Rooftop Solar Photovoltaic
Seventh Plan Approach to Analysis

CRAC November 13, 2014

Northwest Power and Conservation Council

SEVENTH NORTHWEST POWER PLAN

Outline

- Approach for Seventh Plan
- Background
- Initial Findings
- Issues for CRAC Feedback

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Why Solar PV at Conservation Advisory Committee?

- A "direct-application" renewable resource under the Regional Act
  - But does not get 10% Act Credit
- Largely a consumer-side resource
- Reduces load on the grid like EE
- Somebody needs to do it

Issues for CRAC

- Is the approach appropriate?
- Forecast cost decline
- Total potential available: Max number installs
- Baseline adoption rate into load forecast
- Is three geographic areas sufficient?
- Ramp Rate: How fast could it be installed?
- How to estimate net back to grid

Approach for Seventh Plan

1) Estimate Rooftop Solar PV System Cost
2) Forecast Changes in Cost & Performance
3) Estimate Total Resource Potential
4) Forecast Status Quo Adoption Rate
5) Status Quo Adoption of PV Reduces Load Forecast
6) Remaining Potential Made Available to RPM
7) Vet Assumptions with Advisory Committees

By 2012 over 10,000 Utility Customers Installed 66 MW of PV Capacity (MW) Selling back about 1 aMW of Power

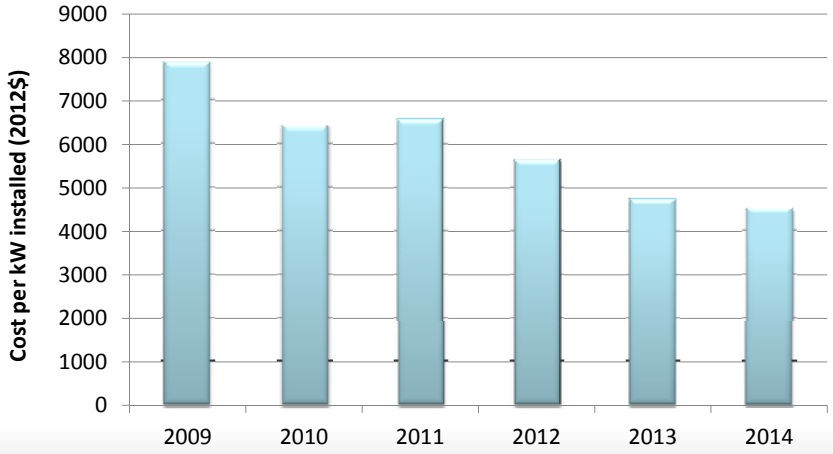
	Net Metering Customer Count	Capacity Installed (MW)	MWh of Power Sold back to utility
Idaho	349	2	2
Montana	1,010	4	122
Oregon*	6,269	43	8,687
Washington	3,222	17	932
Region	10,850	66	9,742

Source: EIA 861 annual Utility Net metering data

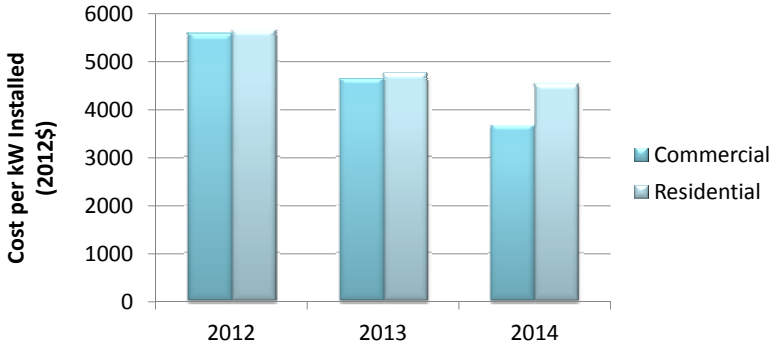
*OPUC's reports that by 2013 about 8000 customers in Oregon are on net-metering.

Installed Cost Falling

Energy Trust of Oregon Program Data



Commercial Costs Lower than Residential



- Residential costs drop 20% since 2012
- Commercial costs drop by one-third since 2012

Average Residential Size Going Up (Energy Trust of Oregon Data)

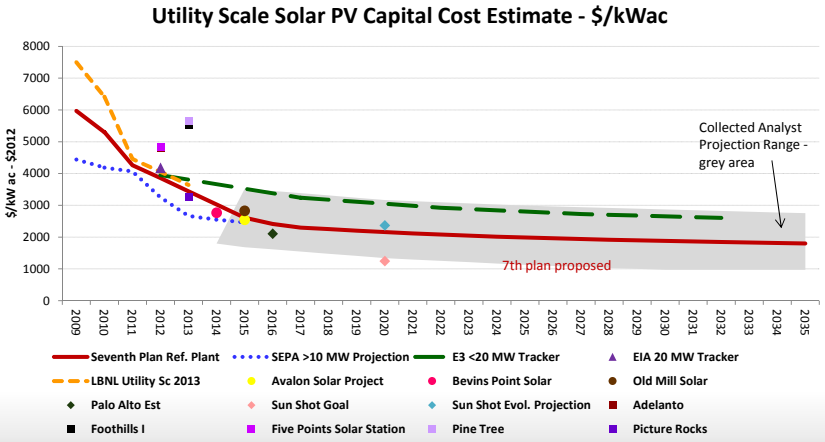
- 2012 = 4.2 kW
- 2014 = 5.3 kW

Cost & Savings Inputs

(In 2012$ for a 2014 Install)

Element	Value(s)	Source/Method
Capital Cost ($/Watt DC)	$4.5 Res, $3.8 Com	ETO 2014 cost
Annual O&M ($/Watt DC)	$0.032 Res, $0.024 Com	NREL
Inverter Replacement	10-Yr Res, 15-Year Com	NREL
Typical System Size	5.3 kW Res, 35 kW Com	ETO 2012-2014
Life	25 Years	NREL
Program Admin Cost	?	
System Integration	$1.07/MWh	BPA Tariff
Locations	Seattle, Portland, Boise	
Production & CF & Shape		PV Watts

Proposed Cost Declines Based on Utility Scale Cost Curve
~ 33% by Reduction 2025



Example Cost of Rooftop PV Energy
Levelized Cost $/MWh (2012$)

	Cost in 2014	Cost in 2025	Cost in 2035
Boise (Residential)	$200	$140	$130
Boise (Commercial)	$160	$110	$100
Portland (Residential)	$260	$180	$170
Portland (Commercial)	$210	$140	$130

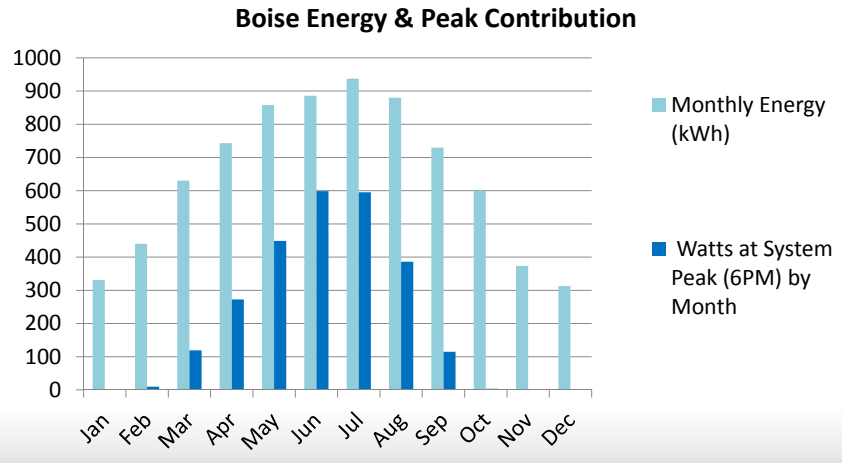
- Levelized Cost per MWh (2012$)
- 25-Year Life
- 4% Discount Rate
- 5.3 kW System
- No Regional Act Credit
- No Federal Tax Credit
- O&M Cost & Inverter Replacement & Integration
- No Program Admin Costs

Total Potential Available

Sector	High (aMW)	Low (aMW)
Residential	2500	1500
Commercial	2000	1000
Total	4500	2500

- Two Methods Used
  - Roof Area * Suitable Roof * kW/SF collector
  - Buildings * Suitability * Typical kW /Building
- Sources:
  - CBSA, RBSA, Solar Studies
  - Council forecast of residential & commercial stock

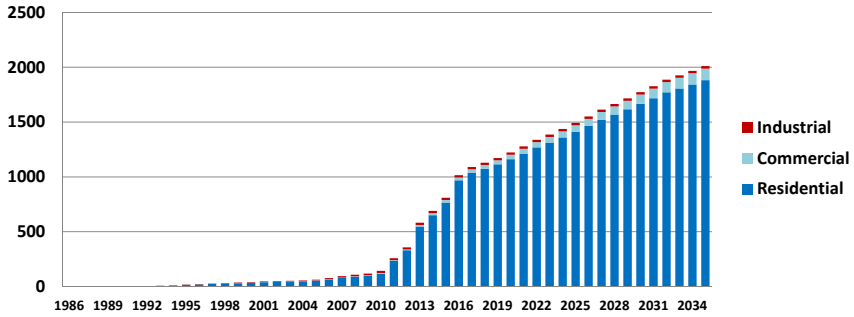
NREL Solar Calculator Used to Shape Energy & Peak Impacts



Forecast Long-Term Adoption (Business as Usual Case)

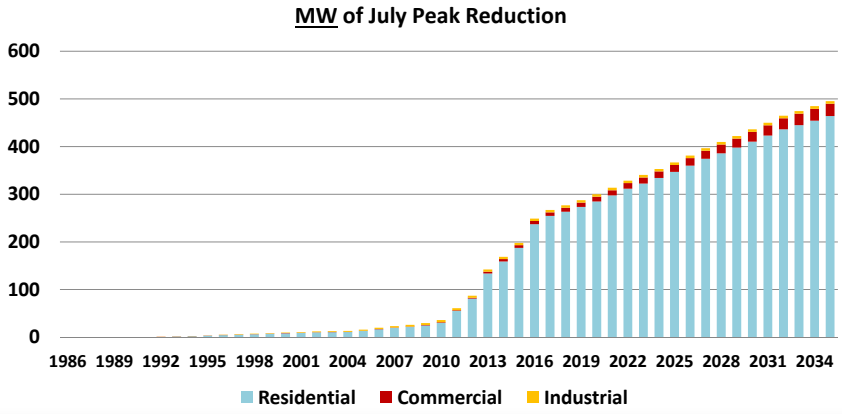
- Council's long-term load forecast model estimates continued consumer PV adoption rates
- Estimated for all sectors
  - Historical PV adoption trends (1985-2012)
  - Forecast retail power rates
  - Solar PV costs & performance
  - Both energy and peak impacts
- Forecast load reduced by forecast adoption of PV
  - Initial estimates: Consumer side-PV generation supplies 0.5-2.0% of regional electric load by 2035

Preliminary Projection Consumer Uptake Rooftop Solar PV Energy (GWh)



- Average Annual Growth Rate 2015-2035 ~ 5%
- Generation : ~ 230 aMW by 2035
- Roughly ~ 1.2% of total load
- Roughly 5% - 10% of potential

Preliminary Projection Consumer Uptake Rooftop Solar PV Peak



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Solar PV Not Adopted in Forecast Model Remains As Resource Option

	In Service 2014	In Service 2024	In Service 2034	Sixth Plan
Total Energy Available aMW			2500 – 4500 minus ~ 200	250
Cost per MWh	$160 - $260	$110 - $180	$100 - $170	> $200
Program Ramp Rate	?	?	?	

Estimated Production 2012 < 10 aMW

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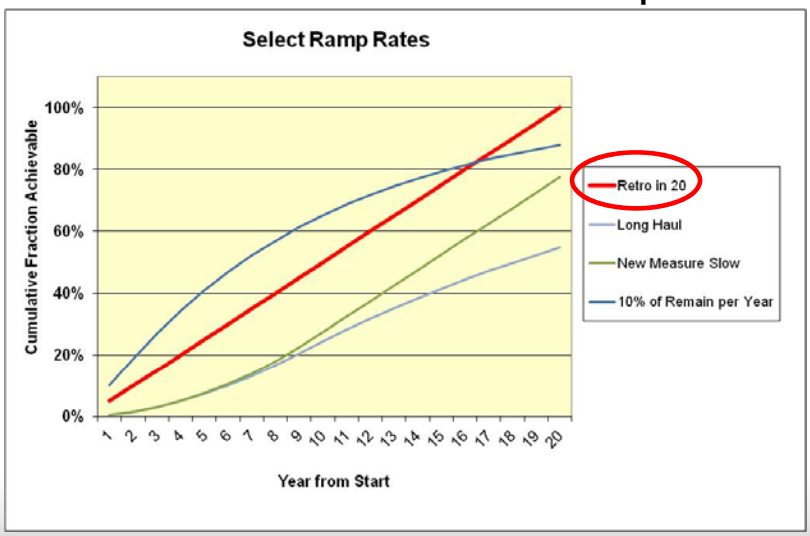
What Max Pace of Development?



Summary: Approach for Seventh Plan

1) Estimate Roof top Solar PV System Cost
   - Use recent cost data from Energy Trust of Oregon
   - By solar zone, residential & commercial applications
2) Forecast Changes in Cost & Performance
   - Use same cost curve decline as utility scale
   - Apply to rooftop prices
3) Estimate Total Resource Potential
   - Number of homes & businesses & roof area
   - Fraction applicable (adjust for orientation & shading)
4) Subtract market adoption
   - Long-term forecast model based on historical adoption
5) Apply maximum annual availability
   - Propose retrofit in 20 years
6) Add remaining potential as Distributed Generation option

Summarize CRAC Perspective

- Is the approach appropriate?
- Forecast cost decline
- Total potential available: Max number installs
- Baseline adoption rate into load forecast
- Is three geographic areas sufficient?
- Ramp Rate: How fast could it be installed?
- How to estimate net back to grid

End

Extra Slides

Background Solar PV

- It's a global market
- Modest consumer uptake in PNW
- Recent uptick in PNW adoption
- Solar PV costs falling
- Other trends: Ownership & financing

Typical Installed Cost

- Residential: $20,000 - $25,000 (4-5 kW)
- Commercial: $50,000-$200,000 (10-40 kW)
- Largest: $22 million (5.7 MW)

- Incentives typically cut consumer costs in half
- Third-Party leased projects at no initial customer cost
- Provide 40-50% of residential electric needs

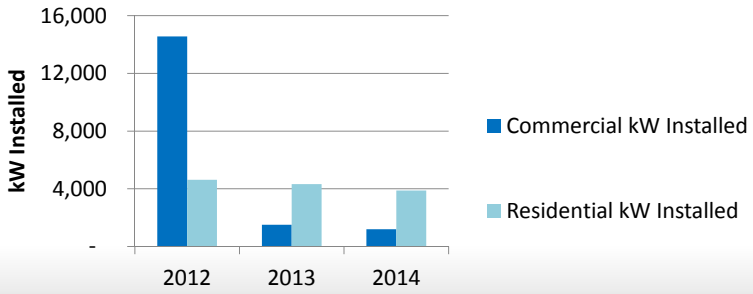
What's Happening in Programs?

Energy Trust of Oregon Program 2012-2014

- ETO Incentives for Residential
  - PGE: $0.95/Watt, up to $9500
  - PacifiCorp: $0.70/Watt, up to $7000
  - Cash or Loan, or
  - Third-Party Leasing, fixed-term lease payment
- Plus State Tax Credit
  - Up to $6000 per residence
- Plus Federal Tax Credit
  - 30% of cost through 2016

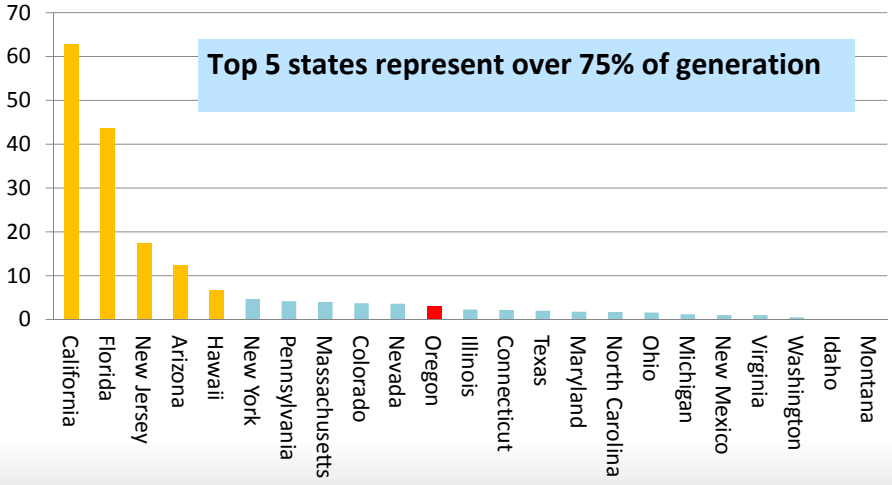
Energy Trust Oregon 2012-2014 Total Installed Capacity 30 MW

- Residential: About 4 MW per year
- Commercial: About 1-2 MW per year
- Utility Scale: Occasional large projects
- Over 6000 systems installed since 2003, total 58 MW
- 20MW Residential, 22MW Commercial, 16 MW Utility Scale



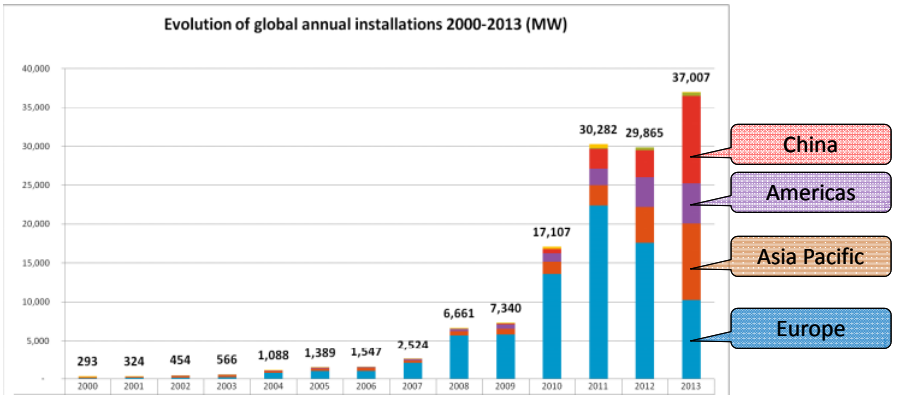
Solar Growth Not Uniform Across States

2012 Roof-top Solar Power Production (Trillion Btu)



Source: EIA SEDS 2012 – includes solar thermal

A World Market

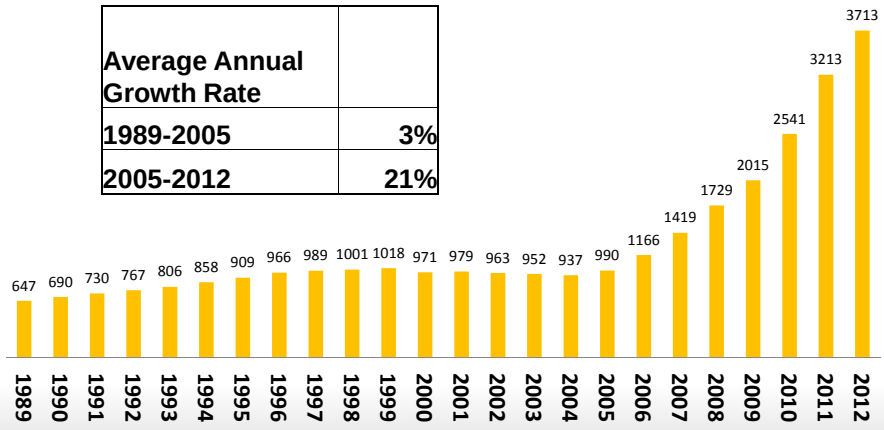


Source: European Photovoltaic Industry Association, Global Market Outlook 2014-2018

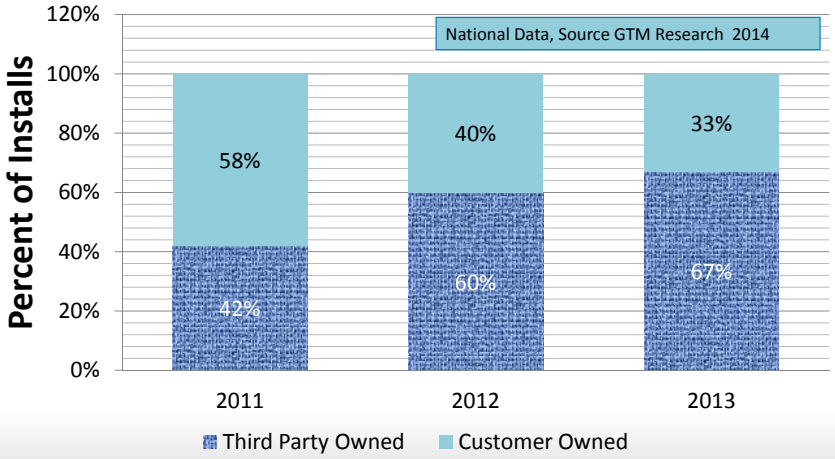
PNW Regional Energy Production by Rooftop Solar (Trillion Btu)

Source EIA : State Energy Data System

Average Annual Growth Rate	
1989-2005	3%
2005-2012	21%



Third-Party Leasing Overtakes Customer-Owned Residential Solar

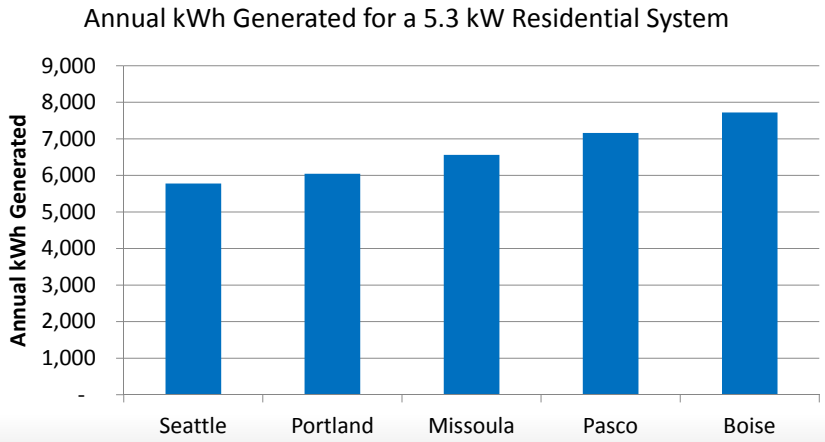


Emerging Ownership & Financing Options

Consumer interest in solar PV has generated new approaches, financing & ownership arrangements

- Community Solar
- Special Purpose Entities
- Solar-Specific Banks
- Lease Options
- Utility-Sponsored Models
- Bulk Purchasing

Location Matters: More Sun Means More Energy Produced



Estimating Potential Applications

- Most homes have some solar access
- Panels do not have to be on buildings