QUANTA TECHNOLOGY

Hurdles in Renewable Integrations – Some Practical Considerations

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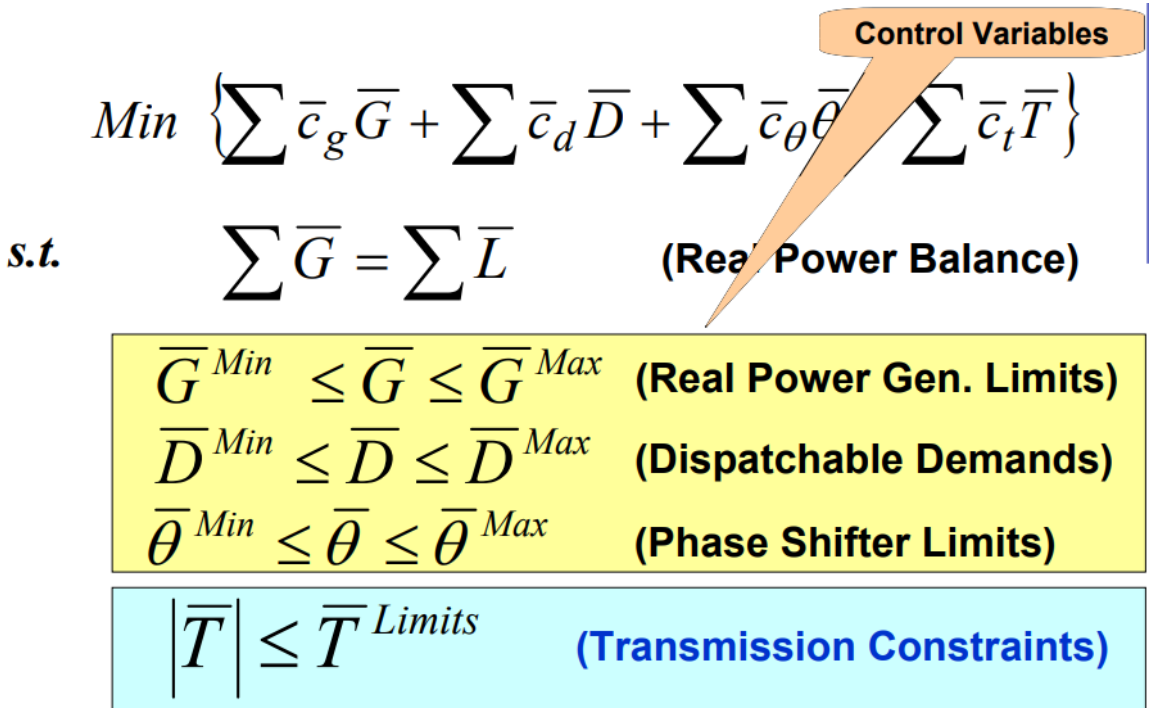
NEXTera ENERGY RESOURCES

Introduction

- Current situation:
  - Rapid introduction of renewable technologies to meet public policy requirements
- Two potential outcomes:
  - Wholesale market energy prices will be lower, challenging economic viability of fossil generation to stay in operations;
  - Renewable projects are subject to high production curtailment
- What do we need:
  - Systematical review of the current analytical practices, grid modeling, data collection method and categorization
  - A complete picture of where the energy deliverability bottlenecks are and what are the cost-effective mitigation solutions
- Our methodology: Production Cost Simulation

Production Cost Simulation

- Perform Security Constrained Economic Dispatch (SCED) simulations for a whole year (8760-hour), to assess the impact of current and future transmission congestion on Locational Marginal Prices (LMPs)

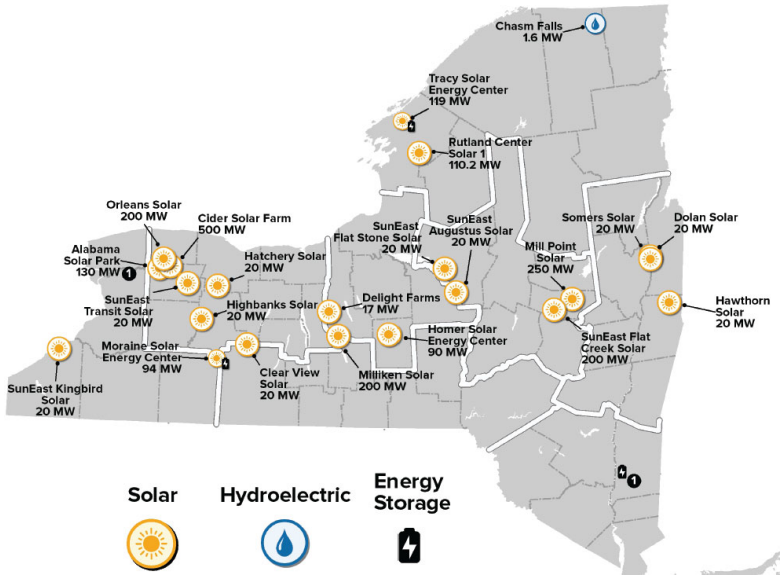


Hurdle 1: Grid Deliverability Capability

- Example: New York state
  - The Climate Leadership and Community Protection Act (CLCPA) mandates that New York consumers be served by 70% renewable energy by 2030 ("70x30")

Year	Gross Load (GWhs)	Renewable Energy (GWhs)	Renewable Energy (%)
2019	155,848	37,294	24
2030	162,378	113,665	70

  - Production cost simulation considering renewable projects that passed NYISO Class Year reports or contracted under NYSERDA Tier 1 REC or RPS

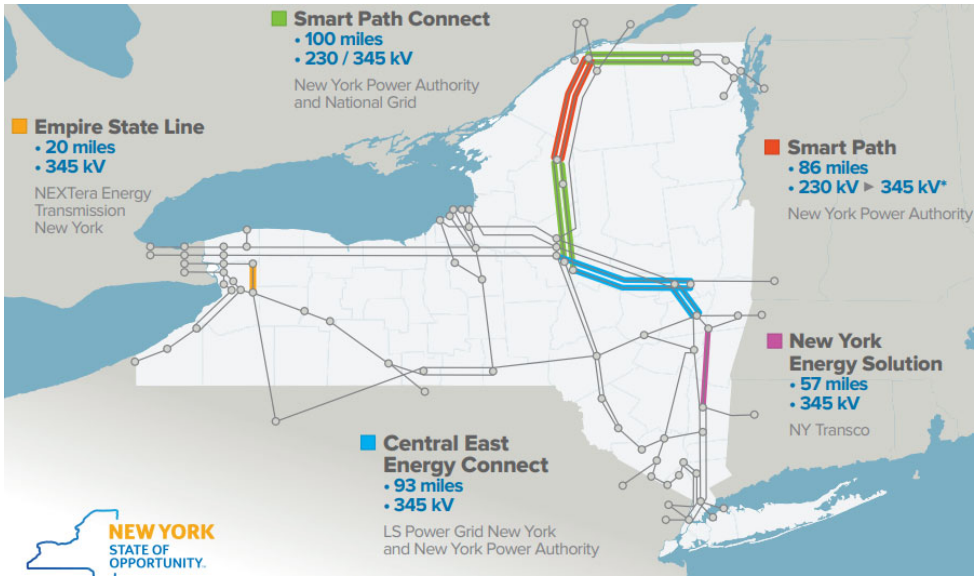


NYSERDA REC Projects	MW Capacity	2025 curtailment	2030 curtailment
Project 1	100.0	2.4%	6.5%
Project 2	50.0	0.7%	12.1%
Project 3	90.0	9.1%	13.2%
Project 4	50.0	0.0%	0.0%
Project 5	180.0	0.7%	0.1%
Project 7	80.0	0.0%	0.9%
Project 8	280.0	0.0%	0.0%
Project 9	200.0	0.0%	0.4%

Resource: https://www.nyserda.ny.gov/All-Programs/Programs/Clean-Energy-Standard/Renewable-Generators-and-Developers/RES-Tier-One-Eligibility/Solicitations-for-Long-term-Contracts/2020-Solicitation-Resources

Hurdle 1: Grid Deliverability Capability (Cont'd)

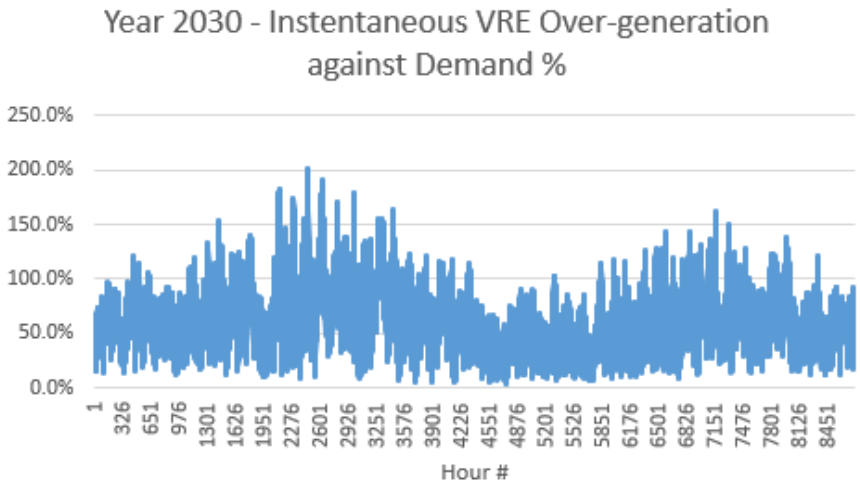
- Key takeaways:
  - Federal and state agencies need to coordinate to ensure the later-procured renewable projects will not cause production curtailments to the renewable projects, existing or previously procured/contracted.
  - The separation of byway (e.g., 115 kV and below) and highways (e.g., 230 kV and above) transmission projects can result in ineffective transmission expansion.



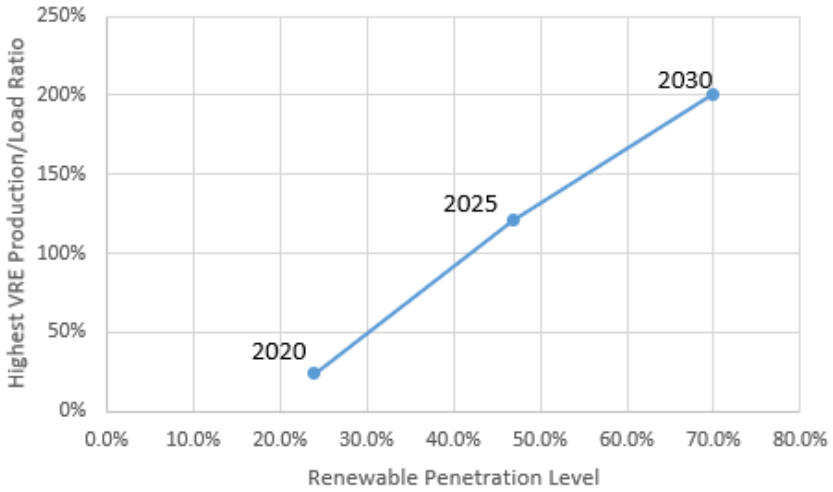
Resource: https://www.nypa.gov/-/media/nypa/documents/document-library/transmission/growing-transmission-capacity-in-nys.pdf?la=en

Hurdle 2: Grid Flexibility in Operation

- The hourly variable renewable penetration (VRE) of renewable resources can reach over 100% of the demand in the future
- Reaching the 70x30 CLCPA goal will require both the existing resources and the development of newer, dispatchable, carbon-free technologies to mitigate the risk to ratepayers



NEW YORK YEARLY RENEWABLE PENETRATION VS LOAD IN 2030



HIGHEST VRE PRODUCTION/LOAD RATIO IN 2020 AND 2030

Hurdle 2: Grid Flexibility in Operation (Cont'd)

- Changes in operations will be required with the large-scale installation of generation
- Grid operators would need more dispatchable and long-duration energy resources to manage the substantially different systems to maintain reliability in 2030

Max VRE Penetration Limit %	Renewable Curtailment %	Renewable Curtailment after 4.4GW Storage
100%	5.1%	1.6%
90%	7.9%	2.7%
80%	11.7%	4.3%
70%	16.8%	6.8%
60%	23.4%	10.3%

Hurdle 3: Grid Operation and Resilience

- Resource adequacy: Additional resource requirements to address resource adequacy alone will rise from 350 MW to 2,650 MW in 2030 for New York City area.
- In 2030, the sustained power ramps will reach 30 GW over a period from 8am to 6pm and will experience a maximum hourly ramp of 13 GW midday.
- Also, the reduction in short circuit currents driven by the prevalence of inverter-based resources (IBRs) will have two serious risks:
    a. Short circuit ratio (SCR) limits and the ability of the NY grid to integrate the required MWs of IBRs without destabilizing the inverter controls,
    b. The ability of the protection system to detect faults.

Conclusion

- Major hurdles for the proliferation of renewable integration:
  1. The limitation of grid delivery capability;
  2. The impact on grid flexibility under changing resource mix
  3. Demand and supply balancing in seasonal and real time grid operations
- Practical approaches to achieve optimal siting and interconnection of renewable projects:
  - Detailed common grid models are necessary for grid and market participants to increase overall renewable utilization and effective integration.
  - Regular and transparent planning studies based on the common models provide the critical information for the renewable development and renewable energy procurement

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Thank You!