Pacific Northwest Renewables
Recent experience & future prospects

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National Energy Modeling System/Annual Energy Outlook Conference

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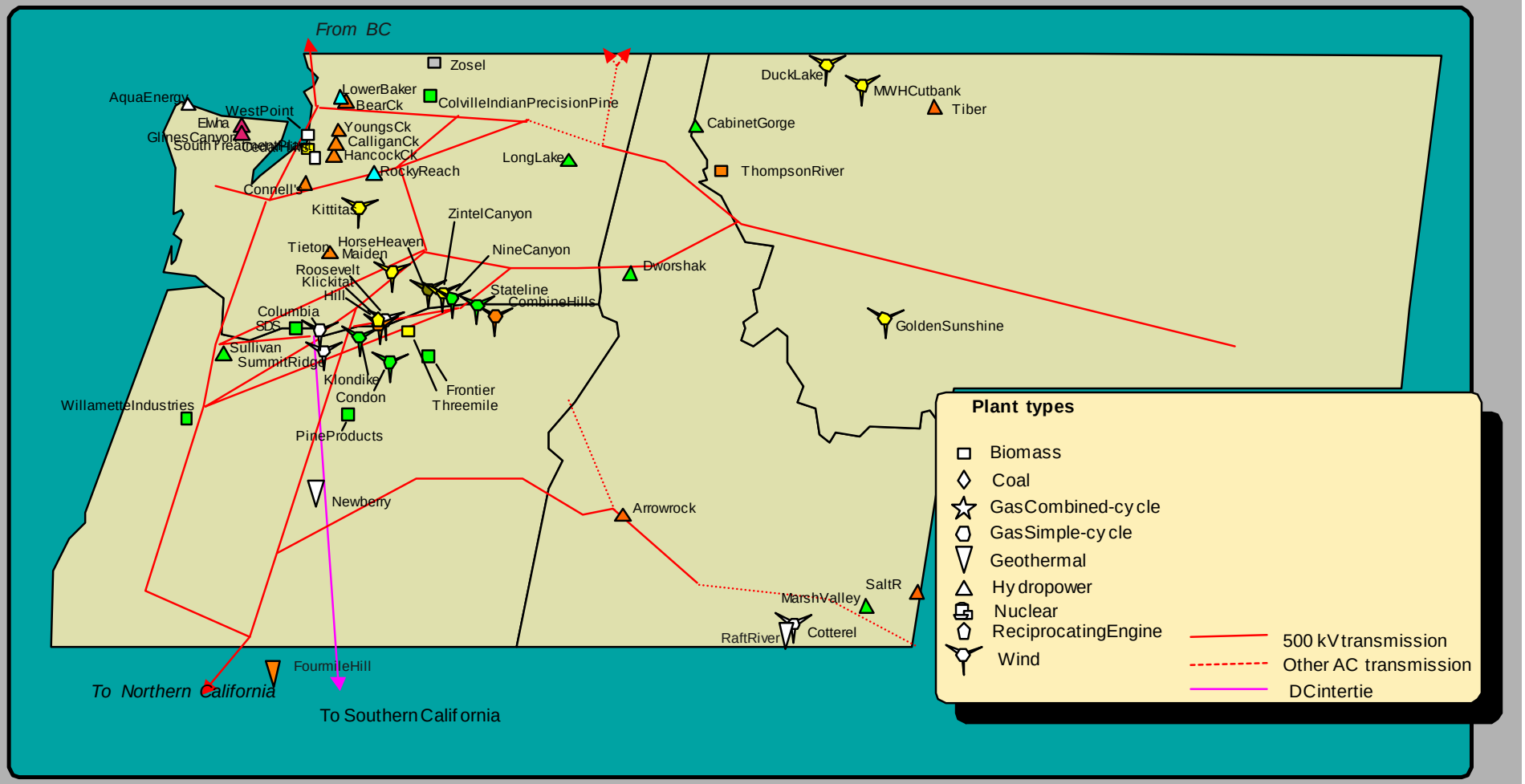
The Pacific Northwest



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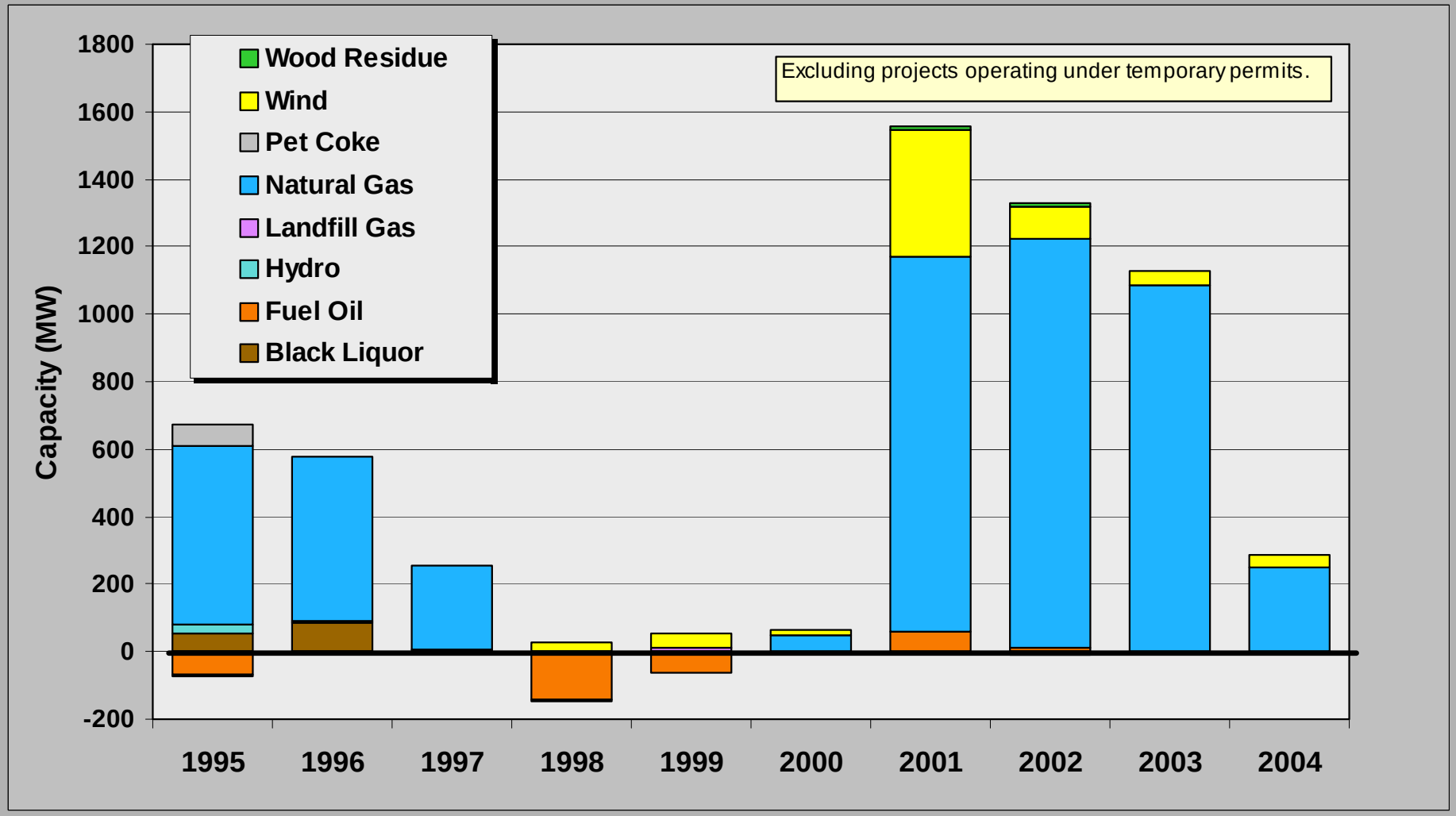
Additions & retirements: 1995 - 2004



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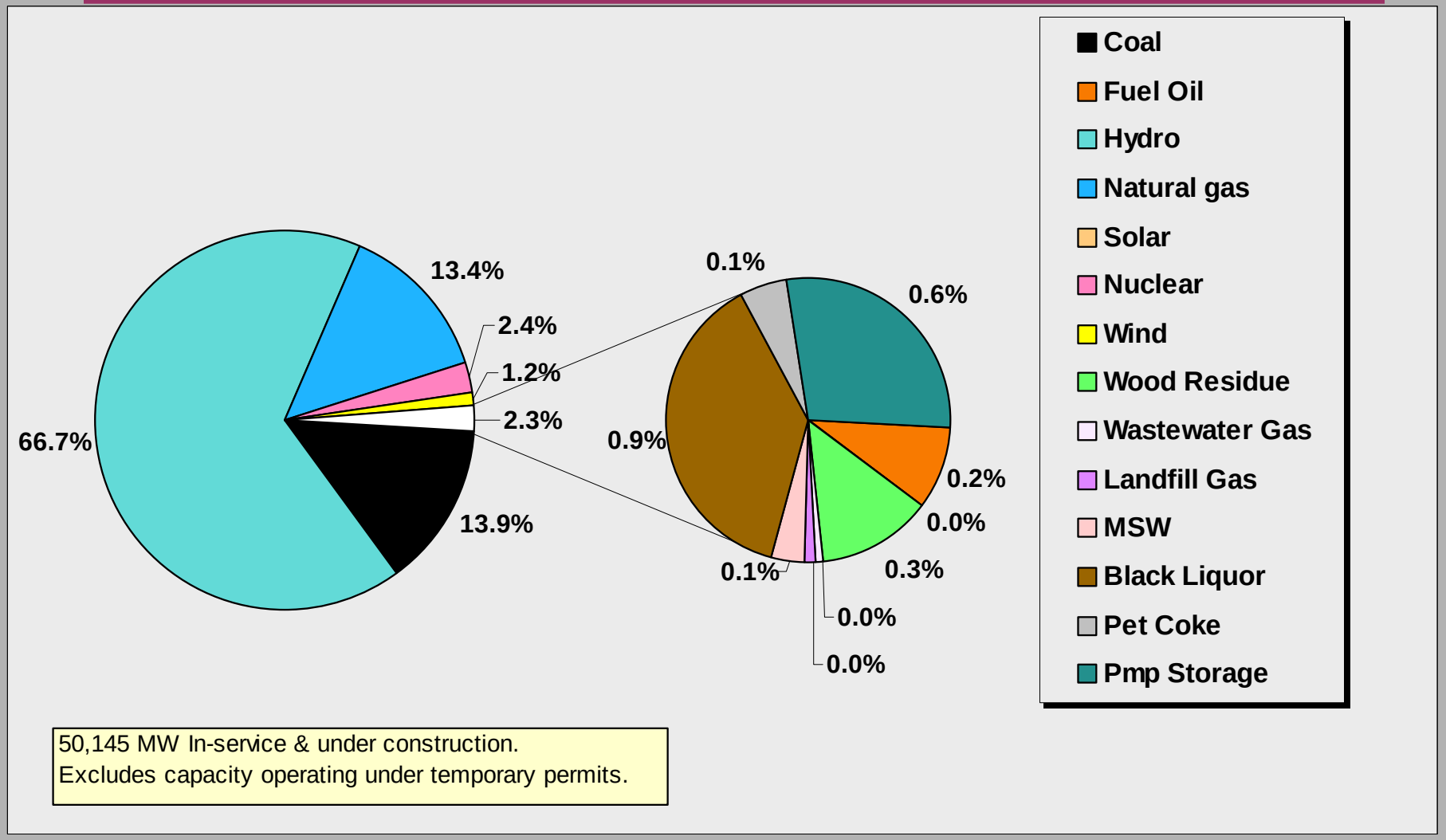
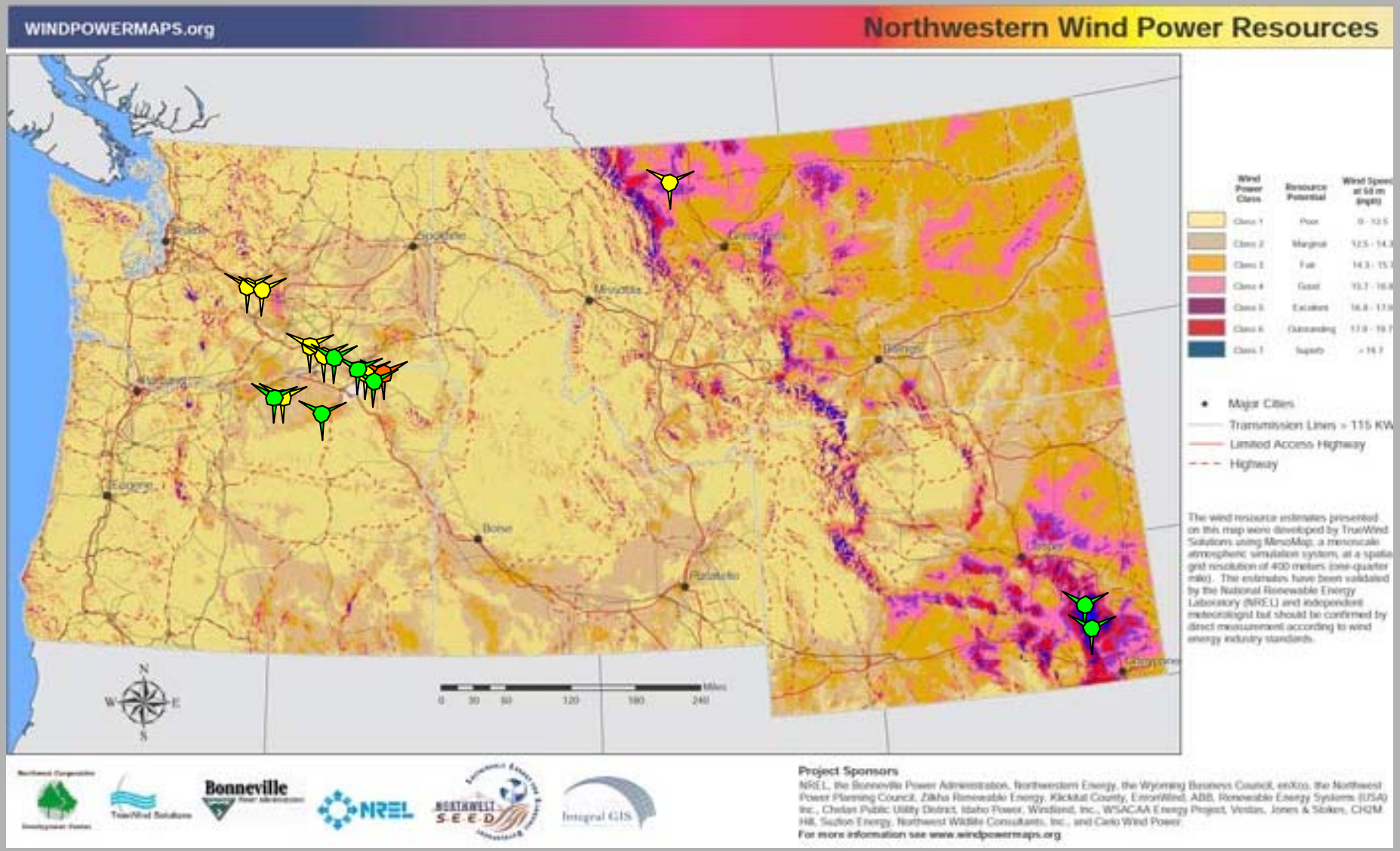
Resource mix (capacity): 2004



50,145 MW In-service & under construction.
Excludes capacity operating under temporary permits.

Wind


WINDPOWERMAPS.org
Northwestern Wind Power Resources
Major Cities
Transmission Lines > 115 KV
Limited Access Highway
Highway
Project Sponsors
For more information see www.windpowermaps.org

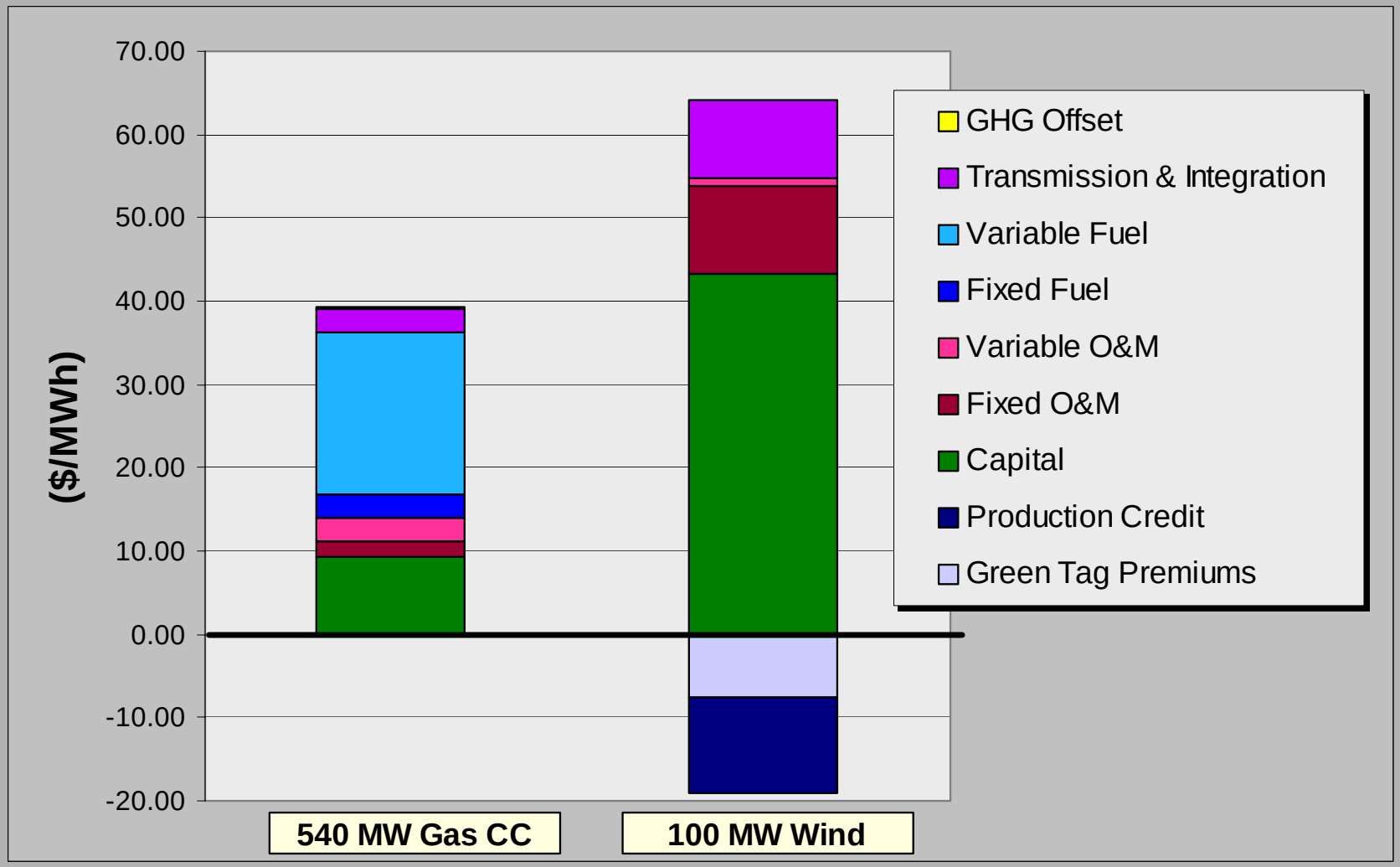
Why the recent success of wind?

- Cost reduction
- Federal production tax credit
- Other revenue streams
- Examples of successful resolution of siting issues
- Optimism
  - 2000-2001 electricity price run-up
  - current natural gas prices
- Speculation
  - CA & other renewable portfolio standards
  - Risk hedging potential
- Deal-making
  - Condition of merger or acquisition

Cost of windpower has declined

- Improved machine productivity
  - Taller towers
  - Larger rotor diameters
- Improved understanding of resource and site conditions
  - Usable width of ridge lines
  - Extensive resource prospecting
- Project scale
  - Economics of development
  - Economics of operation
- Better understanding of the availability & cost of shaping

Production tax credit is key to development



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Supplementary revenue closes the gap

- RPS/System benefit charges
  - OR & MT SBC “clean energy funds”
  - Speculative effects of pending California; possible Washington RPS.
- LSE risk-hedging
  - gas price volatility
  - future CO2 mitigation requirements
- Retail green power purchases
  - Residential (somewhat disappointing)
  - Commercial (surprisingly robust)
- CO2 offset market (minor player so far)
- Energy component of green building certification (e.g. LEED certification)
  - green product purchases
  - green tag purchases

Siting solution is available

- Dryland wheat – the ideal wind site
  - Monoculture w/low ecological diversity
  - Generally remote from prime aesthetic areas & population
  - Few native American cultural sites
  - Private ownership
- Potential rent/royalty income to landowners
  - Has eased siting & permitting
  - Created unlikely allies for state RPS/SBC adoption.
- Past & present conflicts
  - Native American cultural sites (vision quest sites)
  - Aesthetically sensitive areas (Columbia R. Gorge, Yakima canyon)
  - Proximity to second home developments (Klickitat Co.)

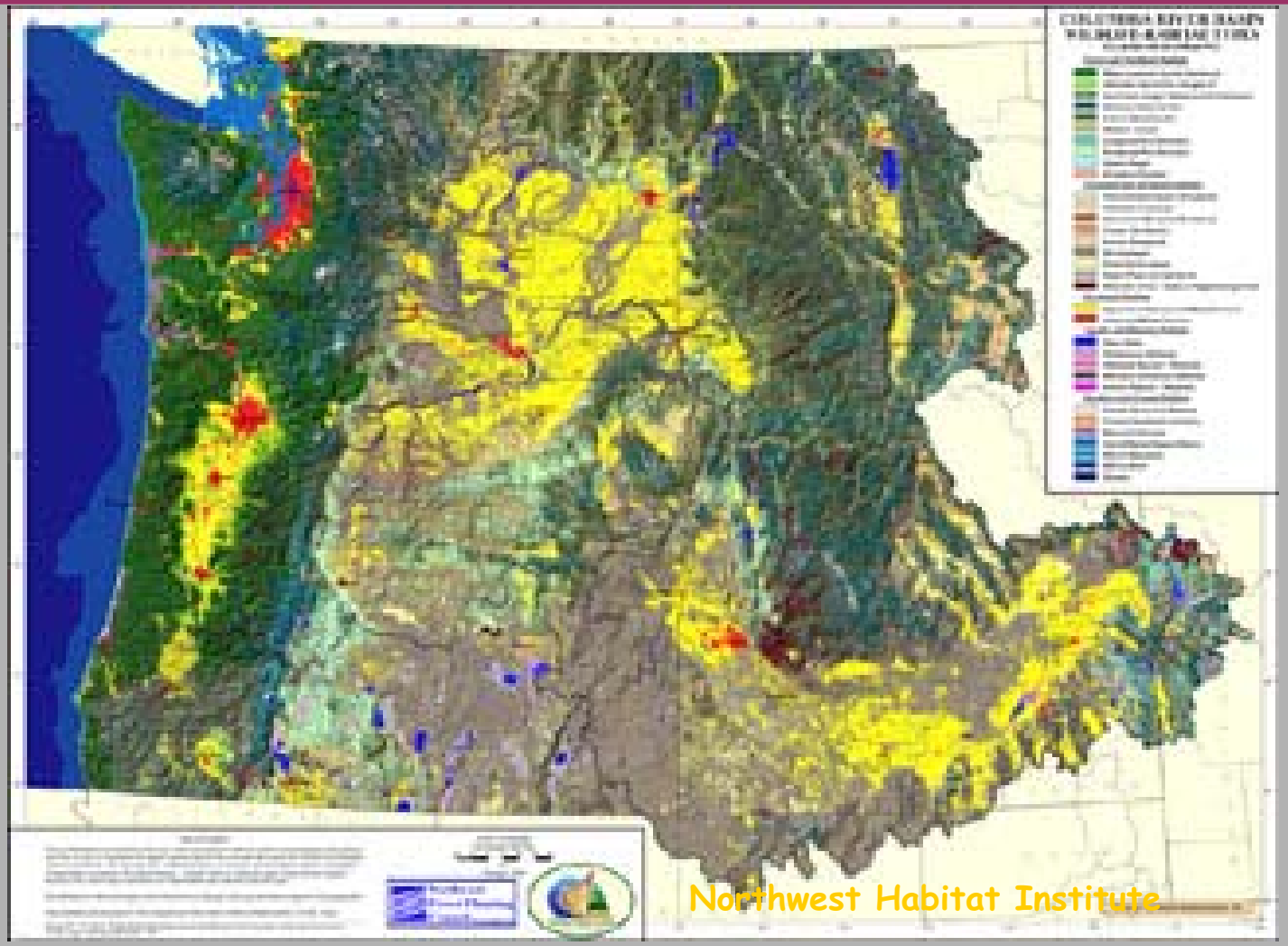
Constraints & issues remain

- Economics – not quite there
- Shaping
  - Some, but poorly-understood existing capability.
  - Substantially attributable to the PNW hydro system.
  - Probably a supply curve, increasing in cost with demand for shaping services. May steepen at 15 – 25% penetration.
  - Geographic diversity of projects may reduce shaping load.
- Transmission
  - Limited wind resource near existing transmission
  - Likely to limit development of High Plains resource
  - New firm transmission expensive for wind (low capacity factor)
  - Non-firm transmission access limited, probably resisted by hydro & thermal plant operators.

Wind prospects

- Least-cost new renewable available in large quantity.
- Near-term: Continued cyclic development driven by PTC and various supplementary revenue streams.
- GW-scale market-driven development possible in long-term
  - Greatest potential remote from load centers.
  - Transmission & system integration may be limiting.
  - Development sensitive to CO2 policy, gas prices.

Biomass



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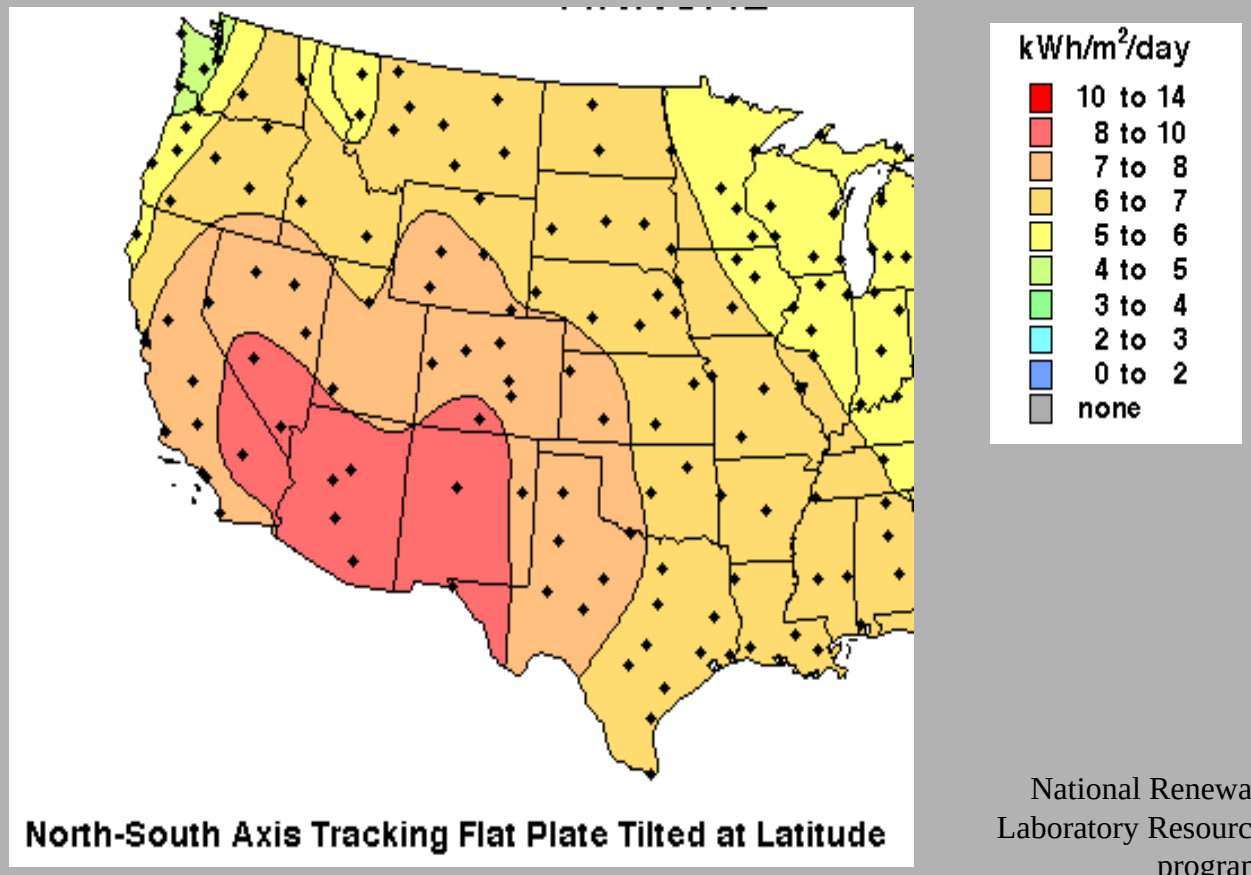
Biomass status

- Mill residue cogeneration has declined significantly
  - declining industry
  - higher value uses for residue (nearly full utilitzation).
- Diverse, small-scale niche applications available:
  - Upgrades of chemical recovery boilers (200 aMW potential).
  - Clean urban wood residue (270 aMW potential)
  - Landfill, wastewater and animal waste energy recovery (140 aMW)
- A few fairly good deals (e.g. landfill gas), but most applications moderately expensive ($50/MWh & up).
- Large PNW forest thinning potential (hundreds of MW), but expensive ($70/MWh) & controversial.
- Uneasy acceptance as green resource: “burning stuff” vs. resolution of environmental problems.

Biomass prospects

- Slow development of niche applications (landfill gas, wastewater treatment, animal manure, chemical recovery upgrades). PTC may speed up.
- The one big-time application, forest thinning residue, is controversial, expensive. Sensitive to PTC & federal forest policies.
- Dedicated biofuel production not likely in foreseeable future (higher value alternative uses).

Solar



National Renewable Energy Laboratory Resource Assessment program

Solar status

- High cost:
  - Photovoltaic costs - $200 MWh & up, declining slooowly
  - Solar thermal – $120 MWh, declining slooowly
- Great regional interest in small-scale photovoltaic projects:
  - Rooftop systems (Ashland, Chelen)
  - Building-integrated systems (Orcas, Portland)
  - “Mini” central-station systems (White Bluffs)
  - Economic “remote” applications (microwave, RR signals, emergency communications, parking meters, etc.)
- Large resource potential if costs can be reduced; but Southwest may be better source of bulk solar power.

Drivers of small-scale PV applications

- Federal investment tax credit
- State energy tax credits (OR)
- System benefit charges/"clean energy funds" (OR & MT)
- Feel good/green symbolism
- Green building certification
  - on-site systems
  - green product purchases
  - green tag purchases

Solar prospects

- Continuing development of cost-effective “remote” PV applications.
- Continuing development of grid-connected kW-scale boutique PV applications.
- Central-station PV or solar-thermal unlikely in foreseeable future.

What about geothermal?

- Potential highly uncertain, but less optimistic now than in the past (unsuccessful exploration).
- Glass Mountain appears to be potentially the big enchilada:
  - Proven production wells
  - Positioned for California RPS
  - BPA holds contract rights
- Continuing basin & range plays in Nevada – may be limited similar potential in OR & S. NV.
- Some development of small-scale direct applications (appears to have been fairly static in recent years).

What about hydropower?

- Will continue to be the major player, though a slowly declining fraction of total capacity.
- Possible, but limited further derating for fish & wildlife mitigation.
- Lower Snake R. breaching seems to be off the table.
- Increasing probability of climate change effects with significant consequences (earlier runoff).
- Limited potential for new construction.
- Limited potential for hydro upgrades.

For more information:

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