THE STATE OF NEW HAMPSHIRE

BEFORE THE

PUBLIC UTILITIES COMMISSION

DE 19-197

Electric and Natural Gas Utilities

Development of a Statewide, Multi-use Online Energy Data Platform

Rebuttal Testimony of Dr. Amro M. Farid

On behalf of
City of Lebanon, NH &
Local Government Coalition

October 23, 2020

Q. Please identify yourself and previous involvement in this docket.

A. I am Dr. Amro M. Farid, an Associate Professor of Engineering at the Thayer School of Engineering at Dartmouth and an Adjunct Associate Professor of Computer Science at the Department Science at Dartmouth College, which is located at 14 Engineering Drive, Hanover, NH. I am also the Chief Executive Officer of Engineering Systems Analytics (ESA) LLC, which is located at 89 Washburn Hill Road, Lyme NH. I previously filed direct testimony in this proceeding on behalf of the City of Lebanon as part of the Local Government Coalition. Prior to that I participated in most of the technical sessions and provided commentary in my areas of expertise. Most recently I responded to a set of discovery/data requests from Eversource and Unitil.

Q. What is your rebuttal testimony?

A. Eversource and Unitil (EU) asked 19 discovery questions of me. Some elicited additional background and clarification of my direct testimony, while others were, perhaps, more adversarial in contrasting their positions with my own. Since all my responses elucidate my testimony in contrast to their positions, especially where we differ, I am submitting my responses to their discovery requests and questions as my rebuttal testimony. The standard discovery response formatting has been removed, except for the request number line. A few responses have had minor (non-substantive) typos fixed. My response to Request No. EU to LGC 1-070 on pages 6-12 below, concerning TVR, was prepared in collaboration with witness Clifton Below and should be considered the joint testimony of both of us.

Request No. EU to LGC 1-067 Witness & Respondent: Dr. Amro M. Farid

Page 132, line 3: Please provide the syllabus for the course referenced and provide details on how long you've been teaching this course.

RESPONSE: Please see Attachment EU to LGC 1-067 for the ENGG 199: Model Based Systems Engineering, Analysis and Simulation course. I've taught some variation of this course since 2011.

Request No. EU to LGC 1-068 Witness & Respondent: Dr. Amro M. Farid

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Page 132, line 8: Does EPECS perform active management of transmission system configuration or voltage or frequency management? Give examples of services or reports provided.

RESPONSE: Yes, it does. Please see the following peer-review publications for details.

1. A. M. Farid and A. Muzhikyan, "The Need for Holistic Assessment Methods for the Future Electricity Grid (Best Applied Research Paper Award)," in GCC CIGRE Power 2013, (Abu Dhabi, UAE), pp. 1–12, 2013.
2. A. Muzhikyan, A. M. Farid, and K. Youcef-Toumi, "Variable Energy Resource Induced Power System Im- balances: A Generalized Assessment Approach," in IEEE Conference on Technologies for Sustainability, (Portland, Oregon), pp. 1–8, 2013.
3. A. Muzhikyan, A. M. Farid, and K. Youcef-Toumi, "Variable Energy Resource Induced Power System Imbalances: Mitigation by Increased System Flexibility, Spinning Reserves and Regulation," in IEEE Conference on Technologies for Sustainability, (Portland, Oregon), pp. 1–7, 2013.
4. A. Muzhikyan, A. M. Farid, and K. Youcef-Toumi, "A Power Grid Enterprise Control Method for Energy Storage System Integration," in IEEE Innovative Smart Grid Technologies Conference Europe, (Istanbul, Turkey), pp. 1–6, 2014.
5. A. Muzhikyan, A. M. Farid, and K. Youcef-Toumi, "An Enhanced Method for the Determination of Load Following Reserves," in American Control Conference, 2014, (Portland, Oregon), pp. 1–8, 2014.
6. A. Muzhikyan, A. M. Farid, and K. Youcef-Toumi, "An Enhanced Method for Determination of the Ramping Reserves," in IEEE American Control Conference, (Los Angeles, CA, USA), pp. 1–8, 2015.
7. A. Muzhikyan, A. M. Farid, and K. Youcef-Toumi, "An Enhanced Method for Determination of the Regulation Reserves," in IEEE American Control Conference, (Los Angeles, CA, USA), pp. 1–8, 2015.
8. A. Muzhikyan, A. M. Farid, and K. Youcef-Toumi, "An Enterprise Control Assessment Method for Variable Energy Resource Induced Power System Imbalances Part 1: Methodology," IEEE Transactions on Industrial Electronics, vol. 62, no. 4, pp. 2448–2458, 2015.

9. A. Muzhikyan, A. M. Farid, and K. Youcef-Toumi, “An Enterprise Control Assessment Method for Variable Energy Resource Induced Power System Imbalances Part 2: Results,” IEEE Transactions on Industrial Electronics, vol. 62, no. 4, pp. 2459 – 2467, 2015.
10. B. Jiang, A. Muzhikyan, A. M. Farid, and K. Youcef-Toumi, “Impacts of industrial baseline errors in demand side management enabled enterprise control,” in IECON 2015 – 41st Annual Conference of the IEEE Industrial Electronics Society, (Yokohama, Japan), pp. 1–6, 2015.
11. A. M. Farid, B. Jiang, A. Muzhikyan, and K. Youcef-Toumi, “The Need for Holistic Enterprise Control Assessment Methods for the Future Electricity Grid,” Renewable & Sustainable Energy Reviews, vol. 56, no. 1, pp. 669–685, 2015.
12. A. Muzhikyan, A. M. Farid, and K. Youcef-Toumi, “An A Priori Analytical Method for Determination of Operating Reserves Requirements,” International Journal of Energy and Power Systems, vol. 86, no. 3, pp. 1–11, 2016.
13. A. Muzhikyan, A. M. Farid, and K. Youcef-Toumi, “Relative Merits of Load Following Reserves and En- ergy Storage Market Integration Towards Power System Imbalances,” International Journal of Electrical Power and Energy Systems, vol. 74, no. 1, pp. 222–229, 2016.
14. A. Muzhikyan, A. M. Farid, and T. Mezher, “The Impact of Wind Power Geographical Smoothing on Operating Reserve Requirements,” in IEEE American Control Conference, (Boston, MA, USA), pp. 1–6, 2016.
15. B. Jiang, A. Muzhikyan, A. M. Farid, and K. Youcef-Toumi, “Demand Side Management in Power Grid Enterprise Control – A Comparison of Industrial and Social Welfare Approaches,” Applied Energy, vol. 187, no. 1, pp. 833–846, 2017.
16. S. O. Muhanji, A. Muzhikyan, and A. M. Farid, “Long-term challenges for future electricity markets with distributed energy resources,” in Smart Grid Control: An Overview and Research Opportunities (J. Stoustrup, A. M. Annaswamy, A. Chakrabortty, and Z. Qu, eds.), pp. 59–81, Berlin, Heidelberg: Springer, 2017.
17. S. O. Muhanji, A. Muzhikyan, and A. M. Farid, “Distributed Control for Distributed Energy Resources: Long-Term Challenges & Lessons Learned,” IEEE Access, vol. 6, no. 1, pp. 32737 – 32753, 2018.
18. A. Muzhikyan, T. Mezher, and A. M. Farid, “Power System Enterprise Control with Inertial Response Procurement,” IEEE Transactions on Power Systems, vol. 33, no. 4, pp. 3735 – 3744, 2018.
19. S. O. Muhanji, A. Muzhikyan, G. Moynihan, D. Thompson, Z. Berzolla, and A. M. Farid, “2017 ISO New England System Operational Analysis and Renewable Energy Integration Study,” in IEEE Systems of Systems Conference, (Anchorage, AK,USA), pp. 1–6, 2019.

20. A. Muzhikyan, S. Muhanji, G. Moynihan, D. Thompson, Z. Berzolla, and A. M. Farid, "The 2017 ISO New England System Operational Analysis and Renewable Energy Integration Study," Energy Reports, vol. 5, pp. 747–792, July 2019.
21. S. O. Muhanji and A. M. Farid, "An Enterprise Control Methodology for the Techno-Economic Assess- ment of the Energy Water Nexus," Applied Energy, vol. 1, no. 1, p. 25, 2019.
22. S. O. Muhanji, W. C. Schoonenberg, and A. M. Farid, "Transforming the Grid's Architecture – Enterprise Control - the Energy Internet of Things and Heterofunctional Graph Theory," IEEE Power and Energy Magazine, vol. 17, no. 5, pp. 71–81, 2019.
23. S. O. Muhanji, C. Barrows, J. Macknick, and A. M. Farid, "An Enterprise Control Assessment Case Study of the Energy-Water Nexus for the ISO New England System," Renewable and Sustainable Energy Reports, vol. 1, no. 1, p. 31, 2020.

Request No. EU to LGC 1-069 Witness & Respondent: Dr. Amro M. Farid

Page 136, lines 20-22:

A. Please elaborate on the definition of "wire's asset".

B. Please explain what communications architecture would be utilized to communicate with customer devices when controlling or indirectly controlling customer devices for the distribution benefit mentioned.

C. Who is responsible for owning and maintaining this communications architecture?

D. Please explain what recourse the utility has for loss of customer communications when relying on immediate demand reduction from customer equipment.

E. Would you expect the customer devices to have local override controls to ensure operation for grid conditions?

F. If the platform does not operate as needed for grid operations, what happens to the grid?

G. Please compare the overall reliability of a customer-controlled device versus a "wire's asset"?

H. How do you expect the customer to be compensated for operation of their devices or penalized for mis-operation?

RESPONSE: The entirety of the second paragraph on Page 136 including lines 20-22 is a direct quote from Electric Power Research Institute website and its peer reviewed EPRI journal. As the leading research and development organization of the electric power sector in the United States, it maintains a membership model for electric utilities. If EU are not already members, I would

encourage them to join where they will have greater access to EPRI research on the Shared Integrated Grid and more specific answers to all of these questions.

Request No. EU to LGC 1-070 Witness: Dr. Amro M. Farid

Respondents: Dr. Farid & Clifton Below

Page 140, lines 4-5: Time varying rates are already available to customers in NH. Please explain "meaningful choices of time-varying rates" in the context of existing rates.

RESPONSE: The quotation is not in specific reference to New Hampshire. The quoted language is part of a one sentence paraphrase of his recent article submitted as "ATTACHMENT D to Testimony of A Farid for LGC" from Bates page 253-259 The full sentence cited in the request is as follows:

"The distinguished energy economist Dr. Ahmad Faruqui[1] in his recent article in the journal Regulation entitled "Refocusing on the Consumer: Utilities regulation needs to prepare for the "prosumer" revolution" recounts the more than 50-year saga of trying to advance a basic building block of grid modernization: customer access to meaningful choices of time-varying rates. [Faruqui 2020][2]. He summarizes this saga and the current state [of] grid modernization in this way: . . ."

The reader is referred to that attachment to understand what Dr. Faruqui might consider meaningful choice of TVR as well as the wealth of articles and presentations he has made on this topic over many years, available through his website hyperlinked to in footnote 1. This EU data request calls for additional research and analysis to consider in the context of NH rates, which is beyond the purpose of a data request, but in this case we won't object as it is a useful exercise to undertake and report thus.

Among Dr. Faruqui's recent writings on rate design we found his co-authored article on "Expanding Customer Choices in a Renewable Energy Future" that includes a section on

[1] https://www.brattle.com/experts/ahmad-faruqui

[2] Attachment D, also found at https://www.cato.org/sites/cato.org/files/2020-03/regv43n1-6.pdf.

"**Principles for Meaningful Rate Options and Signals.**"[3] This article is appended as Attachment EU to LGC 1-070 for easy reference..

Here is what we understand to exist for choices of time-varying rates in existing rates for NH investor-owned electric distribution utilities:

- Unitil apparently does not currently offer any choice of time-varying rates.[4]
- Eversource offers two choices of optional time-varying rates that they call "Time-Of-Use." These are both very simple 2-part rates with a very broad definition of "on-peak"- from 7 am to 8 pm all weekdays, except holidays, with limited differentiation of overall per kWh rates. There is one rate option for residential customers, R-OTOD, and one for small commercial customers under 100kW demand, G-OTOP. While some rate components for larger C&I customers have time varying elements, others do not, and none are optional choices.
- Liberty offers two TVR options, however the choice is limited in both cases to residential customers. Most residential customers can choose the Rate D-10 option. It has a broad on-peak period of 8 am to 9 pm weekdays except holidays. It only applies TOU rates to distribution charges, though it does so with a broad differential. The other TVR option is rate D-11, the 3-part TOU rate developed for Liberty's battery pilot, in part by LGC witness Clifton Below.[5] The Regulatory Assistance Project characterized it this way in their recent publication "Rate Designs for Modern Grid"[6]: ***"[t]he Liberty storage pilot rate design accepted by the New Hampshire PUC is the most advanced modern rate design in New England, and closest to the Maryland rate designs" that they characterize as one of the most well designed TOU rates.*** The battery storage pilot at this stage is limited to only 100 customers and we understand that it is fully subscribed with a waiting list, so unless someone drops out and you are at the top of the waiting list, this rate is not currently a choice for anyone. An identical 3-period TOU rate has recently been made available to residential customers for charging plug-in electric vehicles as Rate EV. However, there is an additional monthly customer charge for the separate meter and it isn't

[3] "Expanding Customer Choices in a Renewable Energy Future," Ahmad Faruqui, Principal, and Mariko Geronimo Aydin, Senior Associate, The Brattle Group, in *Leadership in Rate Design, A Compendium of Rates Essays, Supplement to Public Power Magazine*, May-June, 2019. Available here: https://www.publicpower.org/system/files/documents/Leadership-in-Rate-Design.pdf

[4] https://unitil.com/energy-for-businesses/electric-information/tariffs

[5] See https://www.puc.nh.gov/Regulatory/Docketbk/2017/17-189/LETTERS-MEMOS-TARIFFS/17-189_2018-11-19_GSEC_TECH_STATEMENT_TOU.PDF

[6] See pages 10-11, "Rate Designs That Work for a Modern, Customer-Oriented Grid" by David Littell and Joni Sliger, Regulatory Assistance Project, 2/20, https://www.raponline.org/wp-content/uploads/2020/02/rap-littell-sliger-rate-designs-modern-customer-oriented-grid-2020-february.pdf

supposed to be used for purposes other than charging EVs. The customer also has to commit to the rate for a minimum of 2 years and they would need to invest in an additional meter socket, load panel, and circuit to power a dedicated vehicle charger if they don't already have such.

In terms of how meaningful these options are, with the exception of Liberty's 3-part TOU rate which is only available to a very limited portion of all customers for limited purposes, the 3 other options all are conventional 2-part rates with a 13 hour on-peak period on all work week days, that is too broad to get much price response from shifting load or storage. It is not clear whether Eversource's R-OTOD and G-OTOD rates are revenue (or customer cost) neutral compared with Rates R and G for a customer with class average load shape particularly because they have fixed customer charges that are about twice that of the standard non-TOU Rates R and G.

The meaningfulness of these limited offerings can be judged, in part, by the portion of customers that find them meaningful enough to choose these options. The Grid Modernization Working Group Final Report[7] included this snapshot of how many customers choose these TVR rates:

Table B.7 Number of Customers for Each Rate Offering

	Eversource			Unitil			Liberty		
	Residential	Gen. Service	Outdoor lighting	Residential	Gen. Service	Outdoor lighting	Residential	Gen. Service	Outdoor lighting
Flat energy rates	426,576	-	953	-	724	-	-	7,239	
Inclining block rates	-	-	-	65,237	-	-	35,435	-	-
Declining block rates	-	75,517	-	-	-	-	-	-	-
Seasonal Rate	-	-	-	-	-	-	-	-	-
Time-of-use rates	38	159	-	-	-	-	1,420		-
Critical peak pricing	-	-	-	-	-	-	-	-	-
Peak-time rebates	-	-	-	-	-	-	-	-	-
Total no. of customers:	426,614	75,676	953	65,237	11,181	1,706	35,877	6,436	685

For Eversource TOU rates attracted a mere 4/100 of 1% of customers, while Liberty's 2-part TOU rate, with the same customer charge as Rate D, did about 100 times better, but still only a mere 3% of all customers found this TOU rate to be meaningful enough to choose. In contrast, Dr. Faruqui reports much higher levels of participation in more meaningful TVR rate programs[8]:

[7] At p. 39, https://www.puc.nh.gov/Regulatory/Docketbk/2015/15-296/LETTERS-MEMOS-TARIFFS/15-296_2017-03-20_NH_GRID_MOD_GRP_APP_FINAL_RPT.PDF

[8] "Moving Ahead with Time-Varying Rates (TVR): US and Global Perspectives, 4/620, Ahmad Faruqui Presented to NARUC Staff Subcommittee on Rate Design, Slide 2: https://brattlefiles.blob.core.windows.net/files/18500_moving_ahead_with_time-varying_rates_tvr_-_us_and_global_perspectives.pdf

TVRs are deployed to residential customers around the world

	Type of Rate	Applicability	Participating Customers
Oklahoma *(OGE)*	Variable Peak Pricing (VPP)	Opt-in	20% (130,000)
Maryland *(BGE, Pepco, Delmarva)*	Peak Time Rebate (PTR)	Default	80%
Ontario, Canada	Time-of-Use (TOU)	Default	90% (3.6 million)
Great Britain	Time-of-Use (TOU)	Opt-in	13% (3.5 million)
Hong Kong *(CLP Power Limited)*	Peak Time Rebate (PTR)	Opt-in	27,000
Arizona *(APS, SRP)*	Time-of-Use (TOU)	Opt-in	APS: 57%, SRP: 36%
California *(PG&E, SCE, SDG&E)*	Time-of-Use (TOU)	Default (2020)	TBD – 75-90%*
California *(SMUD)*	Time-of-Use (TOU)	Default	75-90%*
Colorado *(Fort Collins)*	Time-of-Use (TOU)	Mandatory	100%
Illinois *(ComEd, Ameren IL)*	Real Time Pricing (RTP)	Opt-in	50,000
Michigan *(Consumers Energy)*	Time-of-Use (TOU)	Default (2020)	TBD – 75-90%*
France	Time-of-Use (TOU)	Opt-in	50%
Spain	Real Time Pricing (RTP)	Default	40%
Italy	Time-of-Use (TOU)	Default	75-90%*

*Estimated participation based on historical trends

Next, we consider the legal and regulatory history in New Hampshire to consider what might be a meaningful choice of TVR rates and consider some historical touchstones:

- For 24 years NH's electric utility restructuring statute has called for the development of a competitive retail market for electricity supply and other related services, and specifically stated:

  Competitive markets should provide electricity suppliers with incentives to operate efficiently and cleanly, open markets for new and improved technologies, ***provide electricity buyers and sellers with appropriate price signals,*** *and improve public confidence in the electric utility industry. [*And that:*] Customers should be able to choose among options such as . . . real time pricing.*[9]

- 22 years ago the original implementation of the EDI in New Hampshire was designed to accommodate 3 period time-of-use rates that could be differentiated by day of week and seasonally and that could be offered by competitive suppliers. The periods were characterized as on-peak,

[9] RSA 374-F:1 and RSA 374-F:3, II.

shoulder, and off-peak, with data fields for kWh usage, kW, and kVA in each period. [10] At that time the anticipated business relationships, like Data Platform Use Cases, to be supported by the EDI included the following:

> "Competitive Service Providers:
>
> "(i) Offer large customers or their authorized agents competitive metering products or services.
>
> (ii) Notify Distribution Company of agreements to provide metering products and services to large customers.
>
> (iii) Install telemetering equipment at customer locations for the purpose of replacing estimated usage data with measured usage data.
>
> (iv) Notify Distribution Company when telemetering installations have been completed and whenever the equipment malfunctions.
>
> (v) Allow Distribution Companies to access the meter for usage determination or provide usage data to Distribution Companies in electronic format in a timely manner.
>
> (vi) Fulfill applicable registration requirements prior to doing business in New Hampshire.
>
> (vii) Abide by applicable rules and/or orders issued by the Commission.
>
> (viii) Nominate business and technical contact persons to facilitate inter-business communications."[11]

- 13 years ago, the Commission took note of the fact:

> . . . that ISO-New England has recommended that the conventional peak/off-peak time-of-use rate structure be modified to provide customers a reasonable opportunity to shift load from peak period. Specifically, ISO-New England recommended a structure that includes a minimum of three periods: peak, shoulder and off-peak. The peak period would be shorter than the peak period in conventional time-of-use rates, which for some utilities extends from 7:00 a.m. until 8:00 p.m., Monday through Friday.[FN omitted] Reducing the number of hours in the peak period and adding a shoulder period would,

[10] See the totality of the documents at https://www.puc.nh.gov/Electric/edi.htm and the definitions in the Glossary of Terms on pages 49-50 of the "Consensus Plan for the Transmission of Electronic Data in New Hampshire's Retail Electric Market," April 2, 1998, DR 96-150, https://www.puc.nh.gov/Electric/EDI/edirev53.pdf.
[11] Id at 11.

according to ISO-New England, provide customers a much greater incentive for customers to shift load out of the peak period because the shorter peak period produces a higher cost-based peak rate, while the shoulder period provides a convenient home for the load shifted out of the peak period.[12]

- Last month, in its "Order Determining the Appropriateness of Rate Design Standards for Electric Vehicle Charging Stations Pursuant to SB 575" while discussing Staff's recommendation for consistent seasonal 3-period TOU rates to apply to all 3 major rate components for residential electric vehicle charging, the Commission noted Eversource's assertion that its existing two-period TOU rates "are an appropriate starting point for serving customers with EVs"[13] The Commission observed and concluded:

> Based on December 2019 registration data, New Hampshire is home to approximately 4,200 electric vehicles. Tr. at 91. Only approximately 40 of Eversource's more than 400,000 residential customers take service under the residential time of use rate. Staff Memo at 3. The lack of interest in Eversource's existing two-part rate structure suggests that it may be inadequate for purposes of electric vehicle charging. We also take administrative notice of Eversource's filing in DE 19-057 to note Eversource's recent petition for a rate increase declined to revise its residential time of use rate despite advice from its own cost of service consultant to the contrary.
>
> The guidelines proposed by the Commission Staff regarding a consistent framework for separately metered residential electric vehicle charging rate designs are appropriate, subject to three clarifications. First, we agree with the City of Lebanon that the five-hour peak duration is more appropriate than the four-hour peak duration. Second, the 3:1 peak to off-peak ratio should represent an average ratio during a given year, not during any one season. Third, we note that these guidelines serve as a useful starting point and are generally consistent with the rate designed and approved for the purposes of Liberty's Battery storage pilot, and later adopted for Liberty's separately-metered EV

[12] NHPUC Order # 24,763, 6/22/07, p. 24, https://www.puc.nh.gov/Regulatory/CaseFile/2006/06-061/ORDERS/Order%20No.%2024,763%20%20Regarding%20the%20Adoption%20of%20Standards%20for%20Time-Based%20Metering%20and%20Interconnection%20-6-22-07.pdf
[13] NHPUC Order # 26,394, 8/18/20, p. 16, https://www.puc.nh.gov/Regulatory/Docketbk/2020/20-004/ORDERS/20-004_2020-08-18_ORDER_26394.PDF.

TOU Rate. Liberty Utilities (Granite State Electric) Corp., Order No. 26,376 at 9. (June 30, 2020).[14]

Request No. EU to LGC 1-071 Witness & Respondent: Dr. Amro M. Farid

Page 144, line 5: Please explain how the PUC would determine the reasonableness of costs before implementing the platform, if the regulatory process excludes these requirements.

RESPONSE: My testimony on Page 144, line 5 and indeed the entirety of Q5.2 does not make any mention "reasonableness of costs". The EU have posed a question that does not concern my testimony.

Request No. EU to LGC 1-072 Witness & Respondent: Dr. Amro M. Farid

Page 146, lines 4-7: If the utilities are stakeholders, users of the data, and solely knowledgeable of back end systems, why should the utilities not be involved in the functional design of the platform?

RESPONSE: The question seemingly misconstrues my testimony. My testimony does not state: "the utilities should not be involved in the functional design of the platform" as written in the question above. My testimony states: *"I do not interpret RSA 378:52,I to mean that the utilities shall exclusively conduct all technical activity related to the data platform.*" It is clear that RSA 378:52, I states: "*the utilities shall design and operate the energy data platform*" which is a statement of the necessity of the utilities' design role. However, the law does not explicitly state that this design and operation role belongs exclusively to the utilities. Therefore, there is no explicitly stated reason for me to conclude that the utilities are sufficient to design and operate the energy data platform. Furthermore, and as my testimony states, "*I do not believe it to be in the best interest of the New Hampshire public to do so*". Necessity is not equivalent to sufficiency.

Request No. EU to LGC 1-073 Witness & Respondent: Dr. Amro M. Farid

Page 146, lines 14-16: Please provide representative examples of where niche engineering consultancies are less expensive.

[14] Id at pp. 16-17.

RESPONSE: mPrest, Kevala, and Engineering Systems Analytics provide engineering services at rates that are "often less expensive" than more "well-known" engineering organizations with expertise in requirements engineering.

Request No. EU to LGC 1-074 Witness & Respondent: Dr. Amro M. Farid

Page 150, lines 9: Please explain extensibility of the platform with examples.

RESPONSE: Page 150, line 9 is the third of five requirements that are summarized from the LGC scoping comments. The scoping comments at tab 27 of the Docket Book in this proceeding explains what extensibility is and how to best achieve it.

Request No. EU to LGC 1-075 Witness & Respondent: Dr. Amro M. Farid

Page 150, line 16: Please provide a list of commercially-neutral grid stakeholders.

RESPONSE: It's impossible to provide an exhaustive list for the simple reason that the implementation of the data platform may require a commercially-neutral non-for-profit entity to be formed as a new entity. Beyond this possibility, some commercial-neutral grid stakeholders are non-for-profit organizations. These include an Independent System Operator (e.g. ISO New England), academia (e.g. Dartmouth College or UNH), a non-for-profit customer-owned utility (e.g. New Hampshire Electric Co-Op), or a government entity such as the Public Utility Commission, Office of the Consumer Advocate, or municipality. For-profit supply-side grid stakeholders such as investor-owned utilities and demand-side consumers are not commercially-neutral.

Request No. EU to LGC 1-076 Witness & Respondent: Dr. Amro M. Farid

Page 153, line 5: Please explain how the platform can make the same data available to all participants at the same time, if the customer may only approve access to data for a limited number of market participants.

RESPONSE: The question seemingly misconstrues my testimony. My testimony does not state that: "*the same data available to all participants at the same time*" as the question states. My testimony states: "*First, the data housed and shared by the data platform must, by design, make sure that competing electric grid market participants have access to the same data at the same*

time". The statement is clear in its reference to competing electric grid market participants. For example, electric distribution utilities and community power aggregators are effectively competing electric grid market participants because a given electricity consumer can opt for electricity service from one or the other.

To elaborate and clarify my testimony, the electric distribution utility, by virtue of its present monopoly over distribution system assets and metering infrastructure, has access to data that other competing electric grid market participants and specifically community power aggregators do not have. Consequently, if the electric distribution utility, in this monopoly role, were to withhold data and information then it could undermine competing electric grid market participants including specifically community power aggregators from developing highly competitive electric rates and services. Furthermore, it is important to note that the relevant customer here need not even be a costumer of the distribution utility. Rather, the customer could receive electricity service from a community power aggregator. Such a situation could lead to the highly undesirable market situation where the electricity distribution utility either inadvertently, knowingly, or intentionally sabotages the community power aggregator's competitive service to its own customers by withholding data information about the community power aggregators own customer for the simple reason that the electric distribution utility has a present monopoly over distribution assets and metering infrastructure. My testimony emphasizes that the data platform enables a level-playing field for a retail electricity market.

Request No. EU to LGC 1-077 Witness & Respondent: Dr. Amro M. Farid

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Page 153, line 7: Please explain why the department of the utility that controls the operation of the platform must be isolated and provide any applicable legal requirements.

RESPONSE: My testimony states: "Second, the department of the utility that operates the data platform itself must be isolated in their communication from the departments responsible for the purchase and sale of electricity to grid stakeholders". Let Team A be the department of the utility that operates the data platform itself. Let Team B be the department of the utility responsible for the purchase and sale of electricity to grid stakeholders. Let Team C be a competing market participant outside the utility. In order to further the for-profit mission of the utility, Team A and Team B are incentivized to collaborate and facilitate each other's respective jobs. It is possible

and likely, for Team A to make data and information available to Team B without necessarily making that same data information available to Team C. Consequently, Team B would have disproportionate market power over Team C.

Request No. EU to LGC 1-078 Witness & Respondent: Dr. Amro M. Farid

Page 154, line 18: Is the API based platform proposed by the utilities substantially different from the ISO example noted? If so, please elaborate.

RESPONSE: Yes. Allow me to highlight several obvious differences. First, each Independent System Operator in the country is a non-for-profit entity tasked with ensuring an equitable marketplace for wholesale electricity transactions. Although, they have access to system data through SCADA systems, they are not transmission owners.

In the meantime, each of the distribution utilities is a for-profit entity and have no obligation to provide a level-playing field for all competing electric grid market participants. Although, they are distribution owners, they have yet to describe a solution that shares system data through their SCADA systems.

Simply having an "API" is not enough to equate the two.

Even if the technical design were identical, and they are far from it, it would be entirely careless to expect that a data platform would have a similar socio-technical market function if the entity that designs and operates works under fundamentally different laws, regulations, and governance structures.

Request No. EU to LGC 1-079 Witness & Respondent: Dr. Amro M. Farid

Page 155, line 20: RSA 378 specifically states that the data platform be certified by the Green Button Alliance. Given your testimony that "this flow of data is not sufficient to achieve the legislative objectives of RSA 378", how do you propose we meet the obligation of Green Button Certification for the platform?

RESPONSE: The question seemingly misconstrues my testimony. The question seems to suggest that because my testimony states "this flow of data is not sufficient to achieve the legislative objectives of RSA 378" then the testimony is somehow advocating that we dispose with the Green

Button Standard. This is categorically false. Please see my testimony in response to Q6.10 on pages 162-163. It makes it clear that the data platform should adhere to the IEC standards commonly referred to as the "Common Information Model (CIM)". It states clearly: "The Green Button Standard is simply a subset of the CIM".

In short, and again, necessity is not equivalent to sufficiency. The Green Button Standard is necessary but not sufficient, whereas the Common Information Model is the most sufficient group of standards available today. Implementing the CIM in no way jeopardizes the implementation of the Green Button Standard.

Request No. EU to LGC 1-080 Witness & Respondent: Dr. Amro M. Farid

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Page 156, line 17: Please provide your definition of "smart interval meters".

RESPONSE: In the context of this testimony, we are using the term "smart interval meters" as a layman equivalent for Advanced Metering Infrastructure or more commonly AMI.

Request No. EU to LGC 1-081 Witness & Respondent: Dr. Amro M. Farid

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Page 156, line 17: Please provide your definition of "market" and "financial data" with a list of expected data fields.

RESPONSE: My testimony specifically states that although the term "market/financial data" is not technically precise, nor does it have a well-accepted definition in the literature, it has been used extensively in the docket's technical sessions. Its use in testimony comes out of a desire to find commonality of language. A more technical precision definition would refer to the data fields in IEC 62325 (part of the Common Information Model). The interested reader is encouraged to read this widely accepted standard for "market/financial data" fields. It is the responsibility of the distribution utilities to design the data platform and select the specific fields from these standards in accordance with the stakeholder requirements identified by this docket.

Request No. EU to LGC 1-082 Witness & Respondent: Dr. Amro M. Farid

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Page 156, line 18: Please provide a list of expected data fields for "system" data.

RESPONSE: My testimony specifically states that although the term "system data" is not technically precise, nor does it have a well-accepted definition in the literature, it has been used extensively in the docket's technical sessions. Its use in testimony comes out of a desire to find commonality of language. A more technical precision definition would refer to the data fields in IEC 61970 and 61968 (part of the Common Information Model). The interested reader is encouraged to read these widely accepted standards for "system data" fields. It is the responsibility of the distribution utilities to design the data platform and select the specific fields from these standards in accordance with the stakeholder requirements identified by this docket.

Request No. EU to LGC 1-083 Witness & Respondent: Dr. Amro M. Farid

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Page 161, line 1: Is a circuit map the extent of system data being requested? If not, please provide detail.

RESPONSE: The testimony on Page 161 Line 1 shows that system data is readily available in neighboring states. To my knowledge, the distribution utilities have yet to commit to the same here in NH.

To answer the question more specifically: No, a circuit map is not sufficient system data for the simple reason that a circuit map is not sufficient system data to enable the community power aggregation use cases that we have previously submitted as part of this docket. With regard to the specific data fields necessary to implement these use cases, the LGC objects to this question as overly broad as it effectively asks the witness to undertake additional analysis, develop new information as part of the data request which is not an appropriate use of discovery. It is the responsibility of the distribution utilities to design the data platform and select the specific fields from established international standards in accordance with the stakeholder requirements identified by this docket.

Request No. EU to LGC 1-084 Witness & Respondent: Dr. Amro M. Farid

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Page 165, line 14: Does the estimated capitalized cost of the proposed third-party platforms include integration with and mapping of the utility's legacy data sources? How do these solutions handle vendor and customer authorization workflows as defined by the Green Button Connect My Data standards?

RESPONSE: Neither Attachment E nor F in my testimony mentions "integration with and mapping of the utility's legacy data sources". Nor do they speak to "Green Button Connect My Data Standards". Consequently, the question is outside the scope of my testimony and I do not wish to speculate. Rather my testimony does explicitly state: "*While this solution would have to be matched to the functional requirements discussed above and likely customized to New Hampshire's needs, its current implementation as described in the attached slides is an excellent starting point from which to discuss practical avenues*". This remains my testimony.

Consequently, the question asks the witness to undertake additional analysis and develop new information as part of the data request which is not an appropriate use of discovery.

Request No. EU to LGC 1-085 Witness & Respondent: Dr. Amro M. Farid

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Page 165, lines 4-12: Please explain who would operate the systems referenced and act as the data platform operator. Please explain how these systems would share data with other stakeholders with specific reference to the Green Button Connect standard.

RESPONSE: RSA 378:52 states: "the utilities shall design and operate the energy data platform". This language leaves open the possibility for the distribution utilities to design, build and operate the energy data platform themselves or outsource this technical activity to a vendor. The mention of mPrest and Kevala in my testimony serves to suggest investigation of the latter possibility.

In reference to the part of the question pertaining to the Green Button Connect standard, please see my response to data request # EU to LGC 1-084.

Q. Does this conclude your rebuttal testimony?

A. Yes, it does.