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Dynamic Hosting Capacity

Introduction

This document is intended to explain the definition and opportunity surrounding Dynamic Hosting Capacity (DHC) as viewed by Ecosuite.

Ecosuite, based in Brooklyn, NY is a technology provider offering digital collaboration tools to deploy and operate DER at scale. The following provides Ecosuite's comments with regard to the definition of Dynamic Hosting Capacity and its resulting opportunities. The scenarios discussed provide examples and foundational information that can be adjusted to any market and stakeholder input.

There are two approaches to Dynamic Hosting Capacity (DHC), depending on how the individual distributed energy resources ("DER") and the utility-owned grid devices are controlled. (1) Uncoordinated dynamic hosting capacity — when only local, autonomous control functions for DER and grid devices are used without communication and (2) Coordinated dynamic hosting capacity — when a communications-based, coordinated control approach is used to adjust the output or behavior of DER. This coordination may occur at various levels, for example through distributed controls within a certain portion of the feeder, at the substation level, or throughout the distribution system and multiple substations. This may also involve an optimization or simply adjusting the output according to a predefined set of rules or principles of access.[1]

There are many different control architectures that can be used in the coordinated case. Interconnecting in this coordinated dynamic regime has previously been referred to as flexible interconnection. Coordinated dynamic approaches to DER integration have also been referred to as Active Network Management or as a subset of distributed energy management systems functionality.[2]

DHC is simply where the future and the present is at, as it is now economically optimal for solar to be overbuilt in conjunction with curtailment.[3] Unfortunately, policy and other status quo societal structures still make this optimal solution hard to deliver.

Ideally, a regulatory and utility commitment is needed to perform necessary grid upgrades, once curtailment reaches some predefined level (likely location or feeder specific). Economically, these upgrades would likely need to be funded through the ratepayer or some similar mechanism, as discussed in references to the Swiss study below.

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[1] See Baringa Partners and UK Power Networks, Flexible Plug and Play Principles of Access Report: Final report on smart commercial arrangements for generators connecting under the Flexible Plug and Play Project, December 2012 Available at: https://www.ukpowernetworks.co.uk/internet/asset/dac8de6d-1243-4689-b5b5-a8285a2553fO/Principles_of_Access_report_FINAL.pdf

[2] NREL, Advanced Hosting Capacity Analysis - Solar Research

[3] Jan Remund, Michael Schmutz, Marc Perez & Richard Perez, Firm PV Power generation for Switzerland 7, Technical Report · June 2022. Available at: https://www.researchgate.net/publication/361208262_Firm_PV_Power_generation_for_Switzerland

Local Assessment in the Grid Planning Process

To improve reliability planning and markets, Ecosuite recommends the development and adoption of long-term planning and rules that match with the high-level policy goals to decarbonize the energy system and protect against climate change. Distribution system flexibility is still a largely untapped opportunity. Ecosuite believes this opportunity can be maximized by accessing potentially different rules for different parts of the grid based on engineering and planning advice. DHC represents the concept of calculating the hosting capacity for a specific location in the distribution grid in real-time at given time intervals. It can be further expanded to include the ability to calculate hosting capacity across all grid levels and can be applied to any given time frame for a specific location in the grid. This observed time frame can stretch from years (analysis of data) to just a single event (real-time) depending on the utility's use case.[4] According to NREL, DHC is '...based on quasi-static time-series simulation, which:

- Considers the behavior of distributed photovoltaics ("DPV"), loads, and grid devices over time
- Accounts for the fact that some over-voltages and thermal overloading are acceptable for short periods of time and during a limited number of time points during the year.'[5]

DHC is not based on worst-case snapshot power flows, so it requires probabilistic screens that consider the uncertainty around the time-series input variables, like hourly PV production and building loads.

There is a huge opportunity for distributed energy resources to unblock hosting capacity constraints, releasing private capital to deliver projects that provide flexibility for both distribution and transmission systems. For example, Hawaii has developed schemes that are part of a wider flexible interconnection framework that have been working for 5+ years. This was discussed in a report on Advanced Inverter Voltage Controls, Simulation and Field Pilot Findings by NREL and Hawaii Electric Company ("HECO").[6] In Hawaii, HECO now manages consenting of new solar in a manner that has effectively unleashed a DER connection solution which delivers dynamic hosting capacity.[7] In particular using this "Quick Connect" approach that HECO customers leverage when connecting solar to the grid, new solar systems that meet basic requirements can be installed and energized without full prior approval from Hawaiian Electric:

> In March 2021, the Companies expanded Quick Connect to all circuits, such that, even on circuits with 30% or less circuit hosting capacity, **customers can now install and energize their systems prior to application submittal** so long as the system is operating in a non-export mode until conditional approval is granted by the Companies. One of the conditions to utilize the Quick Connect process is for the customer to **activate Volt-Watt** so that the Companies can mitigate

[4] OpusOne Solutions, Dynamic Hosting Capacity A dialogue on Extracting Distribution Maximum Value from Interconnected Distributed Energy Resources for Distribution Utilities and Customers 2017. Available at: Dynamic Hosting Capacity

[5] NREL, Advanced Hosting Capacity Analysis - Solar Research

[6] Giraldez Miner, J. I., Hoke, A. F., Gotseff, P., Wunder, N. D., Emmanuel, M., Latif, A., ... & Blonsky, M. (2018). Advanced inverter voltage controls: simulation and field pilot findings (No. NREL/TP-5D00-72298). National Renewable Energy Lab.(NREL), Golden, CO (United States).

[7] See Advanced Inverter Voltage Controls: Simulation and Field Pilot Findings. This will likely result in a similar overall outcome on the grid to that advocated for by the Swiss study in note 9.

high-voltage risk in allowing customers to **"install first, get approval later.**[8]

Every utility in the USA should be offering a DER connection solution similar to what HECO already offers with the goal to deliver an optimally economic and vastly cleaner grid. This is evidenced by a study from Switzerland that shows how an aggressive DER approach can be economically optimal given certain conditions and assumptions.[9] In summary, the Swiss study states, "Our analyses show that firm PV power is an enabler of the energy transition and can ease the energy trilemma – regarding security of supply, sustainability and affordability."

How would the headroom (capacity and energy) assessments account for ability to modulate RE output (via storage, demand response, or curtailment)?

Ecosuite believes the answer is to embrace DHC and mandate the installation of a direct utility controlled Photovoltaic (PV) system shutdown capability as a fail safe. The development and deployment of a DHC solution can then allow utilities to dynamically ramp specific categories of system (e.g. any systems 500 kW or above) when necessary (or simply leverage smart inverter Volt-VAR or Volt-Watt controls to have this automatically controlled).

Some careful commentary could be useful for legislators here. For example, legislation could be introduced requiring that if a solar array is curtailed more than a specified percentage such as 3% on average (or some similar figure) during a 12 month period, then Utilities would be mandated to address the cause of this with grid upgrades within the next 2 years. An equitable cost sharing plan can eliminate concerns regarding financing DER projects when curtailment via DHC technology is a potential problem for the projects financial viability in the longer term, rate basing this would be ideal (see Swiss Study for why this can be argued as an equitable approach for ratepayers).

If this approach was embraced it would solve the problems that many Utilities are concerned about with respect to hosting capacity challenges at the distribution system level. A similar approach is implemented for an Ecosuite customer's project in Delaware that can be implemented across the U.S. to solve our climate and renewable energy goals.

Case Study: Remote Rapid Shutdown for the Wilmington Housing Authority (WHA) in DE:

Ecogy Energy, a NY based developer, financier and operator of distributed generation projects, developed a 1.65MW ground-mount on a Wilmington Housing Authority (WHA) brownfield. The project will offset energy costs at multiple high and mid-rise buildings which could not access solar. The project was accepted into the Department of Energy Solar in Your Community challenge for its unique focus on low-income solar access including hiring and training residents of WHA for the construction.

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8 Steven Rhymsa, New Jersey Interconnection Stakeholder Workshop, January 28, 2022. Available at: Sunrun 2202-28- New Jersey Interconnection Working Group.pptx

9 Remund, J., Perez, M., & Perez, R. (2022, June). Firm PV Power Generation in Switzerland. In 2022 IEEE 49th Photovoltaics Specialists Conference (PVSC) (pp. 0661-0666). IEEE.

At its installation, it was the largest PV system in the US for a housing authority financed by a third party.

Location: Wilmington, Delaware
System Size: 1,650kW
Installation Type: Ground-Mount
Installation Year: 2018

In today's world, flexibility is invaluable. Ecogy Energy's entire project portfolio leverages Ecosuite's technology which offers an open edge-compute and data acquisition system architecture created for commercial and industrial DER such as buildings and PV to increase visibility and reduce operating costs. With Ecosuite's platform customers can seamlessly integrate data streams from a variety of device sources into a consolidated operating platform and enable utility compliant controls. Ecosuite's edge compute node combines commercial off the shelf hardware with interoperable open source software providing customers and their partners with extreme flexibility and world class security.

In this example, the utility for WHA's project requested remote capability to rapidly shut down the system, if needed. Ecosuite was leveraged to provide a solution for enhanced Utility communication to the site without the need for additional costly hardware.

More specifically WHA has two systems at the same site. System #1 has many inverters that Ecosuite can communicate with over Modbus, hence resulting in a lower cost, efficient, and quick software solution that does not require any additional hardware. Ecosuite's edge compute node simply sends an appropriate Modbus signal to all of the inverters to satisfy the utility's request, with the ability to ramp the solar array down to zero and shut it off when requested. For system #2, Ecosuite has digital control to an existing automated switch/breaker, which is a more brute force physical solution compared to the more nuanced Modbus controlled inverter shutdown on System #1 (but it was a pragmatic and simple approach for system #2 given the switch/breaker was existing hardware and hence zero additional cost for the project). This functionality on both System #1 and System #2 was all controlled by the Utility via DNP3 communication between the Utility and the Ecosuite's edge compute node. The Utility signals to disconnect the solar array from the grid and receives confirmation that the event has occurred (as well as ongoing continuous telemetry) via DNP3. Because both System #1 and System #2 are controlled via Ecosuite, the DNP3 controlled shutdown is a seamless solution from the Utilities perspective. With Ecosuite, it is easy and cost effective to listen to a Utility specific DNP3 signal and configure a shutdown solution for any solar array hardware or equivalent DER system.

While SunSpec Modbus and DNP3 are two communication protocols used in this example, Ecosuite supports even more communication protocols and will continue to add more. It is the combination of these transport layers implemented concurrently that can deliver a multitude of reliable solutions across many sites - that is the real value of the interoperability.

While this is a simplified example, it shows the foundations of the technical needs for a DHC solution can be deployed at scale and easily standardized, empowering utilities to ramp up and down solar array production when and where needed.

Conclusion: The What and the Why

What:

DHC is the ability to more fully leverage the existing infrastructure of the grid to accelerate decarbonisation via increasing deployment of new DERs (such as solar) and also the increased use of existing DERs to improve grid resiliency and reliability. And we want to achieve all of this without the need for expensive and time consuming physical grid upgrades.

Why:

The why is already answered to some degree in “The What” above. But to be explicit:

- We want to accelerate deployment of DERs and zero carbon energy sources.
- We want to deliver more with less.
- We want to increase grid reliability.
- We want to increase societal resilience via increased grid resilience.
- We want to accelerate the transition to a global zero carbon energy system.

We need a step change in what is considered a standard approach and standard technology within the Utility industry for achieving all of the above. It is time to embrace modern and open digital technologies and approaches.

For more information or if you are interested in diving deeper on DHC please contact info@ecosuite.io

Thank you