

BUILDING A WORLD OF DIFFERENCE

RENEWABLE ENERGY COSTS

**JON
PIETRUSZKIEWICZ**

PROJECT MANAGER
ENERGY DIVISION

DOCKET

12-IEP-1D

DATE MAY 22 2012

RECD. MAY 23 2012

22 May 2012



BLACK & VEATCH
Building a world of difference.®

SOURCE OF BLACK & VEATCH COST DATA

- **Cost estimates/completed projects**
 - Feasibility-level, EPC projects, etc.
- **Financial due diligence**
 - Project finance, mergers and acquisitions
- **Broad, high-level studies**
 - Strategic planning (RETI, Western Renewable Energy Zones, NREL Renewable Energy Futures, etc.)
- **Market modeling and assessments**
 - Energy market modeling, forecasts, integrated resource planning, locational marginal pricing

Black & Veatch is a primary source, experienced with real projects



ECONOMICS OF ENERGY VARY WIDELY- 2010-2011 CAPITAL COSTS

	Capacity Factor (%)	Capital Cost (U.S. \$ / kW)
Solid Biomass	70 to 90	3,500 to 5,800
Wind	32 to 42	2,000 to 2,600
Geothermal	80 to 90	4,000 to 6,900
Solar Thermal	22 to 27	5,000 to 6,300
Solar PV	22 to 27	3,600 to 4,400
Natural Gas CCCT	70 to 90	1,000 to 1,600
Natural Gas SCCT (Frame)	5 to 50	600 to 900

Notes: B&V estimates from various projects being initiated in 2012 for completion in 2013 and beyond. Includes current incentives, but does not include any carbon costs (either for capture or incentives). Levelized cost of generation reflect life-cycle cost estimates at the output of the power plant (the “busbar”). Transmission costs and system integration costs excluded. Capacity factors based on local resource availability and can vary outside of the ranges here. Variable energy resources (wind, solar), do not include storage to firm the resource. Values shown are for typical commercial projects, subject to resource availability described below.

Resource availability: Landfill gas and biomass resources generally available in much of the U.S. Onshore wind (class 3+) available in many areas of the country except the Southeast; offshore wind available in coastal areas, but substantially more expensive. Geothermal limited to Western U.S. Highest quality (capacity factor) solar resource is in Southwest U.S. Costs elsewhere will be significantly higher.

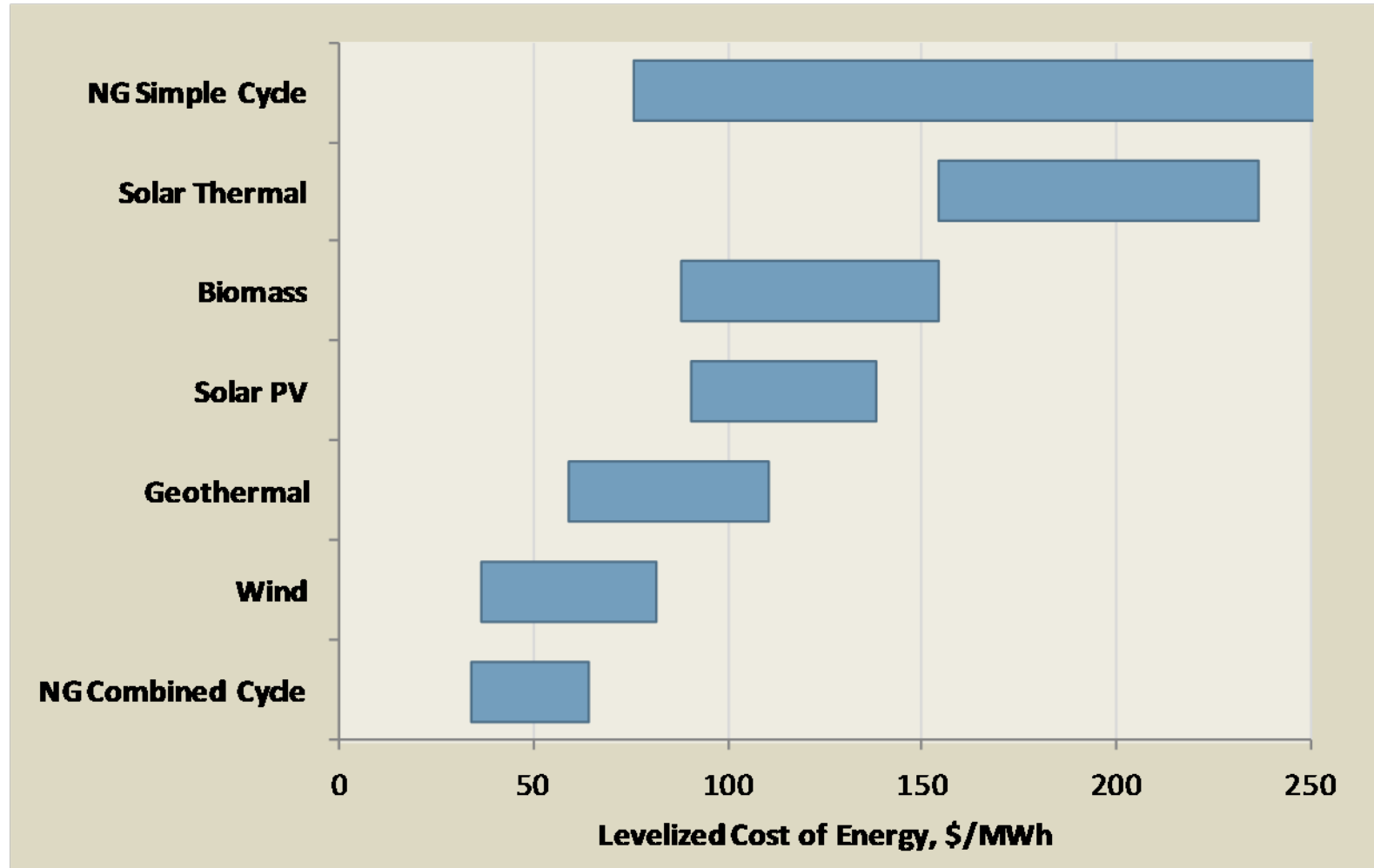
2012 RENEWABLE ENERGY COSTS

	Capacity Factor (%)	Capital Cost (U.S. \$ / kW)	Levelized Cost of Generation (U.S. \$ / MWh)
Solid Biomass	70 to 90	4,000 to 5,800	88-154
Wind	32 to 42	1,800 to 2,600	37-81
Geothermal	80 to 90	4,500 to 6,900	59-110
Solar Thermal	22 to 27	5,000 to 6,900	154-236
Solar PV	22 to 27	2,700 to 3,500	90-138
Natural Gas CCCT	70 to 90	900 to 1,500	34-64
Natural Gas SCCT (Frame)	5 to 50	600 to 900	75-346

Notes: B&V estimates from various projects being initiated in 2012 for completion in 2013 and beyond. Includes current incentives, but does not include any carbon costs (either for capture or incentives). Levelized cost of generation reflect life-cycle cost estimates at the output of the power plant (the "busbar"). Transmission costs and system integration costs excluded. Capacity factors based on local resource availability and can vary outside of the ranges here. Variable energy resources (wind, solar), do not include storage to firm the resource. Values shown are for typical commercial projects, subject to resource availability described below.

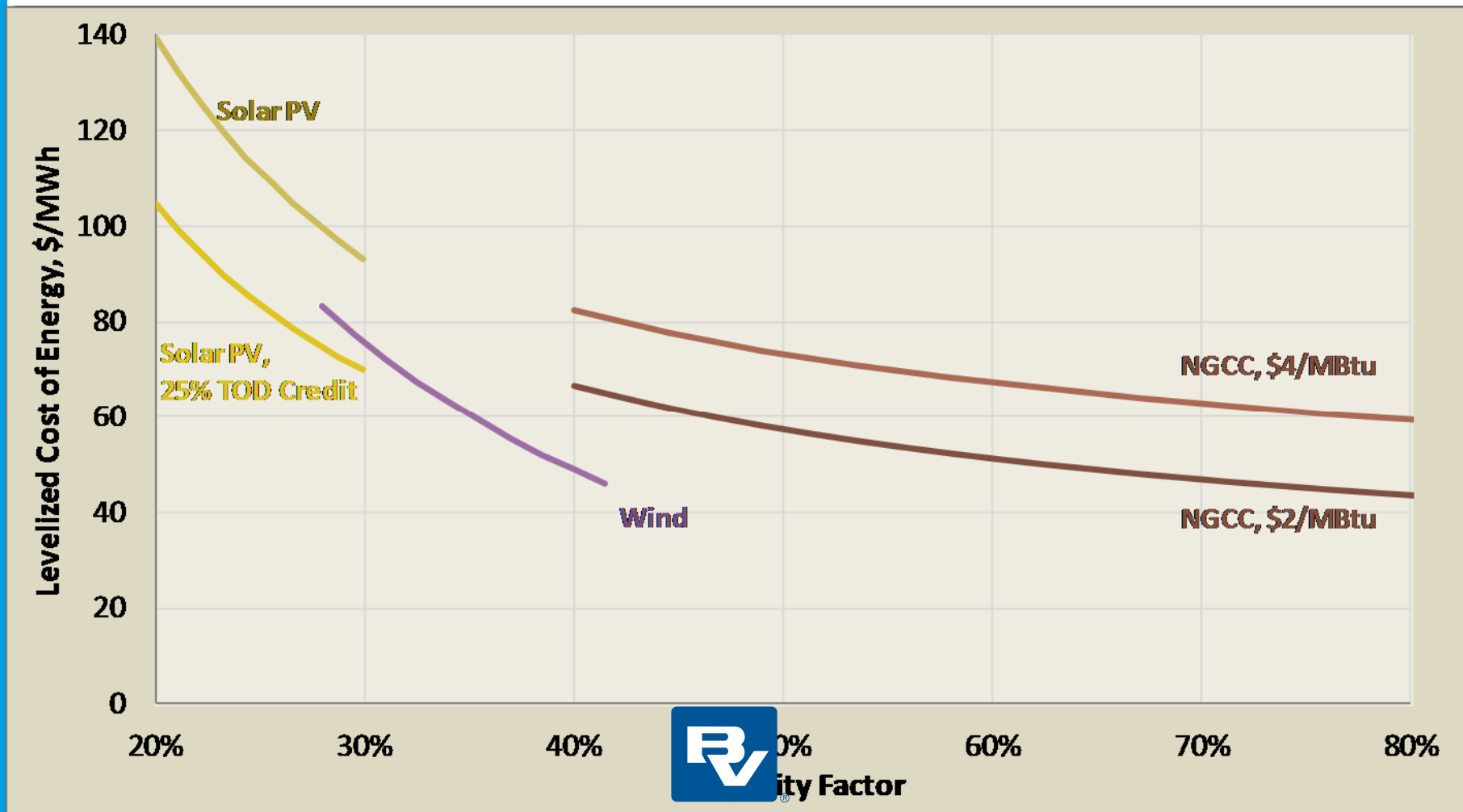
Resource availability: Landfill gas and biomass resources generally available in much of the U.S. Onshore wind (class 3+) available in many areas of the country except the Southeast; offshore wind available in coastal areas, but substantially more expensive. Geothermal limited to Western U.S. Highest quality (capacity factor) solar resource is in Southwest U.S. Costs elsewhere will be significantly higher.

LEVELIZED COST OF ENERGY COMPARISON



See notes on previous slides

LEVELIZED COST OF ENERGY COMPARISON



Hypothetical Comparison – For Example Only

Source: Black & Veatch Analysis. Note: Hypothetical comparison based on generic project costs and financing assumptions for 2012 projects. Costs likely to vary outside of these ranges based on specific project assumptions. Includes currently available tax credits.

HOW HAVE COSTS CHANGED OVER LAST FIVE YEARS?

- Financial crises effects- Everything peaked in 2008
- Energy market effects- Natural gas prices are low
- Technology improvement- large for PV
 - PV: Steep price decline over last 5 years
 - Wind: Small decline recently due to over supply, technology
 - Biomass: Projects are site specific
 - Geothermal: projects tapping lower quality resource, drilling cost may compete with nat. gas drilling
 - Solar thermal: costs perceived by BV to be moving higher

PV is the outlier, relative comparative value has improved

WHAT ARE THE KEY DRIVERS? ARE THEY UNIQUE TO CALIFORNIA?

- Drivers not generally specific to California, but are influenced by California unique resource availability
- Drivers are:
 - Technology development,
 - Commodity pricing,
 - Competitive landscape and the resulting margins,
 - Site availability,
 - Incentive availability

Site availability and technology development will drive the long term market, incentives the short term

WHAT RD&D EFFORT COULD HELP REDUCE BALANCE OF SYSTEM COSTS?

- Varies by technology
- Influenced by the owners cost which applies to that technology
- R&D for distributed systems, net zero, microgrids will have the most impact. Particularly business rules that change the status quo.

WHAT OTHER COST MUST BE CONSIDERED?

- Owners costs represent 15% to 35%
- Include:
 - Project development
 - Utility interconnections
 - Spare parts and plan equipment
 - Owner's Project Management
 - Plant startup/construction support
 - Taxes/advisory fees/legal
 - Owner's Contingency
 - Financing

Owner's cost are a sizeable consideration

WHAT FACTORS CAN CHANGE COST PROJECTIONS?

- Projections difficult because all types of public policy impact demand, margins, overall market price, and relative values of technologies
- Changes in distributed PV costs have the most potential for relative impact
- Technology R&D, net metering laws, community microgrid rules and regulations, net zero law, etc potentially can change the landscape

Building a **world** of difference.®

Together



BLACK & VEATCH