ADVANCING RENEWABLE ELECTRICITY CONSUMPTION WITH REINFORCEMENT LEARNING

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Climate Change AI workshop
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Goal

Reducing the share of coal and natural gas in electricity generation.

Challenge

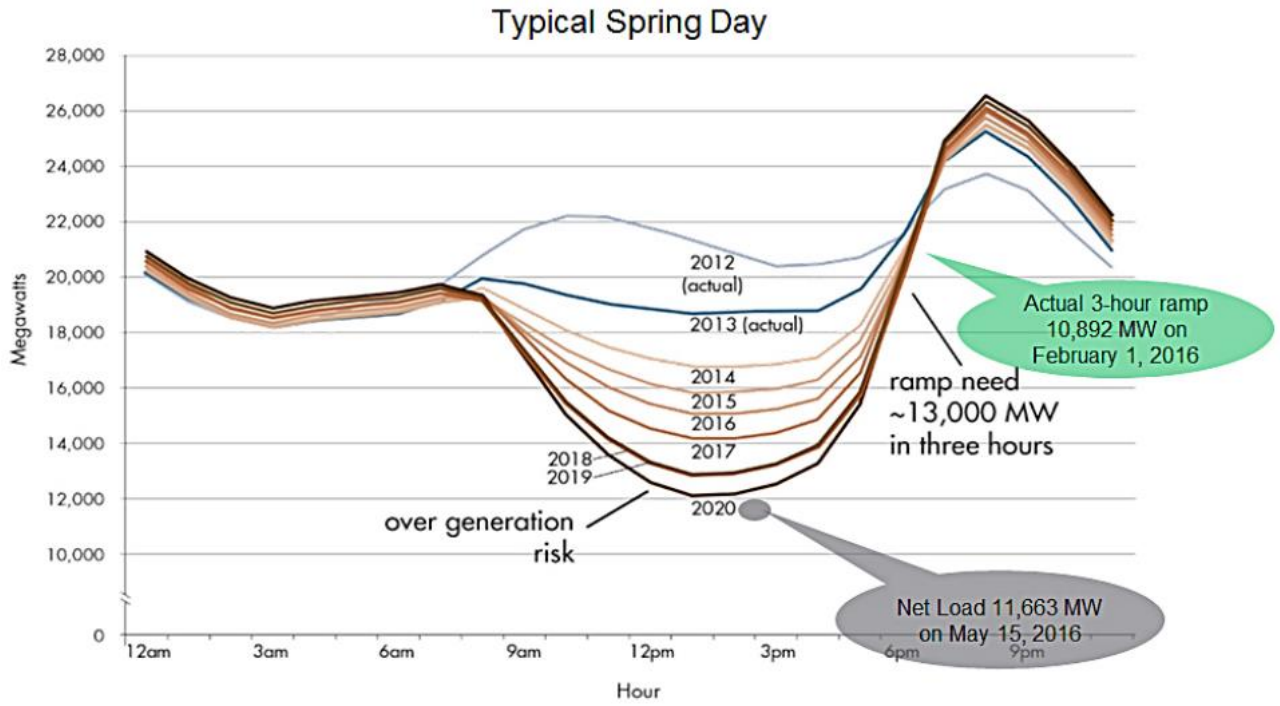
Addressing the intermittence of renewable electricity in the absence of scalable storage options.

Proposed solution

Shift the customers electricity demand to periods of oversupply due to peak in renewable electricity generation.

Intermittence of solar energy sources

Generation can be **inconsistent** to the customer load demand

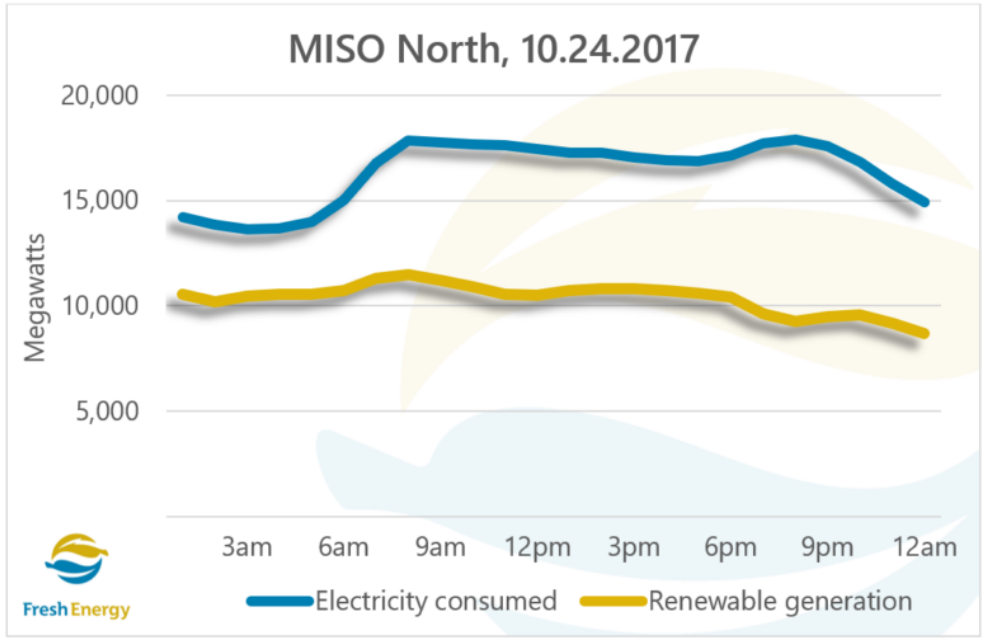


Difference between forecasted load and expected electricity production from intermittent energy sources

- Source: California Independent System Operator

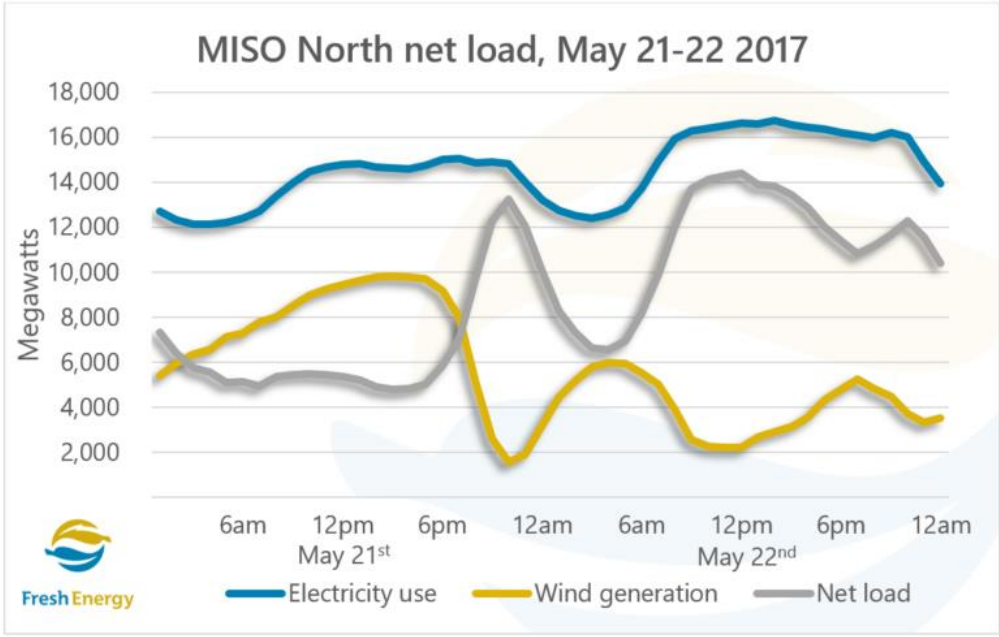
Intermittence of wind energy sources

Generation is consistent to the customer load demand



October 10th - Highest daily wind generation for 2017

Generation is **not** consistent to the customer load demand



May 21st and 22nd - Example for variable wind generation

- Source: MISO (Midcontinent Independent System Operator) North Planning Zone and https://www.greentechmedia.com/

Reinforcement Learning Approach

Environment:

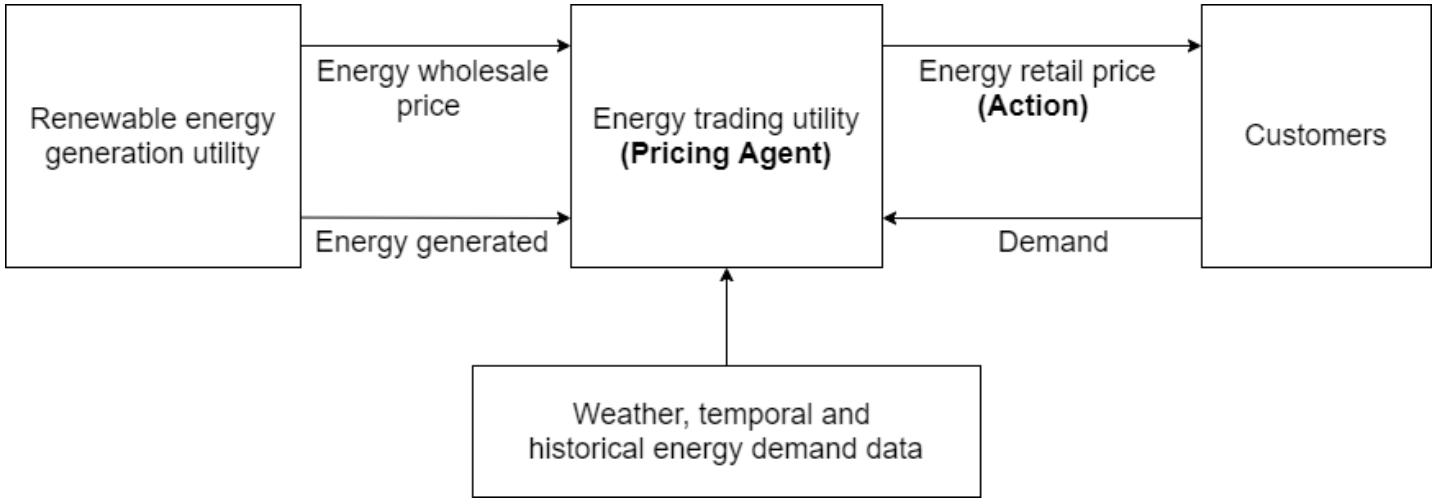
- Customers
- Electricity generation utilities
- Weather conditions
- Historical demand data

Agent:

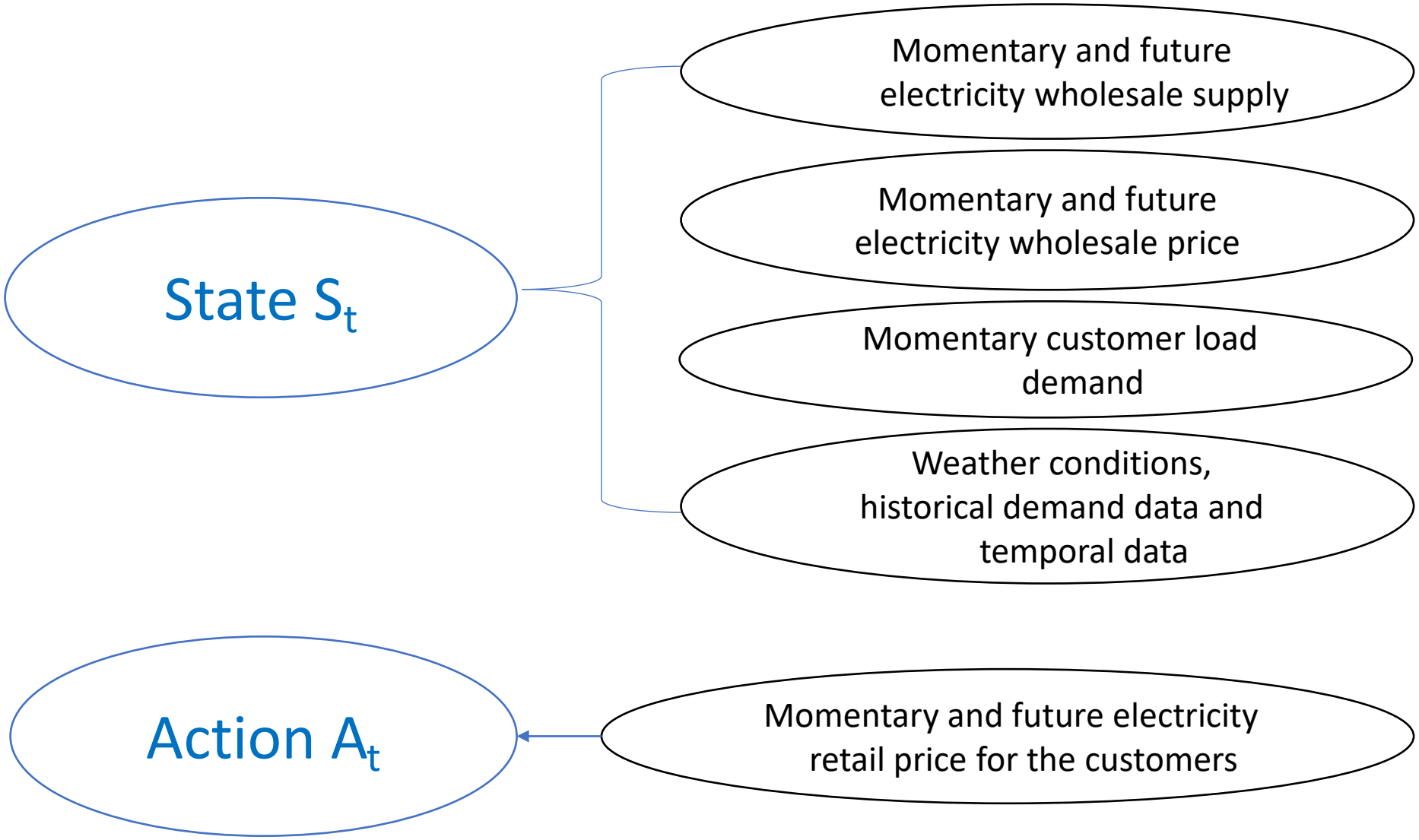
- Energy trading utility

Action:

- Energy retail price



State and action



Reward Function

Objectives:

- Decrease the difference between the supply of renewable energy and demand
- Keep the energy utility profitable

$$r(s,a) = \sum_{j=1}^{2} \alpha_j r_j(s,a)$$

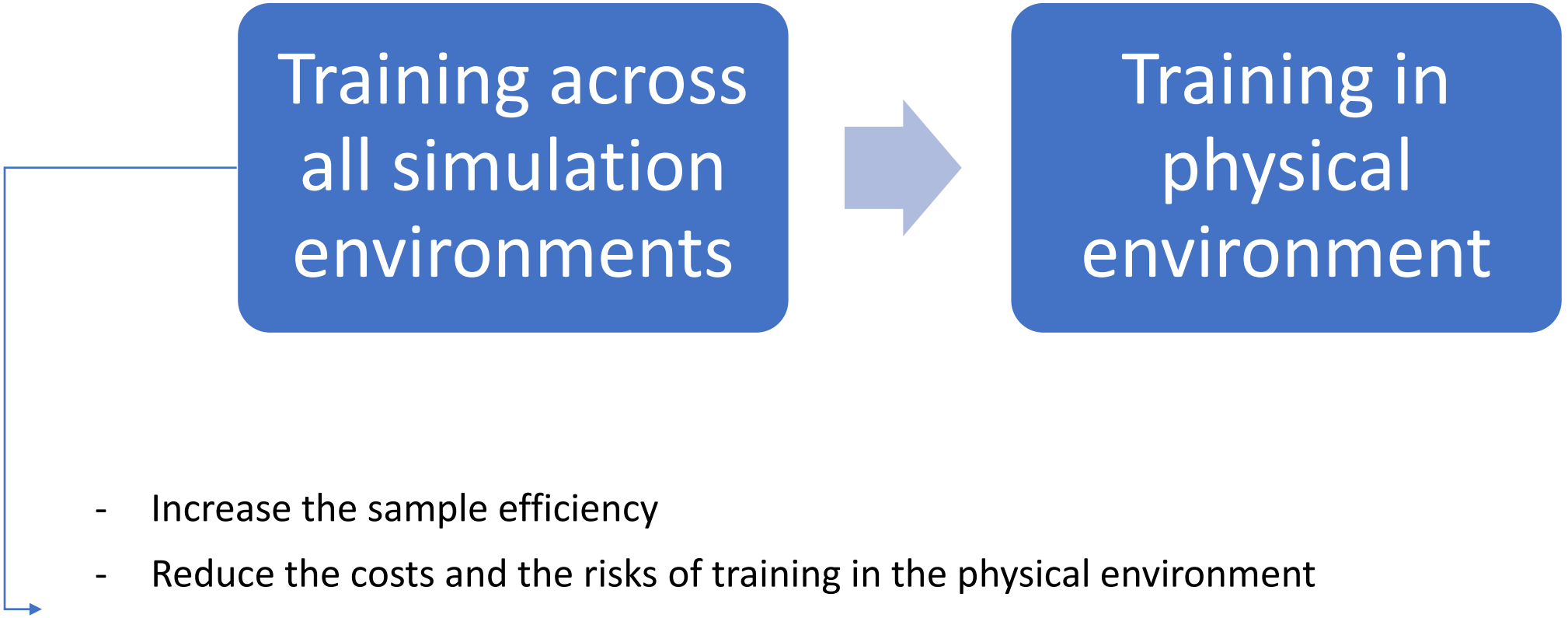
- $r_1(s,a) = (Price_{retail}(s,a) - Price_{wholesale})$
- $r_2(s,a) = -\left(Energy_{renewable} - Energy_{demand}(s,a)\right)^2$
- Hyperparameter α_j initially set to 1

Simulation Environment

- Customers- previously trained demand response agents in CityLearn
- Customers - independent or cooperative
- A number of different simulation environments - combining customer agents
- Distribution of customer agents in an environment set to mimic physical environment

CityLearn - environment for reinforcement learning agents for demand response https://sites.google.com/view/citylearnchallenge

Training



- Increase the sample efficiency
- Reduce the costs and the risks of training in the physical environment
- Increase the robustness of the agent in the physical environment
- Increase generalization across physical environments

Safety and Explainability

- Safety is ensured using a constraints on the price it signals to the customers
- Evaluation of safety - summary of all violations to the constraints
- Learning a policy as a function of the constraint level
- Tracking the performance on the two objectives of the reward function

Summary and further work

- Pricing agent and an appropriate simulation environment, used for training and evaluation
- Addressing the challenges of safety, robustness and sample efficiency with a simulation environment
- Implementation of the simulation environment(ongoing)
- Further training of the customers with the pricing agent

Thank you for your attention!

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