Emerging Technology Scenario

Conservation Resources Advisory Committee

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The 3B Scenario

- Eliminating carbon emissions with emerging technology
  - Not (completely) modeled in RPM
- Identify possible path to zero carbon future for electricity system by 2035
- Not limited by cost

Step 1: Identify the Gap

- Run RPM with:
  - No new carbon-emitting resources
  - No cost limit on carbon-free resources
    - Conservation (include EE>$170/MWh)
    - Demand response
    - Distributed PV, with achievability assumptions
    - Utility-scale PV
    - Wind
- Determine how much of remaining energy and peak demands are being met with carbon-emitting resources
  - This is the amount to offset
- RPM will seek an adequate system
- **This is not an economic optimization!**

Step 2: Fill the Gap with ET

- Approach 1: Emerging technologies
  - Energy efficiency resources, such as: CO_2 heat pump water heaters, next gen solid state lighting, highly insulated dynamic windows, advanced controls, evaporative cooling
  - Generation resources: Utility PV, enhanced geothermal, small modular reactors
  - Combined heat and power (biomass)
- Identify amounts and availability

Step 2: Fill the Gap with ET & Revised Hydro Dispatch

- Approach 2:
  Reconfigure hydro system dispatch
  - Operate the hydro system with emphasis on capacity rather than energy
  - Significant changes in standard operations, but still meeting regulatory requirements
  - Would still need emerging technology to fill a smaller gap (perhaps)
  - Likely a much lower cost option

Status

- Have estimates of ET (by 2035):
  - Conservation 1,100 aMW, 2300 MW_{winter}
  - Distributed PV 4,000 aMW, 0 MW_{winter}
  - Utility PV 1,000 aMW, 0 $MW_{winter*}$
  - Geothermal 9,000 aMW, 10,000 MW_{winter}
  - Modular reactors 2,000 aMW, 2300 MW_{winter}
- Currently running RPM to identify the gap
- Result will be narrative discussion of resources needed for adequacy and possible solutions

**1,200 MW with Storage*

Conservation ET Data

Emerging Technology	2025			2030			Required Conditions
	aMW	MW (winter)	TRC Net Lev Cost ($/MWh)	aMW	MW (winter)	TRC Net Lev Cost ($/MWh)	
Additional Advances in Solid-State Lighting	200	400	$0-$30	400	800	$0-$30	Continued tech improvement, resource availability
CO_2 Heat Pump Water Heater	110	200	$100-150	160	300	$90-140	UL approval; U.S. market development
CO_2 Heat Pump (space heat)	50	160	$130-170	130	350	$110-160	Best suited for hydronic heating, need research and development (R&D) for U.S. applications
Highly Insulated Dynamic Windows - Commercial	20	130	$500+	35	200	$300	Intensive R&D effort needed to bring down cost; slow ramp due to window replacement schedule
Highly Insulated Dynamic Windows - Residential	80	230	$500+	120	350	$400	
HVAC Controls – Optimized Controls	140	230	$90-120	200	350	$80-110	Significant developments expected in next 5 years
Evaporative Cooling	50	0*	$100-130	80	0*	$90-120	Need R&D on configurations & applications in PNW
Distributed Photovoltaics	800-1400	0*	$70-280	2200 - 4000	0*	$60-250	High penetration may require additional integration costs and distribution system upgrades.

Generation ET Data (2035)

Emerging Generation Technology	Capacity (MW)	Energy (aMW)
Enhanced Geothermal Systems (EGS)	5,000	4,500
EGS Rapid Develop	10,200	9,100
Utility Scale Solar (per plant)	48*	10*
Small Module Reactors (SMR)	2,300	2,000

**Per plant*