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Guy Norman Washington

Patrick Oshie Washington



Bo Downen Vice Chair Montana

Jennifer Anders Montana

> Jim Yost Idaho

Jeffery C. Allen Idaho

February 4, 2020

MEMORANDUM

TO: Power Committee Members

FROM: Massoud Jourabchi and Steven Simmons

SUBJECT: 2021 Plan Load Forecast

BACKGROUND:

Presenter: Massoud Jourabchi and Steven Simmons

- Summary: Staff will update Power Committee Members on the 2021 Plan load forecast. A range of load forecasts will be presented. Economic drivers and load forecasts show slower growth over the next 20-30 years. Lower load forecasts are in part due to increase in behind the meter solar and increased impact of building codes and appliance standards. Factors increasing loads come from commercial and transportation sectors. Staff will also present updated transportation, behind-the-meter solar and natural gas end-use demand.
- Relevance: Load forecast is an essential building block of the Resource Plan.

Update on Load Forecasts For 2021 Plan

February 11, 2020

Massoud Jourabchi

Steve Simmons



THE 2021 NORTHWEST



FOR A SECURE & AFFORDABLE ENERGY FUTURE

In Today's Presentation

- What you have seen in previous presentations
- Fast overview of key economic and temperature drivers
- Climate Change Models selected
- Components of load forecast
 - Residential, Commercial, Industrial Sectors Agricultural Sector Streetlighting and public pumping facilities (MJ)
 - Transportation sector (EV's, light duty trucks) (SS)
 - Behind-the meter solar capacity installed (SS)
 - Demand for Natural Gas (SS)
- Next Steps



In the past presentations

- We discussed
 - Major economic drivers of the plan
 - Residential, Commercial, Industrial, Agriculture, Transportation
 - Retail price of natural gas and electricity
- We presentenced on Climate Change
 - What General Circulation Models are and how to select among them
 - How to incorporate its impact many aspects of the power planning.
 - Estimated direct and secondary economic and load impact of climate change
- We presented on how to select from the range of GCMs
- Additional information about past presentations can be found:
 - <u>https://www.nwcouncil.org/meeting/demand-forecast-advisory-</u> <u>committee-february-14-2019</u>
 - <u>https://www.nwcouncil.org/meeting/sif-climate-change-and-2021-power-plan-workshop-may-1-2019</u>

https://www.nwcouncil.org/meeting/demand-forecast-advisorycommittee-september-10-2019

Review of Key Economic Drivers

Prior to incorporating impact of Climate Change



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Current Forecasts indicate a Slower Growth in Key Economic Drivers



		6th Plan	7th Plan	8th Plan (draft)
A	Verage Annual Growth Rate	2010-2030	2015-2035	2020-2040
	Residential	1.37%	1.19%	1.09%
	Commercial	1.25%	1.20%	1.08%
	Industrial	1.74%	1.06%	0.74%
	Agriculture	2.78%	0.81%	1.41% _{THE 2021}
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Regional Growth in Residential Building Stock

6



Number of residences (1000)	1985	2017	2020	2040	2050	
Single Family	2,753	4,352	4,510	5,572	6,112	
Multi Family	578	1,198	1,290	1,727	1,880	
Other Family	329	607	615	669	697	
					THE 2021 NORTH	WEST
					POWER	

Other Family is referring to Manufactured housing

Annual Growth in Commercial SQF slowing down

7



Manufacturing Employment is recovering but does not regain 1990s high level



Range of Economic Drivers - prior to Climate Change Secondary impacts

2050 9,826 5,546
9,826 5,546
5,546
201
206
32
2050
7,568
4,838
99
21
2050
8,722
5,105
150
28

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Normal VS GCM Temperatures



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Historic 1986-2018 Annual Cooling Degree Days and Forecast of Normal CDD to 2050



Historic Annual HDD 1986-2018 with 2019-2050 Forecast under GCM 1 Oregon HDD GCM 1 ----Washington HDD GCM1 ---- Idaho HDD GCM 1 --- Montana HDD GCM 1 THE 2021 NORTHWEST **POWER PLAN**

Historic Annual CDD 1986-2018 with 2019-2050 Forecast under GCM 1



Selecting Climate Change Models (GCMs)

- In November 2019 we discussed the process for selecting GCMs considering both variations in range of hydro power and load.
- Four climate models were selected.
- GCM's labeled A and F cover range of cooling and heating requirements

GCM	Winter HDD	Summer CDD
А	low	high
С	-	-
F	high	near low
Н	-	-



F: CNRM-CM5_RCP85_MACA_VIC_P1 H: CSIRO-Mk3-6-0_RCP85_BCSD_PRMS_P1

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Components of Load Forecast



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Components of Load Forecast

- Overall load forecast
- Residential
- Commercial
- Industrial
- Transportation
- Agriculture
- Streetlighting and fresh and waste water pumping facilities



Range of Load Forecasts over Planning Horizon prior to incorporating Climate Change

Current forecast indicates slower load growth rate compared to 7th plan

	7 th Plan 2015-2035	8 th Plan 2021-2041
Low	0.4%	-0.05%
Medium	0.7%	0.33%
High	0.9%	0.7%

Load forecasts for 2050 are lower by about over 5800 aMW due to increased impact from codes and standards and behind the meter solar:

- State/Federal codes and standards ~ 3500 aMW
- Behind-the-meter solar ~ 2300 aMW

Impact of Code and Standards on Loads (- aMW)



Impact of Codes and Standards on Regional Loads Base Case Prior to Climate Change (-aMW)





15% average annual growth rate between 2021 and 2041

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Range of Key Regional Economic Drivers after incorporating impact of Climate change

			2021-2030) Period		2031-204	0 Period		2041-205	0 Period
Population in Millions	2018	Minimum	Average	Maximum	Minimum	Average	Maximum	Minimum	Average	Maximum
Across all GCMs *	14.6	14.8	16.2	17.9	16.3	17.9	20.3	17.1	19.4	22.5
* minimum and Maximum										

Residential Sector			2021-2030	Period		2031-2040) Period		2041-2050) Period
Millions of Sq. feet	2018	Minimum	Average	Maximum	Minimum	Average	Maximum	Minimum	Average	Maximum
Across all GCMs *	10,965	11,668	12,642	13,615	12,979	14,206	15,362	14,257	15,586	16,734

Commercial Square foota		2021-2030 Period			2031-2040 Period			2041-2050 Period		
Millions of Square feet	2018	Minimum	Average	Maximum	Minimum	Average	Maximum	Minimum	Average	Maximum
Across all GCMs *	3,587	3,609	3,992	4,495	4,137	4,588	5,282	4,710	5,193	5,955

Industrial Output			2021-2030	Period		2031-2040) Period		2041-2050) Period
Billions of 2016 Dollars	2018	Minimum	Average	Maximum	Minimum	Average	Maximum	Minimum	Average	Maximum
Across all GCMs *	224	180	241	307	151	254	362	131	268	412
* minimum and Maximum	loads in e	ach period								



Labels for Load Forecast Graphs

- Graph labels consists of four elements- for example Climate1-XGO_base_noFreeze label indicates:
 - 1. Climate change model used (1-4)
 - 2. XGO indicates that primary and secondary impacts of climate change are incorporated in the load forecast.
 - 3. Base, Low, High labels refer to economic growth scenario being used
 - 4. No Freeze, indicates that we are not Freezing the efficiency (this is the Price-effect forecast)
- Due to natural of uncertainty in GCM's temperature forecasts, at this point, we will be showing decadal values for loads rather than annual loads.

Range of Load Forecasts

by 2050 primary and secondary Climate Change increase regional loads by about 2000 aMW



Range of load Forecasts

			2021-2030	Period			2031-2040 Period		2041-2050 Period) Period
	2018	Minimum	Average	Maximum	Ν	Minimum	Average	Maximum	Minimum	Average	Maximum
Base Economic Growth	21,098	21,873	22,157	22,398		22,465	22,813	23,225	23,345	24,084	24,918
Low Economic Growth	21,098	20,922	21,103	21,304		20,895	20,931	21,023	21,084	21,494	21,962
High Economic Growth	21,098	22,419	23,252	23,952		24,110	24,847	25,709	25,929	27,122	28,426
GCM1_Base	21,098	21,802	22,486	22,901		22,933	23,703	24,430	24,490	25,654	27,055
GCM1_Low	21,098	21,110	21,423	21,685		21,366	21,789	22,176	22,116	22,977	23,961
GCM1_High	21,098	22,349	23,590	24,272		24,598	25,780	26,985	27,256	28,813	30,749
GCM 2_Base	21,098	21,766	22,427	22,898		22,992	23,576	23,959	24,556	25,463	26,835
GCM 2_Low	21,098	21,167	21,366	21,666		21,427	21,665	21,808	22,242	22,791	23,750
GCM 2_High	21,098	22,312	23,530	24,452		24,655	25,650	26,499	27,213	28,614	30,516
GCM 3_Base	21,098	22,101	22,546	23,177		23,103	23,589	24,664	24,409	25,640	27,015
GCM 3_Low	21,098	21,073	21,484	21,721		21,403	21,677	22,409	22,098	22,966	24,023
GCM 3_High	21,098	22,687	23,650	24,754		24,886	25,664	27,223	27,063	28,796	30,583
GCM 4_Base	21,098	21,769	22,524	22,968		23,385	23,800	24,397	24,740	25,615	27,048
GCM 4_Low	21,098	21,198	21,462	21,775		21,646	21,886	22,206	22,373	22,940	23,958
GCM 4_High	21,098	22,316	23,628	24,541		25,056	25,878	26,951	27,406	28,772	30,737
			2021-2030	Period			2031-2040	Period		2041-2050) Period
	2018	Minimum	Average	Maximum	Ν	Minimum	Average	Maximum	Minimum	Average	Maximum
Across all GCMs **	21,098	21,073	22,510	24,754		21,366	23,721	27,223	22,098	25,753	30,749
*- Estimated											
* minimum and Maximum											



Range of Load Forecasts Across Sectors and GCMS

			2021-2030			2031-2040				2041-2050	
		Minimu	Period			Period				Period	Maximu
	2018	m	Average	Maximum	<u>Minimum</u>	Average	Maximum	Mini	mum	Average	m
Total Load	21,098	21,073	22,510	24,754	21,366	23,721	27,223	22	2,098	25,753	30,749
Residential	8,116	8,048	8,602	9,135	8,589	8,980	9,697	8	8,428	9,058	9,786
Commercial	6,157	5,945	6,346	6,862	6,206	6,861	7,675	e	6,833	7,665	8,726
Industrial	5,518	4,734	5,950	6,692	3,827	5,501	6,745	3	8,257	5,186	6,893
Transportation	81	130	307	567	566	1,002	1,633	1	,461	2,351	3,610
Irrigation	975	964	1,048	1,226	946	1,114	1,444		939	1,225	1,745
SL & PL	251	245	257	274	248	263	284		252	268	296



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Difference Between Min and Max load (aMW) Across Decades											
	2021-2030	2031-2040	2041-2050								
Total Load	3,681	5,858	8,651								
Residential	1,087	1,108	1,358								
Commercial	917	1,469	1,893								
Industrial	1,958	2,918	3,636								
Transportation	436	1,067	2,150								
Irrigation	261	498	806								
SL & PL	28	36	45								







Industrial Demand For Electricity Base Case (GWH) includes Ag and Data Centers



Industrial Demand for Energy By Fuel Type TBTU Base Case



Behind the Meter Solar

Steven Simmons

end of 2018, there was 326 MW of behind-themeter solar installed in Northwest 2) Primarily in Oregon & WA(90%) and

in the Residential sector (70%)

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1) Installations of solar are forecast to grow - especially during the outer years of the planning horizon. 2025 - 662 MW 2030 - 1,725 MW 2035 - 3,732 MW 2040 - 6,540 MW 2) WA is expected to lead the region in installations with OR close in

second

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Transportation Forecast

Steven Simmons

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Forecast of Electric Passenger Vehicle Sales Market Share

Forecast of Electric Passenger Vehicle Stock Market Share

Forecast of Electricity Demand for Passenger Vehicles

End-Use Natural Gas Forecast

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End-Use Natural Gas Forecast

- 1. Demand forecast for natural gas in the region excluding the power generation sector
- 2. Shares of gas use by sector:
 - a) Residential = 36%
 - b) Commercial = 26%
 - c) Industrial = 30%
 - d) Transportation = 8%
- 3. Forecast results shows slow growth in end-use demand for gas in the region from 2020 thru 2040
 - a) Average annual growth = 0.24%
 - b) Residential & Commercial are growing Residential at 0.6% & Commercial at 1% annually
 - c) Use in Industrial and Transportation Sectors are declining

End-Use Natural Gas Demand Forecast for Region By Sector

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Next Steps

- 1. Hourly load forecasts (RA and RPM)
 - System hourly loads would be estimated for each GCM under range of economic condition
 - Hourly FE loads for 12 scenarios will be provided for:
 - Resource Adequacy for 2024 and 2035
 - RPM would use quarterly average and peak loads for each scenario
- 2. Forecast of GHG emission profiles for the region
 - Upstream emissions
- 3. Test of strategies to reduce GHG emissions
 - Pathways to Decarbonization

Questions?

End of Presentation

Residential Load across range of climate change models aMW

			2021-2030 Period			2031-2040 Period			2041-2050 Period	
	2018	Minimum	Average	Maximum	Minimum	Average	Maximum	Minimum	Average	Maximum
GCM1_Base	8,116	8,067	8,557	8,893	8,719	8,970	9,307	8,748	9,040	9,295
GCM1_Low	8,116	8,060	8,533	8,859	8,674	8,905	9,242	8,659	8,932	9,195
GCM1_High	8,116	8,084	8,613	8,972	8,818	9,104	9,442	8,923	9,242	9,486
GCM 2_Base	8,116	8,080	8,535	8,987	8,707	8,889	9,094	8,532	8,931	9,167
GCM 2_Low	8,116	8,073	8,511	8,957	8,626	8,825	9,035	8,428	8,825	9,038
GCM 2_High	8,116	8,097	8,591	9,059	8,869	9,022	9,220	8,727	9,131	9,401
GCM 3_Base	8,116	8,308	8,647	9,040	8,657	8,877	9,303	8,760	9,105	9,549
GCM 3_Low	8,116	8,287	8,623	8,998	8,589	8,813	9,216	8,653	8,996	9,419
GCM 3_High	8,116	8,359	8,704	9,135	8,798	9,010	9,475	8,960	9,309	9,786
GCM 4_Base	8,116	8,055	8,627	8,907	8,840	9,091	9,579	8,830	9,033	9,332
GCM 4_Low	8,116	8,048	8,603	8,876	8,770	9,026	9,525	8,718	8,925	9,200
GCM 4_High	8,116	8,072	8,683	8,977	8,983	9,227	9,697	9,037	9,235	9,570

			2021-2030			2031-2040			2041-2050	
			Period			Period			Period	
	2018	Minimum	Average	Maximum	Minimum	Average	Maximum	Minimum	Average	Maximum
Across all GCMs **	8,116	8,048	8,602	9,135	8,589	8,980	9,697	8,428	9,059	9,786

*- Estimated

* minimum and Maximum loads in each period, can come from different GCMs.

Range of Commercial Sector Loads

			2021-2030 Period			2031-2040) Period		2041-2050) Period
	2018	Minimum	Average	Maximum	Minimum	Average	Maximum	Minimum	Average	Maximum
Base Economic Growth	6,157	6,179	6,218	6,306	6,343	6,535	6,751	6,802	7,059	7,278
Low Economic Growth	6,157	5,907	5,949	6,034	6,068	6,254	6,467	6,522	6,750	6,930
High Economic Growth	6,157	6,340	6,475	6,636	6,678	6,936	7,240	7,309	7,640	7,925
GCM1_Base	6,157	6,274	6,375	6,499	6,571	6,842	7,142	7,258	7,616	8,014
GCM1_Low	6,157	6,039	6,100	6,219	6,287	6,549	6,842	6,960	7,285	7,623
GCM1_High	6,157	6,437	6,639	6,838	6,918	7,263	7,659	7,800	8,244	8,726
GCM 2_Base	6,157	6,226	6,338	6,448	6,487	6,796	7,054	7,150	7,532	7,872
GCM 2_Low	6,157	5,992	6,064	6,170	6,206	6,504	6,750	6,856	7,204	7,487
GCM 2_High	6,157	6,388	6,600	6,785	6,830	7,214	7,543	7,684	8,153	8,571
GCM 3_Base	6,157	6,227	6,345	6,521	6,549	6,821	7,126	7,126	7,536	7,905
GCM 3_Low	6,157	5,945	6,070	6,241	6,265	6,528	6,827	6,833	7,207	7,524
GCM 3_High	6,157	6,417	6,607	6,862	6,895	7,240	7,642	7,658	8,157	8,607
GCM 4_Base	6,157	6,254	6,343	6,480	6,569	6,817	7,157	7,265	7,583	7,919
GCM 4_Low	6,157	5,990	6,069	6,201	6,285	6,525	6,857	6,966	7,253	7,533
GCM 4_High	6,157	6,416	6,605	6,818	6,916	7,237	7,675	7,807	8,208	8,623
			2021-2030	Period		2031-2040) Period		2041-2050) Period
	2018	Minimum	Average	Maximum	Minimum	Average	Maximum	Minimum	Average	Maximum
Across all GCMs **	6,157	5,945	6,346	6,862	6,206	6,861	7,675	6,833	7,665	8,726
*_Estimated										
* minimum and Maximum	loads in	each perio	d, can com	e from diffe	rent GCMs	-				
										ТНЕ 2021 NODTHW

Industrial Load across range of climate change models aMW

			2021-2030 Period			2031- 2040 Period			2041- 2050 Period	
	2018	Minimum	Average	Maximum	Minimum	Average	Maximum	Minimum	Average	Maximum
GCM1_Base	5,518	5,794	5,971	6,101	5,411	5,579	5,752	5,217	5,275	5,378
GCM1_Low	5,518	4,734	5,272	5,751	3,827	4,209	4,630	3,257	3,486	3,757
GCM1_High	5,518	6,382	6,607	6,692	6,688	6,715	6,745	6,749	6,797	6,893
GCM 2_Base	5,518	5,794	5,971	6,101	5,411	5,579	5,752	5,217	5,275	5,378
GCM 2_Low	5,518	4,734	5,272	5,751	3,827	4,209	4,630	3,257	3,486	3,757
GCM 2_High	5,518	6,382	6,607	6,692	6,688	6,715	6,745	6,749	6,797	6,893
GCM 3_Base	5,518	5,794	5,971	6,101	5,411	5,579	5,752	5,217	5,275	5,378
GCM 3_Low	5,518	4,734	5,272	5,751	3,827	4,209	4,630	3,257	3,486	3,757
GCM 3_High	5,518	6,382	6,607	6,692	6,688	6,715	6,745	6,749	6,797	6,893
GCM 4_Base	5,518	5,794	5,971	6,101	5,411	5,579	5,752	5,217	5,275	5,378
GCM 4_Low	5,518	4,734	5,272	5,751	3,827	4,209	4,630	3,257	3,486	3,757
GCM 4_High	5,518	6,382	6,607	6,692	6,688	6,715	6,745	6,749	6,797	6,893

			2021-2030 Period			2031- 2040 Period			2041- 2050 Period	
	2018	Minimum	Average	Maximum	Minimum	Average	Maximum	Minimum	Average	Maximum
Across all GCMs *	5,518	4,734	5,950	6,692	3,827	5,501	6,745	3,257	5,186	6,893

* minimum and Maximum loads in each period, can come from different GCMs.

Transportation Load Across Range of Economic and Climate change scenarios

			2021-2030	Period		2031-2040	Period		2041-2050) Period
	2018	Minimum	Average	Maximum	Minimum	Average	Maximum	Minimum	Average	Maximum
Base Economic Growth	81	135	301	515	578	945	1,381	1,500	2,126	2,795
Low Economic Growth	81	130	284	487	546	877	1,255	1,359	1,894	2,458
High Economic Growth	81	139	318	550	617	1,028	1,526	1,664	2,407	3,216
GCM1_Base	81	135	307	531	598	998	1,479	1,613	2,334	3,143
GCM1_Low	81	130	290	502	566	925	1,341	1,461	2,082	2,772
GCM1_High	81	139	324	567	639	1,085	1,633	1,787	2,639	3,610
GCM 2_Base	81	135	307	531	598	998	1,479	1,613	2,334	3,143
GCM 2_Low	81	130	290	502	566	925	1,341	1,461	2,082	2,772
GCM 2_High	81	139	324	567	639	1,085	1,633	1,787	2,639	3,610
GCM 3_Base	81	135	307	531	598	998	1,479	1,613	2,334	3,143
GCM 3_Low	81	130	290	502	566	925	1,341	1,461	2,082	2,772
GCM 3_High	81	139	324	567	639	1,085	1,633	1,787	2,639	3,610
GCM 4_Base	81	135	307	531	598	998	1,479	1,613	2,334	3,143
GCM 4_Low	81	130	290	502	566	925	1,341	1,461	2,082	2,772
GCM 4_High	81	139	324	567	639	1,085	1,633	1,787	2,639	3,610
			2021-2030	Period		2031-2040	Period		2041-2050) Period
	2018	Minimum	Average	Maximum	Minimum	Average	Maximum	Minimum	Average	Maximum
Across all GCMs **	81	130	307	567	566	1,002	1,633	1,461	2,351	3,610

THE 2021

			2021-2030 Period			2031-2040 Period			2041-2050 Period	
	2018	Minimum	Average	Maximum	Minimum	Average	Maximum	Minimum	Average	Maximum
GCM1_Base	975	998	1,019	1,031	1,033	1,055	1,085	1,093	1,130	1,175
GCM1_Low	975	964	983	1,004	946	952	961	939	941	945
GCM1_High	975	1,046	1,141	1,226	1,243	1,336	1,444	1,473	1,604	1,745
GCM 2_Base	975	998	1,019	1,031	1,033	1,055	1,085	1,093	1,130	1,175
GCM 2_Low	975	964	983	1,004	946	952	961	939	941	945
GCM 2_High	975	1,046	1,141	1,226	1,243	1,336	1,444	1,473	1,604	1,745
GCM 3_Base	975	998	1,019	1,031	1,033	1,055	1,085	1,093	1,130	1,175
GCM 3_Low	975	964	983	1,004	946	952	961	939	941	945
GCM 3_High	975	1,046	1,141	1,226	1,243	1,336	1,444	1,473	1,604	1,745
GCM 4_Base	975	998	1,019	1,031	1,033	1,055	1,085	1,093	1,130	1,175
GCM 4_Low	975	964	983	1,004	946	952	961	939	941	945
GCM 4_High	975	1,046	1,141	1,226	1,243	1,336	1,444	1,473	1,604	1,745

Irrigation Load across range of climate change models aMW

			2021-2030			2031-2040			2041-2050	
			Period			Period			Period	
	2018	Minimum	Average	Maximum	Minimum	Average	Maximum	Minimum	Average	Maximum
Across all GCMs **	975	964	1,048	1,226	946	1,114	1,444	939	1,225	1,745

*- Estimated

* minimum and Maximum loads in each period, can come from different GCMs.

			2021-2030	Period		2031-2040) Period		2041-2050 Period	
	2018	Minimum	Average	Maximum	Minimum	Average	Maximum	Minimum	Average	Maximum
GCM1_Base	251	254	257	260	260	261	261	261	262	262
GCM1_Low	251	245	246	247	248	250	251	252	253	255
GCM1_High	251	260	268	274	274	279	284	285	290	296
GCM 2_Base	251	254	257	260	260	261	261	261	262	262
GCM 2_Low	251	245	246	247	248	250	251	252	253	255
GCM 2_High	251	260	268	274	274	279	284	285	290	296
GCM 3_Base	251	254	257	260	260	261	261	261	262	262
GCM 3_Low	251	245	246	247	248	250	251	252	253	255
GCM 3_High	251	260	268	274	274	279	284	285	290	296
GCM 4_Base	251	254	257	260	260	261	261	261	262	262
GCM 4_Low	251	245	246	247	248	250	251	252	253	255
GCM 4_High	251	260	268	274	274	279	284	285	290	296
			2021-2030	Period		2031-2040) Period		2041-2050) Period
	2018	Minimum	Average	Maximum	Minimum	Average	Maximum	Minimum	Average	Maximum
Across all GCMs **	251	245	257	274	248	263	284	252	268	296
- Estimated										