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# PV LARGE SYSTEMS PROJECT

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## Utility Oil Conservation A Near-Term PV Central-Station Market

### ● PRIMARY MARKET AREAS

- CALIFORNIA, FLORIDA, HAWAII, PUERTO RICO
- OIL-DEPENDENT
- HIGH INSOLATION
- PRESENT (1978) OIL USE: 500,000 BBL/DAY (30% OF U.S. UTILITY OIL CONSUMPTION)

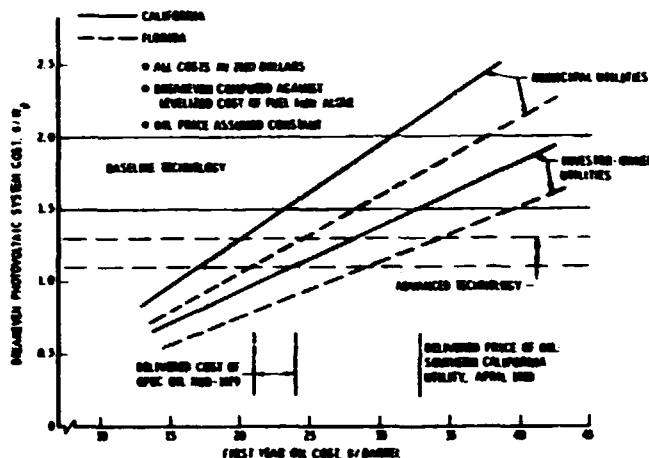
### ● SECONDARY MARKET AREAS

- LOUISIANA, TEXAS, OKLAHOMA
- DEPENDENT ON NATURAL GAS, OIL
- GOOD INSOLATION
- PRESENT (1978) OIL USE: 85,000 BBL/DAY
- PRESENT (1978) NATURAL GAS USE: 1,000,000 BBL/DAY (OIL EQUIVALENT)

### ● CONCLUSION

- IF BASELINE TECHNOLOGY COMMERCIAL READINESS GOALS ARE REACHED, IT WILL BE COST-EFFECTIVE BY THE LATE 1980's IN THE PRIMARY MARKET AREAS TO CONSTRUCT PHOTOVOLTAIC PLANTS SOLELY TO REDUCE OIL CONSUMPTION, EVEN IF THE REAL (inflation-adjusted) PRICE OF OIL DOES NOT INCREASE OVER 1980 VALUES

BREAKEVEN PHOTOVOLTAIC SYSTEM COST vs  
OIL-STEAM POWER GENERATION



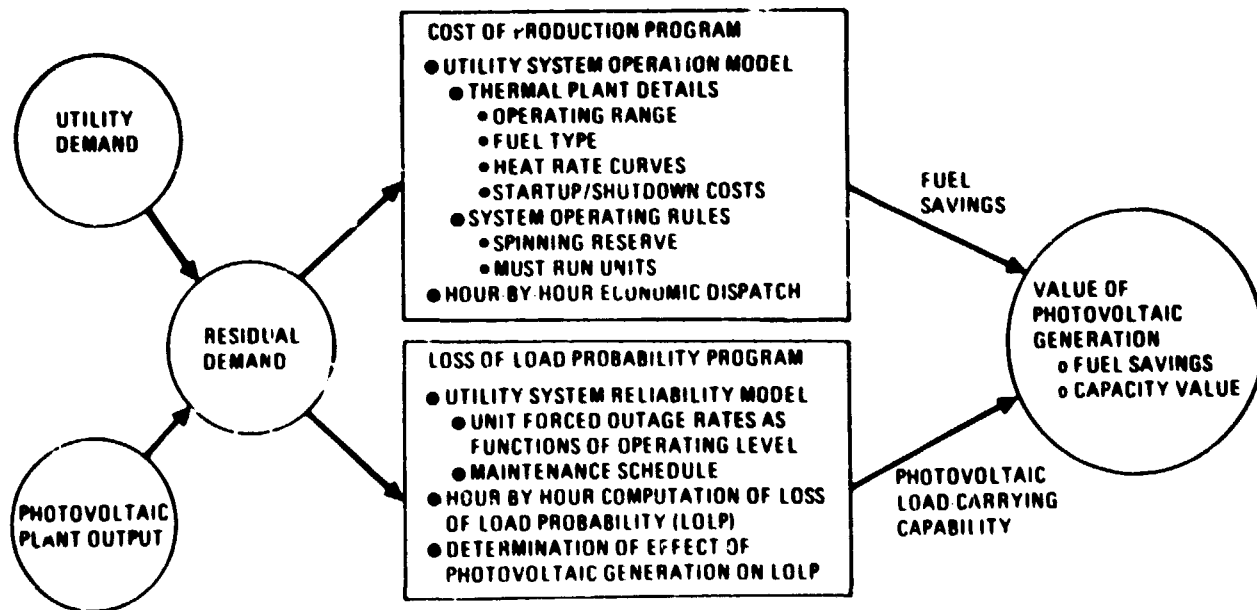
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### Issues

- QUESTION: IS THIS APPARENT OPPORTUNITY REAL, OR IS THE ANALYTICAL APPROACH TOO SIMPLIFIED?
  - RESPONSE: DETAILED ANALYSES OF VALUE OF PHOTOVOLTAIC GENERATION IN SPECIFIC OIL-DEPENDENT SUNBELT UTILITIES
- QUESTION: ARE THESE RESULTS CREDIBLE TO THE INDUSTRIES THAT WOULD BE INVOLVED?
  - RESPONSE: EXTENSIVE IN-DEPTH DISCUSSIONS WITH REPRESENTATIVE ORGANIZATIONS IN THE UTILITY, PHOTOVOLTAIC MANUFACTURING, AND CONSTRUCTION INDUSTRIES
- QUESTION: HOW CAN TECHNICAL AND ECONOMIC RISKS BE REDUCED TO THE POINT THAT THE PRIVATE SECTOR WILL TAKE ADVANTAGE OF THIS OPPORTUNITY?
  - RESPONSE: ANALYSES OF INNOVATIVE FINANCING ARRANGEMENTS THAT COULD LEAD TO HAND-OFF TO THE PRIVATE SECTOR AT CURRENTLY ACHIEVABLE SYSTEM COSTS, ONCE TECHNICAL FEASIBILITY HAS BEEN DEMONSTRATED

SUPPORT OF FEDERAL PARTICIPATION IN INITIAL UTILITY-SCALE PROJECTS THAT DEMONSTRATE TECHNICAL FEASIBILITY OF LARGE PHOTOVOLTAIC SYSTEMS FOR UTILITY APPLICATIONS

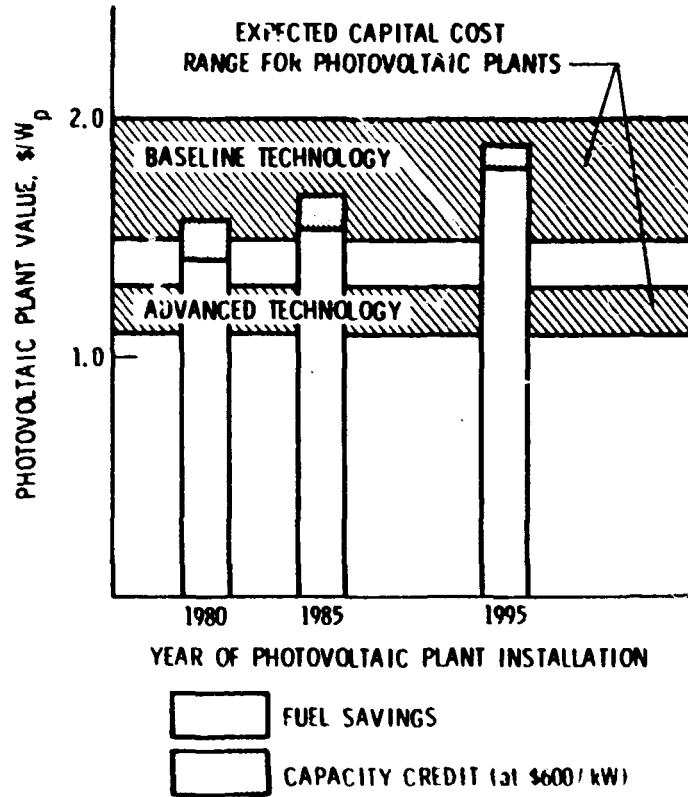
### Value Analysis Methodology



**Value of PV Power Plants in the Southern California Edison System**

**ASSUMPTIONS**

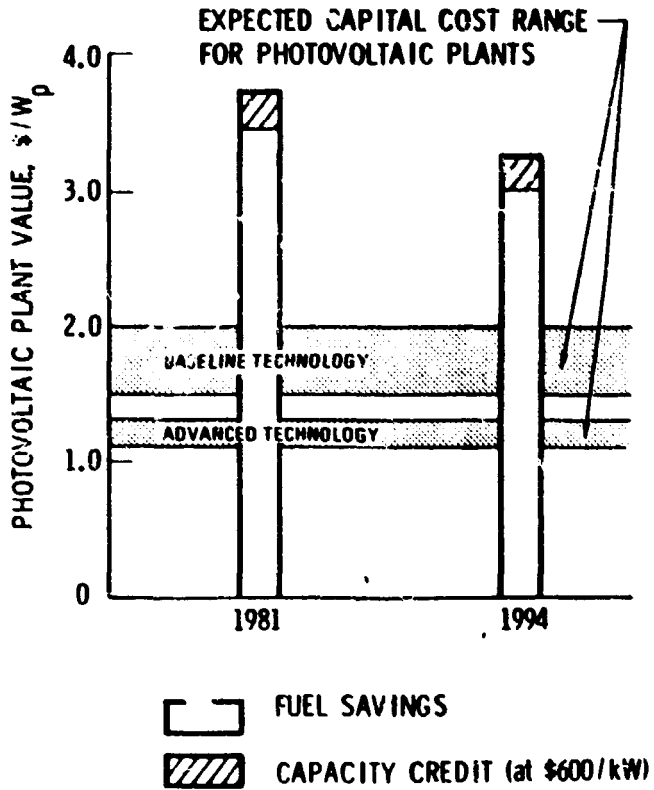
- ALL COSTS IN 1980 DOLLARS
- GENERAL INFLATION RATE
  - 1981 - 1987: ~ 8.4% / YR
  - 1988 - : 5% / YR
- REAL FUEL PRICE ESCALATION
  - 1981 - 1984: ~ 2.7% / YR
  - 1985 - : 2% / YR
- PHOTOVOLTAIC SYSTEM LIFE: 30 YR
- PHOTOVOLTAIC PENETRATION
  - ENERGY: 5%
  - CAPACITY: 11%



Value of PV Power Plants in the Los Angeles  
Department of Water and Power System

ASSUMPTIONS

- ALL COSTS IN 1981 DOLLARS
- GENERAL INFLATION RATE
  - 1981 - 85: 9.12% / YEAR
  - 1986 - 90: 8.30% / YEAR
  - 1991 - : 5.95% / YEAR
- REAL FUEL PRICE ESCALATION
  - 1981 - 85: 0.88% / YEAR
  - 1986 - 90: 1.70% / YEAR
  - 1991 - : 2.05% / YEAR
- PHOTOVOLTAIC SYSTEM LIFE: 30 YEARS
- PHOTOVOLTAIC PENETRATION
  - 1981: 2.1% OF ELECTRIC ENERGY FROM THERMAL UNITS
  - 1994: 1.5% OF ELECTRIC ENERGY FROM THERMAL UNITS



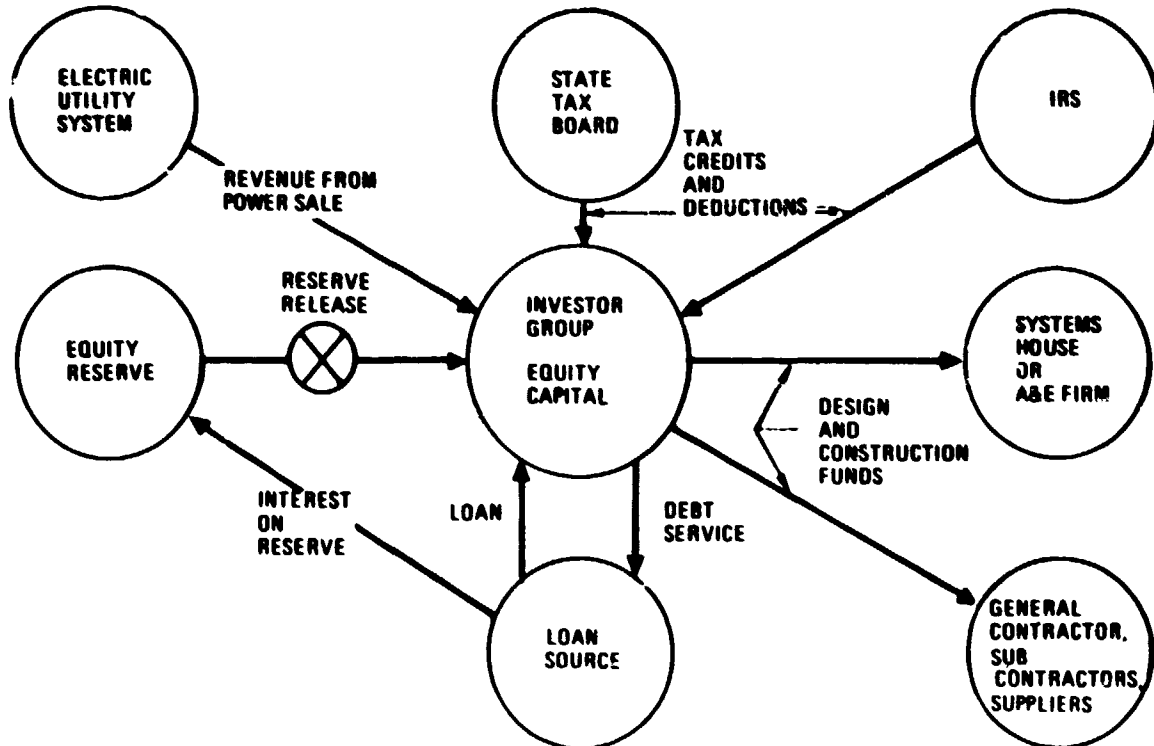
### Third-Party Ownership Option

**CONCEPT:**

INVESTOR GROUP FINANCES CONSTRUCTION OF PHOTOVOLTAIC POWER PLANT, SELLS ELECTRICITY TO UTILITY, TAKES ADVANTAGE OF TAX INCENTIVES NOT AVAILABLE TO UTILITY

**ADVANTAGE:**

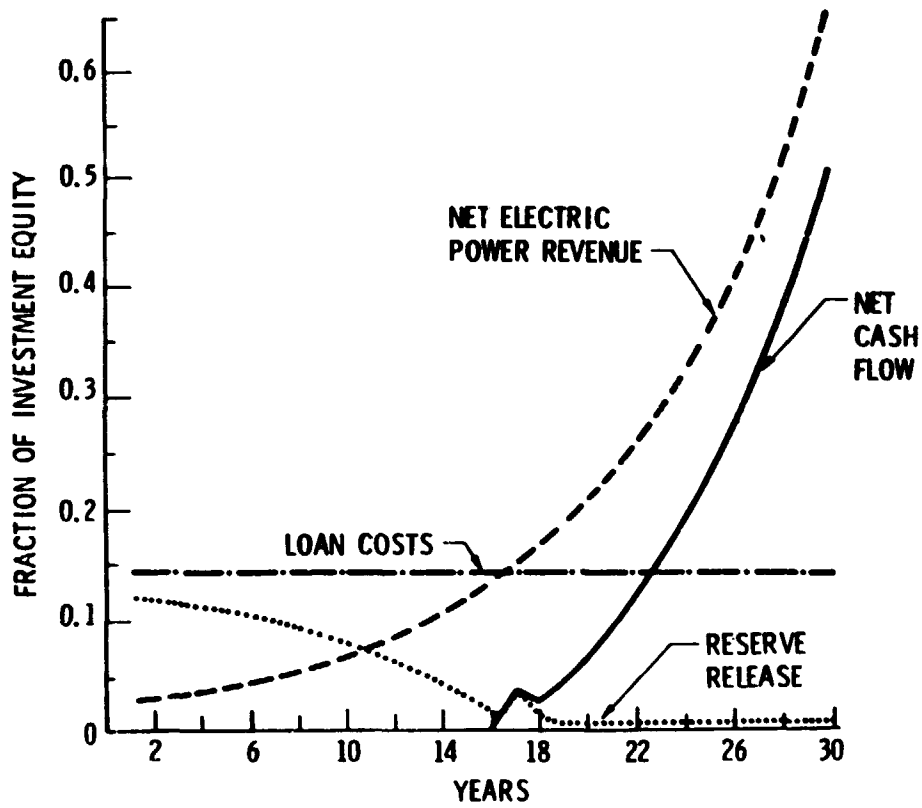
INCLUSION OF TAX BENEFITS MAKES INVESTMENT ATTRACTIVE WHEN COST OF PLANT IS STILL TOO HIGH FOR UTILITY PURCHASE



Investment Evaluation: Third-Party Financing Arrangement

<b>ECONOMIC ASSUMPTIONS</b>			
SYSTEM COST (\$/W <sub>p</sub> )	13.00	10.50	7.00
REAL ESCALATION OF ELECTRICITY PRICE	5%/yr	3%/yr	0%/yr
EQUITY CAPITAL (% of system cost)	25	25	50
DEBT CAPITAL (% of system cost)	75	75	50
EQUITY RESERVE (% of system cost)	50	48	21
REQUIRED AFTER-TAX RETURN ON EQUITY	15%/yr	15%/yr	15%/yr
<b>BENEFIT/COST BREAKDOWN (After-Tax Net Present Value as Percentage of Equity)</b>			
FEDERAL INVESTMENT TAX CREDIT	12.4	12.8	13.0
FEDERAL ENERGY CREDIT	18.7	19.2	19.6
CALIFORNIA ENERGY CREDIT (net of Federal Tax)	16.8	17.2	17.6
DEPRECIATION: FEDERAL	37.9	38.9	39.8
CALIFORNIA (net of Federal Tax)	4.3	4.4	4.5
NET LOAN COST (less interest shelter)	(46.8)	(48.1)	(32.7)
NET ELECTRIC POWER REVENUE (net of O&M)	15.5	15.6	17.4
RESERVE RELEASE	21.8	22.1	12.7
RESERVE INTEREST	19.4	18.9	7.6
	100.0	101.0	99.5

### Before-Tax Cash Flow



Investment Evaluation: Selected Sensitivities

<b>ECONOMIC ASSUMPTIONS</b>				
SYSTEM COST (\$/W <sub>p</sub> )	10.50	6.00	7.60	4.50
SYSTEM SERVICE LIFE (years)	30	20	30	30
REAL ESCALATION OF ELECTRICITY PRICE	3%/yr	3%/yr	3%/yr	3%/yr
EQUITY CAPITAL (percent of system cost)	25	60	25	30
DEBT CAPITAL (percent of system cost)	75	40	75	70
EQUITY RESERVE (percent of system cost)	47.4	9.65	50	21.2
RATE OF INTEREST ON DEBT	12%	12%	16%	12%
REQUIRED AFTER-TAX RETURN ON EQUITY	15%	15%	15%	15%
FEDERAL AND STATE SOLAR TAX CREDITS	YES	YES	YES	NO
<b>BENEFIT/COST BREAKDOWN (after-tax net present value as percentage of equity)</b>				
FEDERAL INVESTMENT TAX CREDIT	12.8	13.4	12.4	18.2
FEDERAL ENERGY CREDIT	19.2	20.1	18.7	0
CALIFORNIA ENERGY CREDIT (net of federal tax)	17.2	18.1	16.8	0
DEPRECIATION: FEDERAL	38.9	40.8	37.9	55.5
CALIFORNIA (net of federal tax)	4.4	4.6	4.2	6.2
NET LOAN COST (less interest shelter)	(48.1)	(31.2)	(58.7)	(64.0)
NET ELECTRIC POWER REVENUE (net of O&M)	15.6	22.7	21.0	51.9
RESERVE RELEASE	22.1	9.2	23.5	24.9
RESERVE INTEREST	18.9	2.2	25.0	7.6
	101.0	99.9	100.8	100.3



### Current Large-System Projects

- SACRAMENTO MUNICIPAL UTILITY DISTRICT PROJECT
  - PLANNED CAPACITY: 1 MW<sub>p</sub> (AC)
  - SITE: RANCHO SECO NUCLEAR POWER PLANT, 30 MILES SOUTH OF SACRAMENTO, CALIFORNIA
  - FUNDING ALLOCATION: \$12 MILLION -- \$6.8 MILLION FROM DOE, \$2 MILLION FROM STATE OF CALIFORNIA, \$3.2 MILLION FROM SMUD
  - PROJECTED IOC DATE: JUNE 1984
  - FIRST STAGE OF PLANNED 100 MW<sub>p</sub> PHOTOVOLTAIC POWER PLANT
- ARCO SOLAR / SOUTHERN CALIFORNIA EDISON COMPANY PROJECT
  - PLANNED CAPACITY: 1 MW<sub>p</sub> (DC)
  - SITE: LUGO SUBSTATION NEAR VICTORVILLE, CALIFORNIA
  - ARCO SOLAR TO BE BUILDER, OWNER, AND OPERATOR
  - SOUTHERN CALIFORNIA EDISON TO PURCHASE AND DISTRIBUTE OUTPUT POWER
  - PROJECTED IOC DATE: DECEMBER 1982
  - PRIVATE VENTURE MADE POSSIBLE BY STATE AND FEDERAL TAX INCENTIVES

## Conclusions

- DETAILED ANALYSES OF THE VALUE OF PHOTOVOLTAIC GENERATION TO SPECIFIC UTILITIES CONFIRM THE RESULTS OF SIMPLIFIED ANALYSIS
  - PHOTOVOLTAIC PLANTS COSTING \$1.50 - 2.00/W<sub>p</sub> WOULD BE COST-EFFECTIVE IN AN OIL-DEPENDENT SOUTHWESTERN INVESTOR-OWNED UTILITY
  - THE BREAKEVEN COST IN A SIMILAR MUNICIPAL UTILITY WOULD BE EVEN LARGER: \$3.00 - 4.00/W<sub>p</sub>
- THE PROGRESSIVE ELEMENTS OF THE UTILITY INDUSTRY ARE KEENLY INTERESTED IN PHOTOVOLTAIC TECHNOLOGY BUT REQUIRE ASSISTANCE TO PROCEED WITH LARGE COMMERCIAL (i.e., non-R&D) PROJECTS
  - RISKS ARISING FROM UNCERTAINTIES IN SYSTEM COST AND PERFORMANCE ARE TOO LARGE TO BE JUSTIFIED UNDER ALLOWED RATES OF RETURN
  - UTILITIES ARE, HOWEVER, WILLING TO ENTER INTO AGREEMENTS WITH THIRD-PARTY FINANCED PROJECTS
- UNDER A PROPERLY-STRUCTURED THIRD-PARTY ARRANGEMENT, CONSTRUCTING A PHOTOVOLTAIC PLANT AT CURRENTLY ACHIEVABLE COSTS CAN BE AN ATTRACTIVE INVESTMENT
  - CURRENT SOLAR TAX CREDITS CONTRIBUTE HEAVILY TO EFFECTIVE RATE OF RETURN ON INVESTMENT
  - LEVERAGED FINANCING AT REASONABLE RATES SIGNIFICANTLY INCREASES RETURNS