Energy Roadmap to 2020

Report to the Oregon Global Warming Commission

The following report, *Energy Roadmap to 2020*, was developed by the Energy Technical Committee of the Oregon Global Warming Commission (OGWC). Energy Committee members are listed in Appendix B of this report.

I. PURPOSE AND CONCLUSIONS

The purpose of the Committee was to develop and prioritize a set of strategies and actions for to reduce greenhouse gas (GHG) emissions from energy production and use in order to meet Oregon's 2020 greenhouse gas goal. The recommendations will be considered by the Oregon Global Warming Commission for inclusion in the Interim Roadmap to 2020/Report to the new Governor and Legislature, to state agencies, and to Oregon's Congressional delegation. Recommendations may also guide private sector investments and university research agendas.

After several months of deliberations the Committee narrowed the list of recommended actions down to the following Key Actions. Appendix A contains the consolidated Inventory of Actions developed by Energy Technical Committee. The Committee's Key Actions are more fully described in Section III – Key Actions For 2020. In summary they are:

- Develop State Energy and Climate Policy
- Energy Efficiency
- Support and Plan for New Transmission
- Phase Out Emissions Associated with Coal Generation
- Oregon University System (OUS) Energy Research Priorities
- Modern Gas Infrastructure
- Smart Grid and Integration of Resources

The Committee recognized that In all our state's greenhouse gas reduction strategies, while Oregon can be a leader, it cannot by itself materially affect the growth of greenhouse gas emissions without reciprocal initiatives by other states, by our federal government, and by other countries across the globe. Attempts to go our own way in isolation would be not only ineffective, but would have adverse economic effects on Oregon households and businesses. Especially this is true in our electricity and gas utility sectors, where we are interconnected, by physical ties, access to fuels, and economics, to the rest of the country and the world. The recommendations that follow should be read with this qualifier in mind.

At the same time, we also assert the importance of providing leadership in this sector as Oregon has done so often in the past, from our transmission arrangement with our neighboring states and with Canada, to our pioneering work in energy efficiency and least cost planning. Leadership provided by Oregon and other states is not only essential to achieving essential greenhouse gas outcomes; it also positions our state to capitalize on emerging national and global clean energy markets. The recommendations must be read in this context as well.

We explicitly acknowledge the essential role that Least Cost/Integrated Resource Utility Planning (IRP) has assumed in the planning and decision-making processes of our state and region over the last three decades. The setting and achieving of energy and climate policy goals for utilities is best accomplished within this framework.

II. FUTURE STATEMENTS

We cannot predict in detail how energy and capacity will be produced, delivered and consumed in 2050, we can propose scenarios that, relying on existing and emerging technologies only, could plausibly meet our aggregated goals of reliability, affordability, and low greenhouse gas and other emissions. It is likely that the architecture and operations of such an evolved system will be as different from today's as today's is from that of the mid-20th century. We can expect it to be reshaped by emerging technologies and evolving values, both reflected in the public policies and market forces of 2050; rearranging the basics – production, storage, transmission, distribution, and use of energy – and perhaps introducing new factors we can't anticipate. In one possible future, carbon capture and sequestration breakthroughs give new life to coal; in another, a policy preference for nuclear technologies prevails. What follows is one future scenario among the many possible; perhaps not even the most likely scenario, but one that can help illuminate the choices we face in reaching our greenhouse gas reduction goals while maintaining system reliability, quality and cost management.

Energy System Architecture and Operations

This 2050 system is more decentralized, contains more – and more diverse – resources, and relies heavily on Intelligence Technology (IT) for dynamic management and integration. It places a higher value on system flexibility, and the resources that supply flexibility. "Integration" is not primarily across generating plants but also between demand and supply sides, and even from customer to customer -- the energy flowing not just downhill from plant to user but uphill as well, from user back into the utility system; and sideways, from user to user. The battery in my plug-in electric vehicle (PEV) powers your toaster in the morning, and may even supply backup capacity when the central grid goes down.

Communities are fully integrated as well. The farm on the corner supplies renewable gas to homes while waste heat from the industrial plant is fed into an efficient district system.

The priority energy resource of this 2050 system is energy efficiency (as it was in 2010, when it was the third largest source of electricity in the Pacific Northwest after hydro and coal) integrated into a modernized electricity grid. New homes and commercial buildings are energy and carbon high performance building, with consumption and related emissions >80% less than in 2010. This is achieved by virtue of their passive energy efficient designs, tight building envelopes, high-efficiency LED lighting (that produces lower heat loads for the air conditioning required by 2050's more frequent heat waves), heat pump or direct gas space and water heating (water preheated with rooftop solar thermal systems), and solar photovoltaic building skin elements (siding, windows, roofs).

The priority capacity resource in this scenario is also found on the customer side of the meter. Those buildings with excess power or thermal energy (or other "distributed" resources) may store it onsite (in a PEV battery or a fuel cell), or return it to the electric grid or gas supply system for storage or redistribution. "Smart" appliances talk to the utility "smart grid," buying and selling stored energy or capacity (from appliances that can be cycled on and off remotely) according to schedules mutually agreed to by the customer and utility.

Gas appliances in both residential and commercial uses can also be programmed to respond remotely to shortages of supply or weather-related spikes in demand (they might also support distributed electrical generation that could be called upon during peak power demand).

In 2050, electric and gas systems are also information systems. Achieving the benefits that Smart Grid technologies offer will require that we think and plan simultaneously for the electric and gas service system and the integrated role the data system will play in supporting these benefits

This active role for customer-side electricity resources has enabled faster progress toward a power grid that is more flexible than today's system; that can respond more quickly and efficiently to changes elsewhere across the system, whether it is following loads or reacting to variable renewable resources ramping up and down. Most of the conventional coal and gas facilities that served as baseload resources in 2010 have been replaced by newer technologies that operate efficiently over a range of load factors, (pulverized coal plants were nearly all retired by 2030, freeing up east-west transmission that now brings High Plains wind to both West Coast and Mid-west markets). New gas turbine technology that can ramp up and down rapidly serves primarily as integrating resource for a grid that contains wind (in diverse wind regimes), solar, ocean, hydro[1], biomass and some geothermal renewable resources.

Wind and solar operate as "predictable" rather than "dispatchable" resources; the difference is that while system operators can't call on a wind-farm to increase generation when loads increase, they will know with higher probability than was the case in 2010 the level of output at which that wind-farm can continue to generate for the next hour, or day, or week ahead. IT systems will monitor and predict (1) changing loads, (2) dispatchable demand-side resources, and (3) available "predictable" resources. It will automatically dispatch (4) integrating resources – hydro plus new storage plus gas turbines – to backfill holes. Wind generators also can contract to reduce output to prevent over-generation and thereby preserve system balance.

Transmission, Storage and Controls

Such a system design relies on its transmission grid nearly as heavily as did the old architecture. But today's transmission grid is an intensively monitored and far more resilient, responsive, reliable and efficient system that can remotely diagnose and often repair its rare malfunctions. Transmission facilities are more strategically located and interconnected to be internally reinforcing, linking together and permitting efficient integration among loads, generation and storage while respecting environmentally sensitive landscapes and ecosystems. Siting new transmission facilities has become easier as communities realize its importance in a strategy of lower carbon emissions and greater energy independence.

[1] Includes some new hydro capability resulting from efficiency investments in existing facilities.

Storage facilities are located both at the supply end (pumped storage, compressed air, advanced batteries, etc.), at load centers (batteries, fuel cells) and within loads (PHEV batteries, remotely-dispatched appliance cycling). Sophisticated control systems optimize flows and reduce congestion. The wide distribution of storage capability across the grid also strengthens system regulation and stability.

Electricity Generating Resources

In 2050, hydro still supplies + 50% of the region's electrical energy supply (and a significant share of the integrating services for wind and solar). That hydro is complemented by a mix of new wind, solar and other renewables, which together comprise >80% of electrical generation[2] Energy efficiency standards and investments have held overall load growth to + 0, excluding shifted transportation load (electric vehicles are estimated to have added 10% to 12% to overall energy load[3] – assuming 60% of the light duty vehicle fleet is electrically-powered in 2050 – but has actually moderated the need for new electrical generating capacity by providing flexible load-center storage to the system). The entire system – supply, delivery and demand components -- is planned and operated for optimum cost-effectiveness within hard reliability and carbon emissions constraints.

Gas

Natural gas supplies for both direct space and water heat, and for electricity generation as described above, are supplied domestically from both conventional and unconventional (e.g.,shale gas) resources, and from renewable gas. This renewable gas may come from anaerobic digestion (animal waste, waste water treatments plants, landfills) or gasification of biomass. Between this supply, and robust US research, development, demonstration and commercialization of other renewable and energy efficiency products – and the shifting of most vehicles to electricity, gas and biofuels – the long-sought achievement of energy independence has been largely attained. To the extent energy products are still imported, whether equipment or fuels, our capability to replace imports with domestically-sourced products assures the US of price and supply leverage in global energy markets.

Oregon policies support, and utilities invest in, combined-heat-and-power (CHP) facilities to retrofit or displace boilers at industrial plants requiring substantial quantities of process heat. Oregon land use policies encourage co-location of such plants (which also enable industrial district heating systems) to reduce stranded investment risks.

Financing and Affordability

Early on, Oregon developed a State-sponsored energy financing platform that made use of State and local bonding authority, State revenues (including user assessments tied to carbon emissions), a strengthened and extended public purpose charge, and regulatory support for efficient utility

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[2] The "Western Wind and Solar Integration Study" (NREL/SR-550-47781) published by the National Renewable Energy Laboratory (NREL) in May, 2010, estimated that a wind/solar (30%/5%) system penetration rate on the WestConnect Grid was technically and operationally feasible even without the hydro system flexibility available to the PNW grid. WestConnect includes utilities in AZ, NV, NM, CO and WY.

[3] See "Electrification Roadmap", The Electrification Coalition, November, 2009, p 99: estimates 10% to 12% increase in electricity load nationally from 60% LDV market penetration.

access to capital markets to provide consistent financing support for realizing this energy future. The State's efforts were supported by BPA and utility investments in transmission capacity and control infrastructure. This financing was particularly important in effectively extending energy efficiency assistance to low-income households (including rental housing efficiencies captured through combined code requirements and loans secured by the properties). The model was not dissimilar to the public financing that created so much essential 20th century infrastructure, from dams and transmission lines to interstate highways.

Research

National and Oregon energy research agendas and budgets have received vigorous support over the last forty years, achieving gains in low- or zero-carbon fuels, energy efficiency (including building and appliance design, and behavioral response tools), supply and demand side controls, and low-carbon generating technologies. Cost-effective carbon capture and storage (CSS) for fossil fuel plants remains elusive; while new energy storage technologies have combined with sophisticated control systems and wind/solar resource prediction capabilities to integrate a greater diversity of resources across larger geographic control areas. Conventional nuclear power plants have been deployed elsewhere in the US, while development interest in the Pacific Northwest focuses on the "pocket" nuclear designs with passive safety systems, standardized design elements and shorter development lead times, that were refined at Oregon State University

Regulatory Predictability

Looking back from 2050, it's clear that the adoption of a mandatory national carbon emissions reduction policy (cap, cap and trade, tax or other device) proved essential to achieving Oregon – and national – GHG reduction goals. This single action provided homeowners, businesses and utilities with the predictability that both incented and enabled them to make carbon reduction investments at the scale required for deep emissions cuts. The required reductions were ramped in over time, while price ceilings and floors flattened out the spikes and dips that unnerve investors and lenders. The reduction curve encouraged innovation in carbon-reducing technologies and strategies (and created marketing opportunities for Oregon entrepreneurs).

III. KEY ACTIONS FOR 2020

In all our state's greenhouse gas reduction strategies, Oregon acknowledges that while it can be a leader, it cannot by itself materially affect the growth of greenhouse gas emissions without reciprocal initiatives by other states, by our federal government, and by other countries across the globe. Attempts to go our own way in isolation would be not only ineffective, but would have adverse economic effects on Oregon households and businesses. Especially this is true in our electricity and gas utility sectors, where we are interconnected, by physical ties, access to fuels, and economics, to the rest of the country and the world. The recommendations that follow should be read with this qualifier in mind.

At the same time, we also assert the importance of providing leadership in this sector as Oregon has done so often in the past, from our transmission arrangement with our neighboring states and with Canada, to our pioneering work in energy efficiency and least cost planning. Leadership provided by Oregon and other states is not only essential to achieving essential greenhouse gas outcomes; it also positions our state to capitalize on emerging national and global clean energy markets. The recommendations must be read in this context as well.

We explicitly acknowledge the essential role that Least Cost/Integrated Resource Utility Planning (IRP) has assumed in the planning and decision-making processes of our state and region over the last three decades. The setting and achieving of energy and climate policy goals for utilities is best accomplished within this framework.

1. Develop State Energy and Climate Policy

Oregon should adopt clear, durable, integrated policy preferences on how best to meet reliability, affordability and environmental goals over a planning horizon of > 20 years, to allow households and businesses to plan and budget with confidence. The resulting energy policy should address: (1) utility energy supply, delivery, use and conservation (IOU and COU; electricity and natural gas), and (2) transportation energy supply, use and conservation; and, (3) environmental and social outcomes, including impacts on communities and workers. These goals should inform, but not supersede, prevailing utility IRP requirements and obligations. Oregon should adopt a set of benchmarks to serve as interim guides towards meeting the goals established in its energy policy. The benchmarks should speak to statewide and sector-specific goals, and not apply to specific entities. Joint planning by the state across fuels (electric and gas) and across sectors (energy, transport) can then inform both transportation and utility planning efforts. Utility integrated resource plans, should consider "net GHG reductions" that reflect load shifting between fuels and meeting new loads that may be emerging from the transportation sector.

2. Energy Efficiency

Develop and implement new standards, codes and incentives to address highly effective yet hard to deliver energy efficiency measures including but not limited to: appliance and lighting codes and standards; a retrofit building energy efficiency code; commercial building commissioning; rental housing codes; utility investment in energy efficiency; and incentives for high performance buildings.

3. Support and Plan for New Transmission

New transmission capacity for both gas and electricity will be required. Oregon siting standards should be periodically reviewed to assure that they satisfactorily reflect State and Federal reliability and safety requirements, the State's environmental values and regional and State energy policies that prioritize (a) the transition to enhanced system flexibility, and (b) access to low-carbon generating resources such as central station wind and solar. Full development and interconnection of distributed/load-center resources (efficiency; demand management; distributed renewables and storage) should be facilitated. New transmission capacity should give due consideration to using existing corridors; and new corridors should be created they are shown to be essential to meeting resource and environmental goals, while assuring power quality and system reliability consistent with applicable reliability standards and performance criteria (including line separation requirements).

4. Phase Out Emissions Associated with Coal Generation

Absent technological and economic breakthroughs in Carbon Capture and Sequestration (CCS) or other carbon abatement technologies, it appears highly unlikely that an Oregon 2020 emissions goal (or a 2030 interpolated target) can be met without a phase-out of service from coal-fired power plants. Thus, subject to the other conditions identified here, Oregon utilities should begin immediately the planning necessary to cease service to Oregon loads from coal-fired generation, with substantial progress achieved by 2020 and the task largely completed by 2030. Other conditions include: (1) reciprocal initiatives by other states or, preferably, by federal action; (2) sufficient time for an orderly replacement resource planning and acquisition process to assure system reliability and manage transition costs (and especially impacts to utility employees, local communities, and businesses and low-income household customers); (3) sustained progress on transmission infrastructure development, integration technologies (e.g., electricity storage) and practices required to bring low-carbon variable renewable generating resources into the electricity grid; (4) success of efforts to reduce emissions in other sectors; and, (5) consideration of effects on Oregon's economy and employment. The process of phasing out coal service should proceed within prevailing IRP processes for Oregon's utilities, including thorough IRP evaluations of the benefits, costs and effects on quality and reliability of service of alternate pathways to these goals.

5. OUS Energy Research Priorities

Oregon should support, through the Oregon University System, research priorities that include: building energy efficiency systems; design-integrated solar distributed generation applications; energy efficiency behavioral initiatives; distributed load center generation, storage (e.g., fuel cells) and control systems; V2G electric vehicle integration controls and configurations; biomass and ocean energy conversion technologies and support (e.g., biomass fuel) systems; small-scale nuclear generating technologies.

6. Modern Gas Infrastructure

In the next decade, natural gas infrastructure and operations will need to drive net reductions in greenhouse gases through: a) harvesting waste heat from generation near thermal loads; b) combining natural gas with renewable generation, such as solar thermal; c) serving a growing fleet of natural gas powered vehicles (e.g., centrally fueled fleets, heavy duty vehicles) and d) gathering and cleaning to pipeline quality renewable natural gas from a wide variety of biogas sources. State energy policies should be designed to ensure "the best fuel for the best use;" these policies should in turn inform utility Integrated Resource Plans. Where a showing is made of net greenhouse gas reduction potential from the direct use of natural gas for critical space and water heating, State policy should prioritize such use

7. Smart Grid and Integration of Resources

To fully realize the potential of renewable and demand side resources, advances are needed in technology, information systems, the grid, and system operations. These include Smart Grid initiatives described in Recommendation 16, and the improvements in the integration of renewable resources including tapping demand-side flexibilities as described in Recommendation 23.

APPENDIX A
Technical Committee Recommended Actions

	ACTIONS/RECOMMENDATIONS	DESCRIPTION			METRIC				COMMENTS
		Lead Gov, Agency, Private, etc.?	Type of Action (use word) Incentive, Tax/Fee, Regulation; Standard,	Timing of Impact (Short = 1-5 yrs) Medium = 5-10 yrs	GHG Savings? (Y/N, Quantity)	Fossil Fuel Savings? (Y/N, Quantity)	Cost (Savings)?	C/E (High, Medium, Low)	Co-benefits? Risks/Tradeoffs? Unintended Consequences? Politics? Adaptation Value? (use concise narrative)
Policy/Planning									
1	**Develop State Energy and Climate Policy:** Oregon should adopt clear, durable, integrated policy preferences on how best to meet reliability, affordability and environmental goals over a planning horizon of ≥ 20 years, to allow households and businesses to plan and budget with confidence. The resulting energy policy should address: (1) utility energy supply, delivery, use and conservation (IOU and COU; electricity and natural gas), and (2) transportation energy supply, use and conservation; and, (3) environmental and social outcomes, including impacts on communities and workers. These goals should inform, but not supersede, prevailing utility IRP requirements and obligations. Oregon should								

	adopt a set of benchmarks to serve as interim guides towards meeting the goals established in its energy policy. The benchmarks should speak to statewide and sector-specific goals, and not apply to specific entities. Joint planning by the state *across* fuels (electric and gas) and *across* sectors (energy, transport) can then inform both transportation and utility planning efforts. Utility integrated resource plans, should consider "net GHG reductions" that reflect load shifting between fuels and meeting new loads that may be emerging from the transportation sector.								
2	**Align Building Code with GHG Goals:** Oregon building and equipment energy codes should be aligned with its GHG reduction goals over a planning horizon of > 20 years to allow households and businesses to plan and budget with confidence.								
Codes and Standards									
3	**Fuel-blind Space/Water Heat Standard:** Oregon should establish a life-cycle fuel-blind carbon-efficiency standard (BTU's/tonne CO_2e assuming the marginal generating resource) for residential and commercial space and water heating, and should systematically transition the standard from incentive into code.								
4	**Appliance and Lighting Codes and Standards:** Oregon should revisit its appliance and lighting incentive and code criteria at least every five years to capture the benefits of likely continuous improvements in efficiencies. For example, Oregon can adopt (initially for its incentive programs, then transitioning into code), the Association of Home Appliance Manufacturers 2010 standards for								

	refrigerators, freezers, washers, dryers, dishwashers and air conditioners. Oregon should look first to advocate for timely improvements in federal standards, then to cooperative initiatives with other States.								
5	**"Retrofit" Building Energy Efficiency Code:** Oregon should develop a "retrofit" energy efficiency code requirement, developed to reflect life-cycle cost-effectiveness (including a carbon adder) of retrofit measures, which will be different from cost-effectiveness in new construction. Oregon should require that any residential or commercial building be brought into compliance with this code at point of property transfer or major remodel/rehabilitation, with the State also providing access to financing through existing and new financing tools.								
6	**Carbon Efficiency Feebate:** Oregon should design and implement a GHG "feebate" for residential energy use that imposes a GHG surcharge (to the property tax) on homes exceeding a "full-time resident x energy consumption" metric. Revenues may be applied first to efficiency retrofits of affected dwellings, then to State energy efficiency programs generally.								
7	**Commercial Building Commissioning:** Oregon code should require that all new commercial buildings (> XX sq ft) undergo building energy systems commissioning as a condition of building inspector signoff; and to undergo recommissioning on schedules that are shown to be cost-effective.								
8	**Energy Management Equipment in Building Code:** Oregon building codes should establish minimum energy								

	management equipment requirements for new and retrofit residential and commercial buildings (e.g., setback thermostats; motion-detection light switches; "vampire" load controls; etc.).								
9	**Rental Housing:** Oregon should require third-party-owned rental housing to be brought into compliance with the Retrofit Efficiency Code at point of sale or major remodeling but not less often than every ten years.								
Finance/Economics/Incentives									
10	**Invest State Revenues in Energy Efficiency:** Oregon should assign priority, in its investment policies for State funds (revenues; pension funds), to investing those funds in Oregon energy efficiency on a showing of comparable risk-return.								
11	**State Energy Financing Platform**: Oregon should develop a State energy facilities financing platform that can attract and deploy capital investment (equity and debt) raised from multiple sources (State funds; bond revenues; private sector investment; utility investment; LID or neighborhood REIT investment; individual investment; etc.) on energy efficiency, infrastructure and distributed generation, relying first upon the Energy Trust of Oregon (in investor-owned utility territory) and consumer-owned utilities (in their territories) to deploy the funding. Homeowners and business owners could also qualify to access the funding.								
12	**Utility Investment in Energy Efficiency:** Where circumstances (e.g., market barriers; large "lumpy" investment requirements) suggest value can be added to Oregon's existing energy efficiency capture capabilities by								

	allowing direct utility investment, the Oregon Public Utility Commission should have authority to permit such investments by Investor-Owned Utilities in energy efficiency, distributed generation and related infrastructure (including controls and storage) in a manner that puts these investments on an even playing field with supply-side investments.								
13	**Incent High Performance Buildings**: Oregon should set a standard for high performance buildings that meet a goal of reducing life-cycle building related GHG emissions by 80 percent from the current baseline and provide a financial incentive (no property tax payments for 20 years?) for the first 1000 High Performance residences commissioned in the State; and the first 100 High Performance commercial structures.								
14	**Convert Energy Tax Credits into Grants:** Oregon and federal investment tax incentives (BETC; ITC) should be redesigned as grants (monetized) to allow third party facility development and non-profit institutional development of qualifying facilities to access these incentives without (as now) being obliged to transfer a significant share of the value to third-party financing, legal and other transaction costs.								
15	**Authorized RETC for Distributed Energy:** Oregon should allow taxpayers to claim Residential Tax Credits (RETC) for heat pump water heaters, solar photovoltaic systems and solar hot water systems and other distributed generation resources (e.g., Combined Heat/Power [CHP] systems; fuel cells).								
Infrastructure									
16	**Smart Grid:** Oregon State agencies, utilities and								

	University disciplines should prioritize, deploy and demonstrate Smart Grid technologies and associated information and applications that result in a future utility system that meets end-user needs more effectively. Three broad areas for emphasis are: (a) distribution/transmission system improvements and reconfigurations, including distribution-transmission interface; (b) underlying data/information systems; and (c) introduction of "Smart Grid-capable" metering, appliances, V2G vehicle and infrastructure designs and other interactive elements of a fully-realized system. Smart Grid improvements that facilitate integration of variable renewable resources, energy efficiency, and taking advantage of opportunities to tap the demand side to meet needs for capacity and flexibility will be emphasized. This future system should encourage and support greater end-user energy use control while also addressing privacy, security, access, equity, and technical considerations. State incentive and regulatory policies for Smart Grid development, planning, deployment, and reporting reflects this prioritization and these considerations.								
17	**Support Combined Heat and Power (CHP) with Co-location and Other Incentives:** Oregon should support and incent, with land use/zoning variances and investment incentives, the co-location of industrial uses that in turn will support a doubling of CHP capacity by 2015, and a further doubling by 2020.		Standard						
18	**Support and Plan for New Transmission**: New transmission capacity for both gas and electricity will be required. Oregon siting standards should be periodically reviewed to assure that they satisfactorily reflect State		Standard						

	and Federal reliability and safety requirements, the State's environmental values and regional and State energy policies that prioritize (a) the transition to enhanced system flexibility, and (b) access to low-carbon generating resources such as central station wind and solar. Full development and interconnection of distributed/load-center resources (efficiency; demand management; distributed renewables and storage) should be facilitated. New transmission capacity should give due consideration to using existing corridors; and new corridors should be created they are shown to be essential to meeting resource and environmental goals, while assuring power quality and system reliability consistent with applicable reliability standards and performance criteria (including line separation requirements).								
19	**Modern Gas Infrastructure**: In the next decade, natural gas infrastructure and operations will need to drive net reductions in greenhouse gases through: a) harvesting waste heat from generation near thermal loads; b) combining natural gas with renewable generation, such as solar thermal; c) serving a growing fleet of natural gas powered vehicles (e.g., centrally fueled fleets, heavy duty vehicles) and d) gathering and cleaning to pipeline quality renewable natural gas from a wide variety of biogas sources. State energy policies should be designed to ensure "the best fuel for the best use;" these policies should in turn inform utility Integrated Resource Plans (IRPs). Where a showing is made of net greenhouse gas reduction potential from the direct use of natural gas for critical space and water heating, State policy should prioritize such use		Technical						
Fuels/Conversion Technologies and Operations									

20	**Phase Out Emissions Associated with Coal Generation:** Absent technological and economic breakthroughs in Carbon Capture and Sequestration (CCS) or other carbon abatement technologies, it appears highly unlikely that an Oregon 2020 emissions goal (or a 2030 interpolated target) can be met without a phase-out of service from coal-fired power plants. Thus, subject to the conditions identified here, Oregon utilities should begin immediately the planning necessary to cease service to Oregon loads from coal-fired generation, with substantial progress achieved by 2020 and the task largely completed by 2030. Other conditions include: (1) reciprocal initiatives by other states or, preferably, by federal action; (2) sufficient time for an orderly replacement resource planning and acquisition process to assure system reliability and manage transition costs (and especially impacts to utility employees, local communities, and businesses and low-income household customers); (3) sustained progress on transmission infrastructure development, integration technologies (e.g., electricity storage) and practices required to bring low-carbon variable renewable generating resources into the electricity grid; (4) success of efforts to reduce emissions in other sectors; and, (5) consideration of effects on Oregon's economy and employment. The process of phasing out coal service should proceed within prevailing IRP processes for Oregon's utilities, including thorough IRP evaluations of the benefits, costs and effects on quality and reliability of service of alternate pathways to these goals.								

21	**New Generation Attributes**: PNW utilities, planners and regulators should place a priority on the *flexibility* attributes of new generating and demand side resources to be introduced into the grid (e.g., ramp response rates; siting for system value)								
22	**Hydropower**: Subject to requirements to operate the Columbia River hydropower system to support healthy salmonid populations and overall ecosystem function, federal and non-federal operators should seek to maximize the generation and operations flexibility of the system to reliably serve utility loads, deliver low carbon power and integrate new low-carbon resource additions (including new capacity and storage capabilities where feasible).								
23	**Integration of Demand- and Supply-side Generation and Loads:** Utilities, regulators and legislators, regionally and in Oregon, should address the planning, regulatory, design and operating issues that currently frustrate the efficient integration of new, low-carbon demand- and supply-side energy resources into the grid. This may involve modifying both (1) utility grid operating protocols and (2) regulatory/incentive signals that frustrate efficient integration of variable, non-dispatchable renewable resources such as wind and solar. Examples of the former include balancing authorities too constricted to capture geographic diversity, and static (vs. dynamic in-hour) scheduling. Examples of the latter include tax incentives and environmental attribute markets that may penalize rather than reward flexible operations of these resources in ways that may adversely affect efficient system operations. These actions are additional to, and interdependent with, new energy management and								

	storage capabilities mediated by Smart Grid tools.								
24	**Regional Integration Services**: The State should collaborate with BPA and other regional parties to ensure that sufficient ancillary services are available to support the development of non-dispatchable/variable renewable resources, and to ensure that the provision of these services does not raise rates to Oregon consumers and does not impair electric reliability.								
25	**Solar Pre-Heating of Water**: Where economically competitive (when compared to other distributed renewable energy sources) and physically feasible (e.g., available installation space; solar access), solar water heating equipment should be a preferred and incentivized pre-heat treatment of residential and commercial hot water supplies. Incentives for this technology will be expected to broaden the market and lower both equipment and installation costs – as is the expectation for PV technology.								
Other									
26	**Support and Strengthen Existing State and Regional Energy Efficiency Tools:** Oregon and the Pacific Northwest have benefited greatly over the years from the planning and delivery capabilities of the NW Conservation and Power Planning Council, the NW Energy Efficiency Alliance, the Energy Trust of Oregon, CleanEnergyWorks (Portland), Battelle NW Laboratory and other entities. Oregon and its investor and consumer-owned utilities must continue to invest in, and extend the reach and capacity of, these institutions if it is to meet its climate and energy goals								

27	**Incent Urban Density, Design**: Oregon metropolitan areas should give preferential property tax treatment and other incentives to encourage higher density common-wall residential developments that also offer energy efficient access to transit and urban services ("locational" efficiencies).								
28	**Water Efficiency**: Oregon should prioritize water efficiency in the supply, delivery, use and disposal of water supplies, to mitigate the energy consumption involved in water resource management.								
Research									
29	**Energy, Carbon Research Funding and Agenda**: Oregon should advocate, through its Congressional delegation and in national policy forums (e.g., WGA) for strengthened national energy and carbon research budgets, with funding allocated based upon least cost, most promising technological and behavioral pathways to achieving national energy and carbon goals.								
30	**OUS Energy Research Priorities:** Oregon should support, through the Oregon University System, research priorities that include: building energy efficiency systems; design-integrated solar distributed generation applications; energy efficiency behavioral initiatives; distributed load center generation, storage (e.g., fuel cells) and control systems; V2G electric vehicle integration controls and configurations; biomass and ocean energy conversion technologies and support (e.g., biomass fuel) systems; small-scale nuclear generating technologies.								
31	**Advanced Energy Research Initiative:** Oregon should consider an Energy Systems Advanced Research Center to attract and concentrate the science and engineering								

	talent to take a leadership position in development and application of selected energy technologies and applications where opportunities for Oregon businesses can be identified.								
32	**Equipment Replacement Protocols:** NEEA, ETO and utilities should develop and maintain protocols for commercial and industrial equipment replacement that weigh embedded carbon against evolving equipment efficiencies. The protocols should be easily accessible to companies deciding whether to keep or replace equipment.								

APPENDIX B

Energy Technical Committee Members

Name	Organization
Paul Norman	Chair
Jason Eisdorfer	BPA
Bob Jenks	CUB
Michael Armstrong	City of Portland
Terry Morlan	NW Power and Cons. Council
John Mohlis	ColPac Bldg Trades Council
Reuben Plantico	PGE
Tom O'Connor	Oregon Municipal Utilities Assoc.
Angus Duncan	Global Warming Commission
Bill Drumheller	ODOE
Phil Carver	OPUC
Erik Colville	OPUC
Bill Edmonds	NW Natural Gas
Robert Procter	Oregon PUC
Jason Heuser	EWEB
Dick Varner	EWEB