

Dealing with Uncertainty in Future Power Distribution Grid with Reinforcement Learning

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¹Institute for Automation and Applied Informatics (IAI)

@International Workshop: Challenges and Opportunities in Modern European Power Systems

Workshop Chair: Dr. Amy Liu, Dr. David Laverty, Prof. Sean McLoone



Motivation

Dealing with Uncertainty in Future Power Distribution Grids

- Energy System in Transition
 - *Bidirectional* Power Supply
- Possible Consequences
 - Overloading and Congestion Problems!



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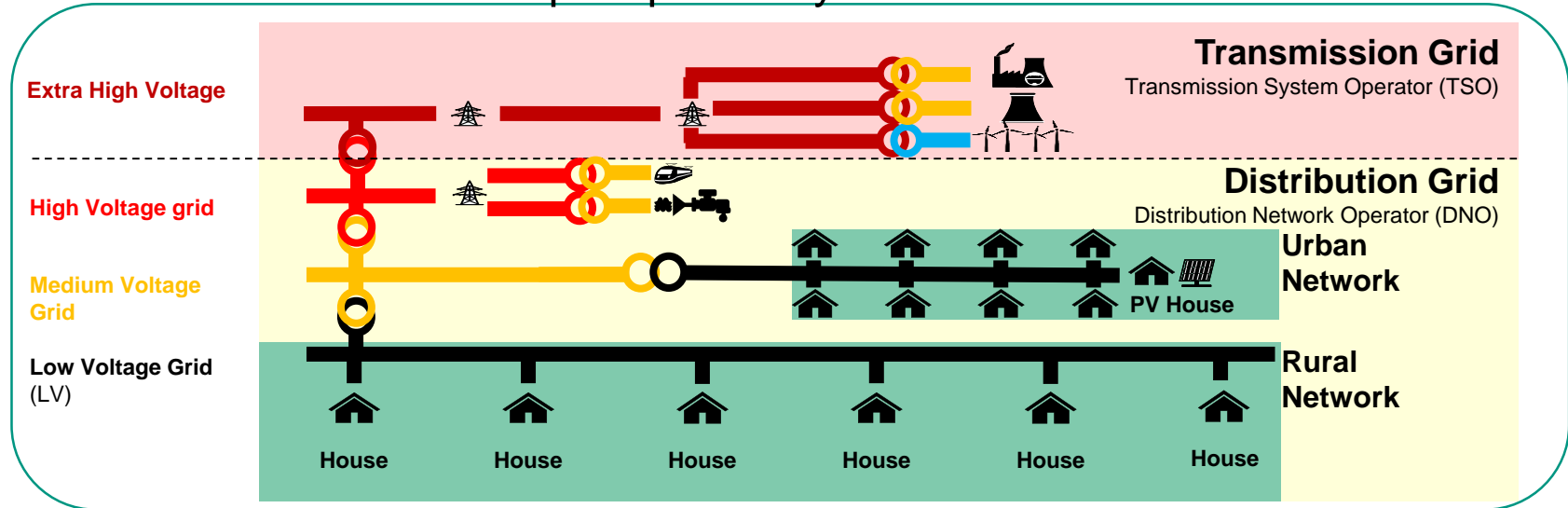


- *Resilience* based on *Flexibility*
 - Utilization of Distributed Energy Resources (DERs)
 - Probabilistic Planning and Decision-Making



Challenges

■ Transformation of Europe's power system

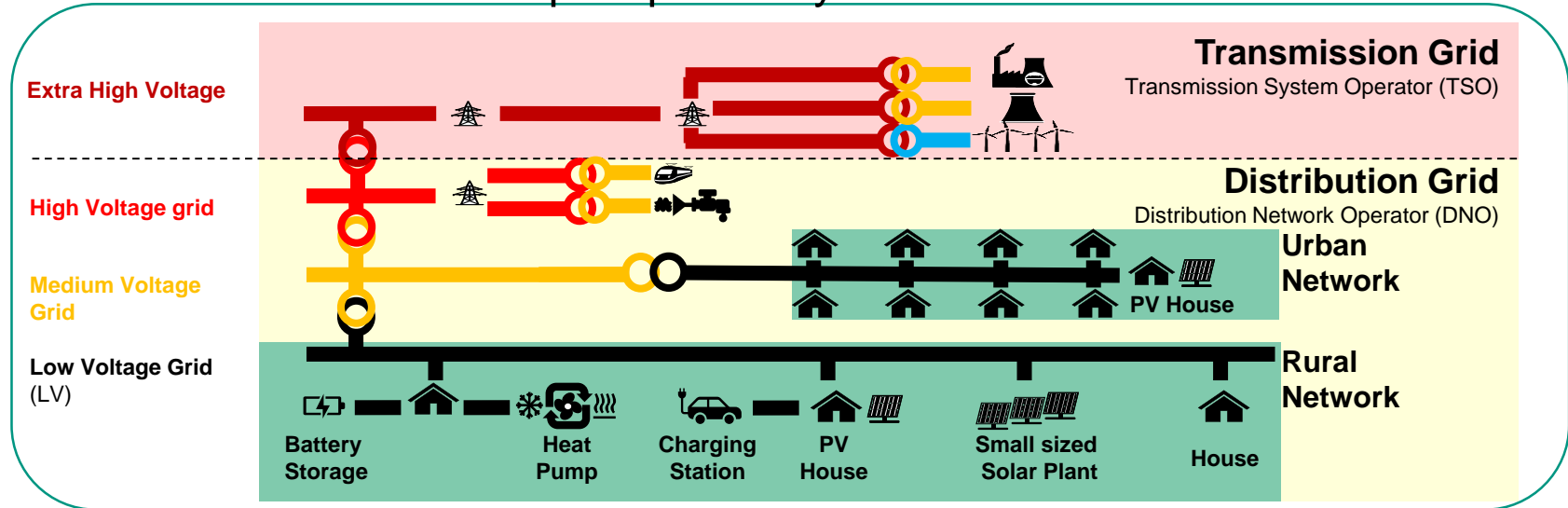


C1: DERs Integration with joint Uncertainty

C2: Considering Uncertainty in RL for Power Grids

Challenges

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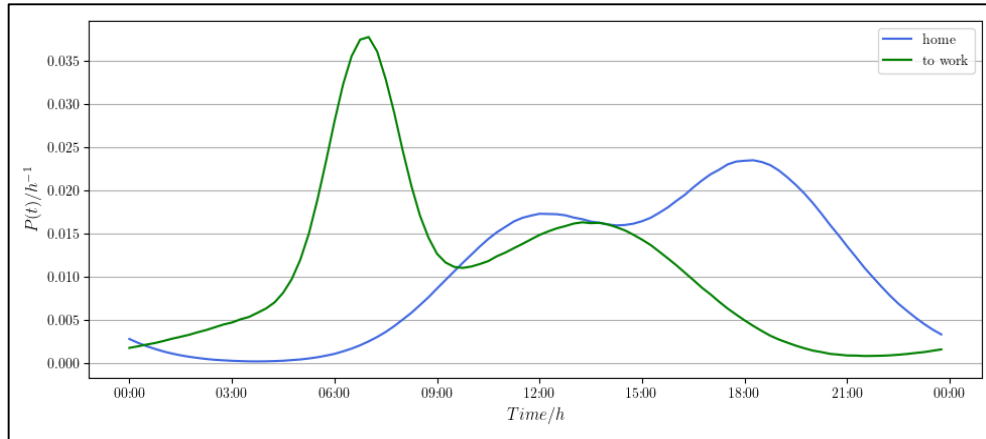


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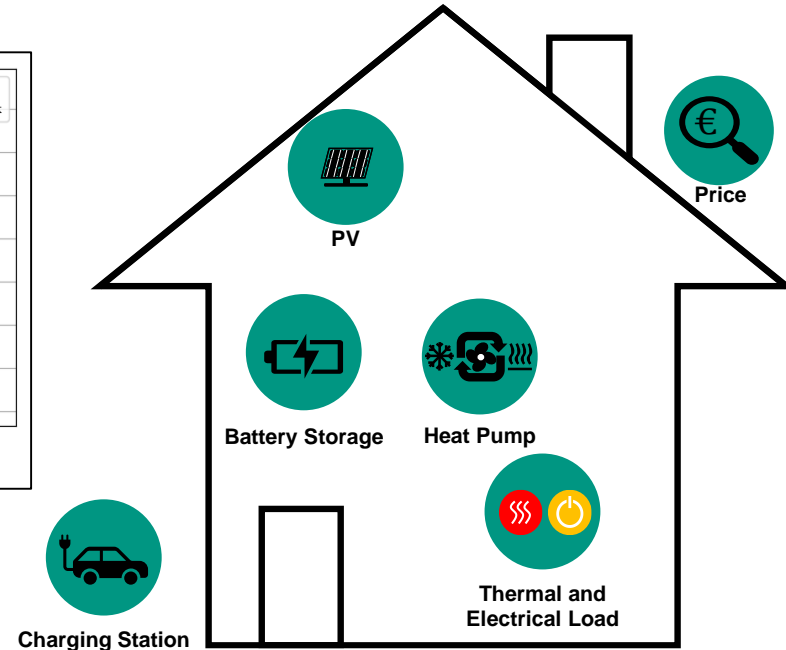
C2: Considering Uncertainty in RL for Power Grids

C1: DERs Integration with joint Uncertainty

- Uncertainty Formulation of single and joint DERs
 - Bayesian Statistics
 - Forecast Catch-Up Effects of DERs



- Probability distribution of the arrival times at home and work for electric vehicles

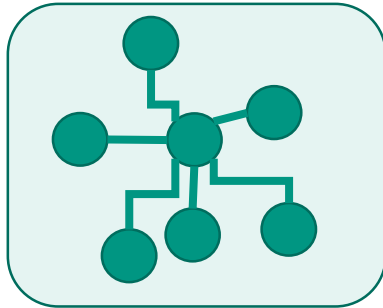


C2: Considering Uncertainty in RL for Power Grids

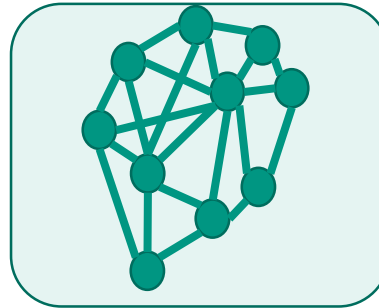
- Reinforcement Learning
 - Energy Flexibility increases Resiliency

C2: Considering Uncertainty in RL for Power Grids

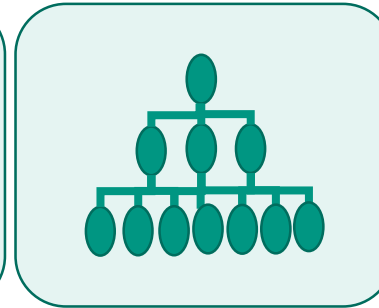
- Reinforcement Learning
 - Energy Flexibility increases Resiliency
 - Using Distributed, Decentralized RLs Instead of Centralized



Centralized



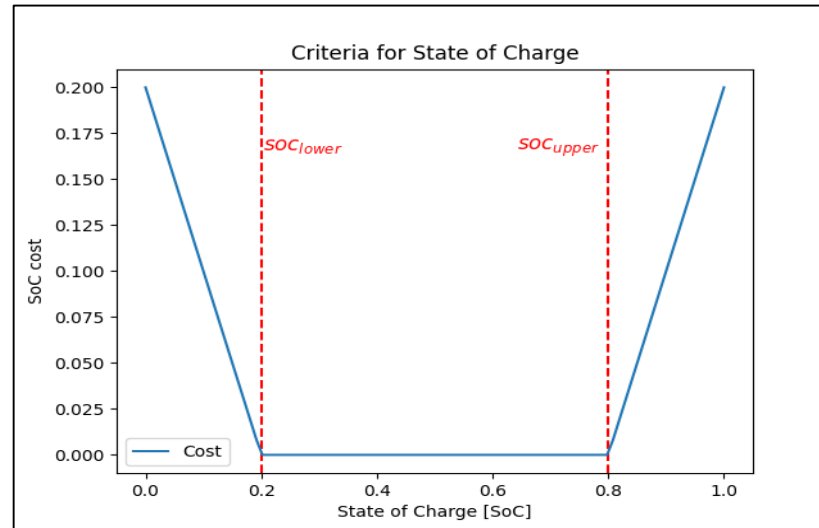
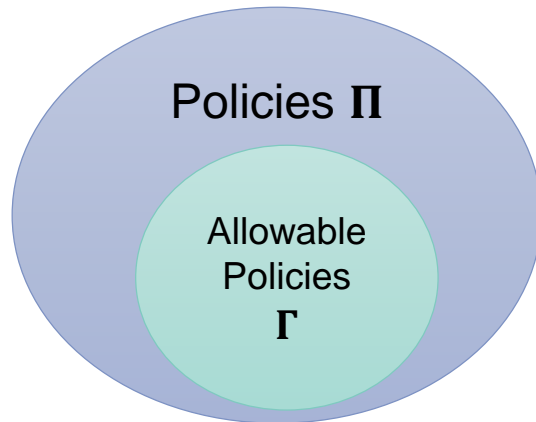
Distributed



Decentralized

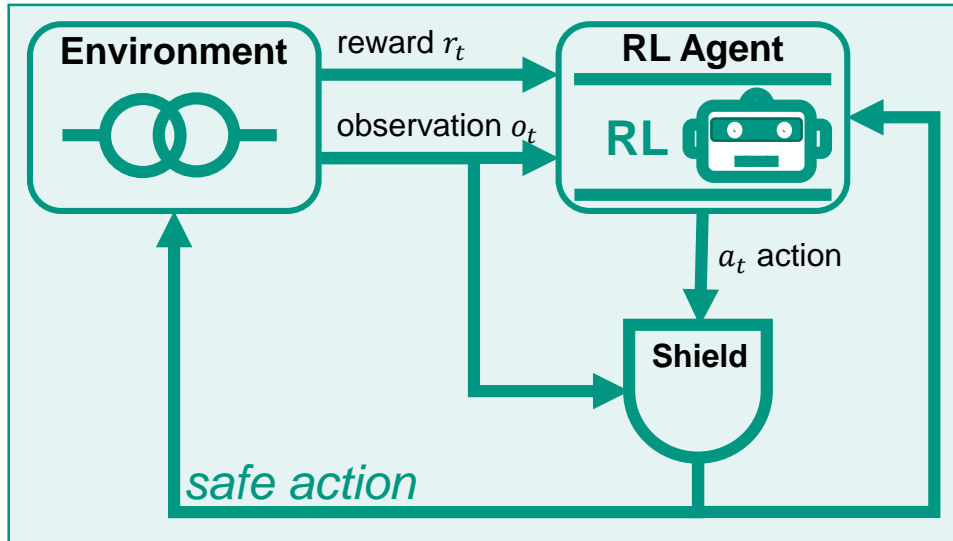
C2: Considering Uncertainty in RL for Power Grids

- Reinforcement Learning
 - Energy Flexibility increases Resiliency
 - Using Distributed, Decentralized RLs Instead of Centralized
 - Safety RL
 - Include C1 into RL



Goal

Automation in Energy Systems using AI



- Energy System Data
 - Application of GANs
- Reinforcement Learning
 - How can we control DERs in energy systems?
 - Multi-Agent Reinforcement Learning
 - Safe and Resilience via Shielding
 - Forecast Catch-Up considered

Thank you very much for your attention!



Suggestions, questions, and advice are welcomed!



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Research Area [IT Methods and Components for Smart Infrastructures \(IT4SI\)](#)

Group [IT-Methods and Components for Energy Systems \(IT4ES\)](#)

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