IEc

Renewable Generation and Grid Integration: Market Adoption, Social Welfare Benefits, and System-Level Avoided Costs through 2045

Presented by:

Christine Lee
Industrial Economics, Inc.

Co-developers:

Daniel Kaufman, Mike Freeman, and Anna Goldstein

November 19, 2020

Overview of EPIC Renewable Generation and Grid Integration Investments

- **EPIC Objective**: Facilitate growth in capacity and grid integration of renewable energy sources
- **2014-2019**: $127 million invested, 68 grants
- **Delphi Panel Grant Selection Criteria**:
  - EPIC investments in **technology improvement**
  - Excluded grants focused on improving renewable energy forecasting or development of energy planning software
  - Limited to grants where a draft or final grant report was available

Overview of EPIC Grants Analyzed

TYPE OF RENEWABLE ENERGY	SUB-GROUPS	NUMBER OF TECHNOLOGIES	NUMBER OF EPIC GRANTS	EPIC FUNDING
Photovoltaic (PV)	Solar tracking	2	2	$1,999,822
	PV cells	2	2	$3,429,940
Concentrating Solar Power (CSP)		2	3	$3,741,760
Bioenergy	MSW and food waste	2	2	$2,996,383
	Dairy waste	1	3	$11,000,000
	Forest waste	2	2	$3,990,071
Geothermal		2	2	$3,873,387
Wind		1	1	$810,438
	Total	**14**	**17**	**$31,841,801**

Overview of Delphi Panel

- **Expert Recruiting:**
  - Identified over 125 candidates
  - Invitations sent to nearly 100 candidates
  - Screening calls conducted with over 30 candidates
- **Expert Selection Criteria:**
  - Significant experience in renewable energy, of which at least half must have California-specific RE experience
  - Familiarity and/or experience with:
    - R&D, demonstration and market facilitation policy
    - California Renewable Portfolio Standard Law
    - California Reference System Plan and Integrated Resource Planning process
    - EPIC program

TYPE	NUMBER OF EXPERTS
Private	5
Government	5
Academia	1
Total	**11**

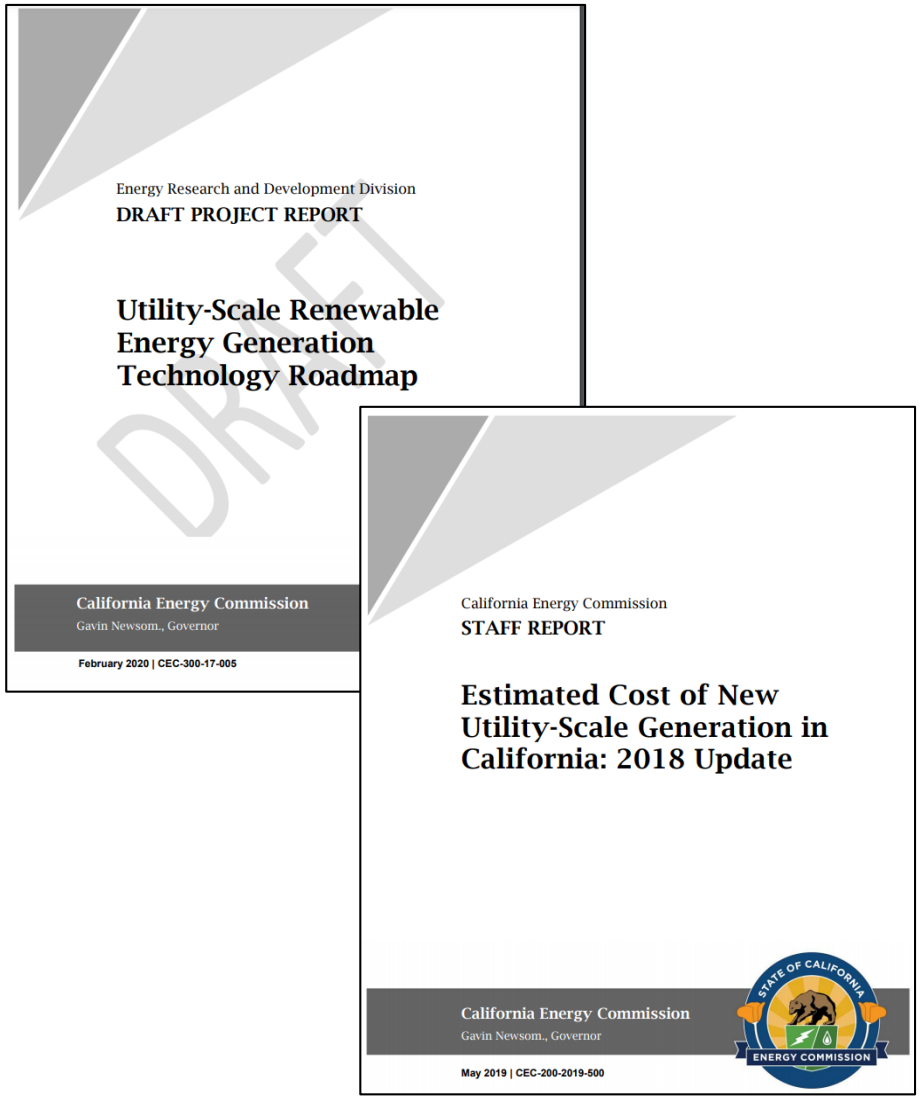
Charge to the Delphi Panel

- **Panelists were asked to project:**
  1. **Installed capacity for each of the 14 EPIC-supported technologies**
  2. **Capacity factors for 8 categories of renewable energy technologies**

TECHNOLOGY	2020	2025	2030	2035	2040	2045
Gasification of refuse-derived biomass	__ MW	__ MW	__ MW	__ MW	__ MW	__ MW
Food waste co-digestion	__ MW	__ MW	__ MW	__ MW	__ MW	__ MW
Total	__ MW	__ MW	__ MW	__ MW	__ MW	__ MW

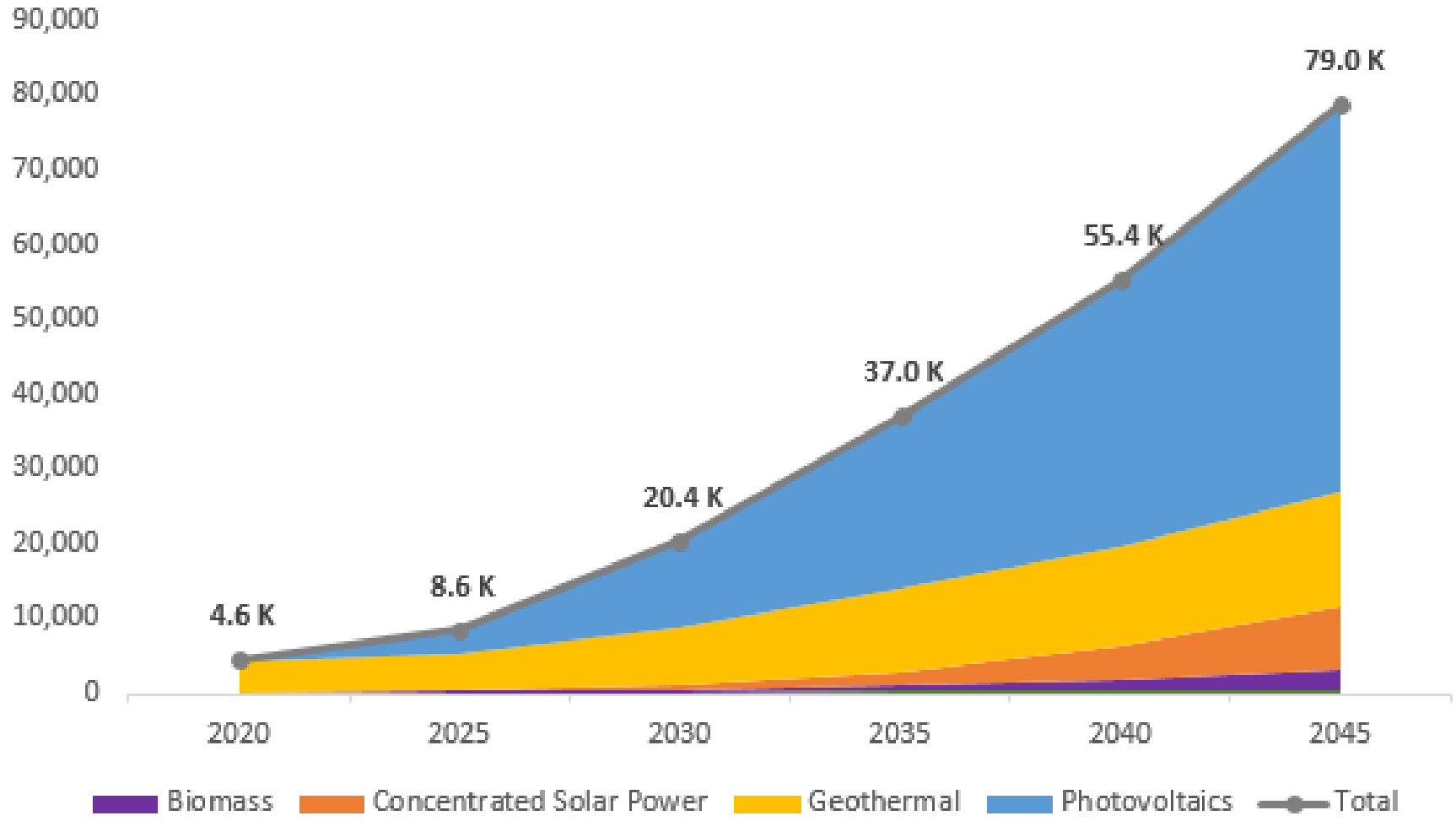
Panelist Packet of Information

- **Market Overview**
  - Current installed capacity and generation
  - Historical growth
  - Key cost metrics
  - Technical potential
  - Challenges and opportunities
- **Grant/Technology Information**
  - Stage of maturity
  - Target market and market potential
  - Problem statement
  - Grant activities and accomplishments
  - Next steps for the technology



Results: Technology Deployment

Annual estimated energy generated in GWh



*Based on average (mean) estimates of market uptake for 14 EPIC-supported technologies considered by the Delphi Panel

Results: Social Welfare Benefits and System-level Costs

Health Effects: $6.6 – 53 billion (PV, 3% discount rate)

Expected health outcomes associated with the change in air pollutant emissions (NO_x, SO_2, $PM_{2.5}$)

Social Cost of Carbon: $3.2 – 10 billion (PV, 3% discount rate)

Socioeconomic benefits associated with the GHG emission reduction/mitigation (CO_2, CH_4, N_2O).

Avoided System-Level Costs: $16 billion (NPV, 7% discount rate)

- Avoided energy procurement (including losses and ancillary services)
- Peak load reduction benefits (including avoided capital costs for new generation capacity, transmission, and distribution)

IEc

Daniel Kaufman, dkaufman@indecon.com, 617-354-0074
Christine Lee, clee@indecon.com, 617-354-0074
Mike Freeman, michael.freeman@emeraldenergyconsulting.com, 610-667-1737