PROJECTION OF DIRECT FARM LABORER DISPLACEMENT FROM GEOTHERMAL DEVELOPMENT, IMPERIAL COUNTY, CALIFORNIA

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ABSTRACT

Reduction in the farm laborer segment of the Imperial County labor force was projected based on losses in agricultural land directly caused by geothermal power plants and wells. A 100 MW power plant and well siting area was assumed to consume 650 acres of land. The proportions of land used in the well siting area by well pads, pipelines, access roads, possible subsidence, etc.--termed interstitial land reduction--were assumed at the levels of 5%, 10%, and 35%. Three scenarios of future power plant capacity in agricultural county areas were assumed. Ratios of farm laborers to land area, based on studies of Johnson (1977) and Sheehan (1976), were then used to project geothermal farm laborer displacement. For 35% interstitial land reduction, $4000 farm worker income, and the medium power plant scenario, the displacement is projected for year 2020 as only 1.96% of the 1970 farm laborer category.

INTRODUCTION

Geothermal energy resources exist as steam, hot water, and hot dry rock along tectonic plate fault lines in many parts of the world, including Sonoma County, north of San Francisco, and Imperial County, adjacent to Mexico in southeastern California. As part of a multidisciplinary project funded by NSF/ERDA, the farm labor impact of land consumption by geothermal development was investigated, and the results are the object of this paper. Other population and labor force aspects of this prospective energy development process have been detailed in previous reports (Pick et al., 1976; Pick, Jung, and Butler, 1977; Lofting, 1977; Rose, 1977), and a summary of the entire multidisciplinary project is available (Dry-Lands Research Institute, 1977).

Imperial County is a dry former desert, which due to irrigation diversions from the Colorado River beginning in 1904 has become one of the most fertile agricultural regions in the United States, producing about $1/2 billion of crops in 1976 from about 500,000 fertile acres in the central valley part. Because the central part of the county lies above a tectonic fault line known as the Salton Trough, there are large deposits of geothermal energy in the form of hot water located under the Imperial Valley at depths of 5-10,000 feet. One estimate of the recoverable energy capacity from these deposits is 10,000 MW over a 30-year lifetime (Biehler and Lee, 1976).

Geothermal development consists of the exploration and drilling of wells (somewhat equivalent to oil drilling) down to the depths of the hot water, transport of the hot water to the surface, and utilization of the hot water by flashing it to steam, to turn turbines in a power plant and generate electricity. Alternatively, the hot water can be used directly for house warming, air conditioning, industrial plant processes, etc.--uses referred to as non-electric.

With such a complicated energy source, there are many pathways that a geothermal development process can take, depending on such factors as total amount of recoverable energy, land ownership, permitting and regulatory processes, drilling costs, community and extra-local leadership, energy consumer market area, etc. It is impossible to project all such unknowns ahead of time, in part because there is only one U.S. geothermal field in active production--the Sonoma County steam resource with about 500 MW of installed electrical generating capacity. Hence projections of different types for Imperial County can only be performed with simplifying assumptions. County population projections were done, based on differing assumptions of buildup in geothermal capacity (Pick et al., 1976). These in turn were used to project county interindustry interactions (Lofting, 1977) and county revenues and taxes (Rose, 1977).

FARM LABOR FORCE REDUCTION BASED ON LAND AREA ANALYSIS

In Table 1 are presented the aggregated employment categories in Imperial County for the last three U.S. Censuses of Population. As expected for an agricultural county, the farming category is greatly enlarged relative to the U.S. as a whole. The 21% reduction in total percentage of the farm laborer category between 1960 and 1970 is exaggerated because of the presence of 4700-8000 border commuters, mostly farm laborers, who live in Mexicali, directly across the border, and commute to work daily in Imperial County. Such persons are not counted by the U.S. Census, since the Census counts persons based on residence (not workplace) in the U.S. (U.S. Senate, 1971). This group of 1970 commuting workers were mostly residents of the County in 1960, prior to the end of the Bracero Program (Samora, 1971).

The addition of the average of 6350 male commuting farm workers to the 1970 U.S. Census employment distribution (see Table 1) gives a 1970 farm worker fraction (40.4) quite similar to that in 1960 (36.9), and a 1970 total of 9537 farm laborers. Such a large proportion of county employment in this category warrants the special projections of the present paper. It is important to note that this total is also affected seasonally by harvesting cycles. Data in the present analysis are based on the Census date of April 15, even though maximal county employment due to crop cycles is in January.

The reduction from geothermal development of the farm laborer category in the Imperial County labor force was estimated based on prior studies of geothermal capacity (Davis, 1976), crop acreage (Johnson et al., 1977) and power plant impact (Sheehan, 1976; Rose, 1977). This analysis is based on the following schema for land reduction at one power plant site.

It is assumed that a 100 MW power plant installation will consume 10 acres (i.e., remove 10 acres from agricultural use by either direct or indirect effects) for the immediate area that the central power plant is sited on and the right-of-way for the central power plant. It is assumed that for the 100 MW capacity, there are 20 production wells and 12 reinjection wells. Each well is assumed to be spaced over 20 acres. The total well-spacing is thus assumed over 640 acres (slant drilling will be discussed below). The key question is then how much of the 640 acres is consumed either by well pads, pipelines, right-of-way, subsidence[1] problems (this will likely be small due to an assumed strong public policy against subsidence), and other environmental and agricultural causes. There are so many regulatory, agricultural, and geologic unknowns in the above causes that the present analysis simplified matters by assuming three possible percentages of land reduction for the well-spacing area (i.e., the 640 acres/100 MW capacity): (1) 5%, (2) 10%, and (3) 35%. These reductions are henceforth referred to as interstitial land reductions (abbreviated as i.l.r.).

For the case of slant drilling,[2] land is still consumed by centralized well pads, pipelines and right-of-way (albeit less), subsidence, and environmental-agricultural causes. Thus for slant drilling one should choose a smaller percentage reduction based on the partial land-consumption benefits of this method. Nevertheless, some land will still be consumed.

CALCULATIONS

The calculations of farm labor reduction are given in Tables 2 and 3. Two types of crop coverage are assumed for displaced KGRA[3]--an average 100 acres and all field crops. Table 2 presents the computations for an average 100 acres of crops as defined in a separate report by Sheehan (1976) and Rose (1977). For each KGRA a manpower reduction (in man-year units) is assumed based on the above report. Also, a scenario of power plant capacity is assumed for each KGRA based on the medium estimate of Davis (1976). The KGRA's are then summed in the right-hand columns to give total farm labor displaced by interstitial land reduction, farm income, KGRA, and year for field crop areas.

RESULTS

The general county results are given in Table 4. It is seen that the maximal reduction in labor force (year 2020, 35% i.l.r., average crops, $4,000 income) is 187 laborers, assuming the fixed agricultural mechanization and other trends. Based on a present labor force (including 6350 border commuters) of 29,829, this is a reduction of only .62%. Since it is likely that the county will increase in population (Pick et al., 1976), this percentage may be reduced by 50% based on year 2020 populations. The 5% i.l.r. for the other above assumptions unchanged yields a farm labor reduction of only 27 laborers, or .09% based on 1970 population. For the case of all field crops, the figures are roughly 75% less than for average crops. Based on a 1970 farm laborer category (including border commuters) of 9537, the 35% i.l.r. and 5% i.l.r. reductions are 1.96% and .28% respectively.

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NOTES

[1]Subsidence is the lowering of land levels in a geothermal production area due to withdrawal of geothermal fluids.

[2]Slant drilling is a drilling process where the angle of the drill to the land surface is significantly different than 90 degrees.

[3]A Known Geothermal Resource Area (KGRA) is a federal designation of a land area of geothermal deposits, based both on geologic and potential commercial characteristics.

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TABLE 1. MALE EMPLOYMENT CATEGORIES FOR IMPERIAL COUNTY 1950-1970

	1950	1960	1970	1970*
Total Male Labor Force	18599	21613	15397	21747
Employment Category:				
Aggregated Categories:				
Farm (Including Farm Managers)	40.1	43.2	20.7	43.8
Farmers and Farm Managers	9.2	6.3	4.8	3.4
Farm Laborers and Foremen	30.9	36.9	15.9	40.4
Clerical and Sales	7.4	6.9	10.4	7.4
Professionals and Managers	13.9	14.6	22.2	15.7
Craftsmen and Operatives	26.0	23.5	31.9	22.6
Other	12.6	11.8	14.8	10.4

*border commuters included (see text)

Source: U. S. Bureau of the Census, 1950-70

TABLE 2. FARM LABOR FORCE DISPLACEMENT BY KGRA, PLANT CAPACITY, FARM WORKER INCOME, AND LAND REDUCTION FOR AVERAGE 100 ACRES

		KGRA									Total		
		Salton Sea			Brawley			Heber					
	Year	Capacity[1]	FLD5	FLD4	Capacity	FLD5	FLD4	Capacity	FLD5	FLD4	Capacity	FLD5	FLD4
	1980	90	.51	.64	35	.18	.22	35	.66	.83	180	1.35	1.69
	1990	250	1.42	1.77	100	.51	.64	100	1.89	2.36	500	4.77	5.97
5% i.l.r.	2000	1,250	7.16	8.95	500	2.55	3.19	500	9.47	11.84	2,500	19.18	23.97
	2010	1,750	10.02	12.52	700	3.57	4.46	700	13.25	16.56	3,500	26.84	33.55
	2020	1,750	10.02	12.52	700	3.57	4.46	700	13.25	16.56	3,500	26.84	33.55
	1980	90	.91	1.14	35	.31	.39	35	1.17	1.46	180	2.39	2.99
	1990	250	2.52	3.15	100	.90	1.12	100	3.33	4.17	500	6.75	8.44
10% i.l.r.	2000	1,250	12.62	15.77	500	4.49	5.62	500	16.68	20.85	2,500	33.79	42.24
	2010	1,750	17.66	22.07	700	6.30	7.87	700	23.35	29.19	3,500	47.31	59.14
	2020	1,750	17.66	22.07	700	6.30	7.87	700	23.35	29.19	3,500	47.31	59.14
	1980	90	2.87	3.59	35	.99	1.24	35	3.69	4.61	180	7.55	9.44
	1990	250	7.98	9.97	100	2.84	3.56	100	13.18	16.48	500	24.00	30.00
35% i.l.r.	2000	1,250	39.90	49.87	500	17.78	22.23	500	52.74	65.93	2,500	110.42	138.02
	2010	1,750	55.85	69.82	700	19.92	24.90	700	73.84	92.30	3,500	149.61	187.01
	2020	1,750	55.85	69.82	700	19.92	24.90	700	73.84	92.30	3,500	149.61	187.01

i.l.r. = interstitial land reduction
FLD5 = farm labor displacement (average annual income = 5,000)
FLD4 = farm labor displacement (average annual income = 4,000)
All capacity figures in MW

TABLE 3. FARM LABOR FORCE DISPLACEMENT BY KGRA, POWER PLANT CAPACITY, FARM WORKER INCOME, AND LAND REDUCTION PERCENTAGE FOR FIELD CROPS

		KGRA											
		Salton Sea			Brawley			Heber			Total		
	Year	Capacity	FLD5	FLD4	Capacity	FLD5	FLD4	Capacity	FLD5	FLD4	Capacity	FLD5	FLD4
5% i.l.r.	1980	90	.23	.29	35	.07	.08	35	.07	.08	180	.37	.46
	1990	250	.64	.80	100	.19	.24	100	.19	.24	500	1.02	1.27
	2000	1,250	3.20	4.00	500	.96	1.20	500	.97	1.21	2,500	5.13	6.41
	2010	1,750	4.48	5.61	700	1.34	1.67	700	1.36	1.70	3,500	7.18	8.97
	2020	1,750	4.48	5.61	700	1.34	1.67	700	1.36	1.70	3,500	7.18	8.97
10% i.l.r.	1980	90	.41	.51	35	.12	.15	35	.12	.15	180	.65	.81
	1990	250	1.13	1.41	100	.34	1.42	100	.34	.42	500	1.81	2.26
	2000	1,250	5.66	7.07	500	1.68	2.10	500	1.71	2.14	2,500	9.05	11.31
	2010	1,750	7.92	9.90	700	2.36	2.95	700	2.40	3.00	2,500	12.68	15.85
	2020	1,750	7.92	9.90	700	2.36	2.95	700	2.40	3.00	3,500	12.68	15.85
35% i.l.r.	1980	90	1.29	1.61	35	.37	.46	35	.38	.47	180	2.04	2.55
	1990	250	3.58	4.47	100	1.06	1.32	100	1.08	1.35	500	5.72	7.15
	2000	1,250	17.88	22.35	500	5.32	6.65	500	5.41	6.76	2,500	28.61	35.76
	2010	1,750	25.04	31.30	700	7.45	9.37	700	7.57	9.46	3,500	40.06	50.07
	2020	1,750	25.04	31.30	700	7.45	9.37	700	7.57	9.46	3,500	40.06	50.07

i.l.r. = interstitial land reduction
FLD5 = farm labor displacement (average annual income = $5,000 in 1970 dollars)
FLD4 = farm labor displacement (average annual income = $4,000 in 1970 dollars)
All capacity figures in MW

TABLE 4. REDUCTION IN THE NUMBER OF FARM LABORERS FROM GEOTHERMAL DEVELOPMENT--JPL SCENARIO

	1980	1990	2000	2010	2020
5% i.l.r., field, M, $5,000	.37	1.02	5.13	7.18	7.18
5% i.l.r., field, M, $4,000	.46	1.27	6.41	8.97	8.97
10% i.l.r., field, M, $5,000	.65	1.81	9.05	12.68	12.68
10% i.l.r.,field, M, $4,000	.81	2.26	11.31	15.85	15.85
35% i.l.r., field, M, $5,000	2.04	5.72	28.61	40.06	40.06
35% i.l.r., field, M, $4,000	2.55	7.15	35.76	50.07	50.07
5% i.l.r., aver., M, $5,000	1.35	4.77	19.18	26.84	26.84
5% i.l.r., aver., M, $4,000	1.69	5.97	23.97	33.55	33.55
10% i.l.r., aver., M, $5,000	2.39	6.75	33.79	47.31	47.31
10% i.l.r., aver., M, $4,000	2.99	8.44	42.24	59.14	59.14
35% i.l.r., aver., M, $5,000	7.55	24.00	110.42	149.61	149.61
35% i.l.r., aver., M, $4,000	9.44	30.00	138.02	187.01	187.01

i.l.r. = interstitial land reduction

field = all field crops

aver. = average crop distribution (Sheehan, 1976)

M = middle Cal Tech power plant capacity Scenario (Davis, 1976)

dollar values = income figures for farmworkers (1970 dollars)