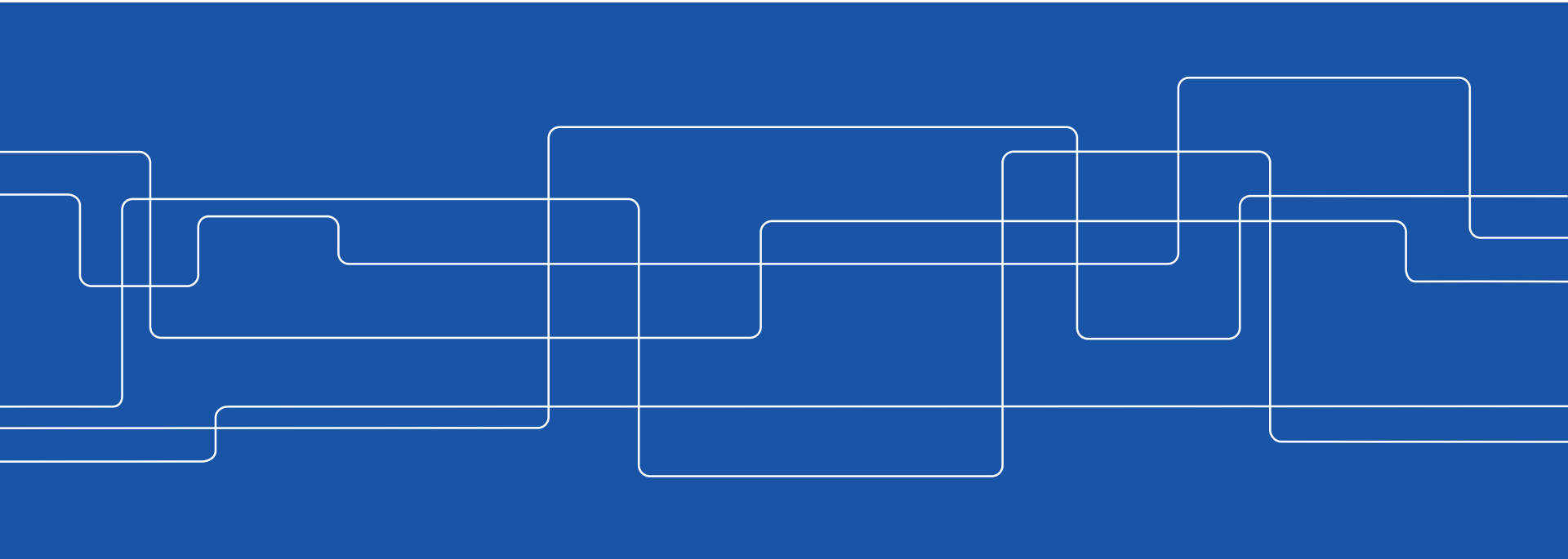




# Efficient trading for integration of wind power

Priyanka Shinde

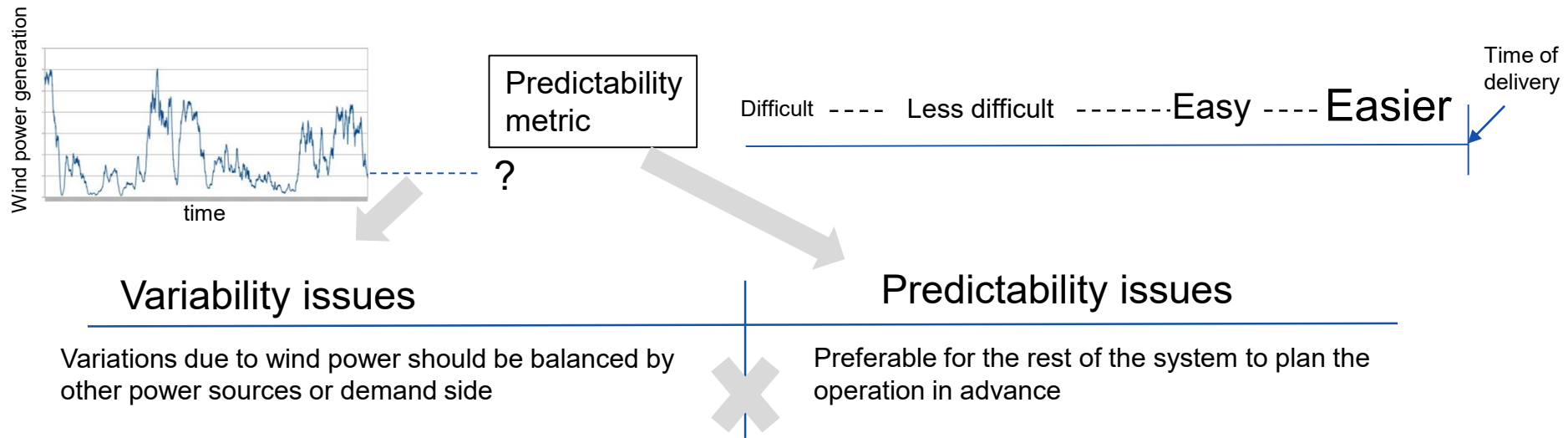




# Overview

- Project summary
- Introduction to Intraday (ID) electricity market
- Introduction to Agent-based modeling (ABM)
- Why to combine ID and ABM?
- Challenges in the project
- Objectives of our proposed model
- Conclusions

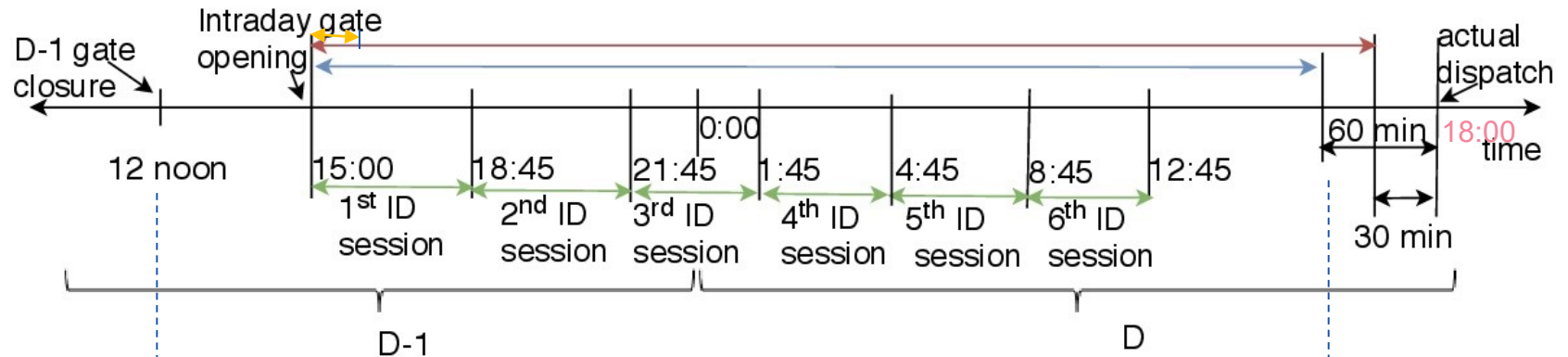
# Project summary



## SOLUTION

- Find the market design to use flexible resources when wind power penetration increases.
- Evaluate how different market design influence integration of wind power.
- Model intraday trading also how wind power penetration and other players should act based on wind power forecasts.

# Specific Intraday (ID) markets



DAY-AHEAD MARKET

INTRADAY MARKET

BALANCING MARKET

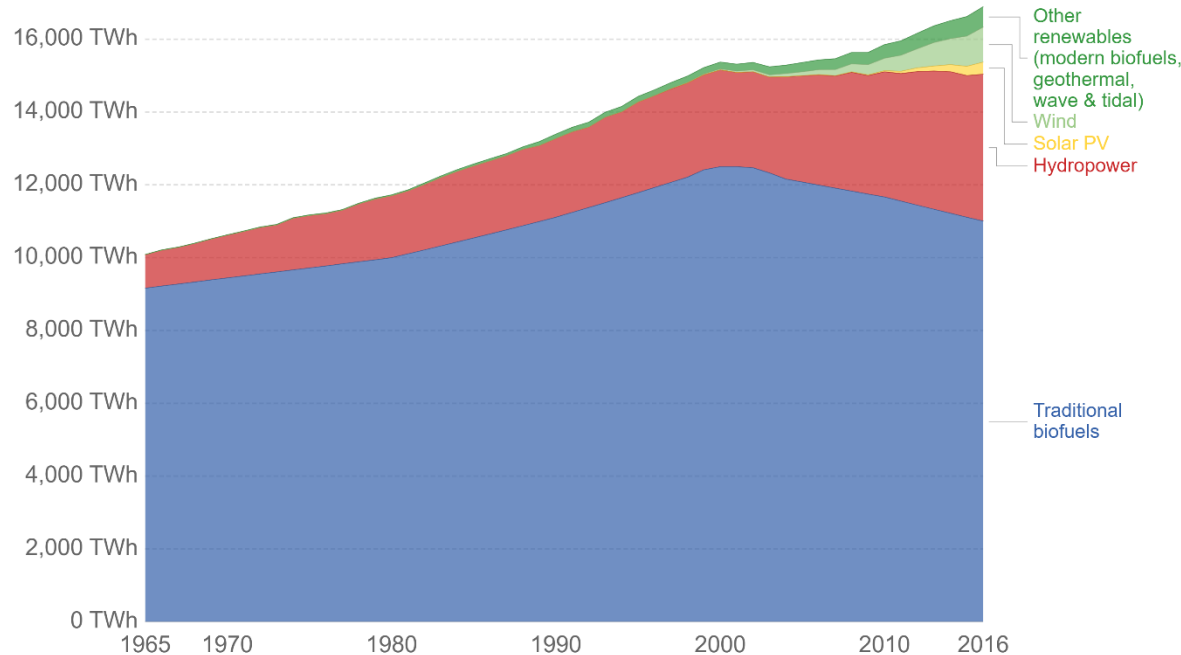
Red color: German ID market  
 Yellow color: Discrete auction interval in Germany  
 Blue color: Elbas market (Nordic ID market)  
 Green color: MIBEL (Iberian electricity market)

# Increase in variable energy sources

## Global renewable energy consumption, terawatt-hours

Total renewable energy consumption over the long-term, measured in terawatt-hours (TWh) per year. Traditional biofuels refer to the consumption of fuelwood, forestry products, animal and agricultural wastes.

Our World  
in Data



How does that affect the trade in electricity market?

Source: Global Energy Production by Source - Vaclav Smil (2017) & BP Statistics, BP Statistical Review of Global Energy  
OurWorldInData.org/renewables • CC BY

# Need for intraday market?

Imbalance  
cost

- Possibility to reduce the imbalance costs by performing adjustments closer to the time of delivery.

Optimize

- Producers/ consumers get an opportunity to optimize their schedules with updates forecasts.

Flexibility

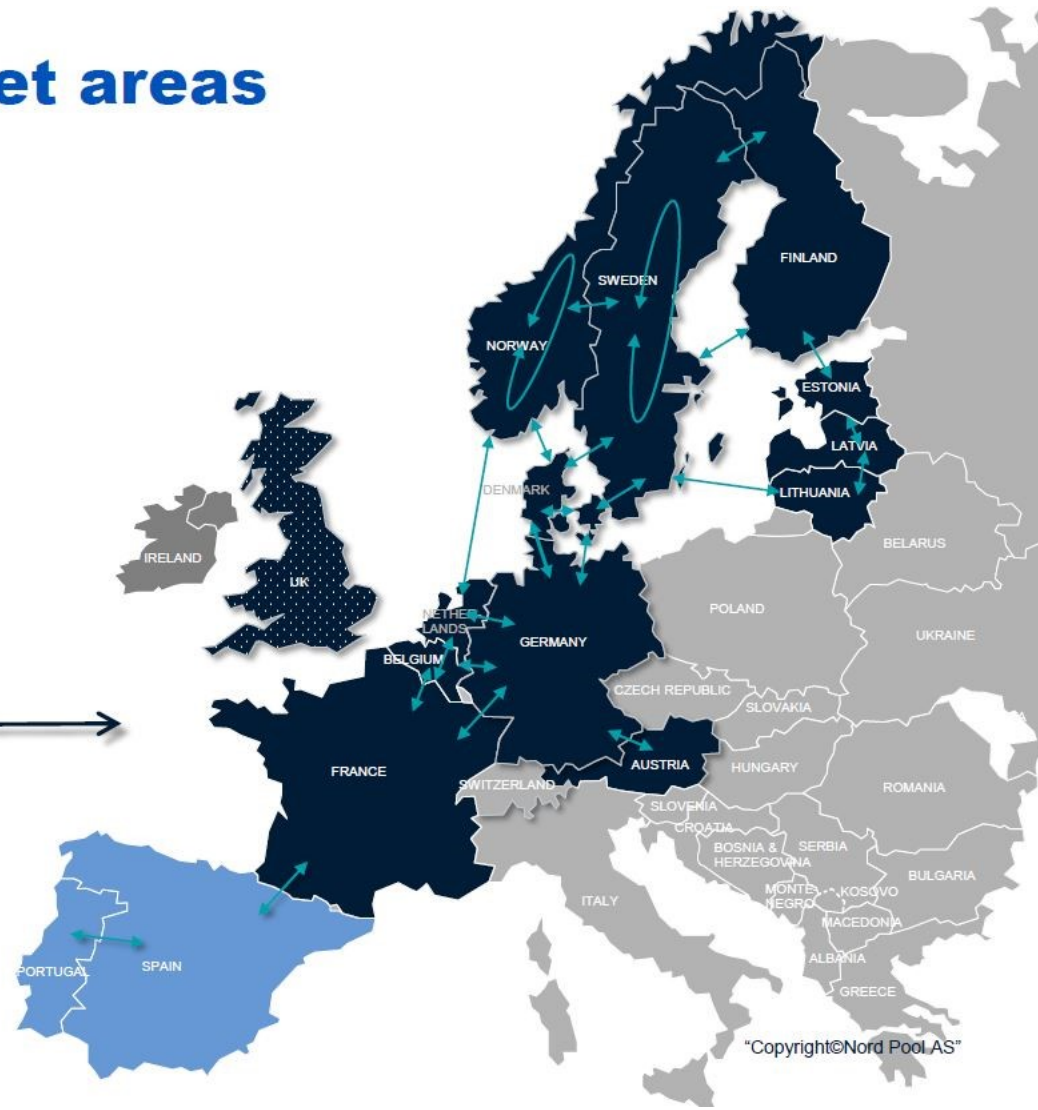
- It allows producers/ consumers to offer more flexibility to the system therefore, reducing the need for expensive balancing actions.

# Nord Pool intraday market areas

## Post SIDC go-live

-  Nord Pool markets, open
-  Nord Pool markets, not part of XBID
-  Nord Pool is not NEMO
-  Capacity available

- ✓ Shared liquidity pool with 6 new countries, compared to Nord Pool's offering pre SIDC
- ✓ Shared liquidity pool with other PXs in Germany, France, The Netherlands, Belgium and Austria

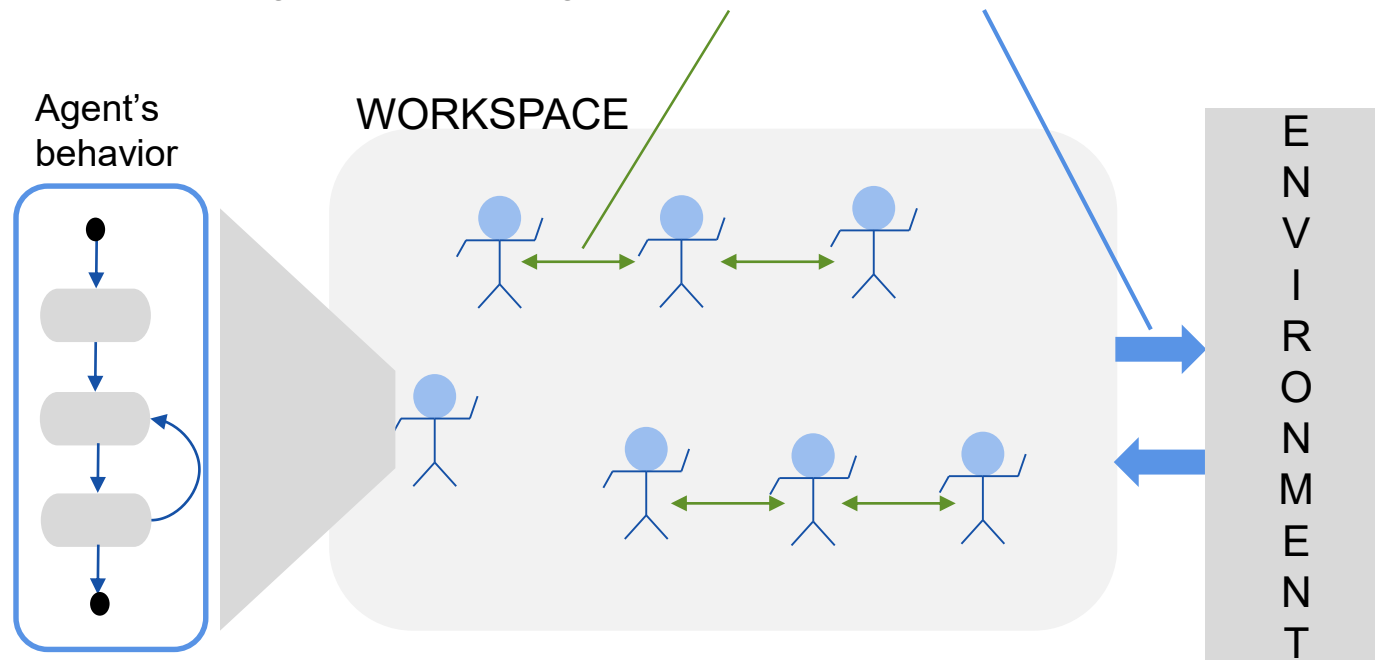


**NORD  
POOL**

"Copyright©Nord Pool AS"

# What is ABM?

Agents interacting DIRECTLY and INDIRECTLY



Agents have local and imperfect information, which combined with their past experiences help them improve their decisions by modifying their strategies.

Attributes:

Static: Name....

Dynamic: memory, neighbors, resources....





# Need for Agent-based modeling in **CONTINUOUS** Intraday market?

- Different types of agents (market participants) have their own objectives and they portray different behavior.
- Agents can try to trade in the market as many times as they want.
- Agents can modify their strategies based on their experiences and interactions.
- There is information asymmetry in the continuous intraday market.

# Challenges in the project



## TOPIC

1. Increasing wind power penetration

2. Wind power forecasts

3. Information asymmetry

4. Limit on flexibility in the system

5. ABM for Intraday trade

## QUESTIONS to ANSWER

Suitable electricity market structure for Nordic?

How accurate?

Effect in different market structure?

Effect on trade?

Due to technical reasons or design of electricity markets?

- Which agents?
- What time?
- Information available to each agent at different time?



# Objectives of our proposed model

- Presently, the main objective of our work was to have a working ABM for the intraday market in Python.
- We tend to observe how the electricity prices develop in the intraday market.
- We also aim to comment on the effect of agents' strategies on the trade in the intraday market.
- Develop the strategies of the agents so that they adapt to the changes in the market situations.



# Conclusions

- With our proposed agent-based model, it is possible to simulate the behavior of different agents in the intraday electricity markets.
- Based on the trade in the intraday market, the agents' behaviors are updated. As a result, the agents start trading more or less actively depending on the situation.
- The renewable agents adapt their preferences regarding their maximum (minimum) prices as a buyer (seller) based on the changes in forecast and try to get closer to the forecast towards the end of the trading horizon.



Thank you