Small-scale Pumped-Hydroelectric Storage (PHS): a solution for reaching the target for renewable energy penetration levels in New England

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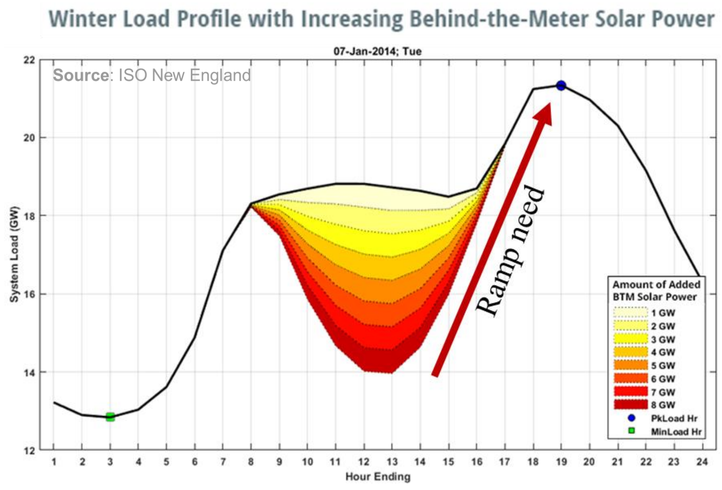
Introduction

The New England region (United States) exhibits an increasing rate of both roof-top and major solar photovoltaic systems. Given the renewable energy goals established by the New England States, projects for new inland and offshore solar and wind farms are surging. These renewable energy penetration plans will increase the dependence of electricity supply and demand on weather.

Problem Statement

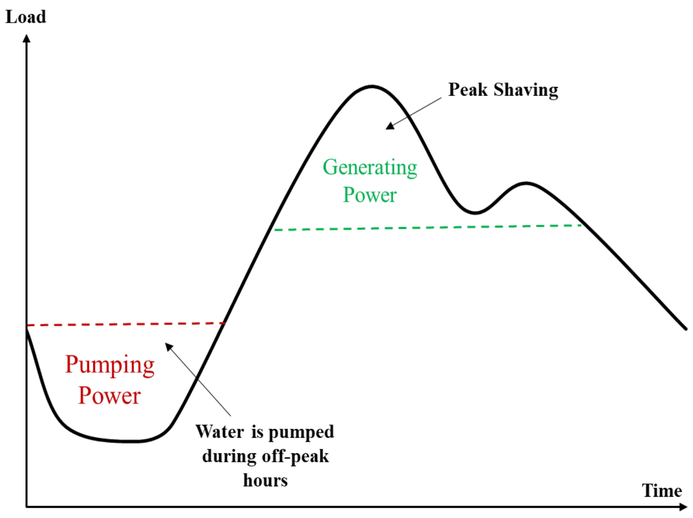


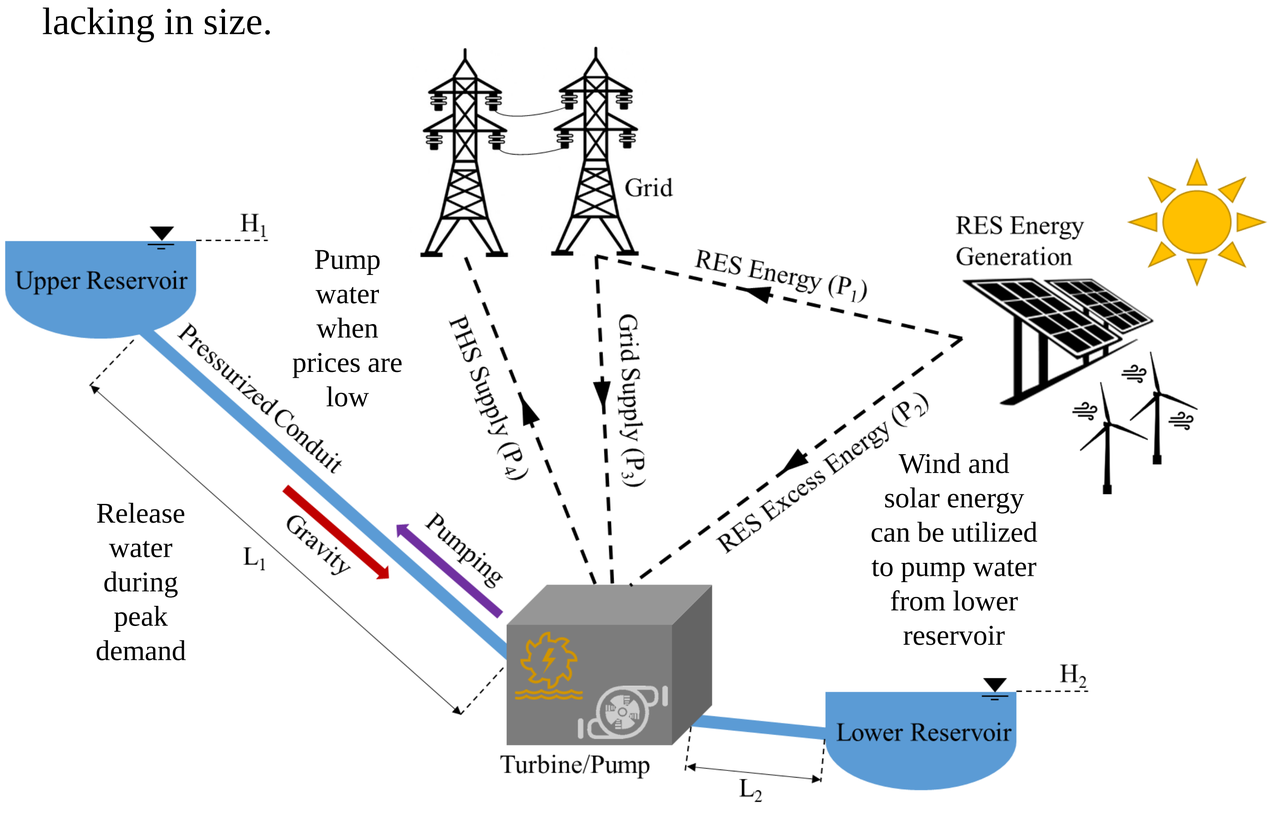
Variations of energy production lead to:

1. unanticipated and undesirable outcomes (e.g. power ramps)
2. complications in planning and operation procedures of the electricity grid.

Potential Solution

- Pumped Hydroelectric Storage (PHS) is the most established technology for the creation of electricity cache at a large-scale.
- Selection and development of new pumped hydropower sites is a major challenge (physical constraints) .
- Converting existing infrastructure to PHS systems offers the benefit of distributed storage, despite lacking in size.

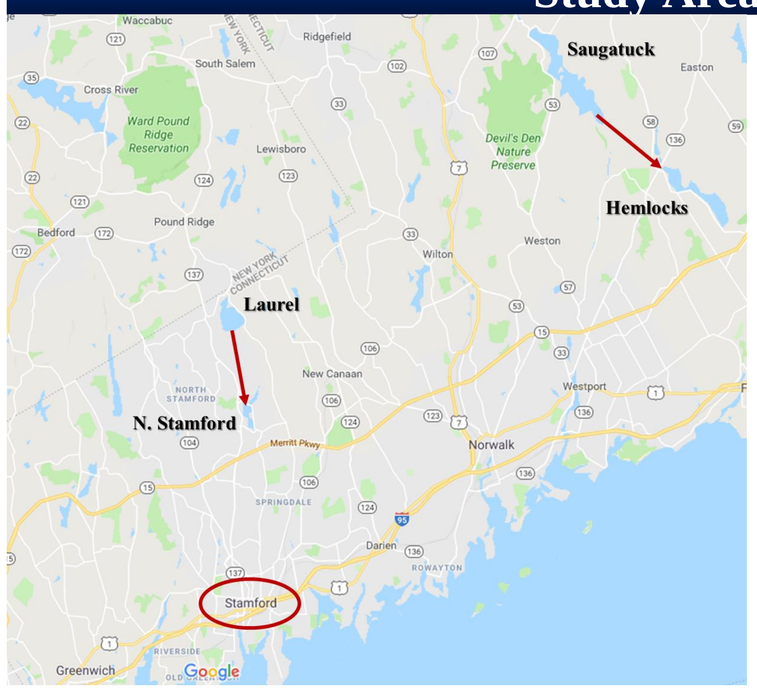




Specifically the objectives of the study aim to:

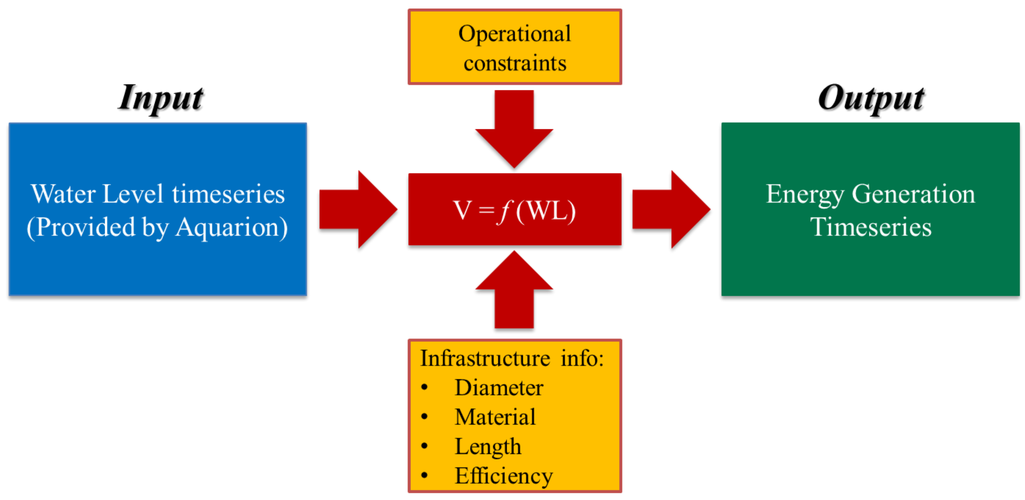
- **Explore the potential of using existent water supply reservoirs as PHS units.**
- **Optimize the design and operation of PHS for "load peak shaving".**
- **Achieve a sustainable integration of PHS and renewable energy sources.**

Study Area

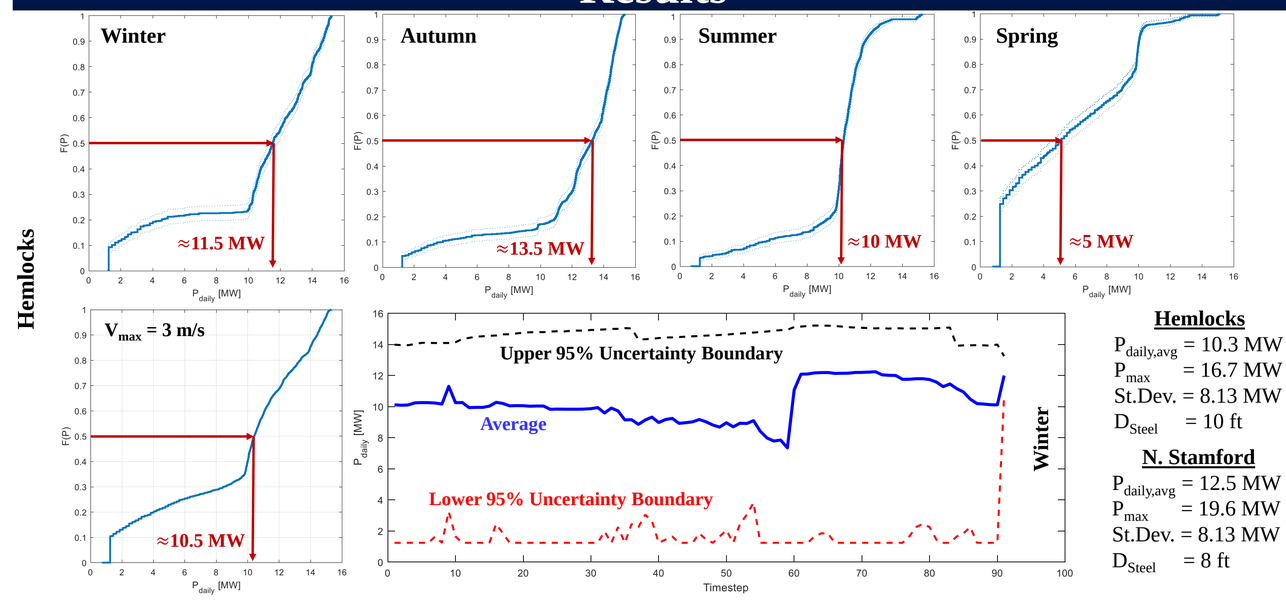


- ***Hemlocks Reservoir System***
  - Saugatuck
    - V_{total} = 11924 MG
    - V_{usable} = 9833 MG
    - Elevation = 85.34 m
  - Hemlocks
    - V_{total} = 3810 MG
    - V_{usable} = 2967 MG
    - Elevation = 68.58 m
- ***N. Stamford Reservoir System***
  - Laurel
    - V_{total} = 2344.6 MG
    - V_{usable} = 2188 MG
    - Elevation = 95.71 m
  - N. Stamford
    - V_{total} = 572 MG
    - V_{usable} = 512 MG
    - Elevation = 60.96 m

Methodology



Results



Hemlocks
$P_{daily,avg}$ = 10.3 MW
P_{max} = 16.7 MW
St.Dev. = 8.13 MW
D_{Steel} = 10 ft

N. Stamford
$P_{daily,avg}$ = 12.5 MW
P_{max} = 19.6 MW
St.Dev. = 8.13 MW
D_{Steel} = 8 ft

Conclusions

- Preliminary results for Connecticut show that existing water infrastructure has **great potential** for pumped hydroelectric storage.
- Improving the operation of water reservoirs can **reduce the variability** in PHS capacity.
- PHS can offer an effective **non-wire solution** for advancing penetration of renewable energy sources.

Future Steps

- Incorporation of potential solar energy output and energy load to assess the feasibility of the concept in realistic scenarios.
- Expansion of the analysis to the whole state of Connecticut (more reservoirs).

Acknowledgements

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