Distributed PV – the road California is already on

PIELC
Bill Powers, P.E., Powers Engineering
March 5, 2011

John Geesman, Energy Commissioner, 2007

source: California Energy Circuit, *State Sees DG Providing 25% Peak Power*, May 11, 2007.

"There's an ongoing schizophrenia in state policy between what we say we want to do and what we actually allow to happen."

CPUC just can't say no

Project	Cost MM ($)	CPUC judge's decision	Full CPUC action
PG&E Oakley 624 MW gas-fired	$800	deny	approve
SCE Eldorado Ivanpah Transmission	$450	deny	approve
SDG&E Sunrise Powerlink Transmission	$2,000	deny	approve

Federal judges can say no

sources: Los Angeles Times, *Court rejects U.S. bid to establish corridors for new electric transmission lines*, February 1, 2011.
San Diego Union Tribune, *Judge blocks Imperial Valley solar project*, December 17, 2010.

- "9th Circuit strikes down DOE's attempt to establish national interest electric transmission corridors."
- "This could be blow to SCE and SDG&E."
- "Federal judge in San Diego blocks 709 MW of solar dishes in Imperial Valley, ruling government had not consulted enough with tribe."

What is the state's plan? Energy Action Plan

- Energy Action Plan Loading Order:
  - Energy efficiency & demand response
    (net zero energy buildings – EE/rooftop PV)
  - Renewable energy
  - Combined Heat & Power - CHP
  - Conventional gas-fired generation
  - Transmission as needed

How much rooftop PV does California need to meet 2020 net zero energy targets for existing buildings? ~15,000 MW

CPUC, California Long-Term Strategic Energy Efficiency Plan, January 2011 update

- Target: 25% of existing residential reaches 70% reduction by 2020
  - Assume 30% reduction with EE, 40% with PV
- Residential rooftop PV requirement = 4,800 MW
- Target: 25% of existing commercial reaches net zero energy by 2020
  - Assume 30% reduction with EE, 70% with PV
- Commercial rooftop PV requirement = 9,800 MW
- Total residential and commercial rooftop PV = 14,600 MW

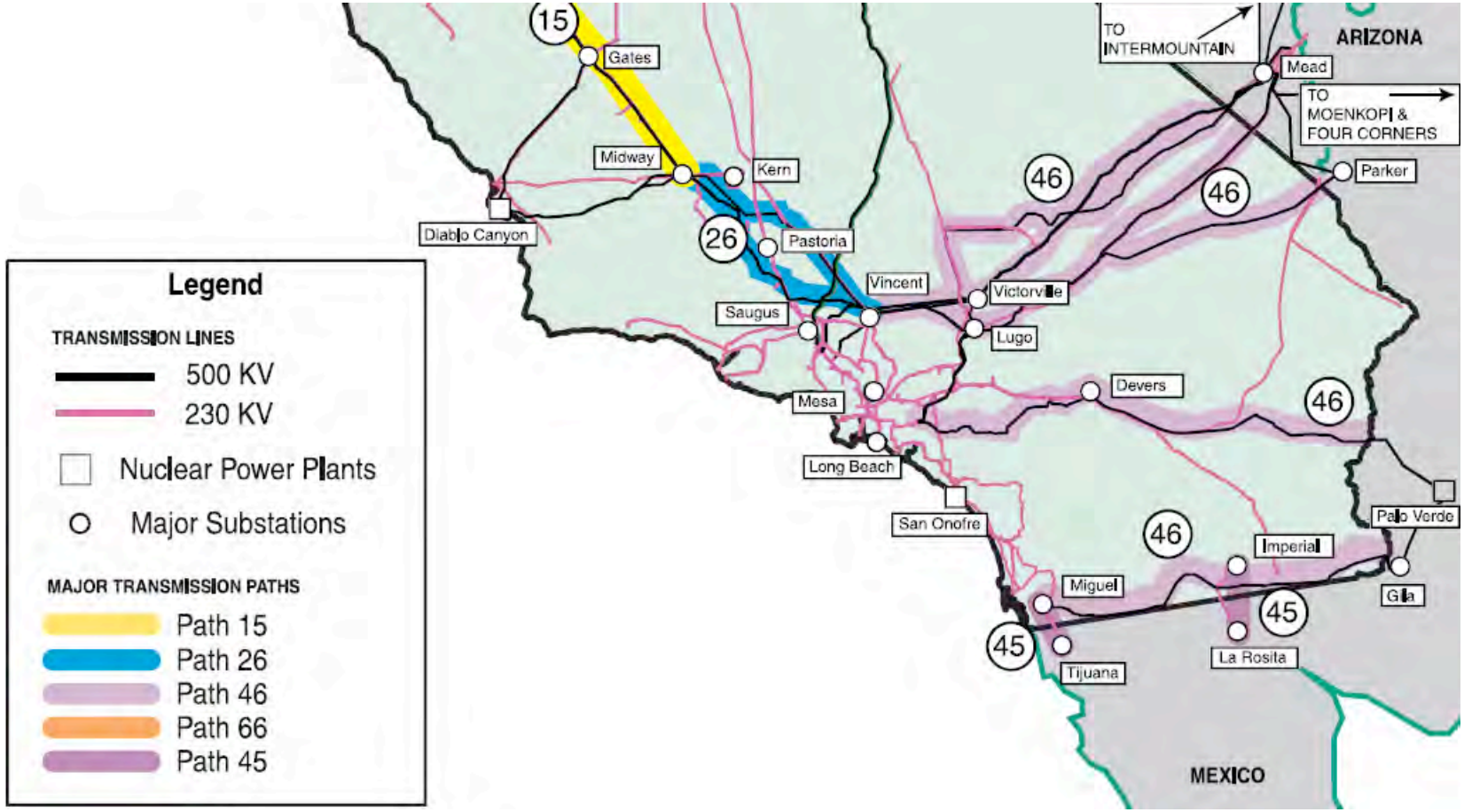
What is utility renewable energy plan?

CPUC, 33% RPS Implementation Analysis Preliminary Results, June 2009, p. 87.
J. Firooz, Transmission in Short Supply or Do IOUs Want More Profits?, Natural Gas & Electricity Journal, July 2010.
graphic: Black & Veatch and E3, Summary of PV Potential Assessment in RETI and the 33% Implementation Analysis, Re-DEC Working Group Meeting, December 9, 2009, p. 10.

- 10,000 MW of large-scale, remote solar. 0 MW of distributed PV.
- Customer-owned rooftop PV is not RPS-eligible.
- The more new, high profit (12% ROI) transmission the better.
- $15 billion in new transmission additions in California, justified on renewable energy, if utility plans realized.

20,000 MW of existing transmission supplying SoCal today, average load is 14,000 MW. 10,000+ MW Path 46 has lightest load in West.

Sources: 2005 CEC Strategic Transmission Investment Study; June 2010 WECC Path Utilization Study Part of TEPPC 2009 Annual Report.



Local PV and remote solar – the tortoise and the hare

PV Project Underway	Capacity (MW)	Completion date
California Solar Initiative	3,000	2016
Utility distributed PV	1,100	2014
SB 32 feed-in tariff	750	2014
CPUC renewable auction mechanism	1,000	2014
SMUD feed-in tariff	100	2012
Total committed DG PV	**~6,000**	

Remote solar projects still standing in ARRA cash grant hunt – extended thru 2011

Remote solar project	Capacity (MW)
Ivanpah	370
Blythe + Palen	1,500
Genesis	250
Desert Sunlight	550
Chevron Lucerne Valley	45
Total large remote solar	**2,715**

Germany – the gold standard

- ~7,000 MW distributed PV installed in 2010
  - 80+% on rooftops
- 1,550 MW of wind installed in 2010
- 80% distributed PV, 20% wind in 2010
- Framework for success: feed-in tariff

Feb. 24th 2011, Germany – PV provides 10% of country's electricity at mid-day, should be ~20% on mild day in June

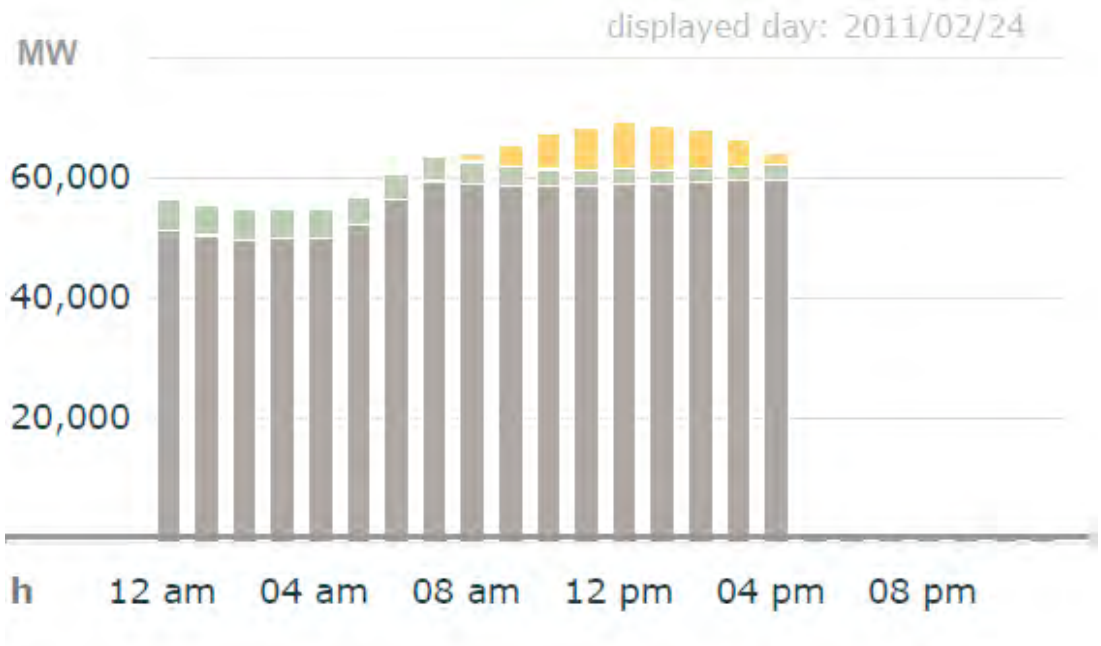
German source, EEX Transparency Platform:
http://www.transparency.eex.com/en/Statutory%20Publication%20Requirements%20of%20the%20Transmission%20System%20Operators

Installed Jan. 1, 2011:

- wind, 27,000 MW_{ac}
- solar PV, 14,000 MW_{ac}
- >80% of PV is rooftop

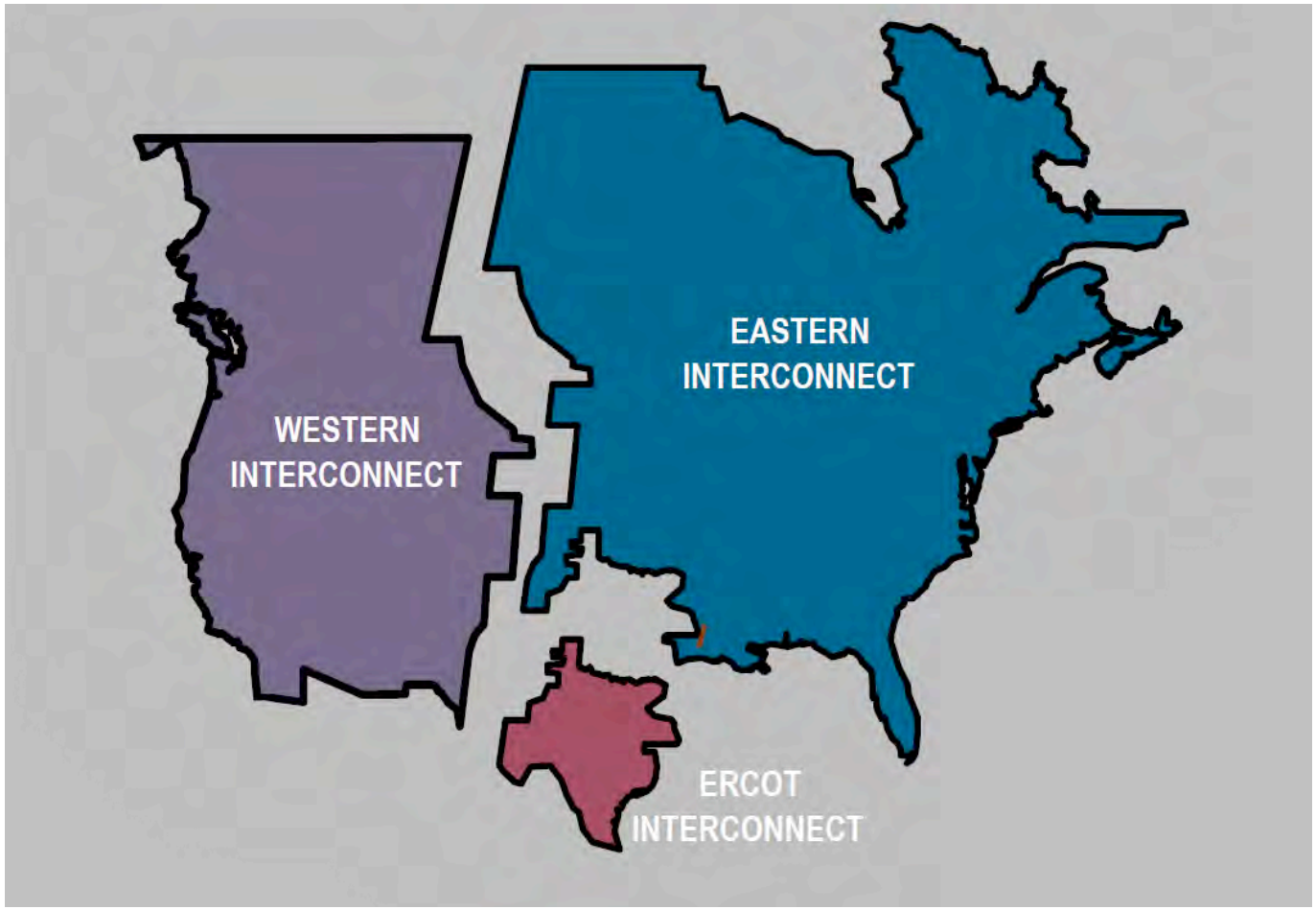
Graphic:

- yellow = PV
- green = wind
- gray = conventional



Western Interconnect 2010 loads a bit higher than German loads: min 73,000 MW, max ~150,000 MW

Black & Veatch, Need for Renewables and Gas Fired Generation in WECC - Wyoming Infrastructure Authority Board Meeting, Jan 25, 2010.



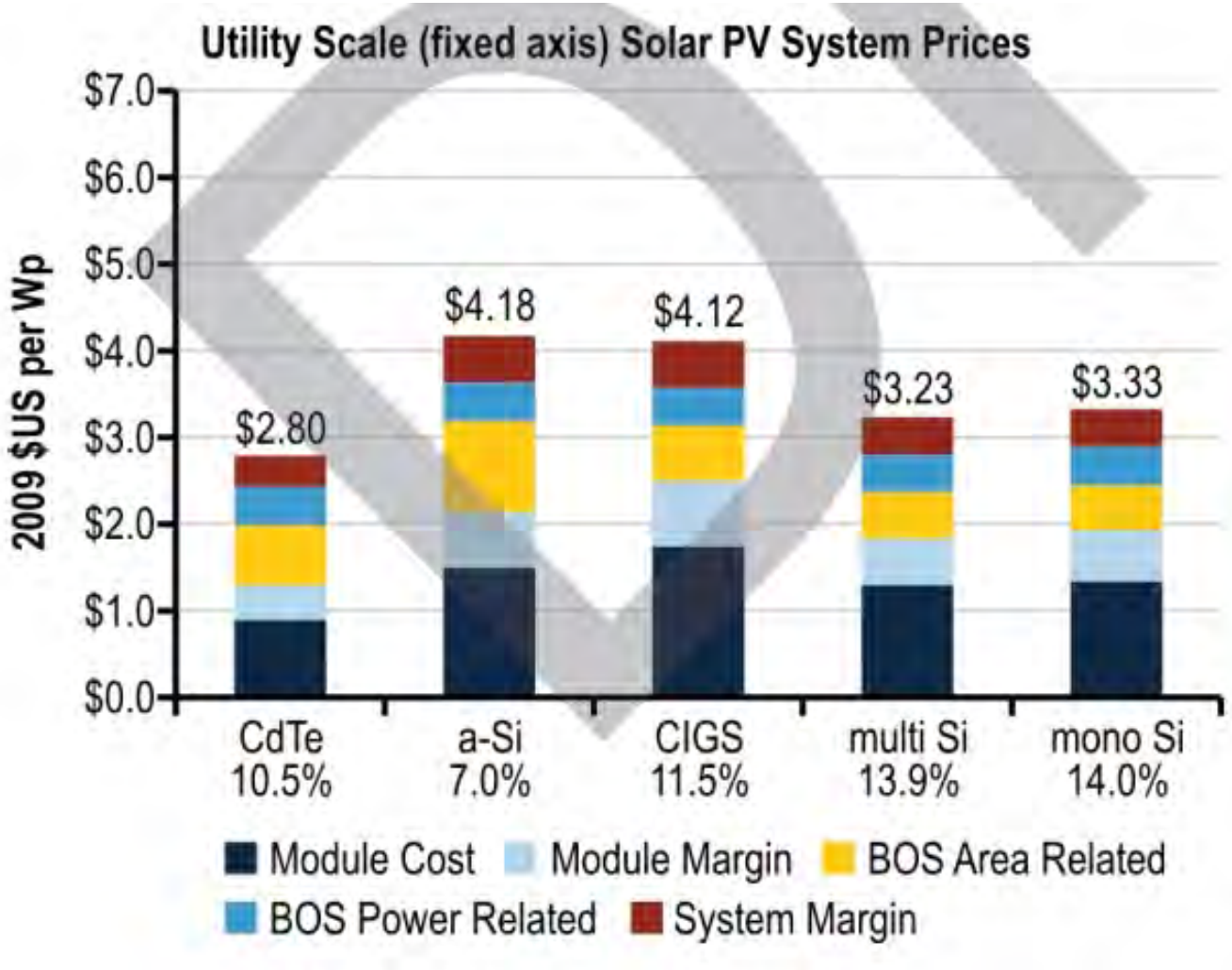
Cost of energy for solar, geothermal, and wind – RETI Phase 2B report and CPUC renewable study

source: Renewable Energy Transmission Initiative (RETI) Phase 2B Final Report, May 2010, Tables 4-5, 4-7, 4-8, CPUC 2010 LTPP proceeding, Long-Term Renewable Resource Planning Standards, Attachment 1, Table 1, June 2010.

Technology	Capacity (MW)	Capacity factor (%)	Cost of energy ($/MWh)
Solar thermal, dry-cooled	200	24	202
Fixed thin-film PV	20	24	138
Tracking polysilicon PV	20	27	135
Geothermal	utility-scale	81	148
Onshore wind	utility-scale	33	95

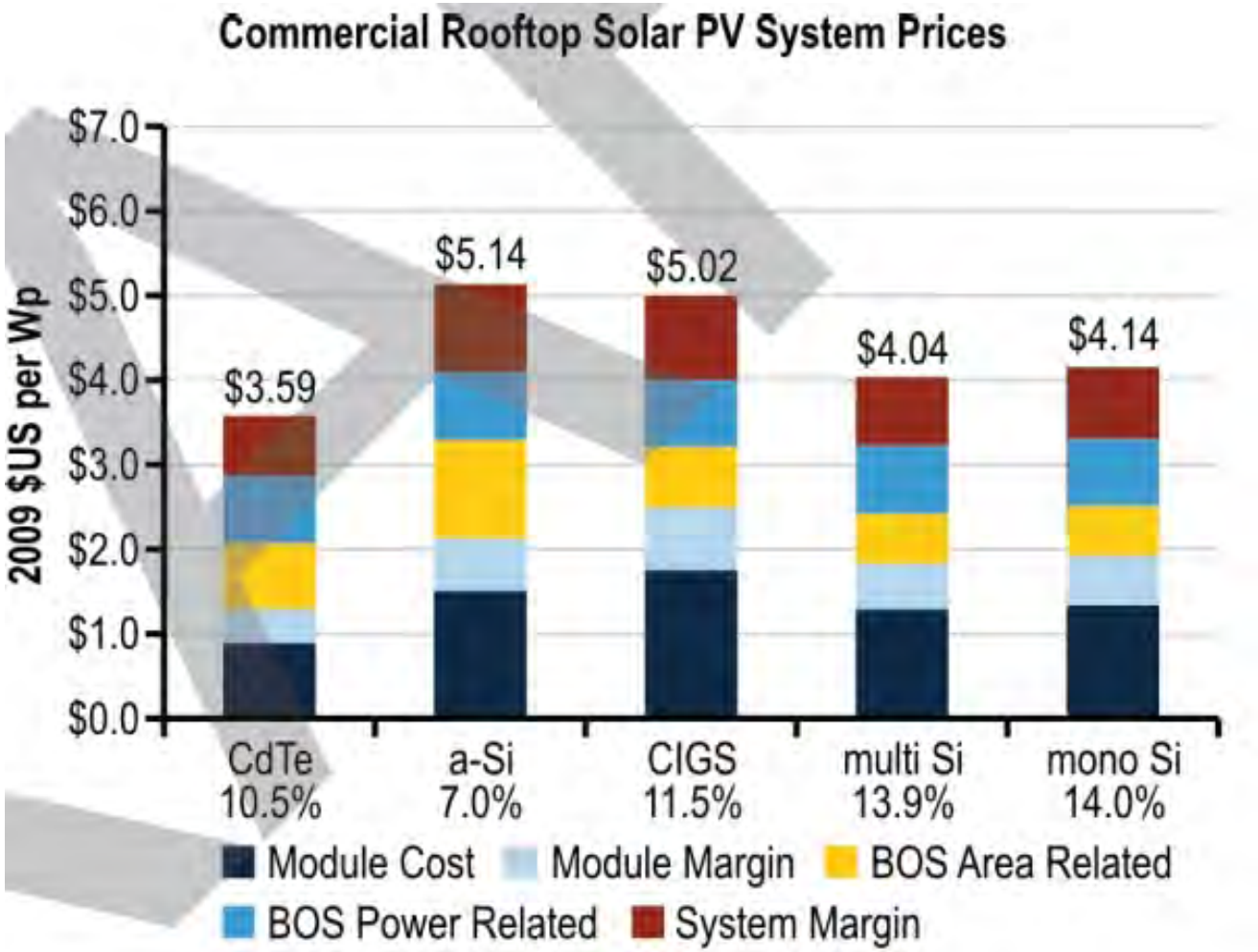
DOE on current cost of distributed 10-20 MW PV

source: DO , Figure 4-4, p. 7.



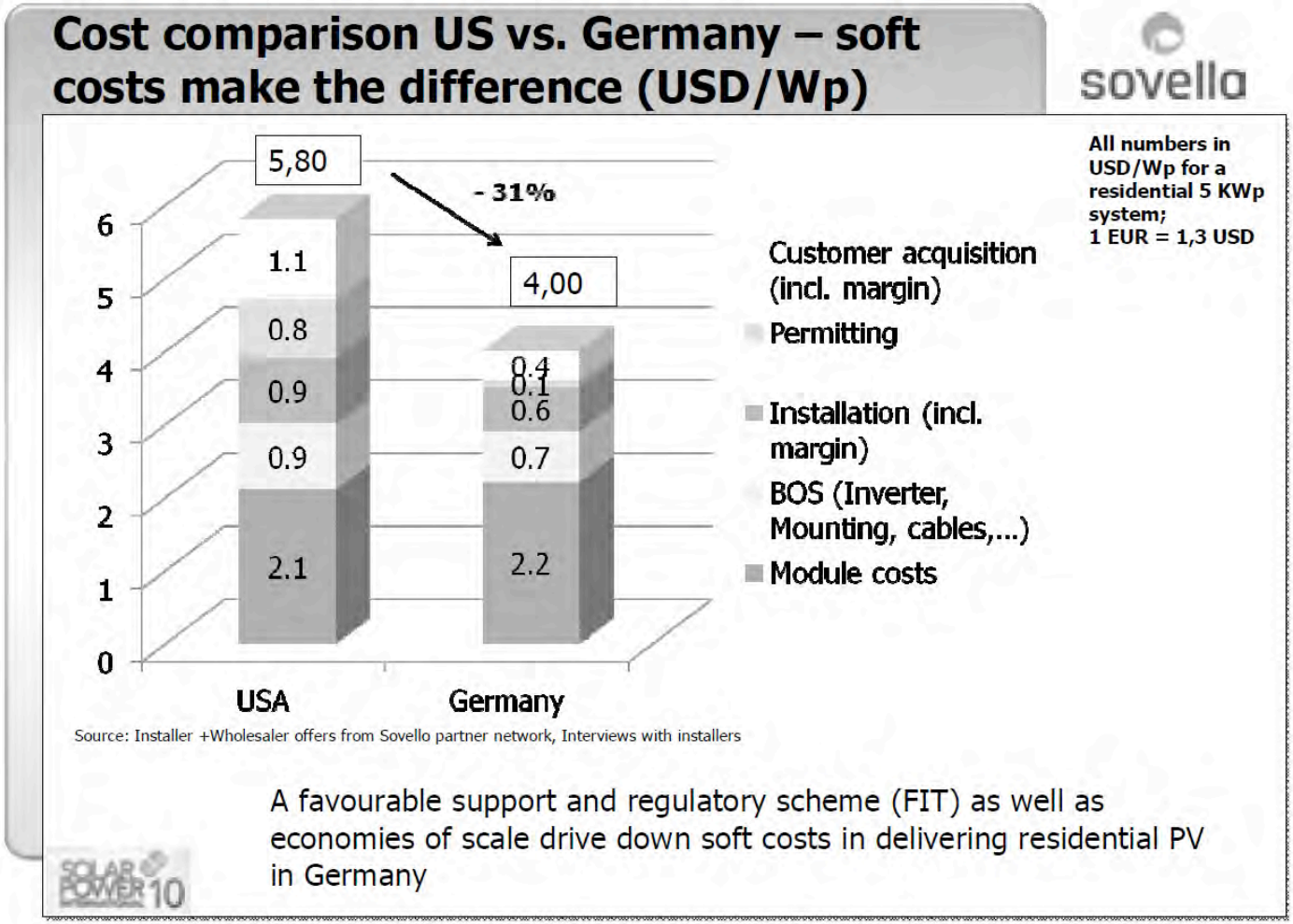
DOE on current cost of commercial rooftop PV

source: DOE, Solar Vision Study – Draft, Chapter 4: Photovoltaics: Technologies, Cost, and Performance, May 28, 2010, Figure 4-4, p. 7.

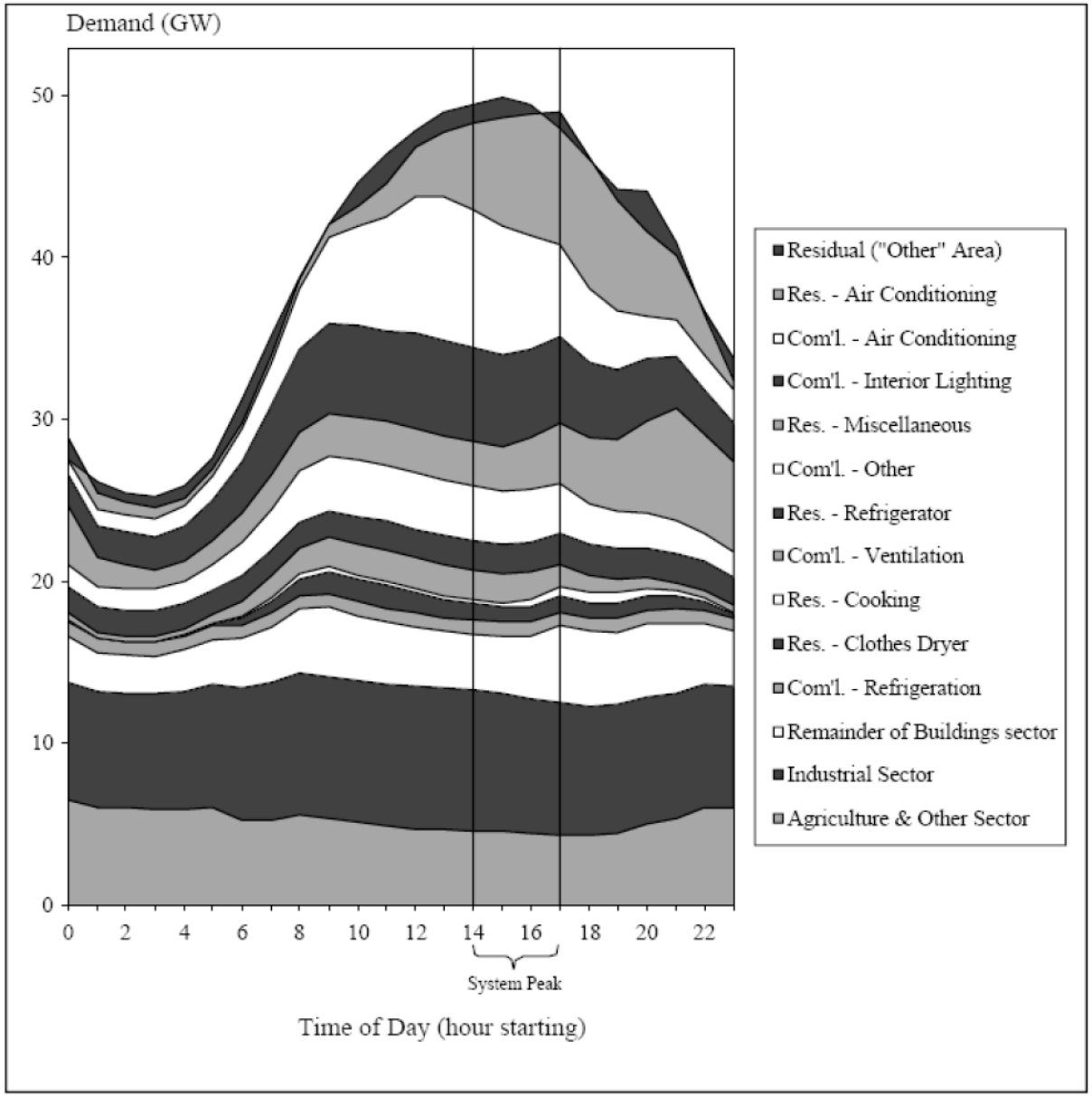


Germany installs residential PV at $4/$W_{dc}$, we do same system for ~$6/$W_{dc}$

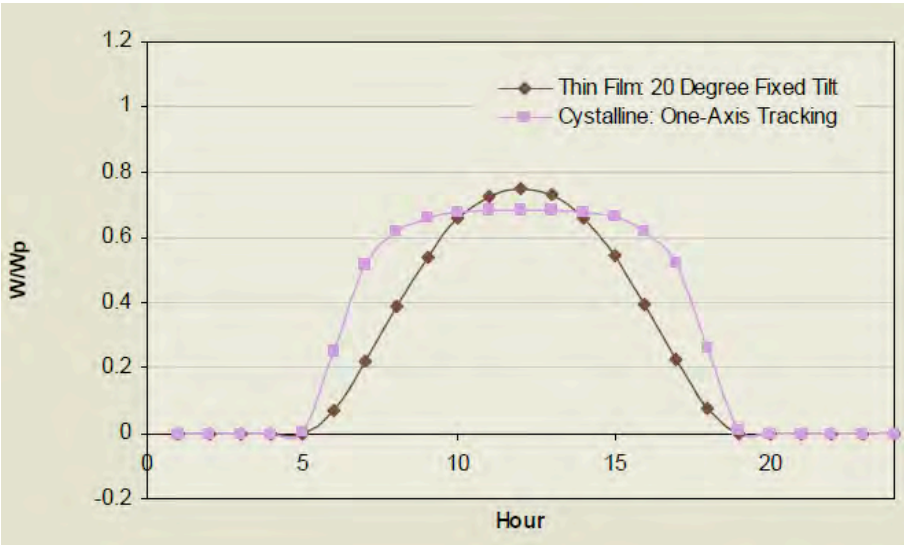
C. Landen – Sovella AG, Complexity cost and economies of scale: Why German residential PV costs 25% less than US, presented at Solar Power International, October 2010.

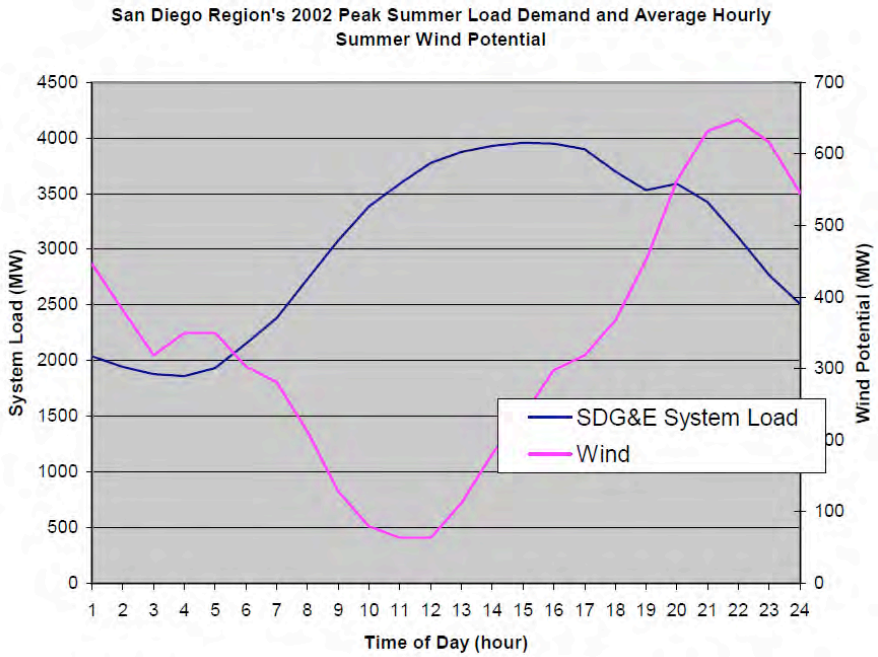


Representative California peak load profile



PV and wind summer output profiles: PV tracks demand, wind is opposite demand





Summer peak availability - sun and wind are not the same

Resource	Reference	Capacity factor (%)
Tracking PV	CPUC/E3, June 2009	77
Fixed rooftop PV	Itron, 2010 CSI evaluation	50 - 60
Onshore wind	PG&E 2006 Long-Term Plan	4

Achilles heel of remote central station generation, whether solar or wind - cost of new transmission

sources: 1) RPS Calculator, 2) J. Firooz, P.E., CAISO: How its transmission planning process has lost sight of the public's interest, prepared for UCAN, April 15, 2010.

- CPUC calculated $34/MWh transmission cost adder in June 2009 for remote renewable generation.
- CPUC assumed renewable generation financed over 20 yr, transmission over 40 yr.
- Cost adder is $46/MWh if generation and transmission financed over same 20 yr period (apples-to-apples).

Achilles heel of wind power is lack of summer daytime output – used by utilities to justify new generation of high cost peaker turbines

source: CEC, Comparative Cost of Electric Generation Technologies, January 2010, Table 4 and Table 5. Note – the dates shown in the

Combustion turbine (MW)	Capacity factor (%)	Cost of energy 2009 ($/MWh)	Cost of energy 2018 ($/MWh)
50	5	844	1,009
100	5	795	951

Utilities – wind power must be backed-up by combustion turbines

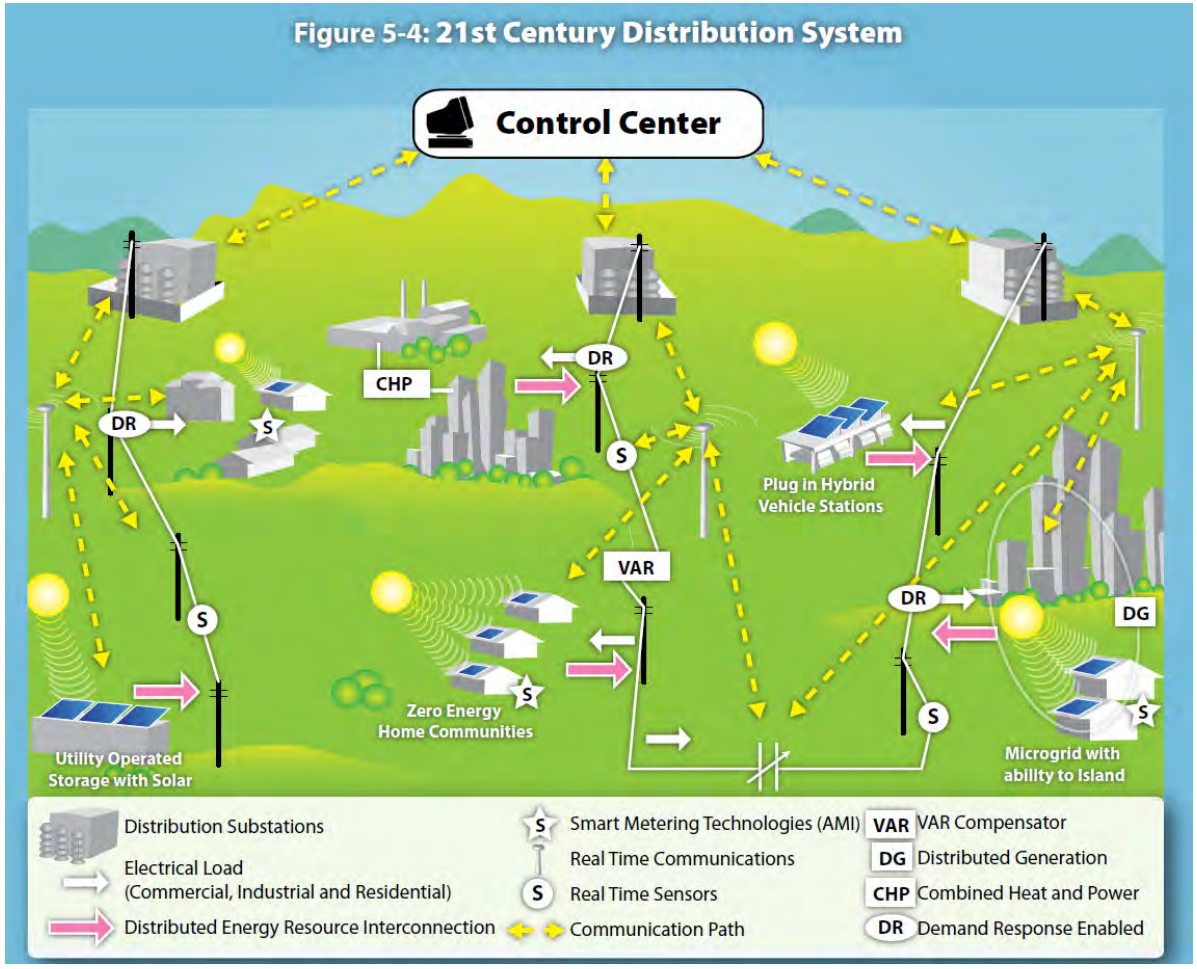
- World without RPS requirements – utilities build combustion turbines to meet rising peak load.
- World with RPS requirements – utilities build combustion turbines, and wind turbines, and new transmission to meet rising peak load.
- Or central station solar thermal or solar PV, and new transmission.
- Or distributed solar PV (ideally with limited 2 to 3 hr energy storage), and no new transmission.

Gov. Brown's Clean Energy Jobs Plan – local focus

- 12,000 MW of local renewable power by 2020, out of 20,000 MW target
- Feed-in tariff for renewables under 20 MW
- 4,000 MW of new combined heat & power
  - (can be fueled with biogas or biomethane)

The 21st century smart grid, with full two-way flow at every substation

source: CEC 2007 Integrated Energy Policy Report, December 2009, p. 155.



Utilities spend ¾ of total budgets on distribution system, but not yet building for 21st century

source: CEC 2007 IEPR, December 2009, pp. 155.-156

- *"Utilities spend approximately three-fourths of their total capital budgets on distribution assets, with about two-thirds spent on upgrades/new infrastructure in most years."*
- *"Investments will remain for 20 to 30 or more years."*
- *"Magnitude of these investments suggests need to require utilities, before undertaking investments in non-advanced grid technologies, to demonstrate that alternative investments in advanced grid technologies that will support grid flexibility have been considered, including from a standpoint of cost-effectiveness."*

2010 UCLA/LABC feed-in tariff for LA: enough for sustained wave of PV, and less than grid power

note: grid power estimate is "all-in" including cost of energy, time-of-use, losses, and transmission & distribution costs

PV category	2011 ($/kWh)	2019 ($/kWh)
residential, 17%	0.29	0.19
commercial, 50%	0.19	0.13
ground, 33%	0.15	0.10
PV composite	**0.19**	**0.13**
Grid power	**~0.22**	**~0.30**

Residential rates are already at $0.30/kWh for about a third of the electricity sold in PG&E territory

sources: 1) PG&E A. 10-03-014 General Rate Case Phase 2 filing, Chapter 3, 2) CEC 2009 Integrated Energy Policy Report (IEPR), Figure 4, p. 52. Assumption – residential IOU customer consumption is 2/3 of total statewide residential consumption.

- California's investor-owned utilities (IOUs) bill residential customers using tiered rates, with high users paying much more.
- PG&E example: Tier 1 and 2 are in the $0.12 to 0.14/kWh range, Tier 3 at $0.30/kWh.
- About a third of the 30,000 gigawatt-hr per year PG&E residential usage is billed at Tier 3 rate.
- This means about 10,000 gigawatt-hr per year is billed at $0.30/kWh.
- 5,000 to 6,000 MW of distributed PV capacity would be required to generate 10,000 gigawatt-hr per year.

SDG&E example: urban PV potential is vast

Commercial buildings: 1,600 to 1,800 MW (www.renewablesg.org)
Commercial parking lots: 3,000 MW, residential: 2,800 MW
Total PV potential: ~7,500 MW
Highest demand ever recorded in SDG&E territory: 4,600 MW

PV and parking lots – smart dual use

Presentation by Chevron Energy Solutions, Solar Forum at Diablo Valley College, Feb. 8, 2008

PV for parking lot- shade is added value

Presentation by Chevron Energy Solutions, Solar Forum at Diablo Valley College, Feb. 8, 2008

California is already on the road to a predominantly distributed PV future

- No technical or economic impediments.
- PV at the point-of-use is more cost-effective than remote solar thermal whether or not new transmission is needed.
- Remote PV that does not require new transmission is comparable in cost to PV at the point-of-use – line losses negate much of the desert sun advantage.
- Hurdles are institutional – investor-owned utility model has not yet been re-aligned to advance distributed energy future.