

# Learning ORDER: Learning for Operationalizing Data into Energy Management

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E4F Interview Committee-Smart Grids/MIT  
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## A few words about myself...

Vladimir (**Vlad**) Dvorkin

**2015-2021** M.Sc.+Ph.D. in Electrical Engineering  
from DTU (Danmarks Tekniske Universitet)

**2019 (1/2)** Visiting scholar at GeorgiaTech  
(Industrial and Systems Eng.)

**March 2021** Ph.D. thesis defense

**Present** Postdoctoral associate at MIT



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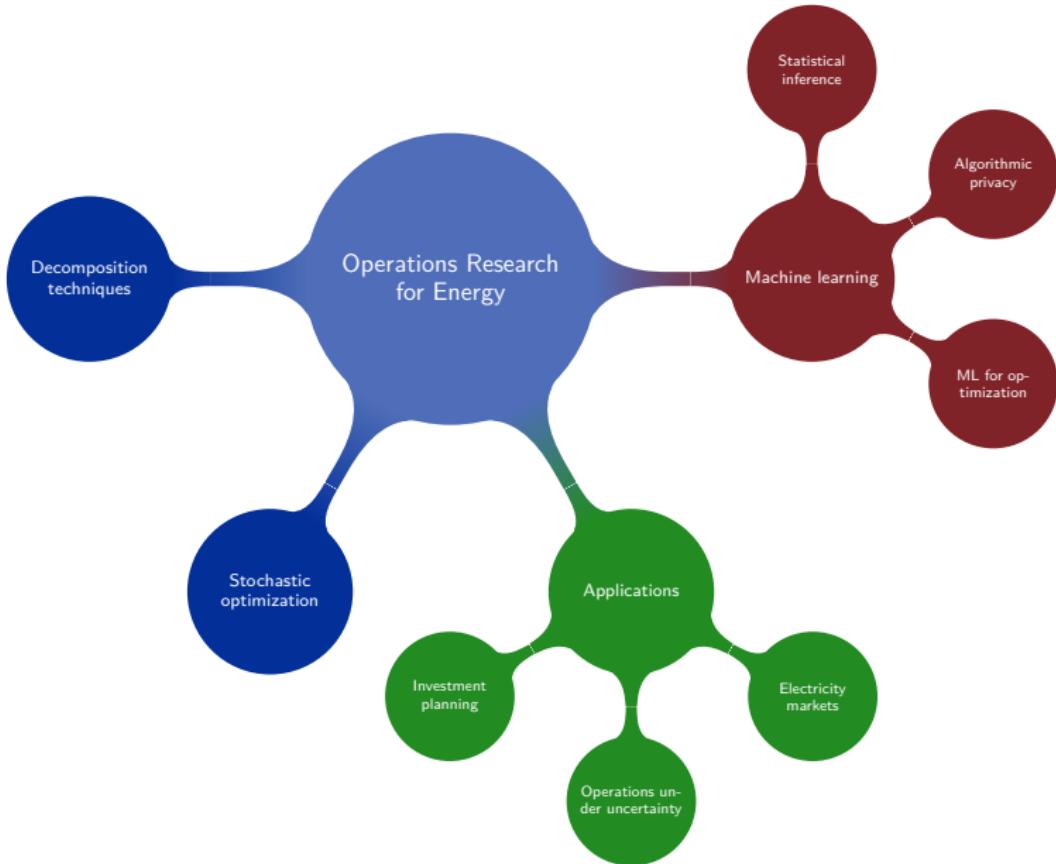
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# My research (biased picture)

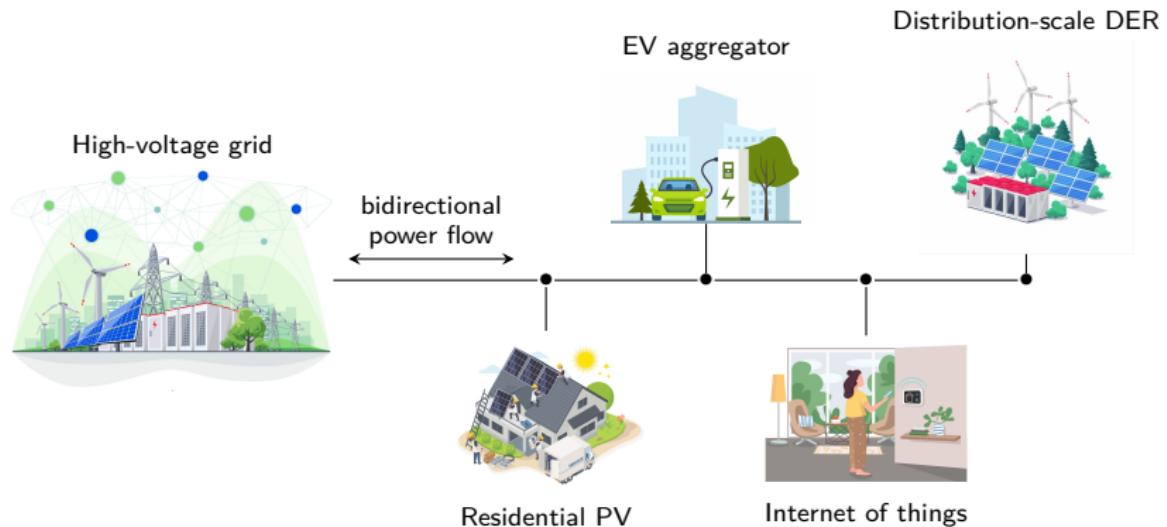


## My research (**unbiased picture ... compiled from my thesis**)

algorithms centralized chance-constrained chapter  
computations control cost data datasets  
deterministic differential differentially dispatch distributed  
distribution efficiency energy feasibility  
guarantees information input market  
mechanism methods noise operational operations  
**optimization** perturbation policies  
**power privacy private** problem  
problems programming properties provide random results risk  
solution solutions stochastic  
**system** systems  
**uncertainty** utility work

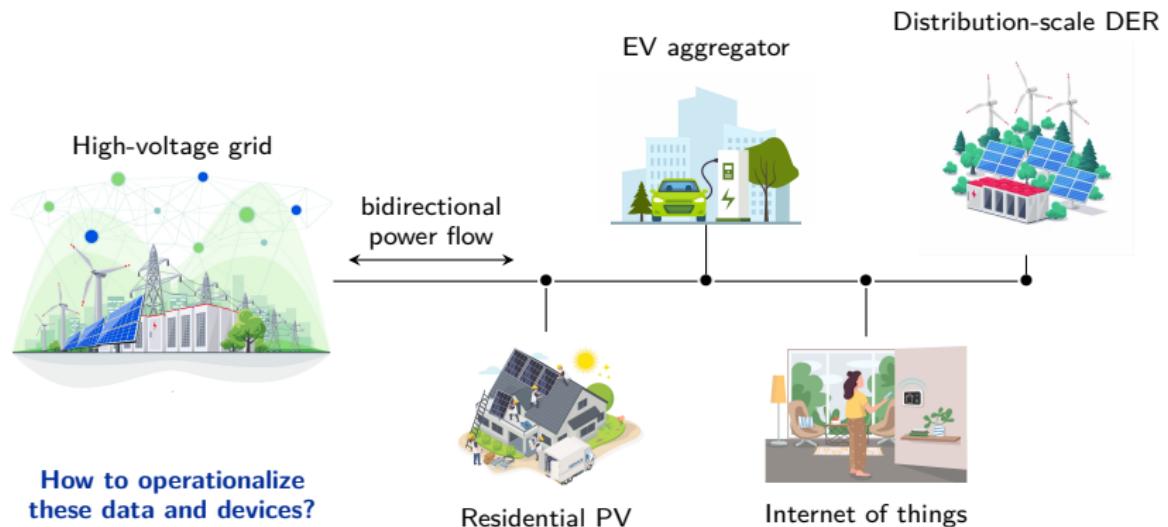
# A modern view on distribution grid operations - Part I

- More control opportunities thanks to many inverter-interfaced DERs
- More distributed grid data as more agents/devices engage with the grid
- More operational flexibility to balance distribution grids in real-time
- DSO tasks: real-time grid control, demand response, transmission-distribution coordination
- Cost and “beyond cost” objectives (e.g., local energy supply, emission-aware dispatch)

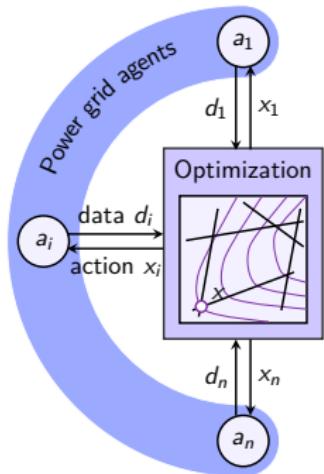


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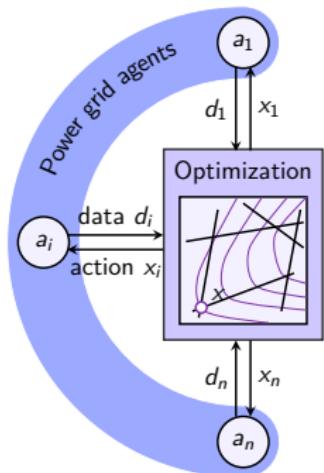


## A modern view on distribution grid operations - Part II



- ▶ Agents submit data  $d_1, \dots, d_n$
- ▶ Operational task is optimized centrally
- ▶ Agents receive and implement control actions  $x_1, \dots, x_n$

## A modern view on distribution grid operations - Part II



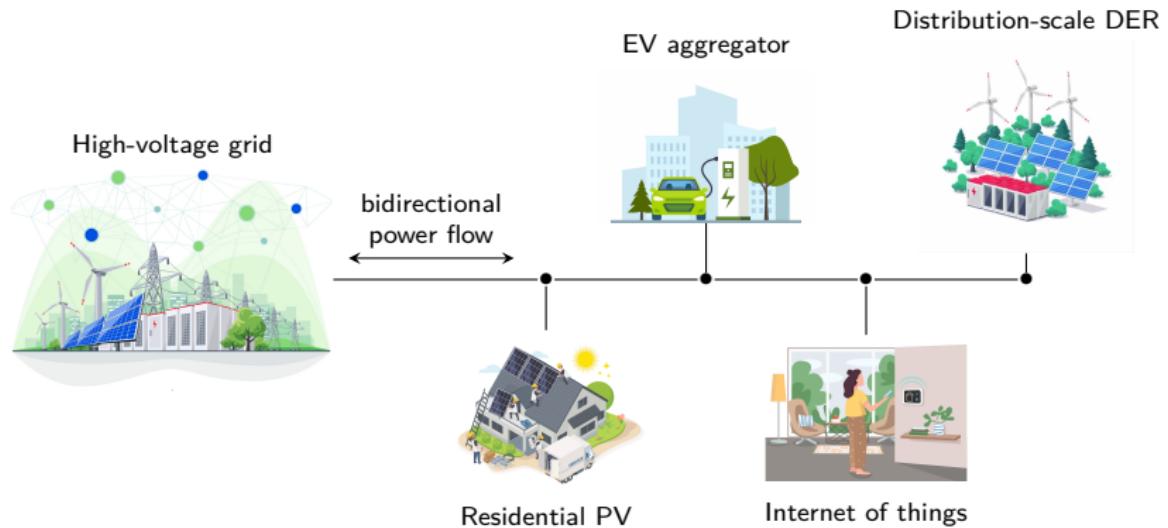
- ▶ Agents submit data  $d_1, \dots, d_n$
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Optimization-based operations face many **challenges**:

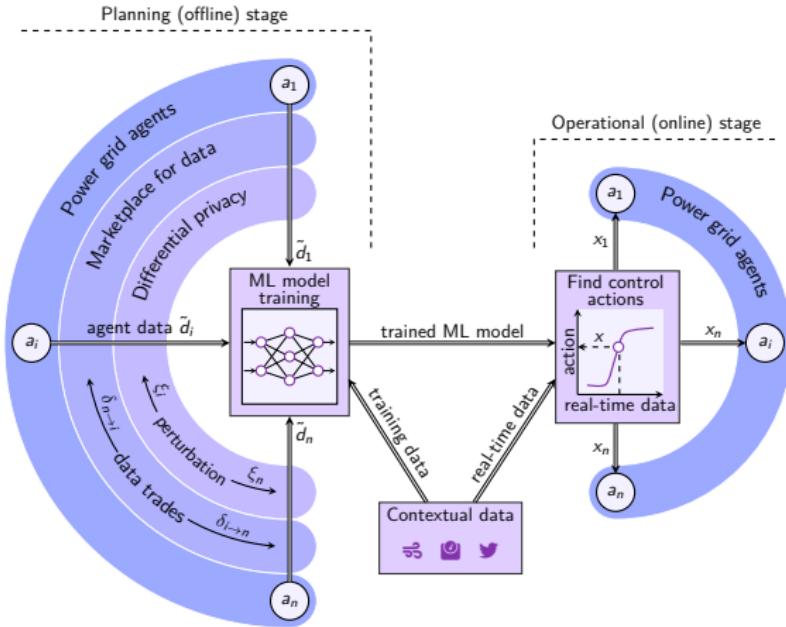
- ▶ Missing incentives for data sharing: privacy risks, compensations, etc.
- ▶ Transmitting thousands of data streams in real-time is expensive
- ▶ Centralized computation is slow to optimize thousands of devices
- ▶ Barriers for contextual data (e.g., weather information, social media information)

# A postmodern (?) view on distribution grid operations - Part I

- ▶ From **optimization-based** to **learning-based** grid management
- ▶ Each controllable device is given a policy which guides its operations
- ▶ The goal is learn the optimal policy for autonomous distribution grid operations



# A postmodern (?) view on distribution grid operations - Part II



- ▶ **Planning stage:** collects grid data and learns the optimal control policies offline
- ▶ **Operational stage:** deploys control policies using real-time contextual data (weather, ...)

- ▶ **Key features:**
  - ▶ Incentives for safe data sharing
  - ▶ Small data and communication requirements in real-time operations
  - ▶ No barriers for contextual data

# Three core research thrusts

## Thrust 1: Marketplace for electric power grid data

Goal	Methods	Broader impact
<ul style="list-style-type: none"><li>Incentives for data sharing</li></ul>	<ul style="list-style-type: none"><li>Game theory</li><li>Sampling theory</li></ul>	<ul style="list-style-type: none"><li>From passive to active role of data</li><li>New forms of customer engagement</li></ul>



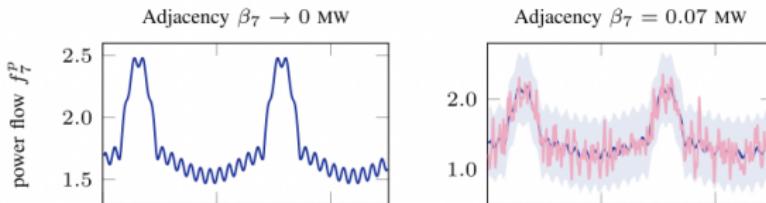
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## Thrust 2: Differential privacy for power grid datasets

Goal	Methods	Broader impact
<ul style="list-style-type: none"><li>▪ Private data utilization</li></ul>	<ul style="list-style-type: none"><li>▪ Differential Privacy</li><li>▪ Optimization</li></ul>	<ul style="list-style-type: none"><li>▪ Compliance with GDPR standards</li><li>▪ Trust in data sharing</li></ul>



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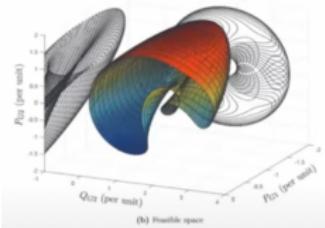
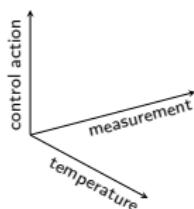
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## Thrust 3: New machine learning models and performance guarantees

Goal	Methods	Broader impact
<ul style="list-style-type: none"><li>▪ Learning-based grid control</li><li>▪ Performance certificates</li></ul>	<ul style="list-style-type: none"><li>▪ Machine learning</li><li>▪ Optimization</li></ul>	<ul style="list-style-type: none"><li>▪ New operational paradigm/industry</li><li>▪ Trust in machine learning models</li></ul>



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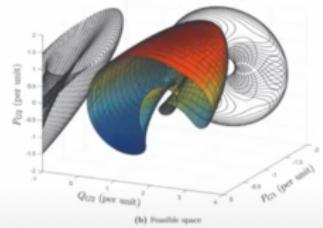
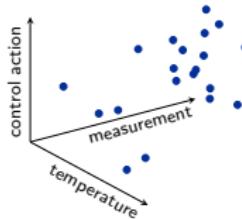
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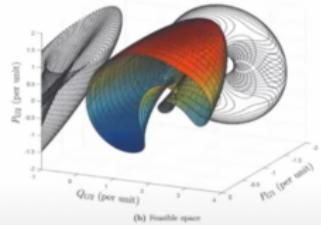
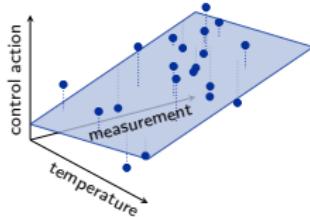
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# Research schedule (at most two tasks at a time)

Research Schedule								
	2022				2023			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
<b>RT1 (Data)</b>								
Task 1	Data trading							
Task 2				DP data trading				
<b>RT2 (Privacy)</b>								
Task 1		Initial DP algo.						
Task 2					Noise reduction			
<b>RT3 (Learning)</b>								
Task 1	Initial ML models							
Task 2		New ML training algorithms						
Task 3					ML verification			
<b>Mobility</b>								
Primal stay		Academic period						
Secondment						Industrial period		



**That you for your attention!**