

## Supplemental Data from PGE’s Decarbonization Study

05/24/2018

After draft results of PGE’s Decarbonization Study were presented at IRP Roundtable Meeting #18-1, stakeholders requested that additional supplemental information be made public, including: energy demand by fuel type, carbon emissions intensities by fuel type, peak electricity demand, total energy system costs, and cost and performance assumptions for space heating and conditioning technologies. These data were provided by the consultant, Evolved Energy Research, and are summarized below.

### Composition of energy deliveries by resource type in 2030

2030 energy composition	Pathway			
	High DER	High Electrification	Low Electrification	Reference
<i>Electricity</i>				
Geothermal	0%	0%	0%	0%
Hydro	5%	5%	5%	5%
Thermal and Imports	16%	17%	15%	15%
Solar	5%	4%	4%	3%
Wind	6%	6%	6%	5%
<b>Total Electricity</b>	<b>32%</b>	<b>32%</b>	<b>30%</b>	<b>28%</b>
<i>Diesel Fuel</i>				
Fossil Diesel	13%	13%	12%	14%
Renewable Diesel	2%	2%	2%	1%
<b>Total Diesel Fuel</b>	<b>15%</b>	<b>15%</b>	<b>14%</b>	<b>15%</b>
<i>Gasoline Fuel</i>				
Fossil Gasoline	17%	17%	16%	18%
Ethanol	2%	2%	2%	2%
<b>Total Gasoline Fuel</b>	<b>19%</b>	<b>19%</b>	<b>18%</b>	<b>20%</b>
<i>Pipeline Gas</i>				
Biogas	0%	0%	1%	1%
Hydrogen	0%	0%	0%	0%
Natural Gas	21%	21%	23%	23%
Synthetic NG	0%	0%	0%	0%
<b>Total Pipeline Gas</b>	<b>21%</b>	<b>21%</b>	<b>24%</b>	<b>24%</b>
<b>CNG &amp; LNG</b>	<b>0%</b>	<b>0%</b>	<b>2%</b>	<b>1%</b>
<b>Other Fuels</b>	<b>13%</b>	<b>13%</b>	<b>13%</b>	<b>12%</b>
<b>Total</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>

Composition of energy deliveries by resource type in 2050

2050 energy composition	Pathway			
	High DER	High Electrification	Low Electrification	Reference
<i>Electricity</i>				
Geothermal	5%	5%	3%	0%
Hydro	5%	5%	4%	4%
Thermal and Imports	4%	3%	2%	12%
Solar	13%	13%	10%	5%
Wind	27%	28%	23%	7%
<b>Total Electricity</b>	<b>54%</b>	<b>54%</b>	<b>43%</b>	<b>29%</b>
<i>Diesel Fuel</i>				
Fossil Diesel	0%	0%	0%	14%
Renewable Diesel	13%	13%	6%	1%
<b>Total Diesel Fuel</b>	<b>13%</b>	<b>13%</b>	<b>6%</b>	<b>15%</b>
<i>Gasoline Fuel</i>				
Fossil Gasoline	1%	1%	1%	14%
Ethanol	0%	0%	0%	2%
<b>Total Gasoline Fuel</b>	<b>1%</b>	<b>1%</b>	<b>1%</b>	<b>16%</b>
<i>Pipeline Gas</i>				
Biogas	0%	0%	8%	1%
Hydrogen	0%	0%	2%	0%
Natural Gas	14%	14%	15%	24%
Synthetic NG	0%	0%	2%	0%
<b>Total Pipeline Gas</b>	<b>14%</b>	<b>14%</b>	<b>27%</b>	<b>25%</b>
<b>CNG &amp; LNG</b>	<b>1%</b>	<b>1%</b>	<b>7%</b>	<b>1%</b>
<b>Other Fuels</b>	<b>16%</b>	<b>16%</b>	<b>16%</b>	<b>14%</b>
<b>Total</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>

Carbon emission intensities by fuel type in 2030

2030 carbon emissions intensities (tCO <sub>2</sub> /MMBtu)	Pathway			
	High DER	High Electrification	Low Electrification	Reference
Electricity	0.069	0.075	0.069	0.073
Diesel	0.062	0.062	0.062	0.066
Gasoline	0.063	0.063	0.063	0.063
Pipeline Gas	0.055	0.055	0.054	0.055

Carbon emission intensities by fuel type in 2050

2050 carbon emissions intensities (tCO <sub>2</sub> /MMBtu)	Pathway			
	High DER	High Electrification	Low Electrification	Reference
Electricity	0.009	0.008	0.003	0.050
Diesel	0.000	0.000	0.000	0.067
Gasoline	0.061	0.061	0.061	0.061
Pipeline Gas	0.055	0.055	0.039	0.055

Peak electricity demand by year (includes impacts of load flexibility)

Peak demand in simulation year (MW)	Pathway			
	High DER	High Electrification	Low Electrification	Reference
2020	3,605	3,584	3,581	3,605
2025	3,661	3,617	3,585	3,661
2030	4,096	3,934	3,717	3,749
2035	4,806	4,806	4,023	3,946
2040	5,737	5,737	4,506	4,241
2045	6,132	6,132	5,140	4,446
2050	6,439	6,439	5,328	4,879
2020-2050 Annual growth rate	2.0%	2.0%	1.3%	1.0%

Total energy system costs by year

Total costs relative to Reference Case (billion 2016\$)	Pathway		
	High DER	High Electrification	Low Electrification
2020	0.07	-0.02	-0.02
2025	0.14	0.00	-0.02
2030	0.37	0.18	0.25
2035	0.49	0.29	0.72
2040	0.40	0.28	1.11
2045	0.23	0.13	1.25
2050	0.16	0.06	1.43

## Space Conditioning End-Use Technology Cost and Performance Assumptions

Vintage	Value	Vintage	Value
<b>Reference Gas Furnace</b>		<b>Air Source Heat Pump</b>	
AFUE (%)		Efficiency - Heating (Btu output / Btu input)	
2013	0.80	2015	2.67
2020	0.90	2020	3.27
2030	0.92	2030	4.08
Installed Cost (2013\$/unit)		2040	4.63
2013	1900	2050	4.79
2020	2500	Efficiency - Cooling (Btu output / Btu input)	
2030	2500	2015	3.73
		2020	4.36
		2030	5.61
		2040	5.92
		2050	6.24
<b>High Efficiency Gas Furnace</b>		Installed Cost (2016\$/unit)	
AFUE (%)		2015	5148
2013	0.98	2020	4945
Installed Cost (2013\$/unit)		2030	4539
2013	2950	2040	4133
		2050	3727
<b>Electric Furnace</b>			
AFUE (%)			
2013	0.99		
Installed Cost (2013\$/unit)			
2013	1100		
<b>Reference Central Air Conditioner</b>		<b>High Efficiency Central Air Conditioner</b>	
Efficiency (Btu output / Btu input)		Efficiency (Btu output / Btu input)	
2013	4.36	2013	9.32
2020	4.68	Installed Cost (2013\$/unit)	
Installed Cost (2013\$/unit)		2013	5300
2013	2300		
2020	2400		
2030	2500		

### Sources

#### U.S. Energy Information Administration (EIA) and Navigant

Data used in support of the Annual Energy Outlook from the National Energy Modeling System (NEMS)  
 NEMS inputs informed by Navigant study *Updated Buildings Sector Appliance and Equipment Costs and Efficiency*  
<https://www.eia.gov/analysis/studies/buildings/equipcosts/>

#### National Renewable Energy Laboratory (NREL)

Electrification Futures Study  
<https://www.nrel.gov/analysis/electrification-futures.html>