

# A Decision Support Assistant to Operate a Power Grids with Zonal Automaton

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## 1. Context

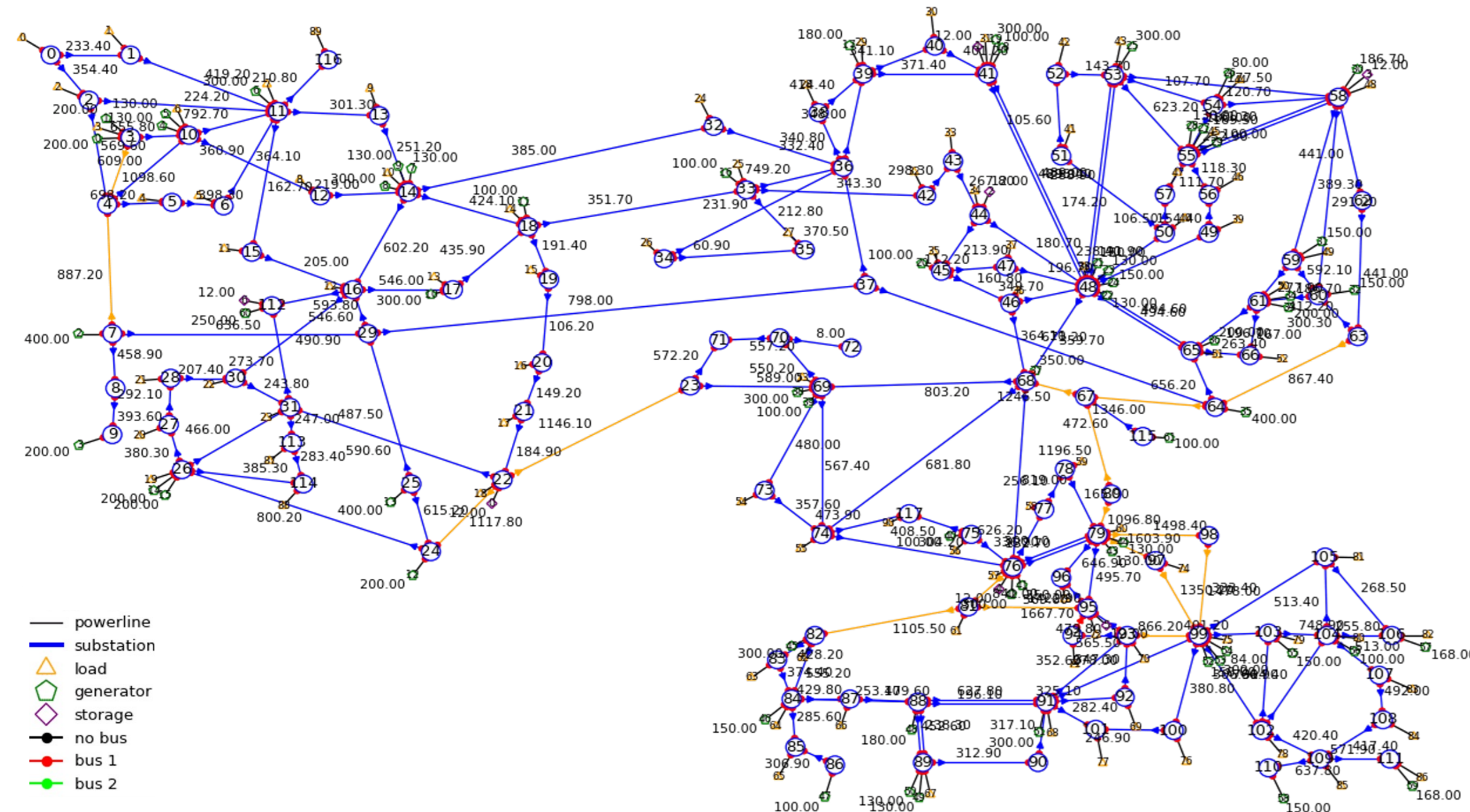
Renewable energy sources are forcing power grid operators to review their grid management strategies

Réseau de Transport d'Électricité (RTE) is developing new adaptive zonal automaton

- Each automaton monitors a zone of the power grid (up to 40 lines) thanks to an optimization algorithm.
- An automaton can act on the power grid configuration and on the electricity production.
- Each automaton can receive a target path or additional information from operators to decide the appropriate actions to be done. Examples of target path include (un)desirable configurations in future hours or information about other zones.

## 2. Objective

Design a decision support assistant for the supervision of zonal automaton able to recommend relevant target paths/information for automaton based on the power grid's configuration and constraints



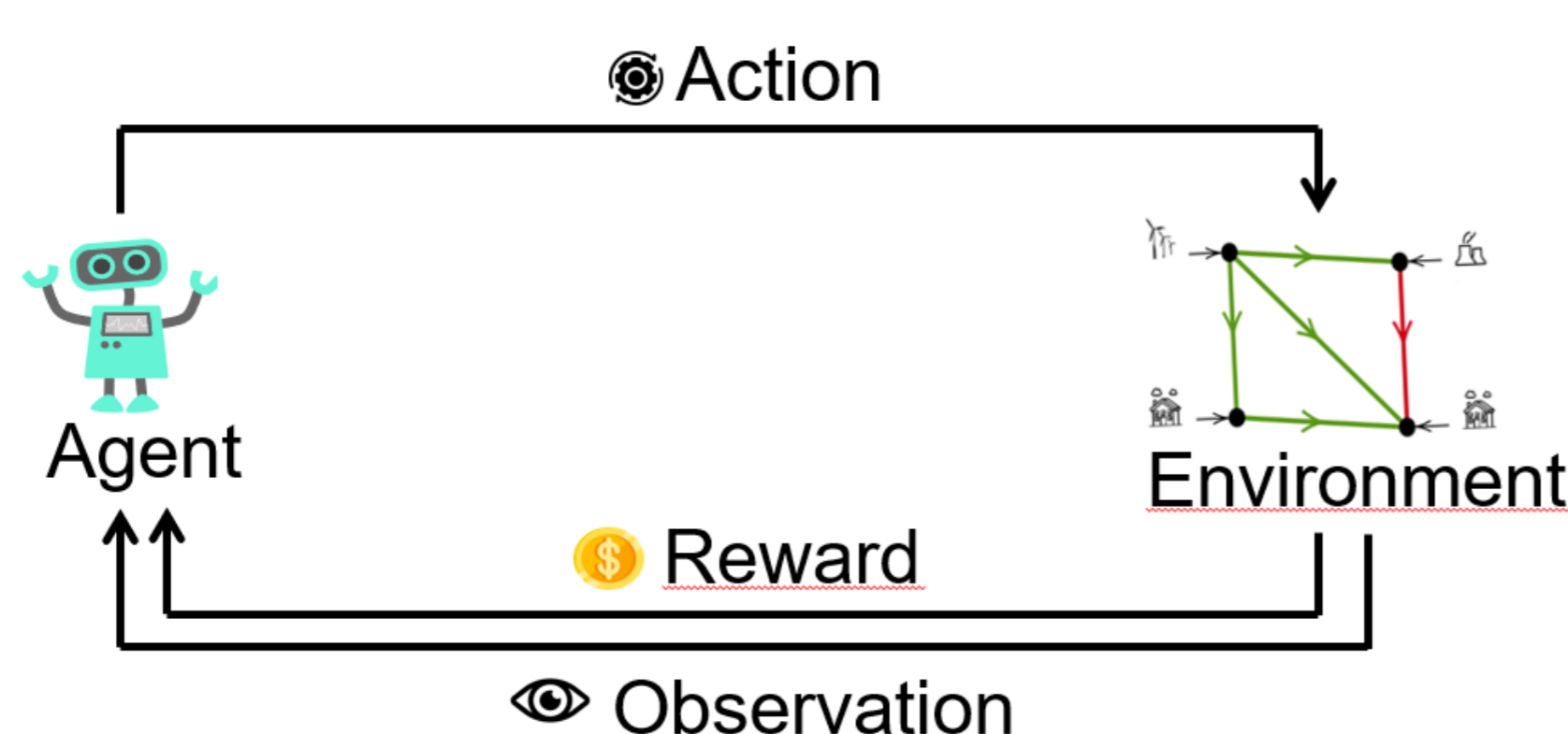
Example of a simulated power grid

## 3. Considered method

### Reinforcement learning (RL)

RL approaches are particularly efficient for sequential problems because:

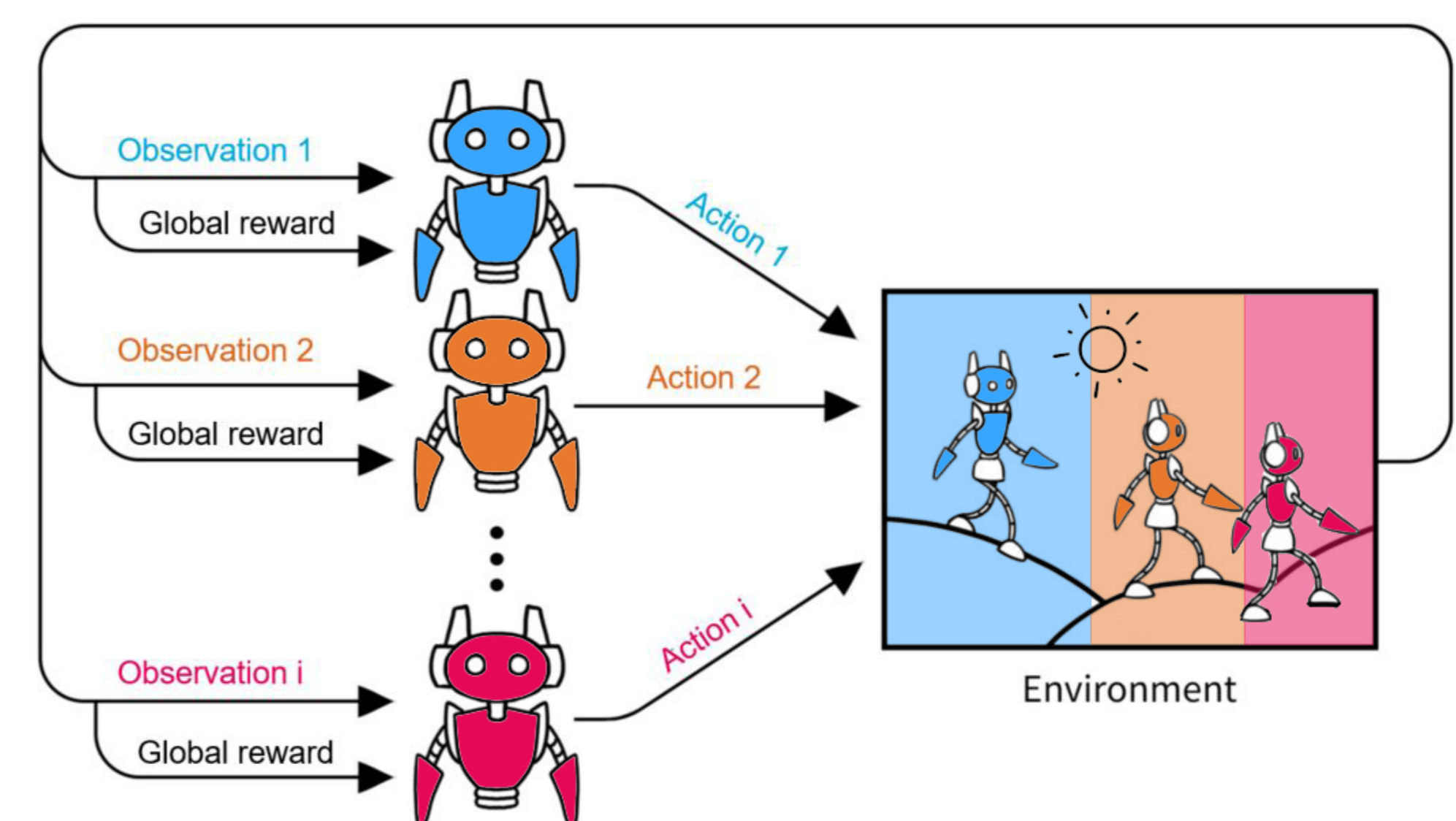
- RL is able to **anticipate** future events
- RL can take into account **uncertainties**



The principle of Reinforcement Learning

### Multi-Agent Reinforcement Learning

Several agents cooperate to ensure the safety of the power grid. We think a decentralized approach could greatly **improve scalability** compared to traditional deep learning methods [1].



Decentralized multi-agent reinforcement learning

For example, each agent can be associated with a subset of automaton and their zones. In this context, at each time-step  $t$ :

- Each **agent**  $i$  chooses an **action** according to its observation.
- The **actions** are combined and executed
- A **reward** representing the safety of the hole grid is returned.

## 4. How to emulate a zonal automaton?

To obtain **reasonable computation times** during training, we need a trade-off between speed and realism.

Emulate an automaton through a reinforcement learning agent to:

- Operate the grid
- Follow a target setpoint

We designed an agent able to operate a 14-nodes power grid by controlling storage power

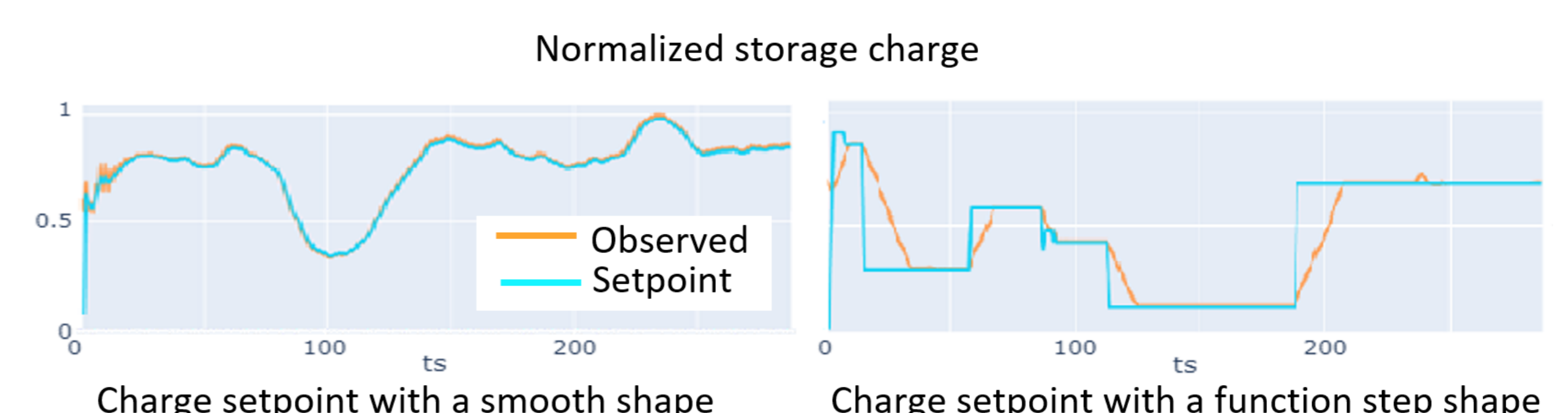
	Do Nothing Agent	RL Agent
Average number of survived time steps per episode	206/288	279/288

Performances of our agent on a 14-nodes simulated grid

We designed an agent able to follow a storage charge setpoint

We got interesting results about:

- how to penalize deviations from the setpoint.
- the impact of hyperparameters.
- the ability to **generalize to other shapes of setpoint** which is great as illustrated in the figures below.



Comparison of observed charge with a smooth setpoint or a step function setpoint

## References

- [1] Karl Johan Åström. Optimal control of markov processes with incomplete state information. *Journal of mathematical analysis and applications*, 10(1):174–205, 1965.