OLD DOMINION ELECTRIC	)	DOCKET NOS. EL17-32-000
COOPERATIVE V. PJM	)	
INTERCONNECTION, L.L.C.	)	
	)	
ADVANCED ENERGY	)	EL17-36-000
MANAGEMENT ALLIANCE V. PJM	)	
INTERCONNECTION, L.L.C.	)	

**COMMENTS OF THE INSTITUTE FOR POLICY INTEGRITY AT NEW YORK
UNIVERSITY SCHOOL OF LAW**

Pursuant to the Federal Energy Regulatory Commission's ("Commission" or "FERC") June 13, 2018 Notice Inviting Post-Technical Conference Comments ("Notice"),[1] the Institute for Policy Integrity at New York University School of Law ("Policy Integrity") hereby files these comments in the above-captioned proceedings. Policy Integrity is a non-partisan think tank dedicated to improving the quality of government decisionmaking through advocacy and scholarship in the fields of administrative law, economics, and public policy.[2]

As discussed below, Policy Integrity concurs with many of the speakers at the April 24, 2018 technical conference that the current design of PJM Interconnection L.L.C's ("PJM") capacity market—the Reliability Pricing Model ("RPM")—is seriously flawed due to poor aggregation rules for resources with capacity factors that vary across the year ("seasonal resources"), and a mismatch between the seasonal variation in load and market rules that provide only an annual capacity product. These flaws inhibit the efficiency of the market by leading to over-procurement of capacity and suppressing the participation of seasonal resources, thereby inefficiently increasing the costs to

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[1] Notice Inviting Post-Technical Conference Comments, *Old Dominion Electric Cooperative v. PJM Interconnection L,L,C*, Docket Nos. EL17-32-000 and EL17-36-000 (June 13, 2018).

[2] No part of this document purports to present the views of New York University School of Law, if any.

electricity customers. The technical conference was an important first step in examining issues related to the seasonality of electricity demand and generation.

In these comments we address some of the questions concerning alternate market designs that the Commission posed in the Notice. In addition, we draw attention to topics that have not received adequate attention in these proceedings. To that end, the remainder of this document offers the following comments:

- PJM's current choice of procuring a single, annual capacity product leads to over-procurement of capacity, inefficiently high costs, and inefficiently low participation of seasonal resources, and thus cannot be justified on economic efficiency grounds.

- The participation of seasonal resources is additionally restricted through poor resource aggregation rules.

- Even small changes in the aggregation rules supplemented by introduction of seasonal capacity products would improve economic efficiency.

- Potential worries about the value of the intermittent resources, if justified, should be solved by means other than excluding those resources from the capacity markets.

RESPONSE TO COMMISSION'S QUESTIONS

I. <u>Q2. According to the 2021/2022 Reliability Pricing Model (RPM) Base Residual Auction (BRA) report, cleared megawatt quantities of wind, solar, demand response, and energy efficiency resources all increased compared to the 2020/2021 RPM BRA and at higher clearing prices throughout the PJM footprint. Please comment on how these results reflect on the efficacy of PJM's seasonal aggregation mechanism and the ability of these resource types to participate in RPM as either annual resources or aggregated resources under existing RPM rules. To the extent you view one or more of the alternative market designs mentioned above as better than the existing RPM rules, please explain how those alternative designs would yield preferable auction outcomes relative to those seen in the 2021/2022 BRA. Please provide evidence and quantitative support where possible.</u>

Before discussing how alternative designs yield superior economic outcomes, it is helpful to understand the inefficiencies inherent in the current design. Below, we first discuss the characteristics of the current market design that lead to suboptimal economic outcomes. And, then, we discuss the

potential for cost reduction when seasonality of resources and load is better incorporated into the

market design.

1. **A market design that procures only annual capacity obligations is not justified on economic efficiency grounds**

Capacity markets are administrative constructs that some wholesale electricity market

operators, including PJM, use to meet capacity needs while accounting for the "missing money"

problem by ensuring revenue sufficiency for generators.[3] These administratively constructed

"markets" differ from standard markets for a number of reasons. One important reason is that the

amount of capacity procured is not driven by market forces, but rather is set using an

administratively-determined formula represented by a Variable Resource Requirement ("VRR")

curve.[4] This formula determines the amount of capacity that will clear the market and the

corresponding per-MW price paid to market participants for a given set of capacity supply bids.

Consequently, PJM's decisions concerning the shape of the VRR curve, together with PJM's

decisions concerning capacity market design, are the main drivers of the economic outcomes in the

RPM.

A key design feature of the RPM is the definition of the product to be procured through the

market. In 2015, PJM, with the approval of FERC, transitioned from multiple capacity products that

had some elements of seasonality to a single annual (year-round) capacity product known as

"Capacity Performance."[5]

a. **Various durations of capacity products are possible**

The academic literature does not provide clear guidance on what the most efficient duration

of a capacity product should be. It is theoretically possible to have infinitely many different types of

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[3] Paul L. Joskow, *Capacity Payments in Imperfect Electricity Markets: Need and Design*, 16 UTIL. POL'Y, no. 3, 2008, at 159.
[4] PJM, Learning Center, Capacity Market (RPM), http://learn.pjm.com/three-priorities/buying-and-selling-energy/capacity-markets.aspx (last accessed July 6, 2018).
[5] *PJM Interconnection, L.L.C.*, 151 FERC ¶ 61,208 (2015).

capacity products, each with a different commitment duration. For example, PJM could require bids

to be submitted for two-year capacity obligations, or monthly capacity obligations. It could also

procure a combination of different products with varying commitment durations. Indeed, many

different constructs were proposed by various parties in pre-technical conference comments,

including a two-season market construct, a three-season market construct, and an annual product

combined with seasonal elements.[6] Even in practice there are different constructs. For example the

New York Independent System Operator ("NYISO") runs its Capability Period ("Strip") Auction,

with six months commitments (summer and winter periods) in combination with a Monthly Auction,

where resources can offer for any month remaining in the Capability Period, and a monthly Spot

Market Auction, with commitments for a single calendar month.[7] No annual capacity commitments

are auctioned in NYISO.

> **b. Procuring solely an annual capacity product results in inefficiencies**

Under its RPM construct, PJM procures solely an annual capacity product. There is little

compelling reason to continue to do so, beyond the convenience of retaining the current approach.

PJM's justification for retaining the current market design—that adoption of a seasonal capacity

product may affect how non-seasonal resources clear the capacity market—is not a compelling

reason to retain the status quo. Because both electricity demand and the available capacity vary by

season, limiting the RPM to only an annual product leads to economic inefficiencies for two reasons.

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[6] *See, e.g.*, Comments of The Brattle Group authors on behalf of the Natural Resources Defense Council, *Old Dominion Electric Cooperative v. PJM Interconnection L,L,C*, Docket Nos. EL17-32-000 and EL17-36-000 (April 12, 2018) [hereinafter "Brattle Group Comments"]; Pre-Technical Conference Comments of Advanced Energy Management Alliance, *Old Dominion Electric Cooperative v. PJM Interconnection L,L,C*, Docket Nos. EL17-32-000 and EL17-36-000 (April 11, 2018).

[7] Mathangi Srinivasan, NYISO Administered ICAP Market Auctions (2017), https://www.nyiso.com/public/webdocs/markets_operations/services/market_training/workshops_courses/Training_Course_Materials/Installed_Capacity_MT_305/6_ICAP%20Auctions.pdf.

i. Relying solely on an annual capacity product leads to capacity over-procurement

Procuring the same amount of capacity for the whole year ignores the fact that the need for generation capacity varies starkly throughout the year. The data prepared by PJM shows that peak load is slightly above 150,000 MW in the summer, approximately 110,000 MW in the fall, approximately 135,000 MW in the winter, and approximately 120,000 MW in the spring.[8] There is also variation within each season. As PJM must ensure enough generation capacity is available to meet the highest level of demand, procurement of the same amount of capacity for the entire year will lead PJM to pay for capacity to be available all year just to meet demand during the highest-load season. Doing so will result in excess capacity during all other seasons, which all have lower levels of load.

There are limited conditions under which relying solely on an annual capacity product might make economic sense. For example, if there were no differences in the availability of resources over the course of the year, then no construction and maintenance of capacity could be avoided by seasonally procuring capacity and so there would be no social welfare gain from increasing the time granularity of the market. In this case, a single annual capacity product would minimize system costs, and therefore would be justified even with existence of load differences.[9]

However, the capability of some resources to generate electricity varies significantly over the course of the year. For instance, wind resources have the highest capacity factors – the ratio of actual electrical energy output over a given period of time to the maximum possible electrical energy output over that period – in winter. Solar resources, on the other hand, have the highest capacity factors in the summer. Additionally, the seasonal changes in capacity for certain resources coincide with

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[8] Tom Falin, PJM , Winter Season Resource Adequacy Analysis Status Report 5 (2017), https://www.pjm.com/-/media/committees-groups/committees/mrc/20171026/20171026-item-16-winter-season-resoruce-adequacy-analysis-status-report.ashx.

[9] Note that even if there were no differences in seasonal resource availability, introducing "seasons" through shortening commitment duration could increase efficiency if the resources could save a significant portion of their capacity costs by remaining dormant in some seasons.

periods of elevated electricity demand. For instance, solar resources have the ability to generate more electricity in the summer time, which coincides with the summer peak period.[10] Similarly, the power and efficiency of combustion turbines sharply increases with decreasing temperatures leading to the highest combustion turbines capacity during the coldest months in the winter, which also happen to be winter peak months.[11]

But, an annual capacity product cannot take into account these differences in generation capacity and capacity factors. Simultaneously, a single, annual product causes the capacity market to disregard the seasonal differences in the amount of load that capacity is needed to serve. In fact, PJM assigns many resources only their lowest capacity factor throughout the year, unnecessarily inflating the amount of nameplate capacity needed from a resource during these seasons and leading to over-procurement. Moving to a more granular design, combined with improvements in assignment of capacity factors, would help PJM acknowledge the value that resources with variable capacity factors contribute to the system and reduce the potential to over-procure capacity.

ii. Procuring only an annual capacity product suppresses participation of seasonal resources

RPM procurement of only an annual capacity product decreases the probability that seasonal resources will clear the capacity market, leading, in turn, to clearing more annual resources (that is, resources that can provide capacity continuously throughout the year) than would clear under a more efficient seasonal market design. Given the seasonality of load, the ability to procure capacity from seasonal resources during only those times that correspond to seasonal peak load can result in lower

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[10] Brattle Group Comments at 4-6.
[11] As EPA explains, "at elevated inlet air temperatures . . . power decreases due to the decreased air flow mass rate (the density of air declines as temperature increases), and the efficiency decreases because the compressor requires more power to compress air of higher temperature." U.S. Envtl. Prot. Agency, Combined Heat and Power Partnership, Catalog of CHP Technologies: Section 3. Technology Characterization – Combustion Turbines 3-10 (2015), https://www.epa.gov/sites/production/files/2015-07/documents/catalog_of_chp_technologies_section_3._technology_characterization_-_combustion_turbines.pdf. For illustration of the relationship between ambient temperatures and the performance of turbines, *see* Figure 3-5 at *id.* at 3-11. Brattle estimates that over a November – April period, combustion turbine capacity in PJM is 9.500 MW higher than in the rest of the year. Brattle Group Comments at 6.

total annual costs to meet capacity needs throughout the year. This can be true even if the per-unit cost of the seasonal capacity is higher than the cost of an annual resource.[12] However, because RPM is limited to an annual capacity product, these savings cannot be achieved.

To be sure, while the RPM includes only an annual capacity product, it also includes a "matching" mechanism that is intended to accommodate the seasonality of resources. Under PJM's aggregation rules, capacity market sellers that, alone, are unable to meet the requirements to supply the annual Capacity Performance product can combine with other resources to offer capacity as a single Aggregate Resource.[13] But, this matching mechanism is not sufficient to achieve efficiency.

An efficient aggregation method would fully recognize the varying capacity contributions of all resources by assigning resources capacity contributions that they are permitted to sell into the market ("qualified capacity") according to their seasonal capacity factors.[14] As various parties contend in their pre-technical conference comments, this approach is currently available only for select resources.[15] For some other resources, qualified capacity is assigned based on the resource's capacity factor during its low capacity season (e.g., thermal unit capacity is set based on the lower summer nameplate capacity value). RPM rules, therefore, currently undercount the level of capacity these resources could provide during certain seasons, and so unnecessarily limit their participation. PJM could improve the efficiency of its aggregation rules by assigning *all* resources with qualified capacity based on seasonal rather than minimum capacity factors.

In addition, PJM's aggregation rules split revenues between matched resources in a way that creates inefficiencies. Currently, PJM splits capacity payments equally between matched resources.

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[12] *See* Section 2, *infra*, for an explanation and derivation for the maximum seasonal resource capacity cost such that the clearing of the market by that resource is still socially desirable.

[13] For details, *see* Docket Nos. ER17-367-000, ER17-367-001, & ER17-367-002.

[14] Equivalently, PJM could assign seasonal resources a minimum quantity of qualified capacity for the year based on their lowest capacity factor, but also allow them to bid additional MWs of capacity for a particular season according to their seasonal capacity factors.

[15] Brattle Group Comments at 4-6; Preliminary Technical Conference Comments of the American Wind Energy Association and Mid-Atlantic Renewable Energy Coalition, *Old Dominion Electric Cooperative v. PJM Interconnection L,L,C*, Docket Nos. EL17-32-000 and EL17-36-000 (April 11, 2018).

But, with this half-half assignment of capacity payments, a more expensive resource may not see its

capacity cost covered after clearing an auction.[16] This limits the extent to which these higher-cost

seasonal resources are able to participate in the current RPM construct. One alternative approach

would be for PJM to gather information on the minimum required price-per-MW of each aggregated

resource. Each of the winning resources could then be assigned their minimum required price-per-

MW, with any surplus shared between the matched resources.

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c. **Impaired seasonal resource participation can lead to additional forgone savings through effects on energy markets**

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The inability of seasonal resources to fully participate in capacity auctions may additionally

hinder efficiency through effects on wholesale energy markets. For example, when seasonal

resources have marginal costs of electricity generation that are lower than those of annual resources,

seasonal resource participation in wholesale energy markets would lead to cost savings compared to

a scenario where those resources cannot participate. However, for seasonal resources that rely on

capacity revenue to recover their fixed costs, when capacity market participation is artificially

restricted through administrative rules, they might decide against entering in the first place.

Consequently, they would not be available to meet energy market demand and wholesale energy

market prices would be higher than they could be with full season resource participation.

2. **Potential benefit for incorporating seasonality into the market design are significant**

A simple exercise shows that moving from procurement of annual capacity to a more

granular measure of capacity can result in significant cost savings. For example, consider one

possible way of designing a seasonal capacity market: a minimum level of capacity to cover the

demand in the period with the lowest load, and splitting the year into seasons, with equal-length

summer and winter seasons, and a "shoulder" period during spring and fall. In PJM, this design

would correspond to a minimum annual capacity requirement of about 138,000 MW during fall and

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[16] The half-half split also does not reflect how additional capacity contributes to reliability across seasons.

spring each, and an additional 34,500 MW and 17,250 MW of seasonal capacity for summer and winter, respectively.[17]

Achieving economic efficiency, given the highly inelastic electricity demand, requires minimization of total costs of providing capacity. Costs of providing capacity mainly reflect opportunity costs but also the costs of going forward in terms of maintenance of capacity, labor required to keep the plant operational etc. Because annual resources have to provide capacity continuously throughout the year, the cost of a megawatt per season for annual resources is determined by spreading these costs over all four seasons. Seasonal resources, on the other hand, provide capacity during only select seasons. Therefore, for seasonal resources, cost of providing capacity can be spread over only the seasons that these resources are available. As a result, per-megawatt per-season costs of capacity are likely to be higher for seasonal resources. However, even then, moving to a seasonal construct can reduce total annual cost of meeting capacity needs.

For an illustration of the potential benefits of moving to a seasonal capacity construct, assume that the cost of a megawatt per season of resource is C_s and the corresponding cost for an annual resource is C_B. In addition, assume initially that the marginal costs of electricity generation are the same for annual and seasonal resources.

The total cost change associated with moving to procurement of differing amounts of capacity across the seasons can be calculated by looking at the sum of capacity costs between the two designs. In a design with only an annual product, PJM would have to procure 172,500 MWs in each season to meet the highest demand during summer, leading to a total annual capacity cost of $690,000C_B$.

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[17] Capacity requirements are calculated by increasing the capacity needed in each season (approximately 150 GW, 110 GW, 135 GW, and 120 GW in summer, fall, winter and spring, respectively), *see* note 8 and accompanying text, by 15% to account for reserve requirements. Therefore, the total capacity requirements for each season, given the seasonal peak loads, would be approximately 172.5 GW, 126.5 GW, 155.25 GW, and 138 GW in summer, fall, winter, and spring, respectively.

In a seasonal capacity construct, costs will vary in each season. Now, during the shoulder period, which covers spring and fall, PJM can procure a minimum level of annual capacity based on the highest load during this period. Therefore, PJM will procure 138,000 MWs in each of spring, and fall, at a combined capacity cost of $276,000C_B$. Because PJM can now procure 34,500 MWs less capacity in each of these shoulder periods, there is a combined cost savings of $69,000C_B$ during these two seasons compared to having an annual capacity market.

In the winter, PJM would have to procure 17,250 MW of capacity in addition to the annual capacity product of 138,000 MWs. So, compared to an annual construct, PJM would pay $34,500C_B$ less for the annual resources, but $17,250C_S$ more for seasonal resources. Therefore, the cost difference for winter season would be $34,500\ C_B - 17,250C_S$.[18] As long as the seasonal resources are not twice as expensive as the annual resources, a seasonal capacity market construct would bring cost savings in the winter period as well.

Finally, in the summer, there are two factors that affect the cost differential of a seasonal design compared to an annual capacity market design. First, 34,500 MW of additional capacity would be required, leading to a cost difference of $34,500(C_B - C_S)$. Second, because with a seasonal capacity market construct there is less capacity in the winter time, PJM would have to increase requirements in summer time to meet the annual loss of load requirements. Therefore, PJM would have to procure an additional amount of summer capacity, γ, leading to a total cost difference of $34,500(C_B - C_S) - \gamma C_S$. As long as the seasonal resources are more expensive than the annual resources, this term would be negative.

When the seasonal costs are summed, a seasonal construct would lead to a total annual cost of $552,000C_B + 51,750C_S + \gamma C_S$. The cost difference between the annual design and the seasonal

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[18] The underlying assumption is that annual resources lacks the ability to supply seasonal capacity. If an annual resource can also provide seasonal capacity and provide cost savings by remaining dormant in others, the cost savings could be higher.

design is $138,000C_B - 51,750C_S - \gamma C_S$. As long as this term is positive, moving to a seasonal design would lead to cost savings. And this term will be positive as long as the additional seasonal capacity does not surpass the savings from reduced base capacity.

Non-negativity of this term requires that $C_B \geq \frac{3}{8}C_S - \frac{\gamma}{138,000}C_S$. Put differently, as long as the costs of seasonal resources are not significantly higher than the cost of annual resources, a seasonal construct would lead to cost savings. The value of parameter γ depends on many factors, including the load differences between seasons and load variability within the individual seasons. However, given the significant over-procurement associated with an annual-only product, this parameter will be small.[19] In other words, the seasonal design would lead to capacity cost savings as long as the seasonal resources are not more expensive than annual resources by an order of magnitude.[20]

Note that these calculations assume there is no difference in the marginal costs of electricity generation between annual and seasonal resources. If there are differences, this calculation would need to be expanded to compare the total capacity generation costs. If marginal cost of the electricity generated by seasonal resources is lower than the marginal cost of electricity generated by annual resources, as can be expected from seasonal resources such as solar and wind, the above presented savings will be even higher. If the marginal cost of electricity generated by seasonal resources is higher, the opposite will be true.

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[19] For instance, Brattle reports that for a two-season market construct with the winter capacity requirement lowered by about 15,000 MW, the increase in the necessary summer capacity would amount to 433 MW $-$ 1,461 MW. Brattle Group Comments at 3-4. Therefore, we can assume conservatively that for our example, around 1,500 of new MWs are needed in the summer, or $\gamma = 1,500$.

[20] For example, if $\gamma = 1,500$, as long as $C_B \geq (\frac{3}{8} - \frac{1,500}{138,000})C_S$—that is, as long as seasonal resources are not approximately 2.77 times more expensive than annual resources—a seasonal construct will yield cost savings.

II. Q1. Some panelists indicated that the current annual construct and existing aggregation rules result in a barrier to entry. Please comment on whether or not there are barriers to entry and provide any supporting information, such as unmatched MWs of capacity. Could this be fully addressed by improving or modifying aggregation rules? If not, what other changes would be required? What would be the downside of modifying such rules?

Participation of seasonal resources in the RPM is currently suppressed

As explained above, seasonal resources face additional participation restrictions in the capacity market due to poor aggregation rules and the fact that the RPM procures only a single, annual capacity product. Current PJM rules undervalue some of the resources showing seasonal characteristics by assigning them an annual qualified capacity value based on their lowest capacity factor. Additionally, inefficiently constructed rules that force matched resources to split capacity market revenue equally can lead some seasonal generators to lose revenue even after clearing the RPM auction. These inefficiencies deter future participation of seasonal resources.

However, even with well-designed aggregation rules and improved assignment of quantified capacity, designing the market with only one, annual capacity product reduces the chances that seasonal resources will clear the market. That is, the current RPM rules create barriers to participation for seasonal resources by discouraging their entry into the capacity market.

While the effect of these flaws is relatively straightforward to quantify for existing seasonal capacity resources, estimating their effect on the potential entry of new resources poses significant challenges. With improved market design, more MWs of seasonal resources would have had entered the market to-date. But the magnitude of this foregone entry and its impact on total electricity system costs is not directly observable and can be measured only through modeling of counterfactual generators' behavior.

III.   Additional Comments

Potential concerns about the value of intermittent resources, if justified, should be solved by means other than excluding those resources from the capacity market.

During the technical conference some of the panelists expressed concern about the potentially lower value of the capacity that some seasonal resources (namely, intermittent renewable resources) contribute to the system, compared to other non-seasonal resources.[21] Of course, any capacity market design should address these concerns, to the extent the Commission determines that they are valid and that the participation of seasonal resources endangers reliability.

However, allowing PJM to retain capacity market rules that prohibit or seriously constrain participation of seasonal resources is not an appropriate solution to solving this perceived problem. By punishing all resources with similar seasonal characteristics, notwithstanding their actual outage performance, existing rules are far too blunt of a tool to efficiently address any concerns with intermittent resources. Instead, the Commission could address concerns regarding unpredictable outages by improving the design of performance incentives. With better performance incentives, resource owners would increase investment in technologies such as storage that would yield higher bids but also higher reliability. Those that are unable to do so would voluntarily leave the market.

PJM has means to ensure that all bidding resources, including seasonal ones, meet reliability standards. Allowing PJM to retain a market design that excludes resources that seem risky is arbitrary and further mitigates the extent to which RPM is governed by market forces instead of administrative decisions. PJM should rely on market tools to provide performance incentives to ensure the proper functioning of the market, and not preemptively place arbitrary restrictions on resource participation.

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[21] For example, Mr. Bowring from PJM argued that solar and wind should not be treated the same as "a normal resource" because those resources may not be able to meet peak demand due to unpredictable and correlated outages. Transcript from PJM Seasonal Capacity Technical Conference at 103, *Old Dominion Electric Cooperative v. PJM Interconnection L,L,C*, Docket Nos. EL17-32-000 and EL17-36-000 (April 24, 2018).

Respectfully submitted,

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