Northwest **Power** and **Conservation** Council

April 5, 2016

MEMORANDUM

TO: **Council Members**

FROM: **Steven Simmons, Gillian Charles**

SUBJECT: **Utility scale PV update: cost, installations, and performance**

BACKGROUND:

Presenter: Steven Simmons, Gillian Charles

Summary: Over the past eight years, installations of solar power in the United States have risen from around one gigawatt to just over 22 gigawatts (according to DOE data). The majority of these installations have been PV technology, both utility-scale and distributed. Now that many of the utility-scale installations have been on-line for at least a few years, the projects may be evaluated for performance, such as whether or not they are reaching expected capacity factors. Staff will present on new information coming out regarding installations and performance of utility-scale PV projects across the U.S, and how projects in the Northwest may compare. In addition, staff will provide an update on new solar development in the region, as well as a brief introduction to additional solar topics to discuss at later meetings.

Relevance: The Seventh Power Plan found that PV costs were decreasing and that the resource is now competitive with wind. In the past, wind has been the dominant renewable resource in the Pacific Northwest. The Plan encouraged looking at solar as an alternative when pursing renewable portfolio standard compliance.

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Workplan: A.4 Generating Resources – update generating resource datasets including RPS, project, and technology

Background: To date, there has been limited development of utility-scale PV in the Northwest. The Outback Solar project in Eastern Oregon is the largest project to date at 4.4 MW (AC). However, due to declining costs of solar technologies, the analysis from the Seventh Plan found utility scale PV may play a greater role in the future regional power system.

In the meantime, installations of utility-scale PV projects across the U.S. has been growing at a rapid pace, and 2016 is expected to be a record year in terms of new installed capacity. Though PV technology is not new, large-scale PV deployment for power generation is a fairly recent phenomena in the United States. In fact, around 90% of the overall capacity of utility-scale PV has come on-line in just the past four years. As more projects have deployed, actual generation data is now available to analyze how well these PV projects are performing.

Utility Scale PV Update:

Cost, Installations and Performance

Power Committee

Steven Simmons, Gillian Charles

April 2016

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Today's Presentation

- 2015 was another banner year for utility scale pv deployment across the U.S. - and 2016 may be even bigger
- How are pv projects performing, and what are the key factors that impact performance ?
- How does the Northwest weigh in ?
- Introduction to community solar

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Utility Scale PV in the USA

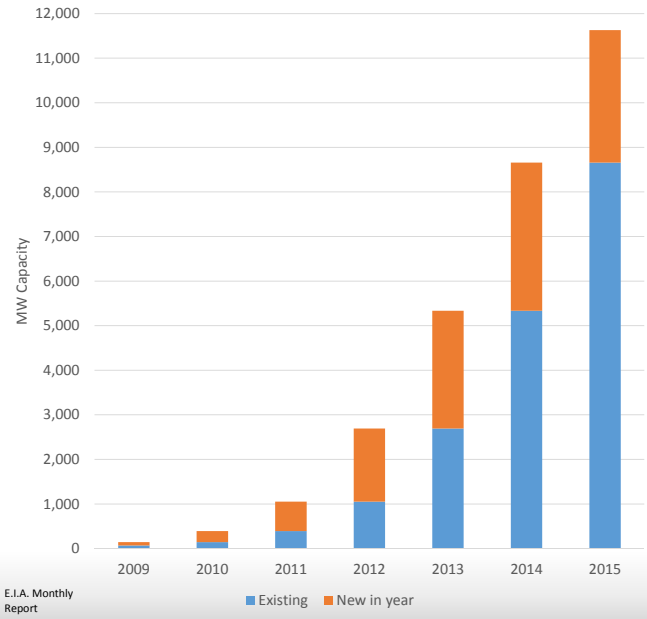
- Deployment of solar is booming
- Both installation costs and PPA prices are declining
- Federal Investment Tax Credit (ITC) extended past 2016
- Of the project nameplate MW in operation by the end of 2015 – around 90% has been installed in just the past 4 years
- Focus shifts from planting hardware into the ground, to performance. How are these installations performing ?

Solar Costs

- Costs for solar have continued to decline year over year
  - improving module technology
  - more efficient manufacturing
- Opportunities to cut costs further
  - Improving technology
  - More steam-lined acquisition and installation
  - Lower overhead costs for solar companies

Utility Scale PV in the USA

Most of the existing capacity has been installed in the past few years



E.I.A. Monthly Report

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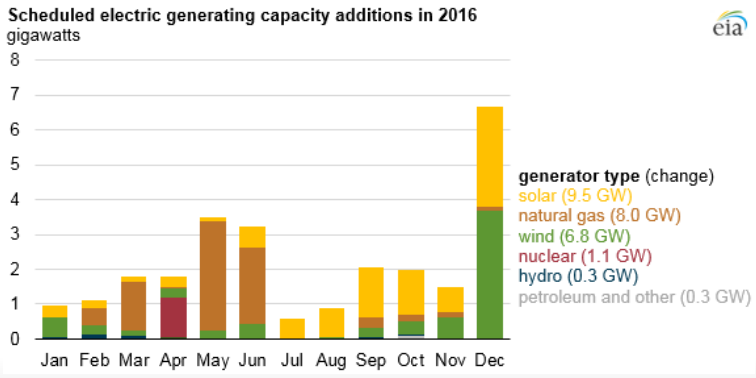
Utility Scale PV in the USA

More is on the way in 2016



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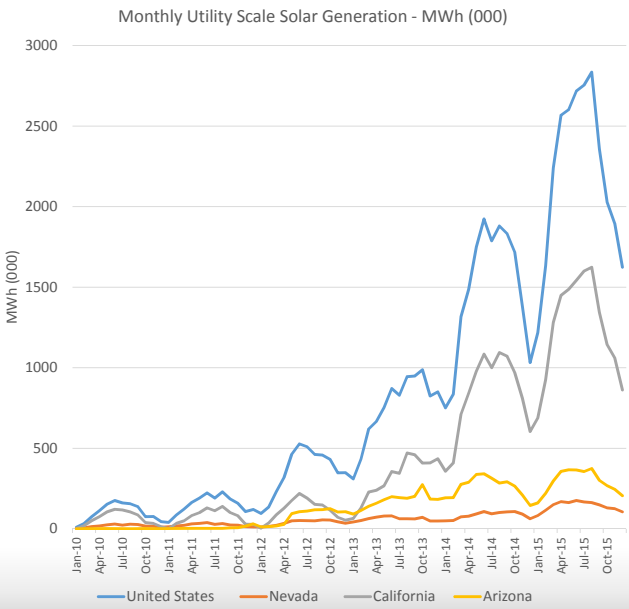
Focus shift – from installed capacity to actual generation

The high up-front capital costs associated with solar projects must be recovered over the number of MWh produced

The realized capacity factor is an important project performance metric



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Utility Scale PV Performance

Lawrence Berkeley National Labs just released a study of utility scale pv performance across the U.S.

- Generation data for a single year (2014) from 128 solar projects totaling 3200 MW_{ac}
- Ground mounted projects, 5 MW_{ac} or larger, with and without tracking
- Projects in the sample represent 18 different states
  - CA & AZ combined for nearly 70% of the capacity
  - None from Northwest

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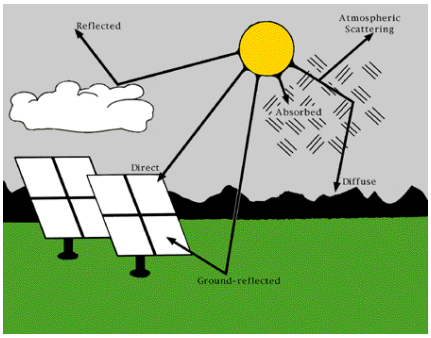
Utility Scale PV Performance

Study found that three primary variables influence project performance

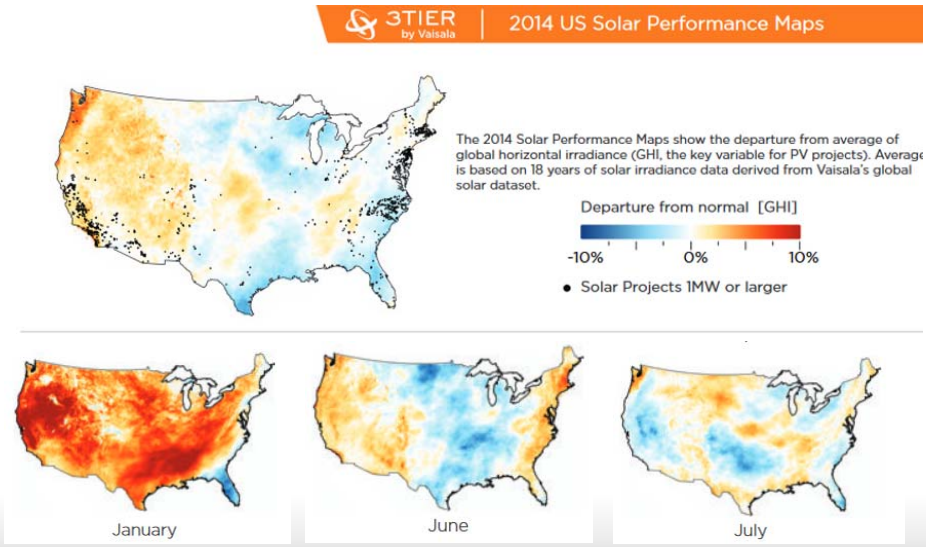
1. Solar resource – Global Horizontal Irradiance (GHI)
2. Design – Tracking (Single Axis) or Fixed
3. Design – Inverter Loading Ratio (ILR)

Solar Resource - GHI

- GHI is a measure of the of the solar resource - a composite of direct and diffuse irradiance – kWh/m^2/day
- For an increase of 1 GHI, pv capacity factors increase roughly
  - 4 % for fixed-tilt
  - 6 % for tracking

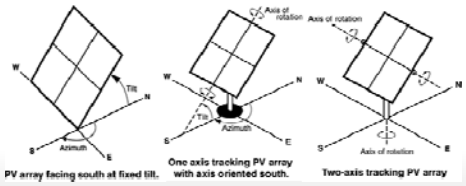


How was the solar resource in 2014 ?



Design - Tracking

- Roughly half of the projects studied were single-axis tracking, and half fixed. None were dual-axis tracking though some projects will be coming on-line soon
- At average GHI & ILR levels, moving from fixed to single-axis tracking adds around 4% to the capacity factor



Design - ILR

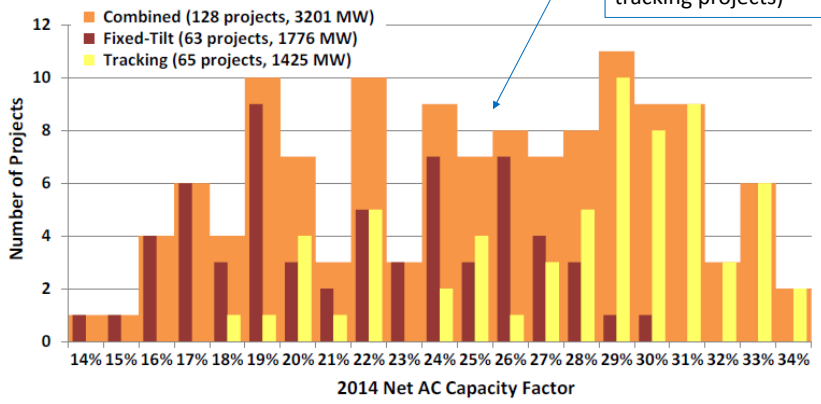
- Inverter loading ratio – ratio of a project's DC capacity rating to its AC capacity rating
- Developers have found it economically advantageous to increase DC rating of array relative to AC rating of inverters
- Can boost production at shoulder hours in morning and evening, sometimes a high ILR is used instead of tracking to achieve desired performance
- Most projects ILR range from 1.05 to 1.50
- For each 0.05 increase in ILR, capacity factors increase roughly 1% – except at higher levels, more "clipping" occurs causing diminishing returns

Other tidbits from the study

- Projects have produced as expected – utility scale pv is not underperforming
- So far, annual degradation of pv modules appear to be on the low range of expectations – around 0.23% per year (expected 0.2 to 1.0 %)

Project Capacity Factors – from LBNL Study Sample

No NW solar plants were included in the sample – however here is where the Outback Solar Project & S. ID Reference Plant would land (both are tracking projects)



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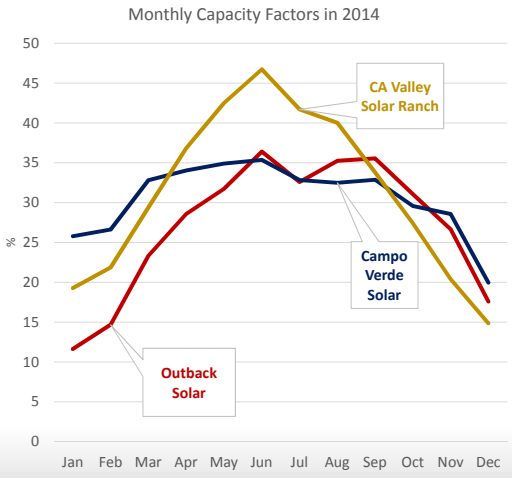
Specific PV Project Generation



Project	Outback Solar	CA Valley Solar Ranch	Campo Verde Solar
Size	4.4 MW	250 MW	139 MW
Location	Lake Co, OR	San Luis Obispo Co CA	Imperial Co, CA
Note	Single-Axis Tracking	Single-Axis Tracking	thin film, fixed tilt
2014 Capacity Factor	27	31	30

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Utility-Scale Solar PV in the PNW

- Currently ~ 220 MW solar PV capacity under development in S. Idaho
  - Power purchase agreements with Idaho Power
  - Estimated online
- Several projects in S/SE Oregon, at various stages of the planning process
- Few small projects in Montana
- Not a lot of development at the moment in Washington

Community Solar – What is it?

- A form of "shared" resource where multiple electricity consumers share the costs to purchase and own – and share the benefits of - a generation project
- Solar PV arrays are a common form of shared resources
  - Increases access to solar developments that may not be feasible (financially and logistically) otherwise
  - Alternative to individually owned rooftop solar installations
- Examples – Utility-owned, solar gardens w/ PPA to utility

Community Solar – Utility-owned

- Utility owns a solar PV array and (a) leases or sells individual panels or shares to customers, or b) applies a solar charge to customers "opting in" to the program to cover costs
  - Utility is in charge of all maintenance
  - If option (a) –
    - Typically a long-term contract (e.g. 25 years); ownership transferable if customer moves out of service area
    - Customer receives reduction of monthly electricity bill (dependent on arrangement)

Community Solar – Utility-owned: Benefits

Utility

- Maintains customer and their load – no utility death spiral!
- Direct ownership and control over operations of project
- Could potentially lower the rates of non-participating customers; only the participants cover the costs of solar project

Customer

- Affordable way to participate in renewable energy; cheaper than owning personal rooftop system → economies of scale

Overall

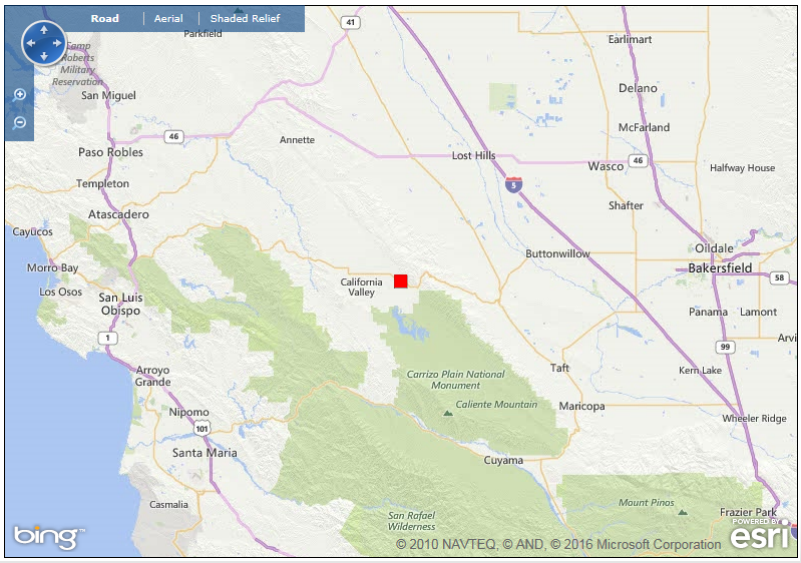
- Increases access to solar developments to a greater share of the market

Next month at the Boise Council Meeting…

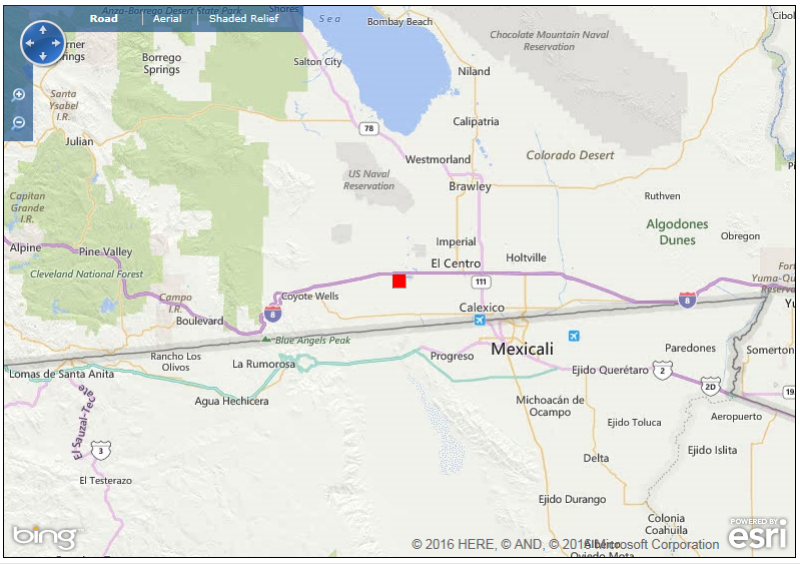
- Development of Solar PV in the region and its effect on existing transmission
  - Are there constraints?
- How does Idaho Power plan to integrate the addition of solar generation planned to come online in the next year?
- Potential tour of a solar PV project in Boise

Extra Slides

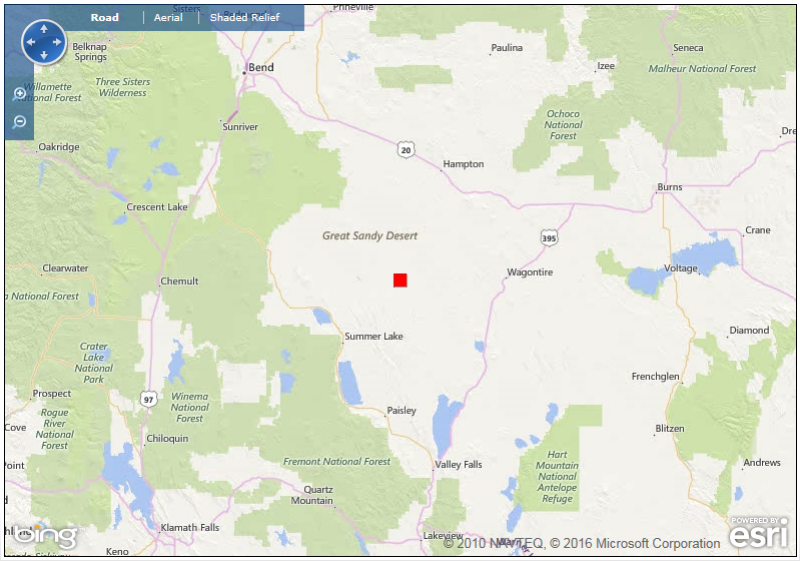
CA Valley Solar Ranch



Campo Verde Solar



Outback Solar



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