In order to inform the DRECP process, Energy Commission staff formulated renewable development scenarios for 2040 and 2050 under the assumption that the state's electricity will strive to meet a GHG emission reduction target of 80% below 1990 values in 2050. Doing so requires a dramatic reduction in electricity generation using fossil fuels. All the more so as electricity consumption is expected to dramatically increase as the transportation sector is electrified in the course of meeting similar emission reduction goals.

The amounts of incremental renewable energy required in 2050 to meet the GHG reduction target may be in excess of 400,000 GWh, roughly ten times what is currently in place to serve California loads. While the scenarios developed by staff assume that one-quarter of this will be met by out-of-state resources, meeting the remaining need in the reference case required 22,000 to 33,000 MW of central station solar, a lion's share of which is assumed to be in the DRECP. In addition, 19,000 MW – 28,000 of wind is required, despite assuming both that baseload renewable resources (geothermal, biomass) will be at levels that exceed current expectations regarding economic/technical potential, and distributed generation will far exceed current targets.

60/40 Reference Cases

For the purpose of illustration staff created 2040 and 2050 reference case portfolios, developing central station solar and wind to reflect 60/40 and 40/60 shares of energy from these sources on a statewide basis after making specific assumptions about energy/capacity from other resources

2040 Scenario

Reference Case

The 2040 reference case scenario posited an incremental need for 194,000 GWh of renewable energy to meet a 58% reduction in GHG emissions from 1990 levels. Staff's assumptions regarding central station resources other than solar and wind were as follows:

Geothermal	3,500
Biomass[1]	3,000
Utility Side Solar DG[2]	11,000
Small Rooftop PV	10,000
CHP	4,500

[1]Conversion of existing gas-fired plants to use of biogas and development of large central station facilities combusting biogas assumed to have no acreage requirement. 1,000 MW assumed to have acreage requirement.
[2] 80% of capacity was assumed to be developed on environmentally-sensitive lands.

Staff then developed two scenarios for the resources developed to meet the remaining renewable energy needed. The first assumed that 60% of the energy will be provided by central station solar (2/3 of the capacity PV, 1/3 solar thermal), 40% by wind. The second assumed 40% of the energy would be provided by solar, 60% by wind. The resulting statewide MW values for central station solar and wind were as follows:

2040	Solar/Wind 60/40	Solar/Wind 40/60
CS Solar Thermal	4,900	3,250
CS Solar PV	9,800	6,500
Wind	8,350	12,500

Only a share of these resources were assumed to be in the DRECP; staff assumed that

- All central station solar thermal is located in the DRECP
- 70% of central station solar PV is in the DRECP
- 50% of the wind is in the DRECP
- 3,000 MW of the geothermal is in the DRECP
- 250 MW of the acreage-intensive biomass is in the DRECP
- 27.5 % of the utility-side DG is located in the DRECP

The Solar/Wind 60/40 case yielded

2040	Statewide MW	Share in DRECP	DRECP MW	Acres
CSST	4.900	100%	4,900	45,455
CSPV	9,800	70%	6,860	62,364
Wind	8,350	N/A	4,175	167,000

Geothermal	3,500	N/A	3,000	18,072
Biomass	3,000	N/A	250	625
DG – Utility Side	11,000[1]	27.5%	3,025	22,000
Total				**315,516**

[1]Only 80% of this capacity is assumed to have an acreage requirement

The Solar/Wind 40/60 case yielded

2040	Statewide MW	Share in DRECP	DRECP MW	Acres
CSST	3,250	100%	3,250	29,545
CSPV	6,500	70%	4,550	41,364
Wind	12,500	N/A	6,250	250,000
Geothermal	3,500	N/A	3,000	18,072
Biomass	3,000	N/A	250	625
DG – Utility Side	11,000[1]	27.5%	3,025	22,000
Total				**361,606**

[1]Only 80% of this capacity is assumed to have an acreage requirement

2050 Scenarios

Staff extrapolated the analysis to 2050 to estimate the potential magnitude of incremental needs over a longer period. The resulting energy and acreage needs are much larger than in 2040 for several reasons.

- Demand growth increases total energy needs by 20,000 – 30,000 GWh (5.3% – 6.7%). The percentage increase in incremental renewable energy needed is greater (12.0 – 12.9%) as all of the energy must come from zero-carbon resources.
- GHG emission reductions are increased from 58% of 1990 levels to 80%. This reduces allowed GHG emissions from 54.0 mmt to 30.6 mmt (and increases (incremental) needed renewable energy by 60,000 GWh in each scenario (25.4 – 35.9%)
- Electrification of the transportation sector accelerates dramatically, with the number of vehicles increasing from 18 million to 41.6 million. This increases energy needed and thus incremental renewable energy needed from renewable resources by 100,000 GWh (42.4 – 59.9%)

- The Palo Verde nuclear plant is assumed to be retired. The 6,000 GWh must now be provided by renewable resources (an increase of 2.5 - 3.5%)

The cumulative impact of these four developments is to increase incremental renewable energy needs to 385,000 GWh. The statewide portfolio developed to meet this roughly doubled the amounts of each class of resources. The values for geothermal and biomass are at the “very upper end” of what is currently deemed to be technical/economic potential and thus implicitly assumes technological advance in the development of these resources/fuels. These assumptions reduce the overall acreage requirements for renewable energy by reducing the amount of wind and solar needed to meet GHG reduction targets.

Geothermal	7,000
Biomass[1]	6,000
Utility Side Solar DG[2]	22,000
Small Rooftop PV	12,000
CHP	6,500

[1]Conversion of existing gas-fired plants to use of biogas and development of large central station facilities combusting biogas assumed to have no acreage requirement. 1,000 MW assumed to have acreage requirement.
[2] 80% of capacity was assumed to be developed on environmentally-sensitive lands.

Staff’s assumptions regarding the share of central station resources on a percentage basis in the DREPC remained unchanged from the 2040 scenarios. The remaining central station resources were allocated to the DRECP as follows:

- 4,000 MW of geothermal is in the DRECP, an increase of 1,000 MW over the 2040 reference case.
- 250 MW of the acreage-intensive biomass is in the DRECP.
- 27.5 % of the utility-side DG is located in the DRECP

- The resulting statewide MW values for central station solar and wind were as follows;

2050	Solar/Wind 60/40	Solar/Wind 40/60
CS Solar Thermal	11,000	7,400
CS Solar PV	22,000	14,800
Wind	18,900	28,400

The Solar/Wind 60/40 case yielded

2050	Statewide MW	Share in DRECP	DRECP MW	Acres
CSST	11,000	100%	11,000	100,000
CSPV	22,000	70%	15,400	140,000
Wind	18,900	N/A	9,450	378,000
Geothermal	7,000	N/A	4,000	24,096
Biomass	6,000	N/A	250	625
DG – Utility Side	22,000[1]	27.5%	3,025	44,000
Total				**686,721**

[1]Only 80% of this capacity is assumed to have an acreage requirement

The Solar/Wind 40/60 case yielded

	Statewide MW	Share in DRECP	DRECP MW	Acres
CSST	7,400	100%	7,400	67,273
CSPV	14,800	70%	10,360	94,182
Wind	28,400	N/A	14,200	568,000
Geothermal	7,000	N/A	4,000	24,096
Biomass	6,000	N/A	250	625
DG – Utility Side	22,000[1]	27.5%	6,050	44,000
Total				**798,176**

[1]Only 80% of this capacity is assumed to have an acreage requirement