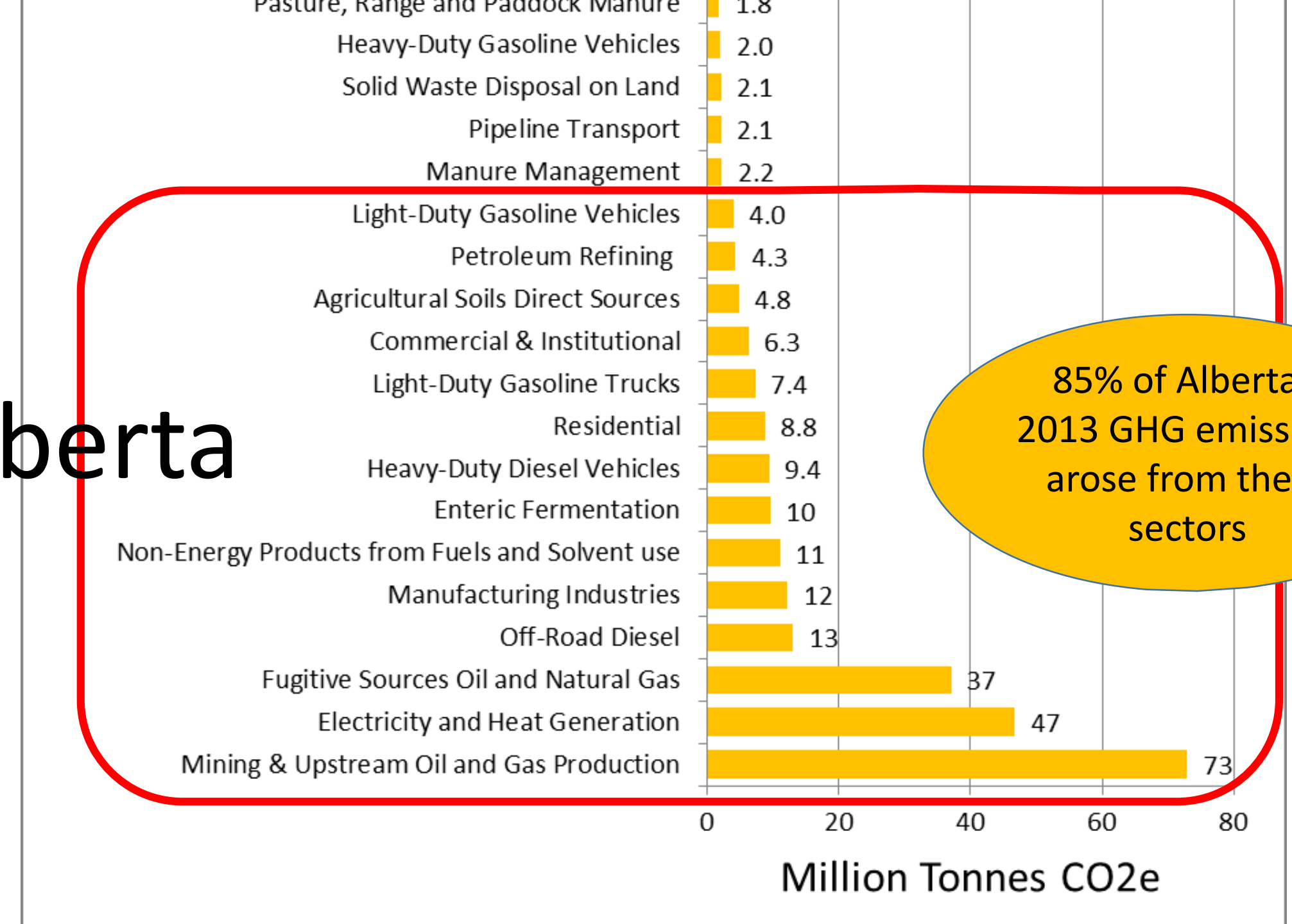
- Reduce fugitive emissions from Oil & Natural Gas by 70%;
  - *(Canada has committed to reducing fugitive emissions by 45% by 2025)*
- Reduce Emissions from Electricity Generation by 67%;
- Reduce Emissions from Solvent Use by 50%;
- Reduce Emissions from Waste Disposal by 30%;
- Reduce Emissions from Crop Residue & Manure by 30%;
- Reduce Fuel Consumed for Oil & Gas Production by 25%;
- Reduce Emissions from Road Transportation by 15%

AREA's estimate of GHG reduction opportunities to reduce from 732 MT to 524 MT by 2030 in **CANADA**



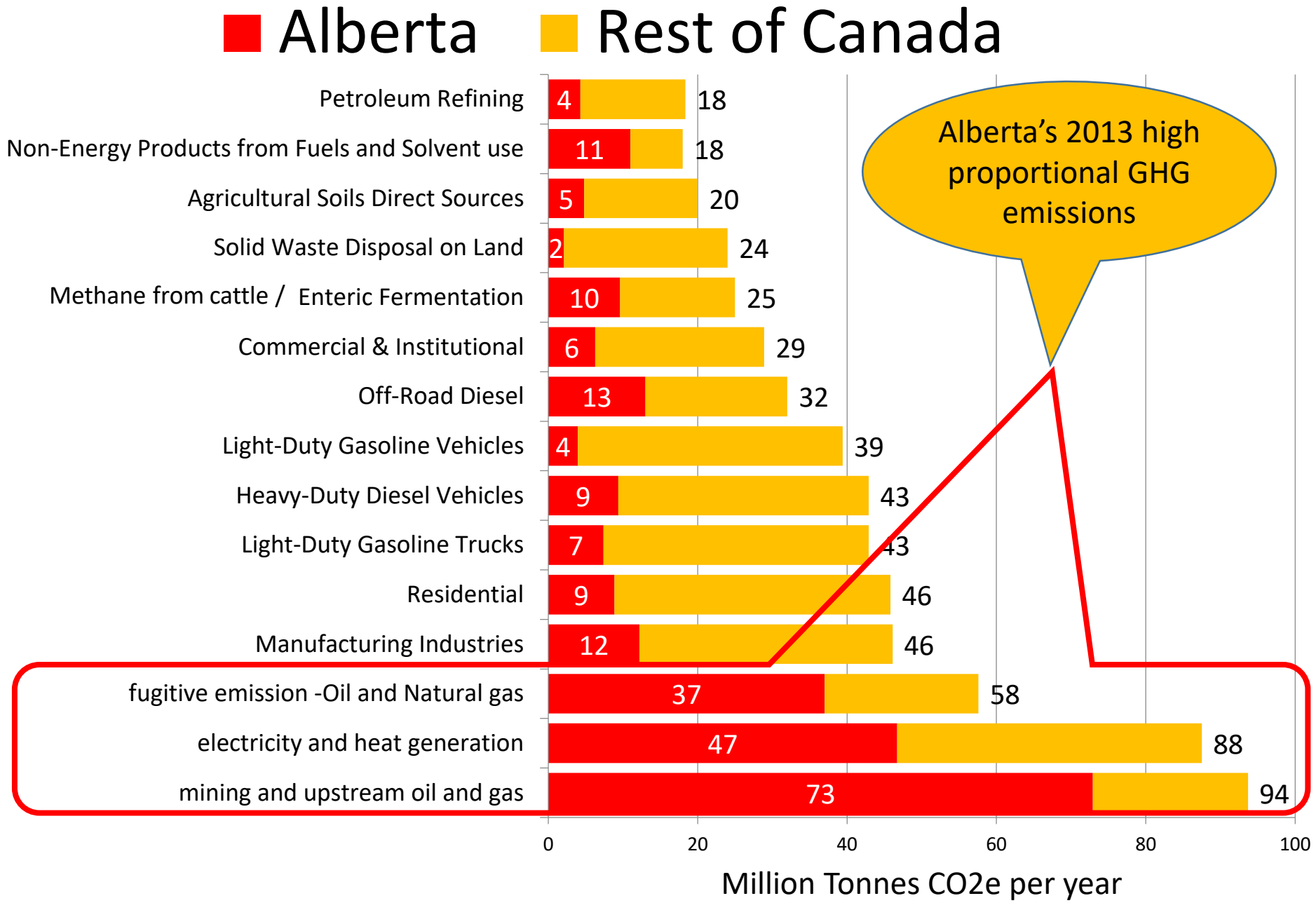
Where do GHG reduction opportunities lie in Alberta?

Alberta



85% of Alberta's 2013 GHG emissions arose from these sectors

GHG emissions in 2013 from 15 high emitting sectors



Where are the priority areas for GHG reduction in **Alberta** by 2030 ?

- Reduce fugitive emissions from Oil & Natural Gas by 67%;
- Reduce Emissions from Electricity Generation by 64%;
- Reduce Emissions from Agriculture & Waste (methane) by 40%;
- Reduce Emissions from Transportation by 37%;
- Reduce Emissions from Buildings (improve EE) by 25%;
- Reduce electricity demand by 15%;
- Phase out coal by 2025 (in one decade);
- Close coal units that have operated for 40 years;
- Increase renewable generation from current 10% to 20% by 2020; 35% by 2025; and 50% by 2030.

AREA's estimate of GHG reduction opportunities to reduce from 274 MT to 200 MT by 2030 in **ALBERTA**