

Flexibility demand in long-term energy scenarios in the U.S.

First results of a case study for New England

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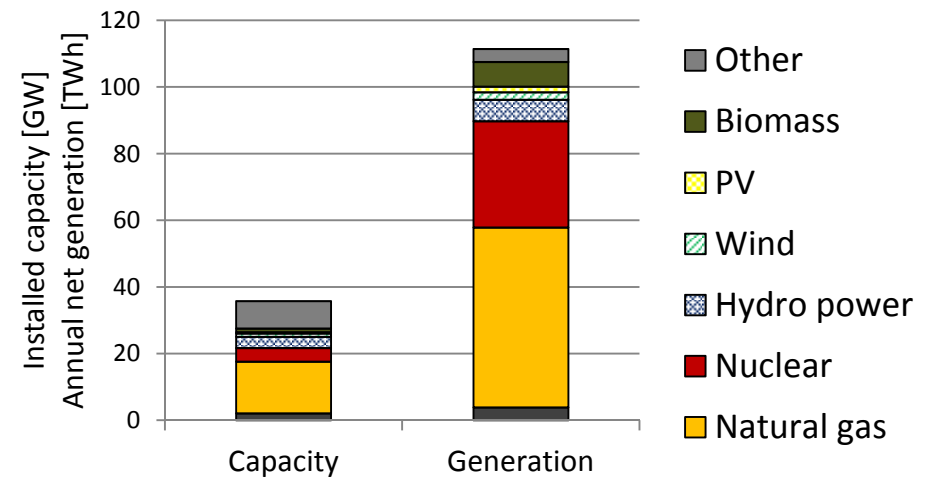
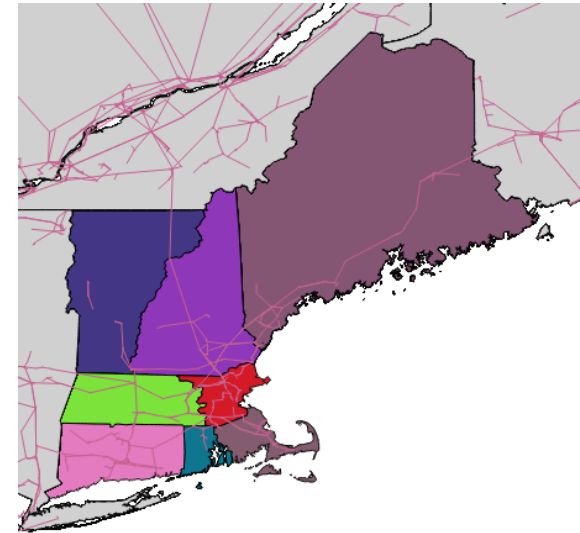
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Overview ISO New England

Generation and capacities (2015)

- Peak load 24 GW
 - Connecticut: 6 GW
 - Boston area: 5 GW
- Power demand 125 TWh/a
 - Connecticut: 31 TWh/a
 - Boston area: 25 TWh/a
- Generation heavily relying on natural gas and nuclear power generation
 - Natural gas: 54 TWh/a
 - Nuclear: 32 TWh/a
- Transmission inter-connectors to New York and Canada



Sources:

[1] U.S. EIA, "2015 Form EIA-860 Data - Schedule 3, 'Generator Data' (Operable Units Only), [Dataset]," 2015.

[2] U.S. EIA, "2015 Form EIA-860 Data - Schedule 3, 'Net Generation by Energy Source', [Dataset]," 2015.



Research questions and main assumptions (I)

Research questions

- Is a highly renewable energy system (heat & power) for New England feasible?
- What is the role of flexibility options?
- How important is the coupling of the power and heat sector?



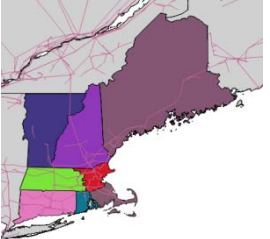
Main assumptions

- Partial greenfield capacity expansion¹ and dispatch optimization (least costs) with the REMix model (**R**enewable **E**nergy **M**ix)
- Constraint forces at least 25% of a model regions electricity demand is supplied by local resources
- Investment options into generation technologies and flexibility options
 - On/offshore wind, PV, gas turbines
 - H₂ storage, stationary Li-ion batteries, PHS (only pump/turbine exp.), grid expansion

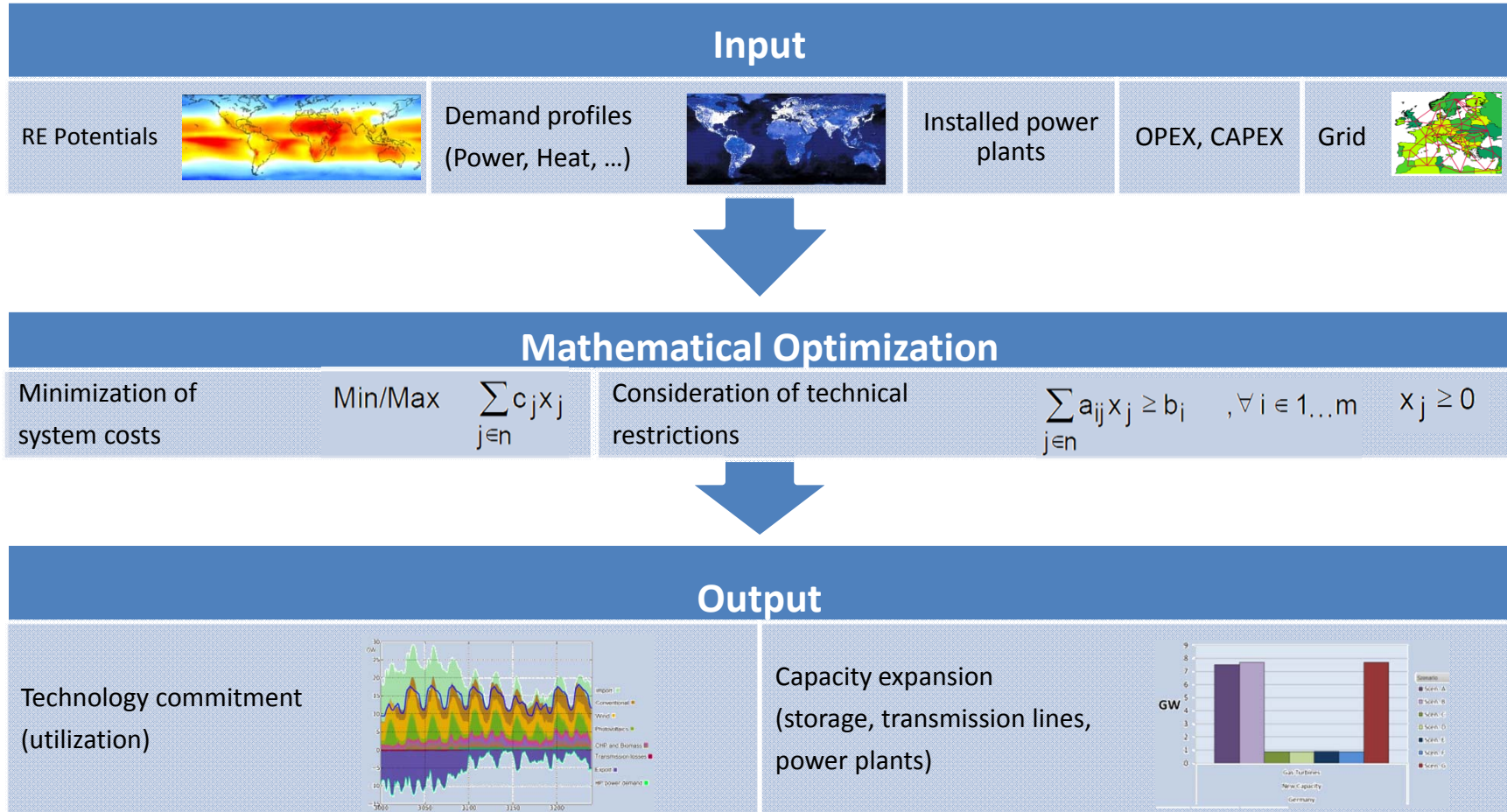
¹ Existing hydro-power plants are included



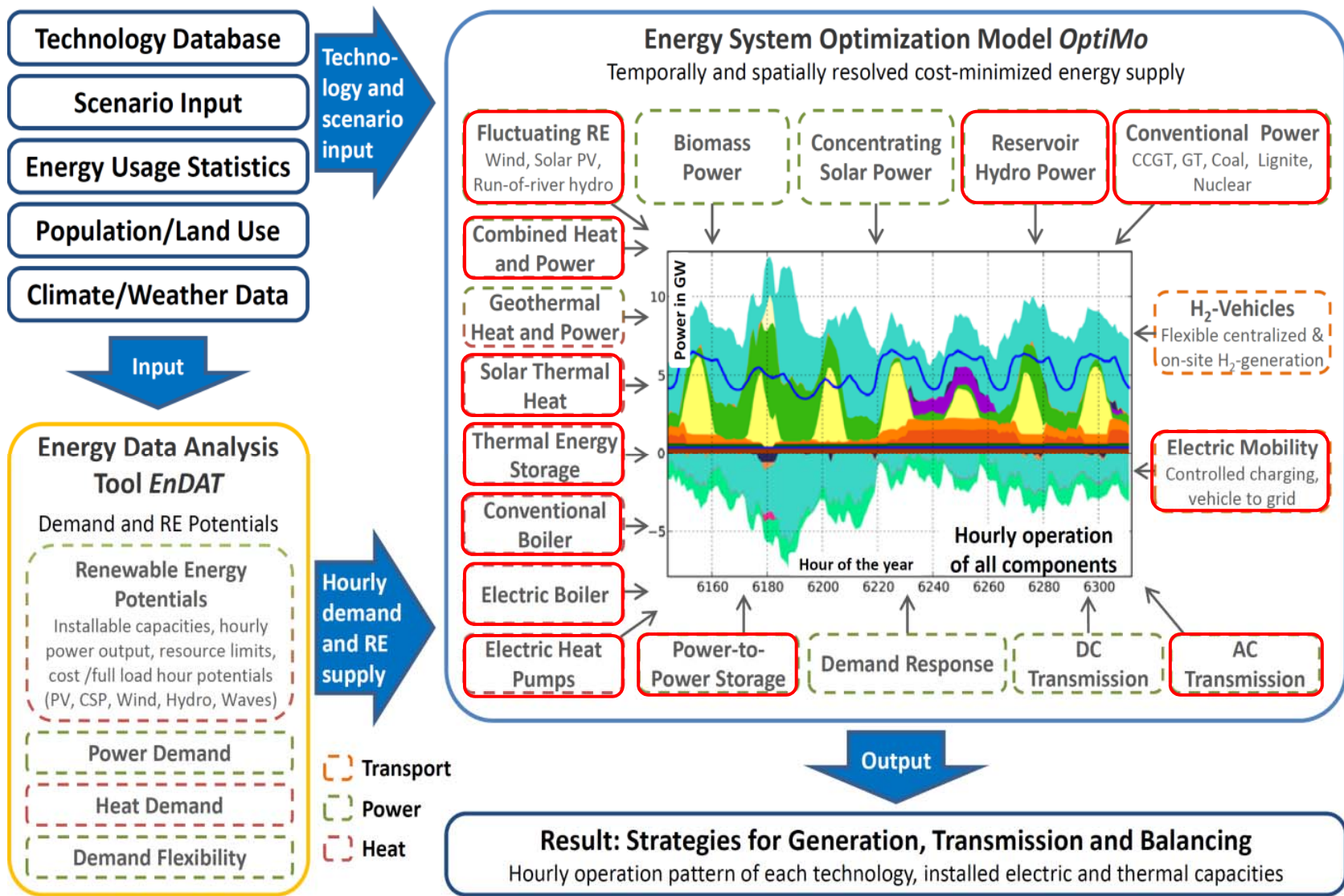
Main assumptions (II)

Technologies	Storage	Modeling	Scenario
	<p>H₂ (power-H₂-power) Stationary Li-ion batteries Pumped hydro</p> <p>(1) </p>	<ul style="list-style-type: none"> Charge/discharge efficiency Self discharge rate Availability CAPEX converter (charge/discharge) & storage Lifetime (economic + technical) O&M costs (fix/var.) 	<ul style="list-style-type: none"> H₂ in salt caverns & power reconversion Model endogenous capacity expansion including expansion limits for all storage technologies
	Renewables	Modeling	Scenario
	<p>Wind on/offshore Photovoltaic Hydro power</p> 	<ul style="list-style-type: none"> Efficiencies (part. temp.-dependent) CAPEX Availability Lifetime (economic + technical) O&M costs (fix/var.) 	<ul style="list-style-type: none"> Model endogenous capacity expansion Expansion limits based on resource assessment Unlimited curtailments Consideration of exiting hydro caps
Transmission grid	Modeling	Scenario	
<p>AC</p> 	<ul style="list-style-type: none"> DC approximation of 3 phase AC CAPEX Grid losses 	<ul style="list-style-type: none"> Greenfield Existing based on SciGrid data ⁽²⁾ Unrestricted capacity expansion 	

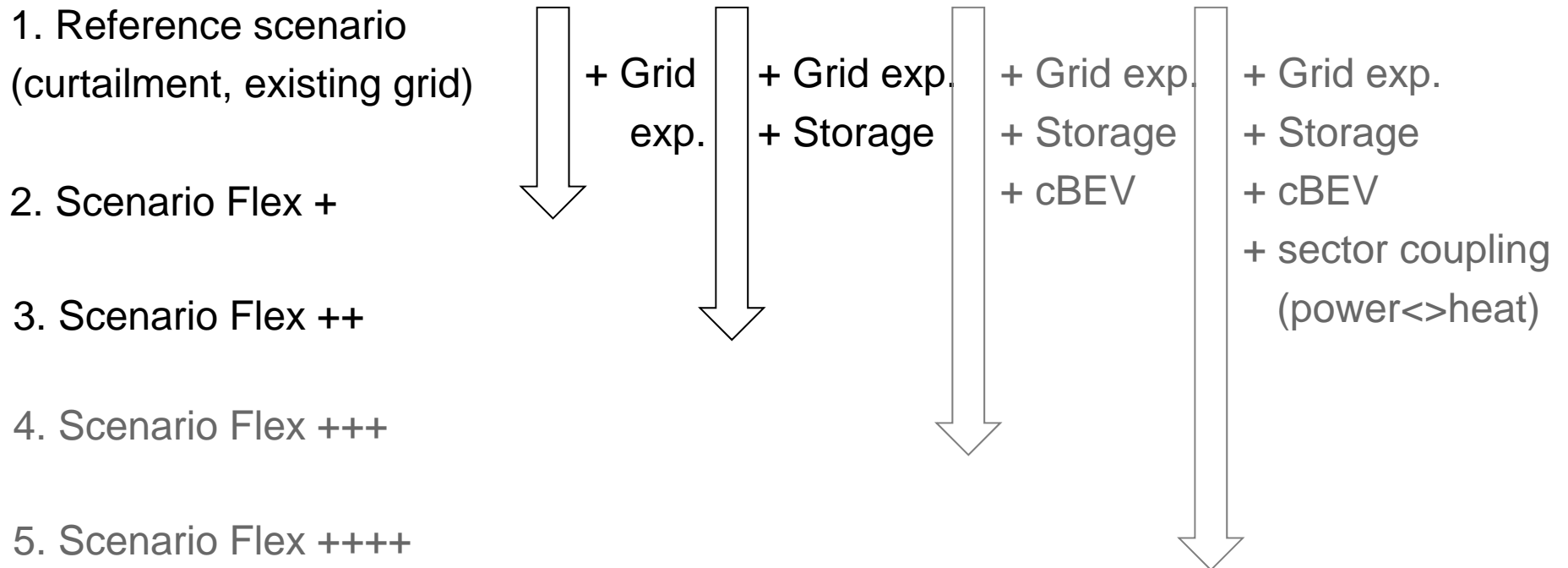
REMix (Renewable Energy Mix)



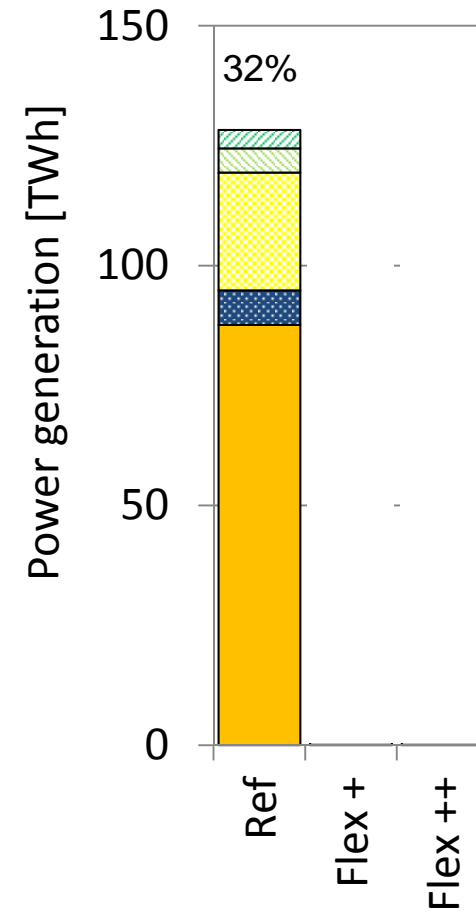
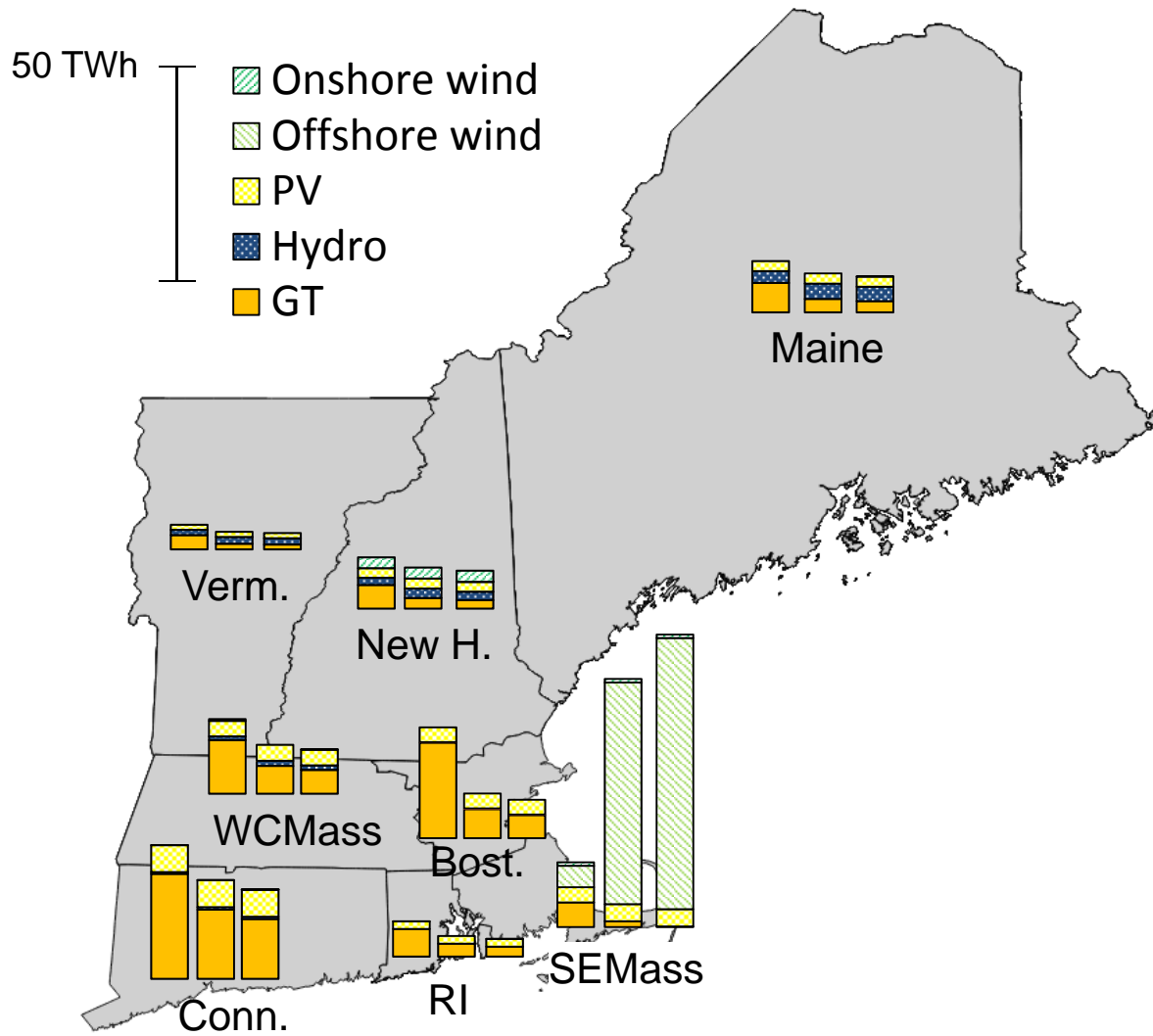
REMix model structure



Scenario definition

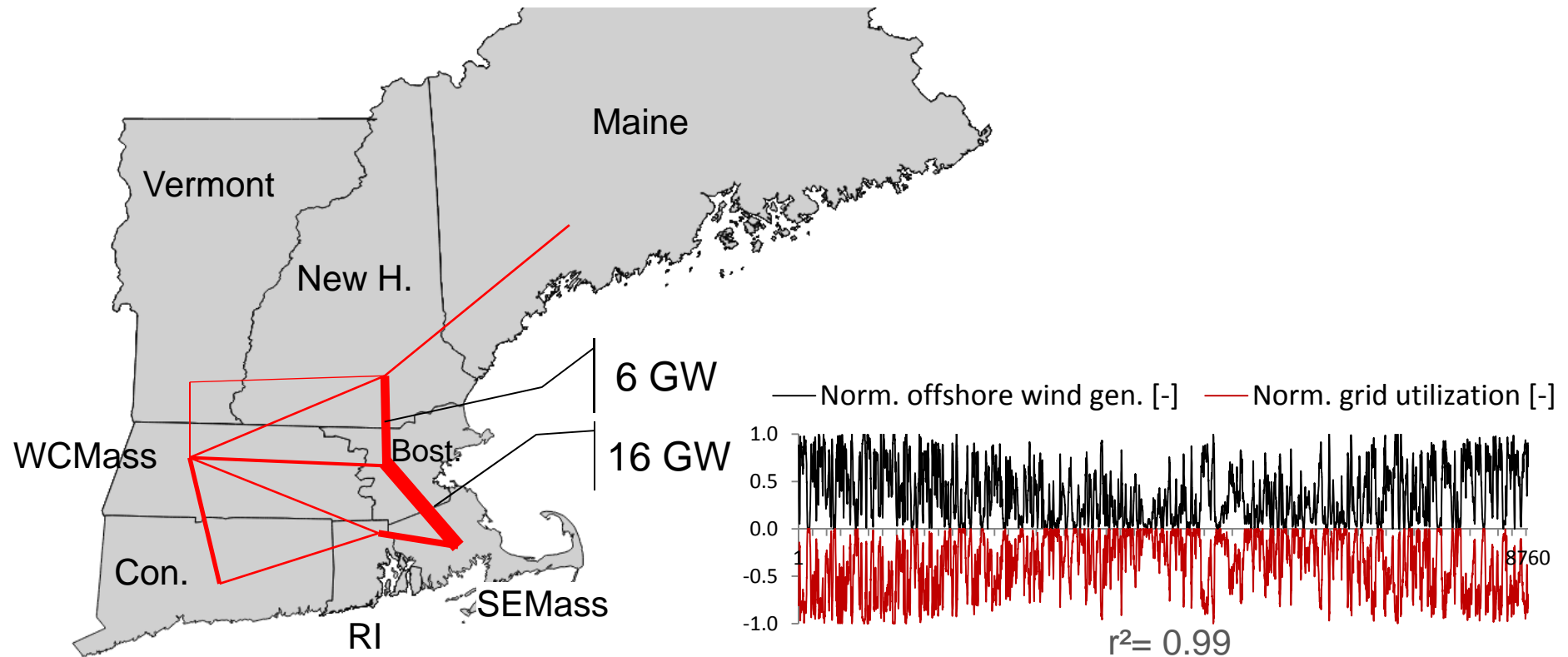


Annual power generation



AC grid expansion (scenario Flex +)

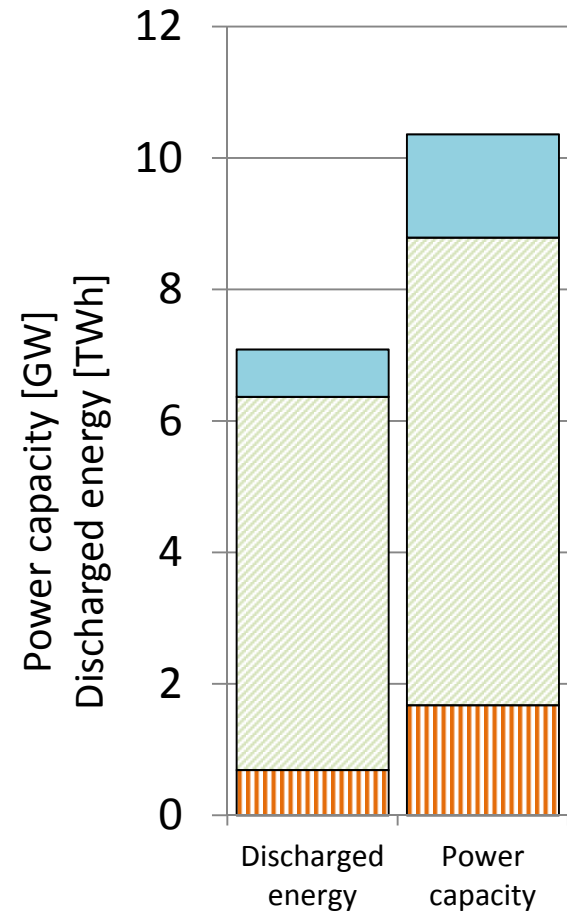
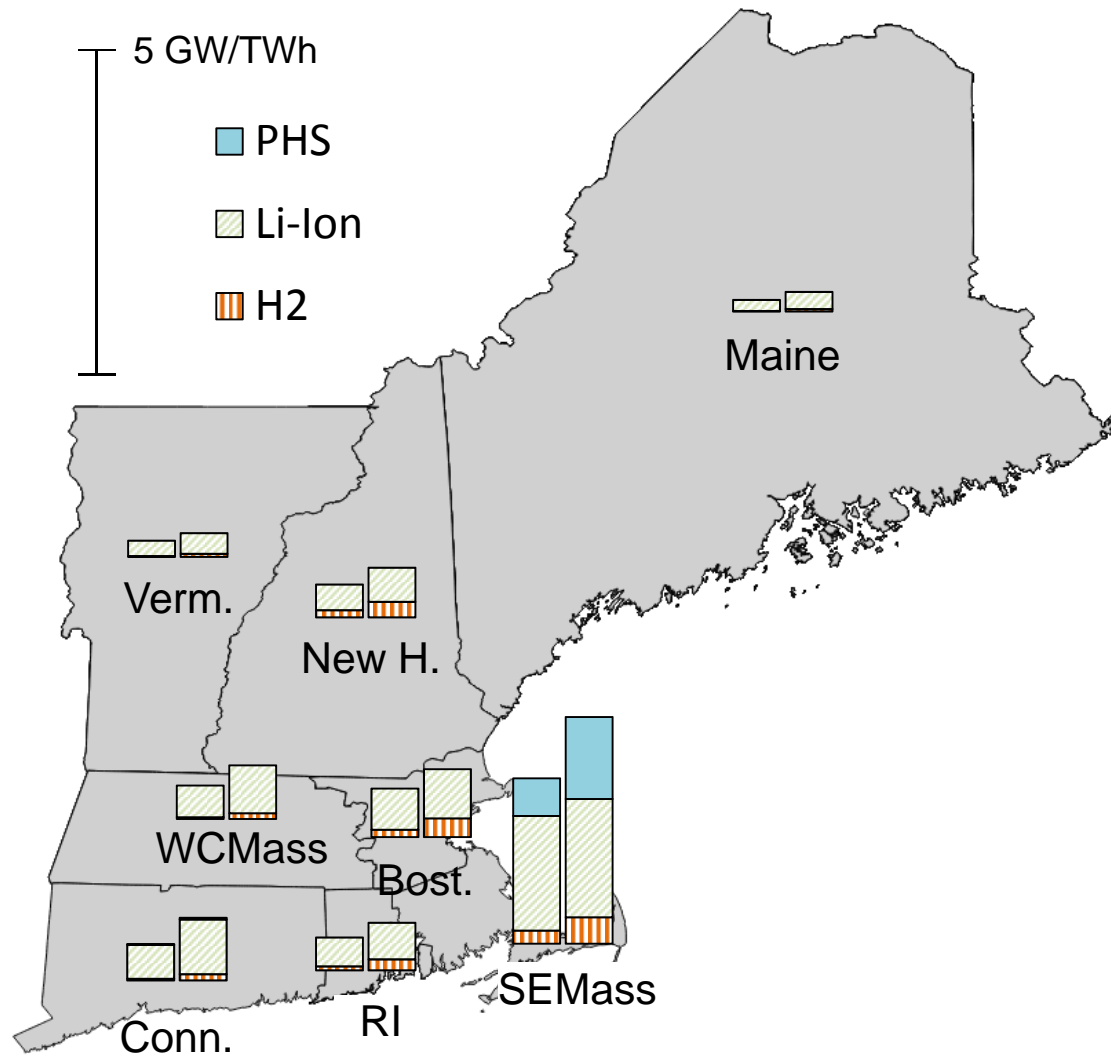
- Capacity expansion: 39 GW, net import/export: 43 TWh



- Grid expansion to connect regions of large RE potential (SEMass) to regions of high demand (Boston area)



Storage capacity



Conclusion & further research

First key results

- Power generation is dominated by offshore wind of the region south-east Massachusetts
- Spatial balancing through grid allows increased RE integration by 41% (from 32% to 73%), substituting ~10 GW of gas turbines
- Further temporal balancing through power storage enables a RE share as high as 80% and reduces curtailments
 - Flex+ = 8.3 TWh/a (~6% of VRE generation, mainly offshore w.)
 - Flex++ = 3.7 TWh/a (~3% of VRE generation, mainly offshore w.)

Ongoing research and open questions

- Coupling to the heat sector
- Test influence of inter-connector to New York and Canada
- Sensitivity analysis: cost variations, expansion limits



Thank you!

Questions?

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Wissen für Morgen