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April 4, 2017

MEMORANDUM

TO: Council Members

FROM: John Ollis, Power System Analyst

SUBJECT: Marginal Carbon Emissions Study Draft

BACKGROUND:

Presenter: John Ollis

Summary: This presentation will be a discussion of the results of the Marginal Carbon Emissions Study and a request to release the draft study for public comment.

Relevance: The study of marginal carbon dioxide production rates of the northwest power system will evaluate what resources are marginal in every hour of four years (2016, 2021, 2026 and 2031) and the implications for conservation replacing the need for that production. The results will summarize the findings into an annual average marginal carbon dioxide rate (lbs per MWh) for the years of the study for two scenarios analyzed in the 7th Power Plan: Existing Policy and Average Social Cost of Carbon.

Workplan: N/A

Background: The cost of future carbon dioxide regulation has been a significant factor in resource planning in the Pacific Northwest. To avoid making higher cost resource choices, a direct evaluation of this risk requires an estimate of the carbon dioxide emissions avoided by purchasing conservation or

another resource. The Council has periodically produced this study using the AURORAxmp model to help inform Council staff and regional stakeholder analysis.

Per the discussion in the January and February 2017 Power Committee, AURORAxmp has been used as the Council's wholesale market electricity price forecasting model. Since the wholesale electricity price is determined by the variable costs of the most expensive, available supply or demand-side resource necessary to meet the load, the Council can also use AURORAxmp, to determine the average CO2 emission rate of the marginal unit.

More Info: 2017 Marginal Carbon Emissions Study Draft will be available for preview before the meeting.

[Marginal Carbon Emissions Study scope](#)

2008 Marginal Carbon Emissions Study:
https://www.nwcouncil.org/media/29611/2008_08.pdf

For more information please contact John Ollis.



Marginal Carbon Dioxide Production Rate in the Pacific NW Power System

John Ollis April 12, 2017

Marginal Carbon Emissions Rate Review

- **Marginal resource** – The most economic way to meet an additional one MW of load
 - The next least *variable* cost resource available to meet load
 - And reserves?
- In the PNW, the average CO₂ production of all resources is significantly less than the average CO₂ production of the marginal resource

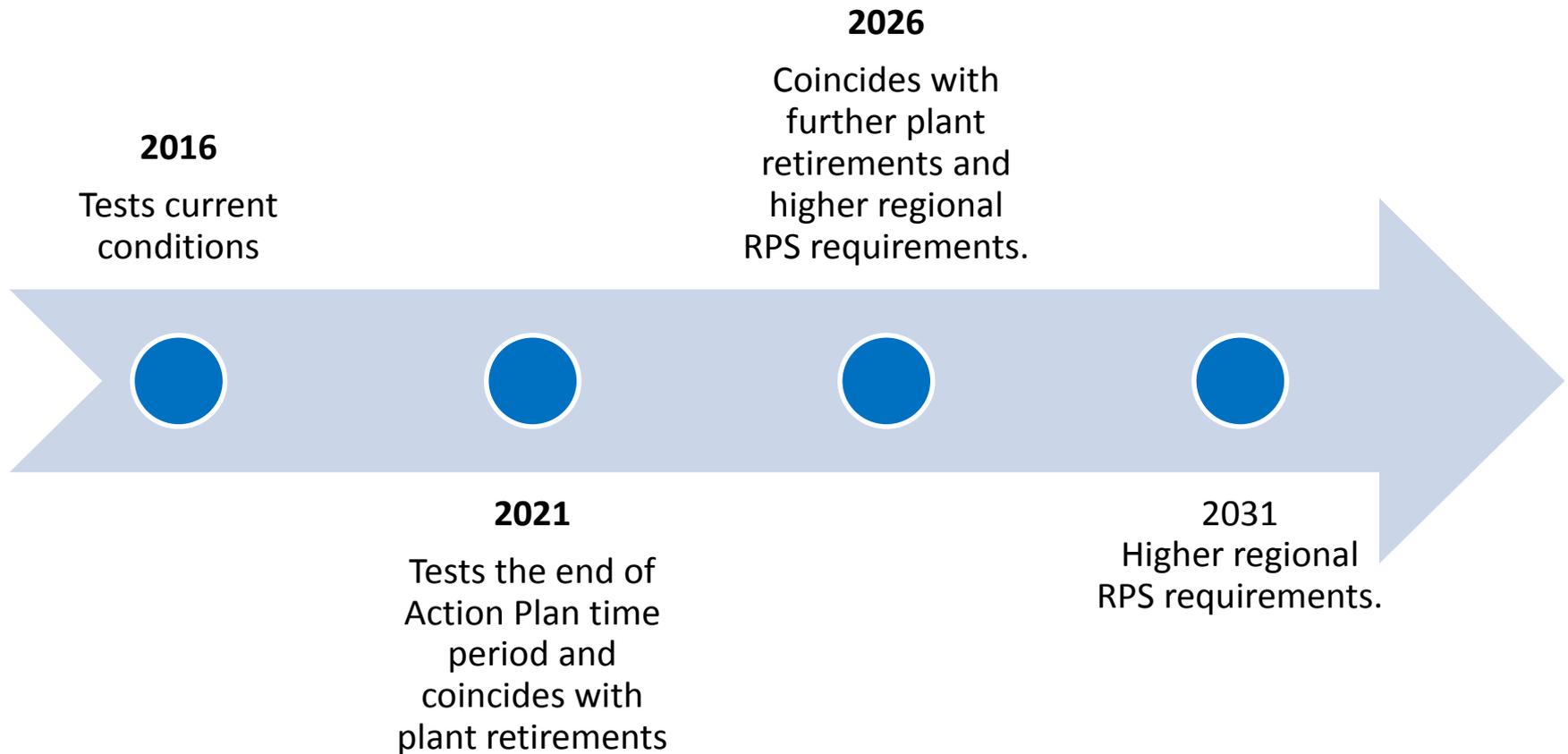
Study Methodology

- **Use AURORAxmp to determine marginal unit of production in the region.**
- **Evaluate CO₂ emissions rate of the marginal resource.**

Changes in Study Methodology

- Instead of using AURORAxmp for resource expansion, used RPM results from 7th Power Plan.
- Each of the 10 scenarios was considered under all 80 hydro conditions instead of just average hydro conditions.
- All scenarios were run with regional reserve requirements and hydro methodology similar to what was used the 7th Power Plan Balancing and Flexibility study

Study Timeline



Scope for analysis: Scenarios

Sensitivity	2016	2021	2026	2031
Existing Policy Scenario	<p><u>1 scenario</u></p> <ul style="list-style-type: none"> Plan EE No new DR No new generation 	<p><u>2 scenarios</u></p> <ul style="list-style-type: none"> Plan EE Minimum and Expected DR No new generation 	<p><u>1 scenario</u></p> <ul style="list-style-type: none"> Expected EE Expected new DR Expected new generation <i>(All from RPM: Existing Policy scenario results)</i> 	<p><u>1 scenario</u></p> <ul style="list-style-type: none"> Expected EE Expected new DR Expected new generation <i>(All from RPM: Existing Policy scenario results)</i>
Average Social Cost of Carbon Scenario	Same as above	Same as above	Same as above except buildout of resources from RPM: SCC-Mid Scenario results	Same as above except buildout of resources from RPM: SCC-Mid Scenario results

Updated Inputs

- **WECC generation resource data outside the region updated per 2026 Common Case dataset and AURORAxmp database updates**
- **In the region, generation data was updated per the Council's Generating Resource Database**
- **Loads and fuel prices was updated per most recent Council forecasts.**

Results Context

- Natural gas-fired combined cycle unit emits roughly 0.8 to 0.9 lbs. of CO₂ per kilowatt-hour.
- Conventional coal-fired steam unit emits roughly 2.1 to 2.4 lbs. of CO₂ per kilowatt-hour.
- Peaker gas units have a larger range of emissions rates 1.1 to 1.7 lbs. of CO₂ per kilowatt-hour.

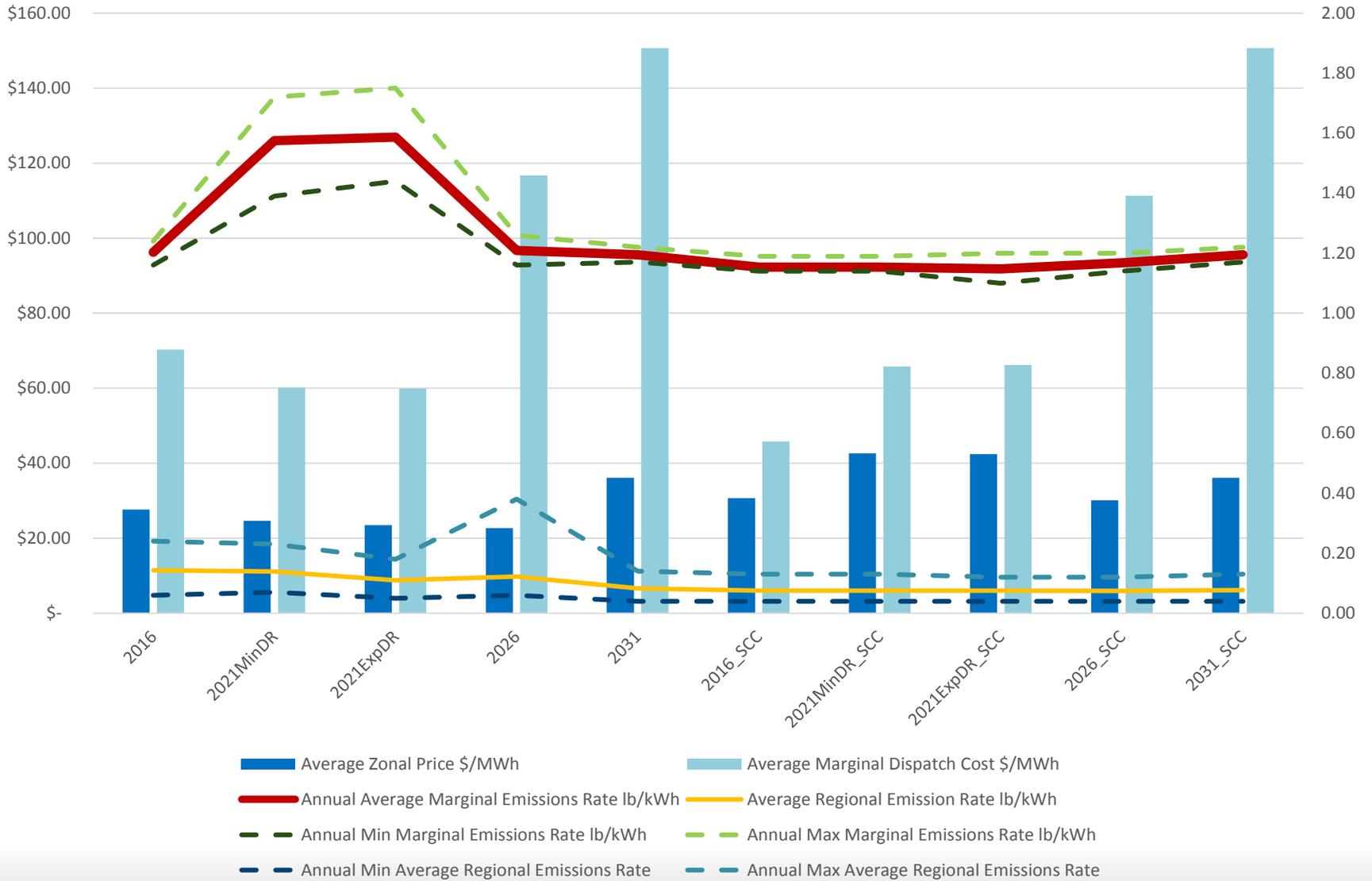
Results

- Annual average marginal CO₂ emissions rate of 1.16 lbs. per kilowatt-hour and 1.75 lbs. per kilowatt-hour under existing policy.
 - Hourly marginal CO₂ emissions rate of 0.83 lbs. per kilowatt-hour and 2.4 lbs. per kilowatt-hour under existing policy.
- Annual average marginal CO₂ emissions rate of 1.1 lbs. per kilowatt-hour and 1.22 lbs. per kilowatt-hour using a carbon penalty priced at the social cost of carbon.
 - Hourly marginal CO₂ emissions rate of 0.74 lbs. per kilowatt-hour and 2.8 lbs. per kilowatt-hour under existing policy.

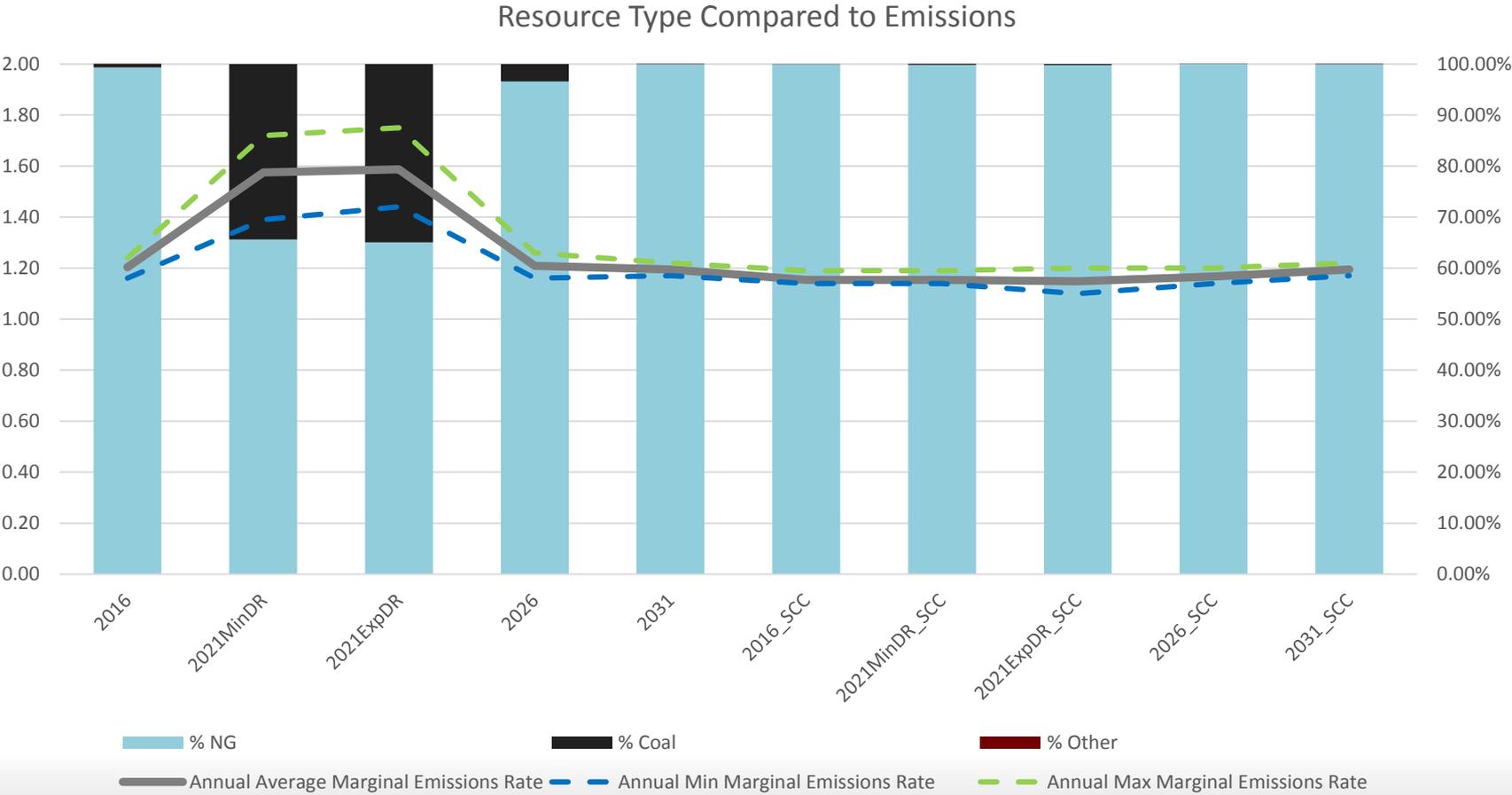
Why are almost all gas plants are on the margin?

- Mostly simple cycle gas units in existing policy case.
- Why?
 1. Coal retirements = less coal on margin.
 2. Reserve requirements not trivial .
 - 1600 MW range, served by mostly thermal flexible units
 3. All 80 hydro conditions instead of average hydro.
 4. More cheap renewables than previous study.

Carbon Emissions Rates and Wholesale Power Prices

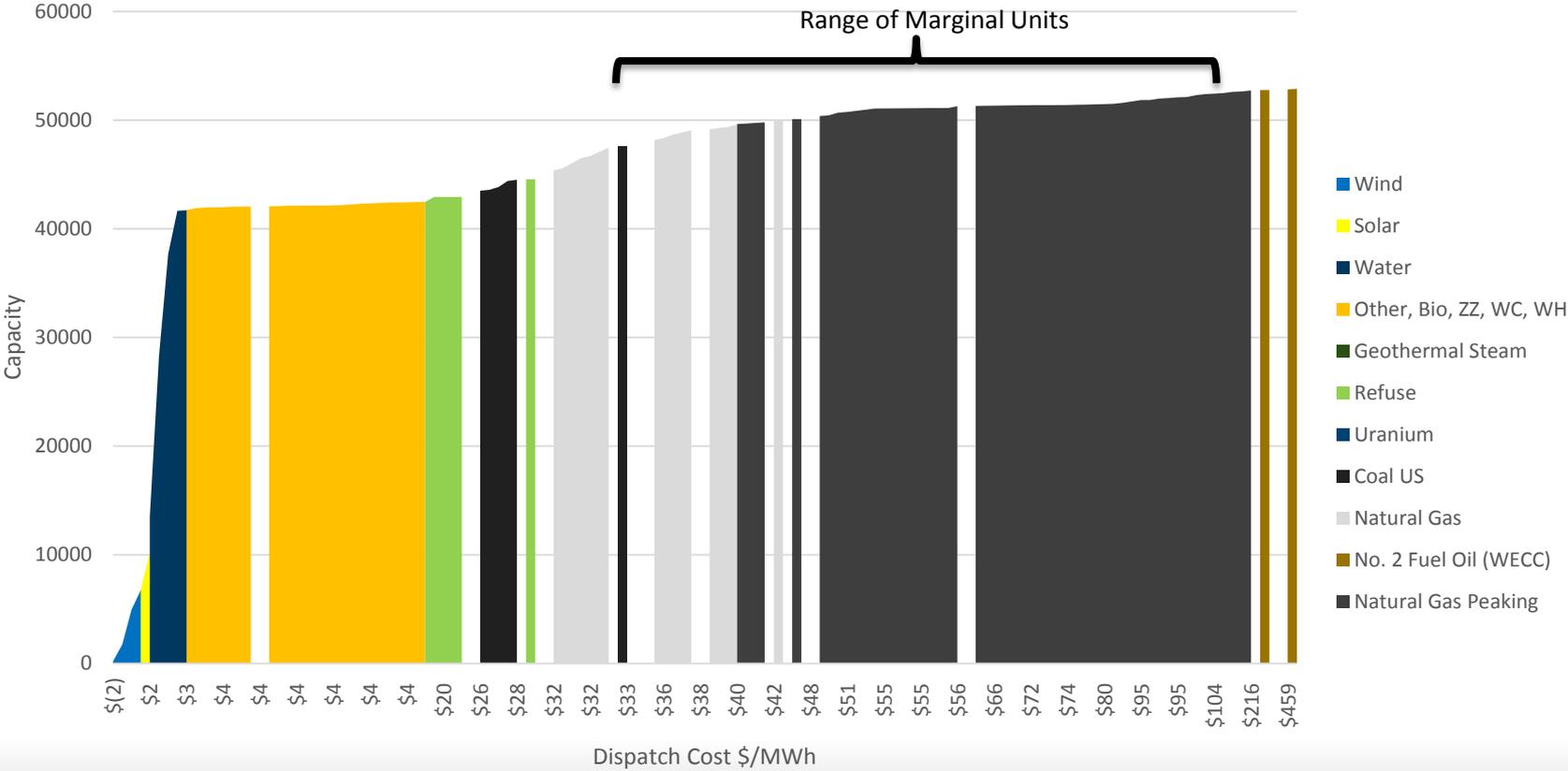


Percent Marginal by Fuel Type



Resource Stack – Existing Policy

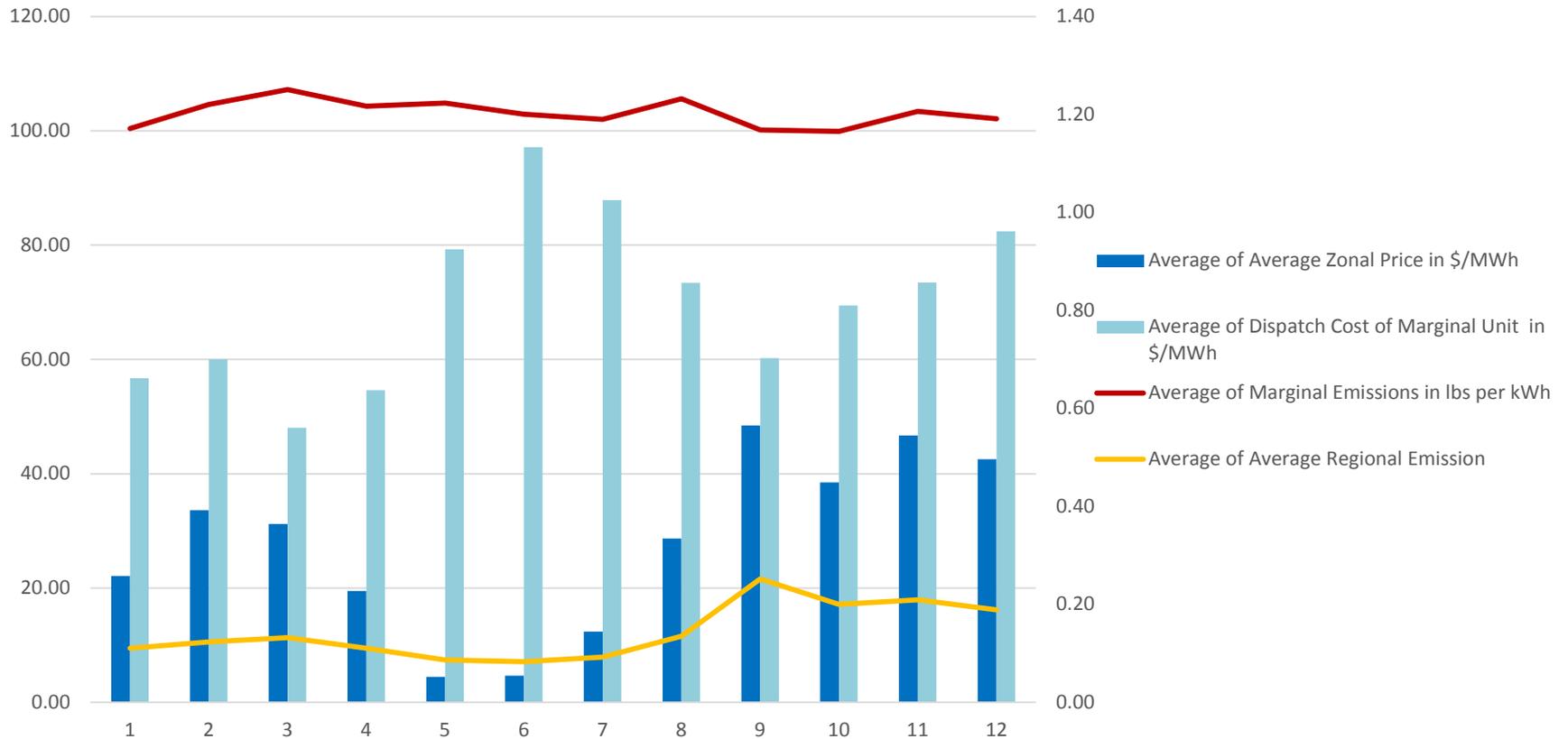
Sample Resource Stack - January 2021



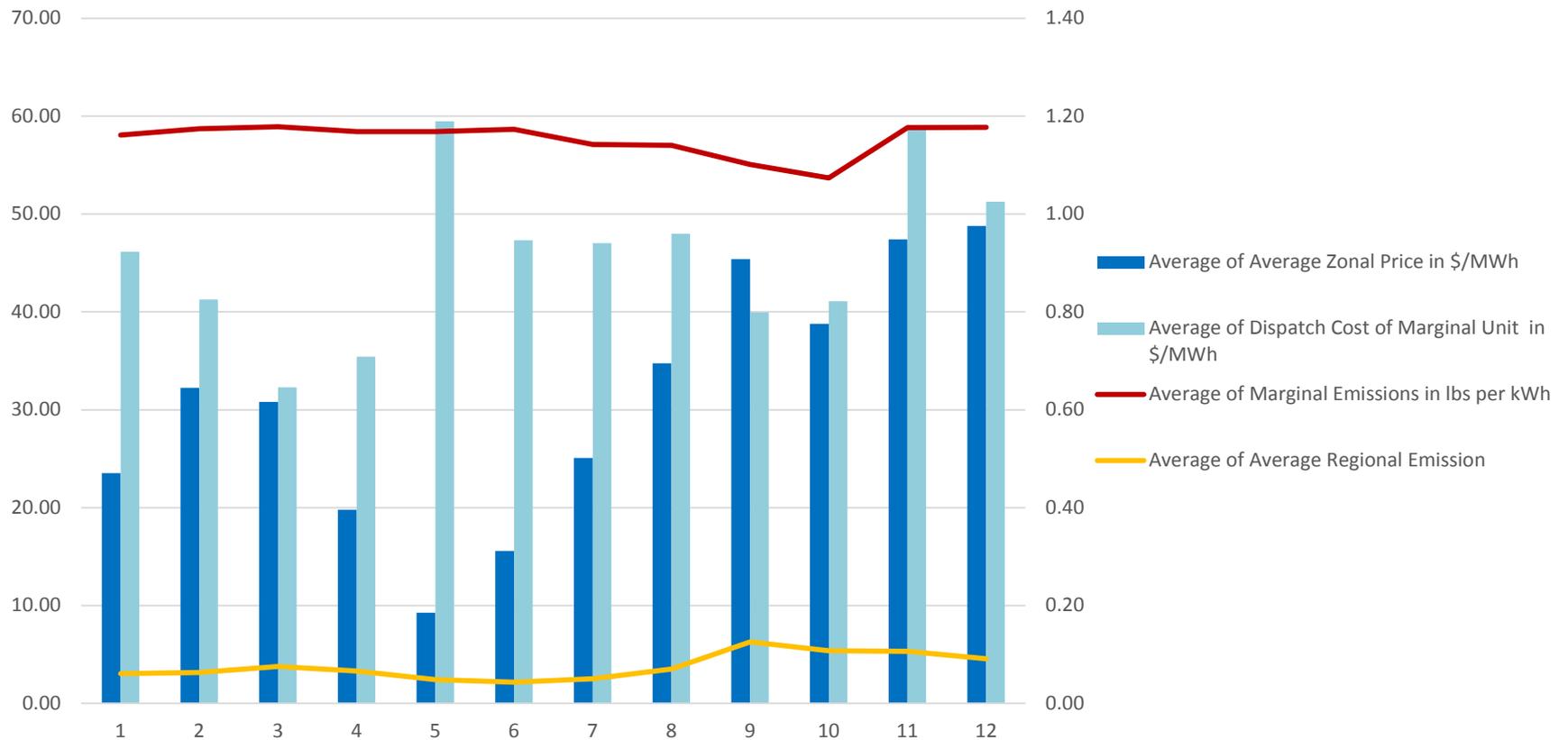
What matters?

- **Seasonality**
 - For dispatch cost and electric prices
 - Average emissions rate
- **Hydro conditions**
 - For dispatch cost and electric prices
 - Range of marginal resources selected
- **Carbon cost**
 - Reduces marginal and average carbon rate variability
 - Bumps coal off margin

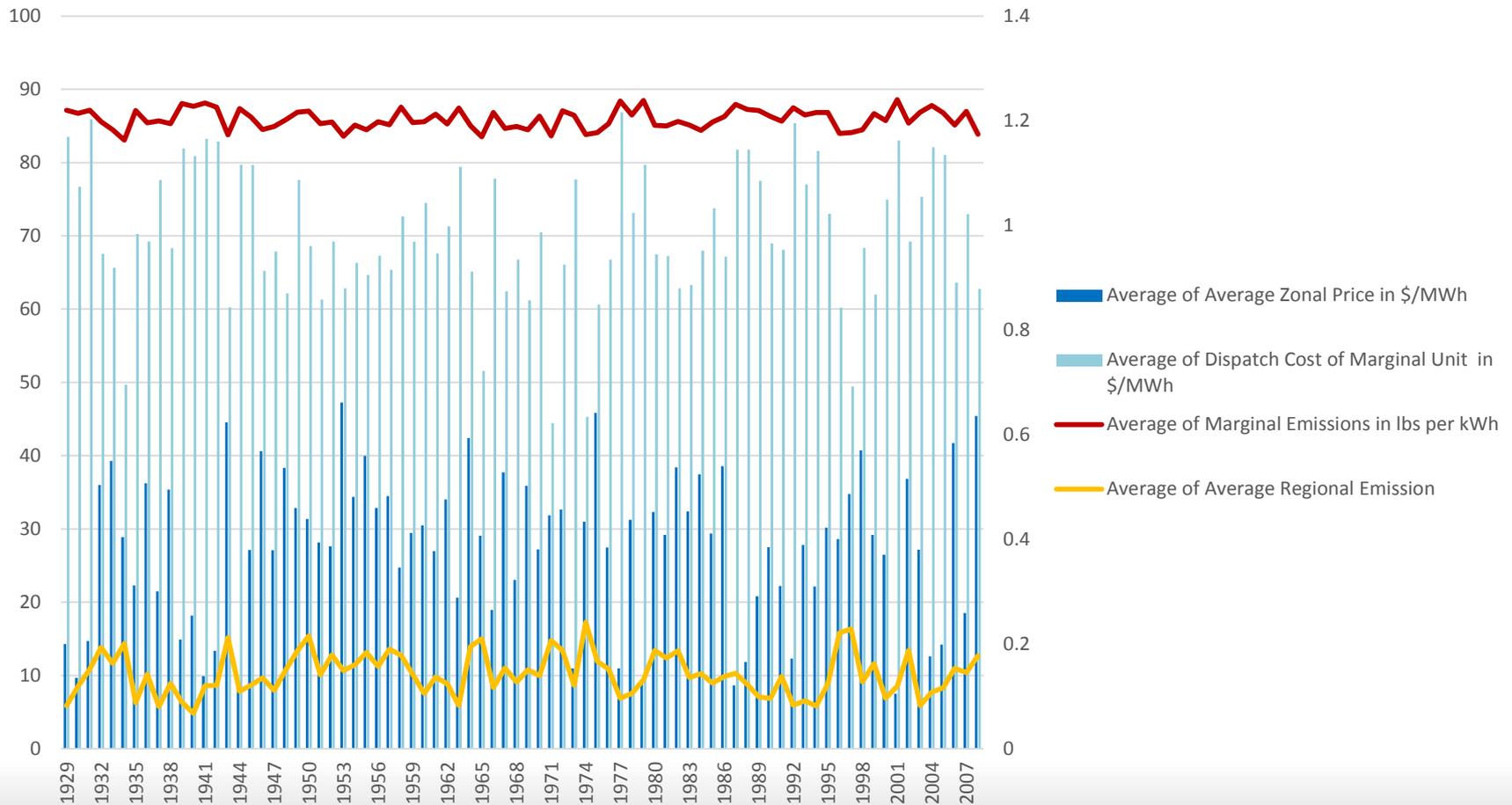
2016 Hydro Monthly



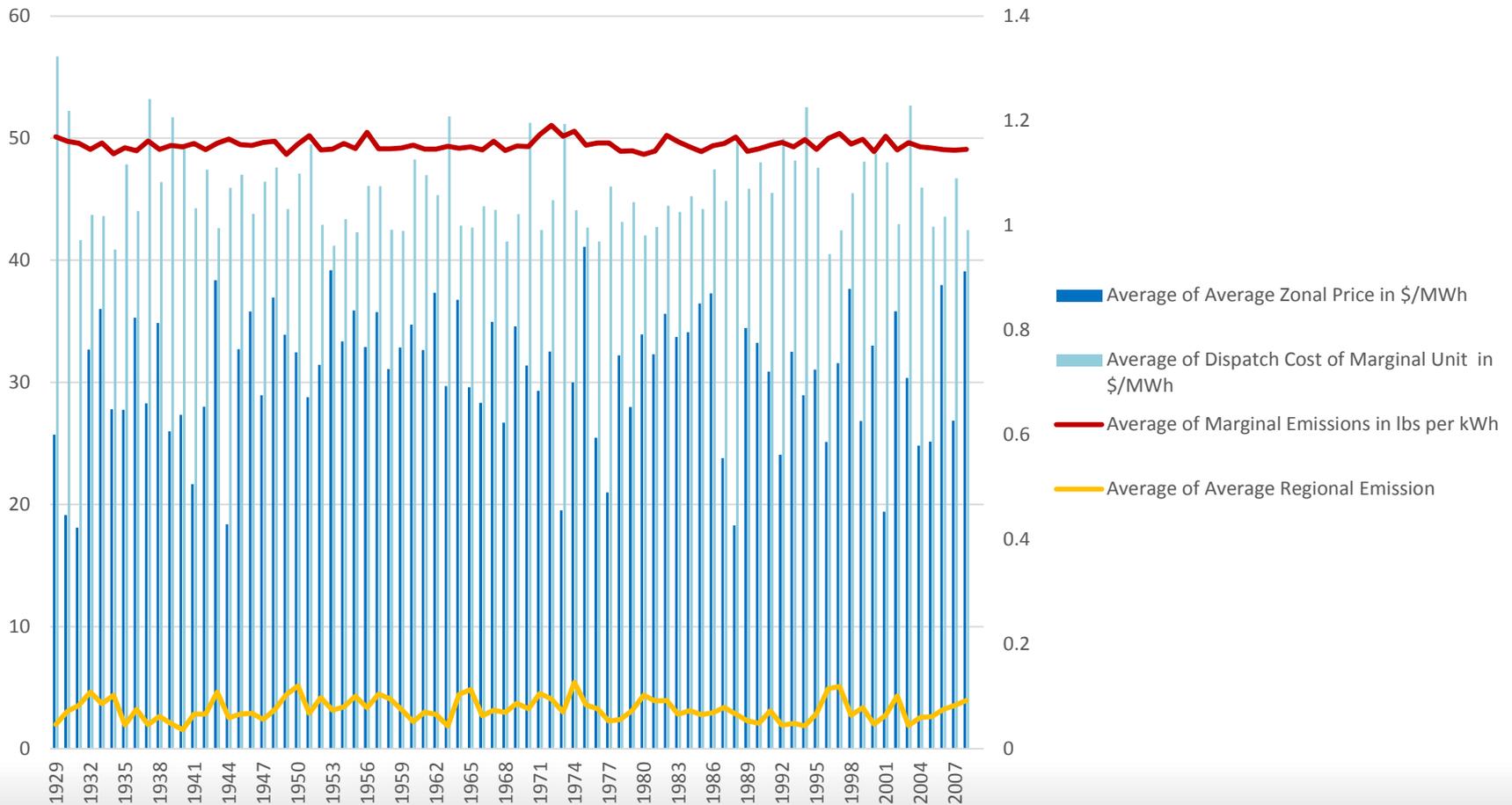
2016 SCC Monthly



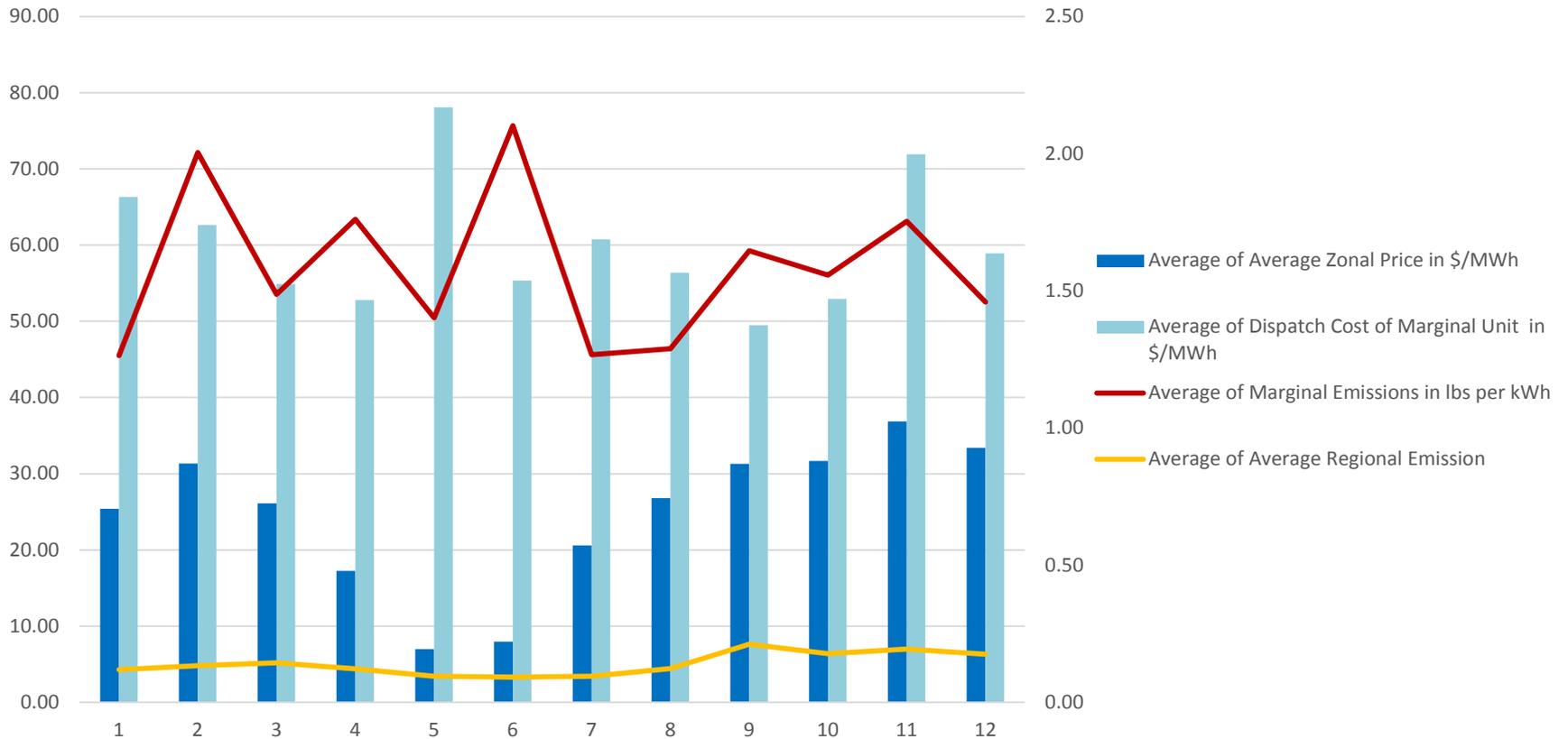
2016 Hydro Condition



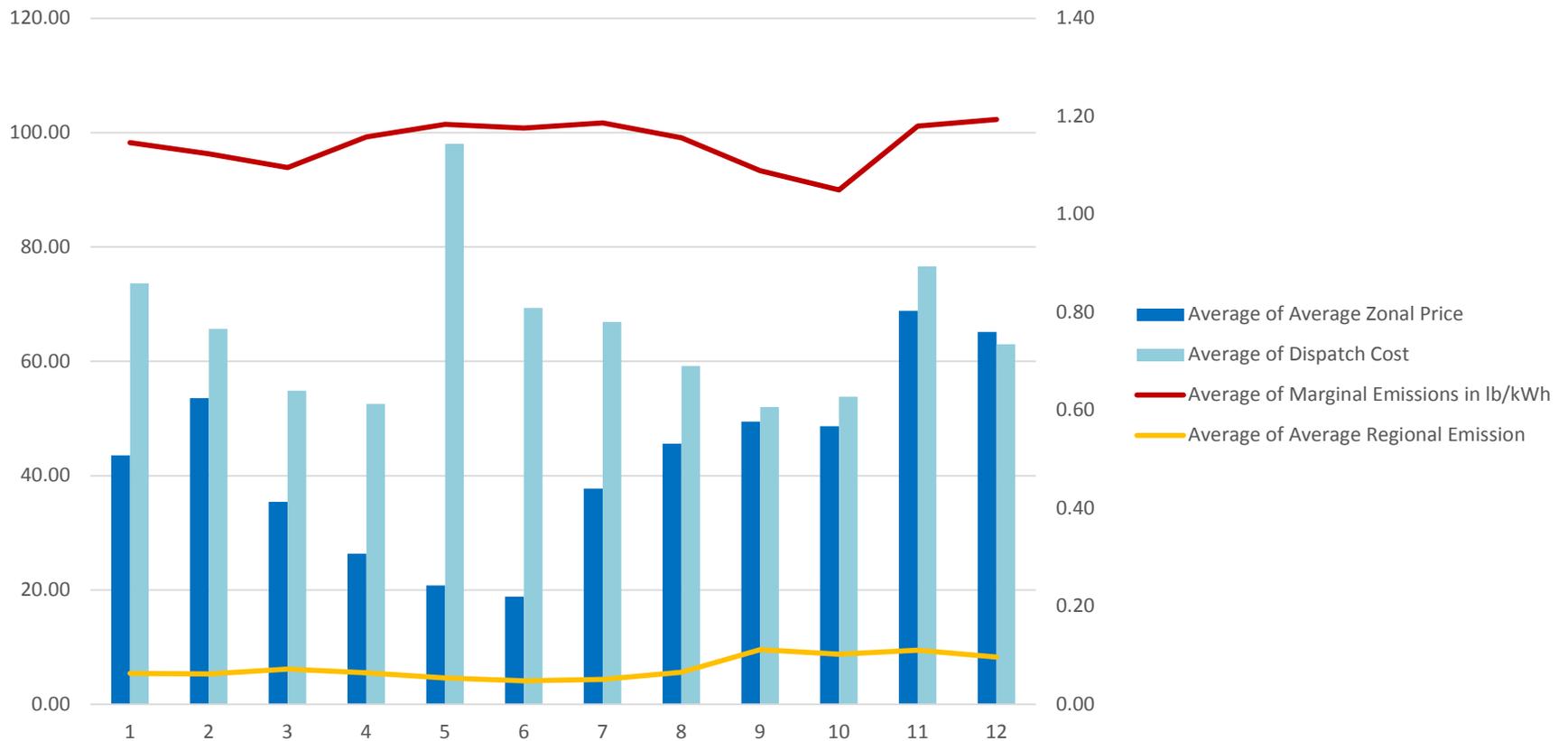
2016 SCC Emissions by hydro year



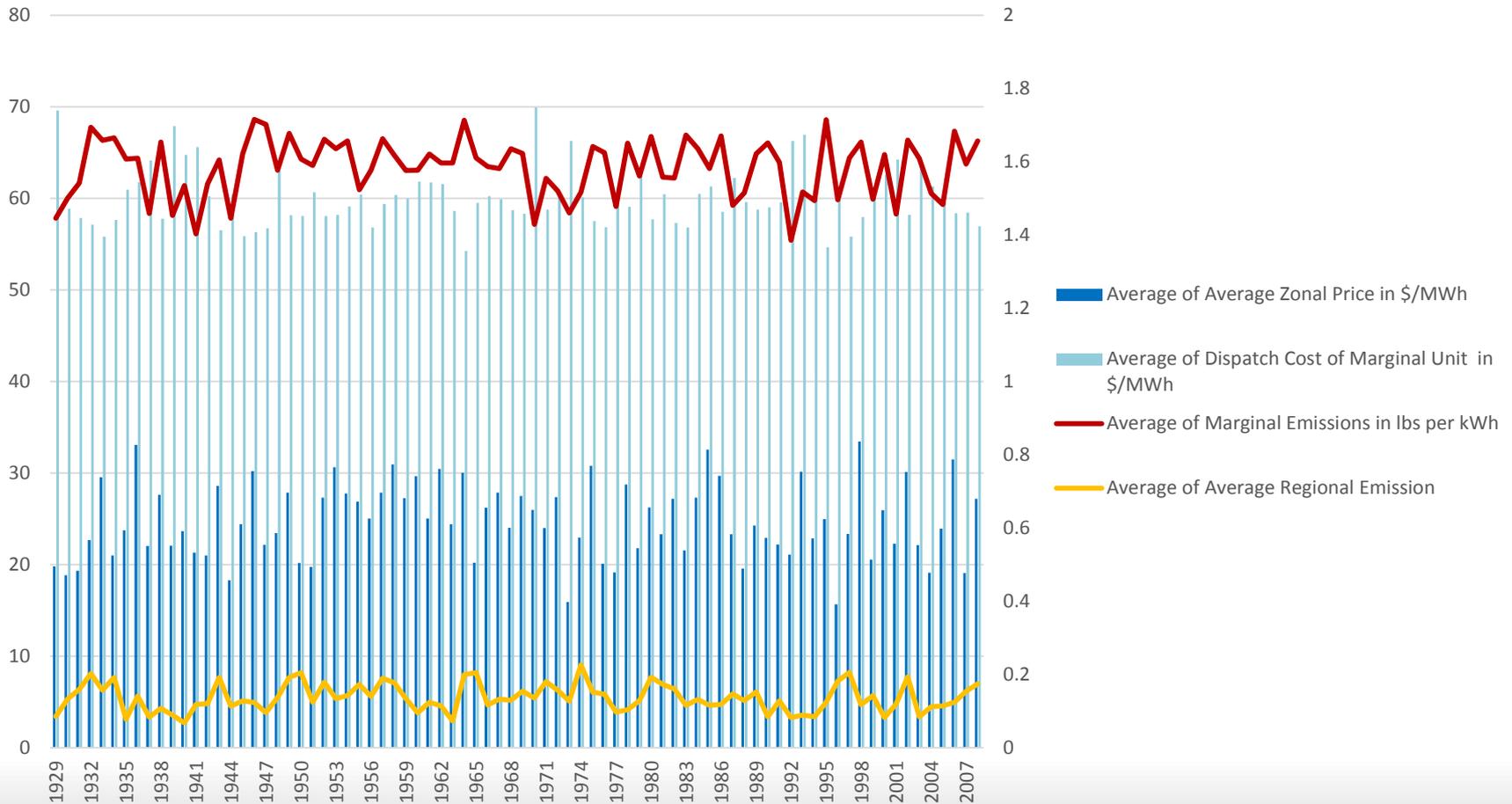
2021 Monthly



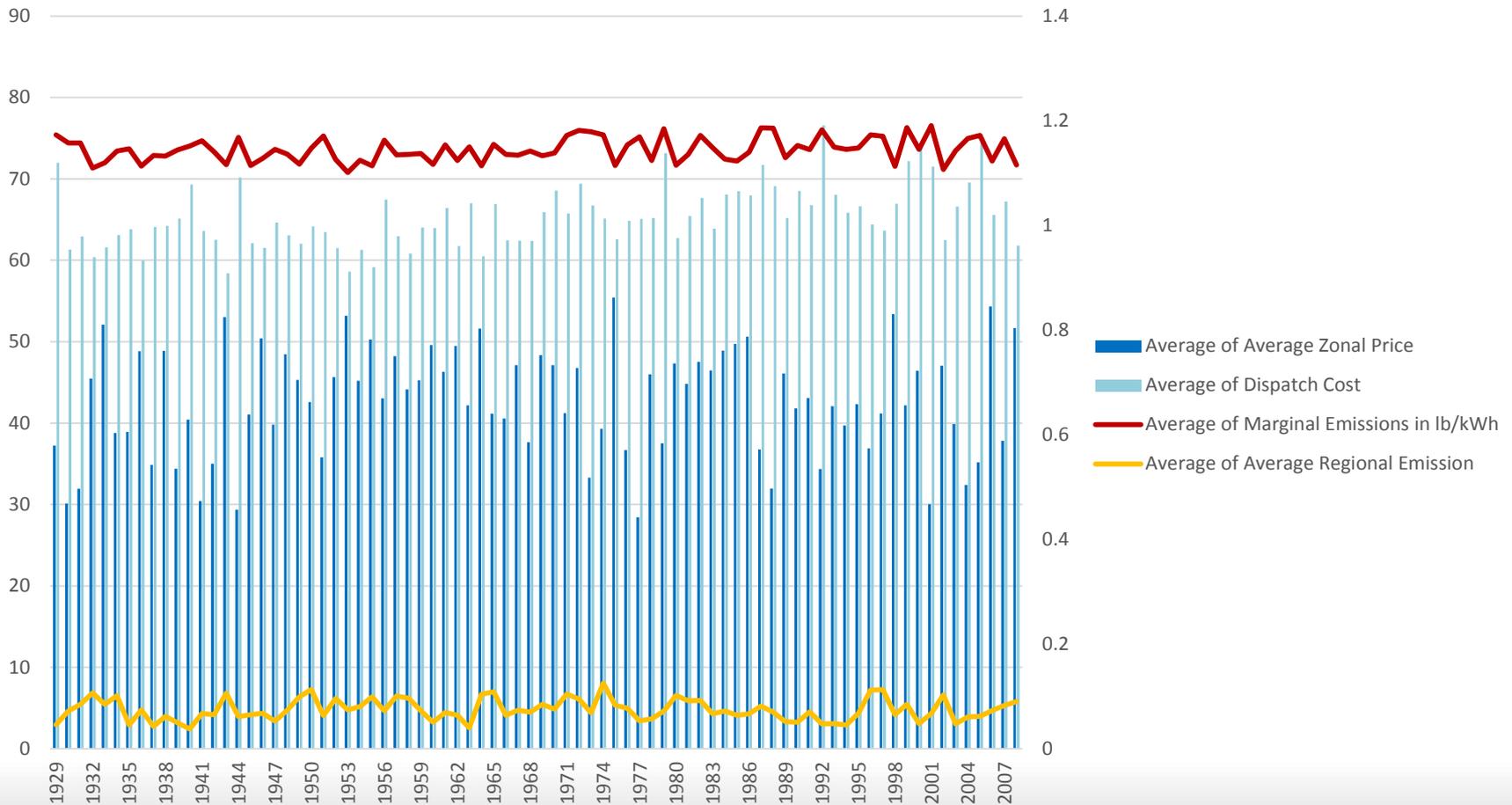
2021 SCC Monthly



2021 Hydro Condition



2021 SCC Hydro Condition



Topics for Additional Study

- **Concept of Marginal Resource**
 - Both energy and reserves considered together?
 - What will best serve stakeholders that use study?
- **Full risk assessment as in GENESYS**
- **Role of unit commitment during good hydro**

Council Approval?

- **Release the Marginal Carbon Emissions Rate Draft study for comment.**

Additional Slides

Uses for the analysis - Council

- **Inform current and future policy issues and model scenarios**
 - **How does the marginal carbon production change when/if certain resources are retired?**
- **Input to ProCost as a way to incorporate carbon costs directly based on physical carbon and cost per physical unit**

Uses for the analysis - Stakeholders

- **Inputs to regulatory proceedings**
 - Regulatory commissions have requested hourly marginal physical carbon impacts for various dockets
- **Cumulative carbon offset tracking**
 - For entities tracking or forecasting net carbon change from mitigation strategies to meet state or Federal compliance requirements