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# ***Exploring the role of Offshore Wind in Italy's 2050 Energy Mix: a Scenario-based analysis using EnergyScope TDs***

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**Research group members:**

*Marco Cappellari - University of Padua*

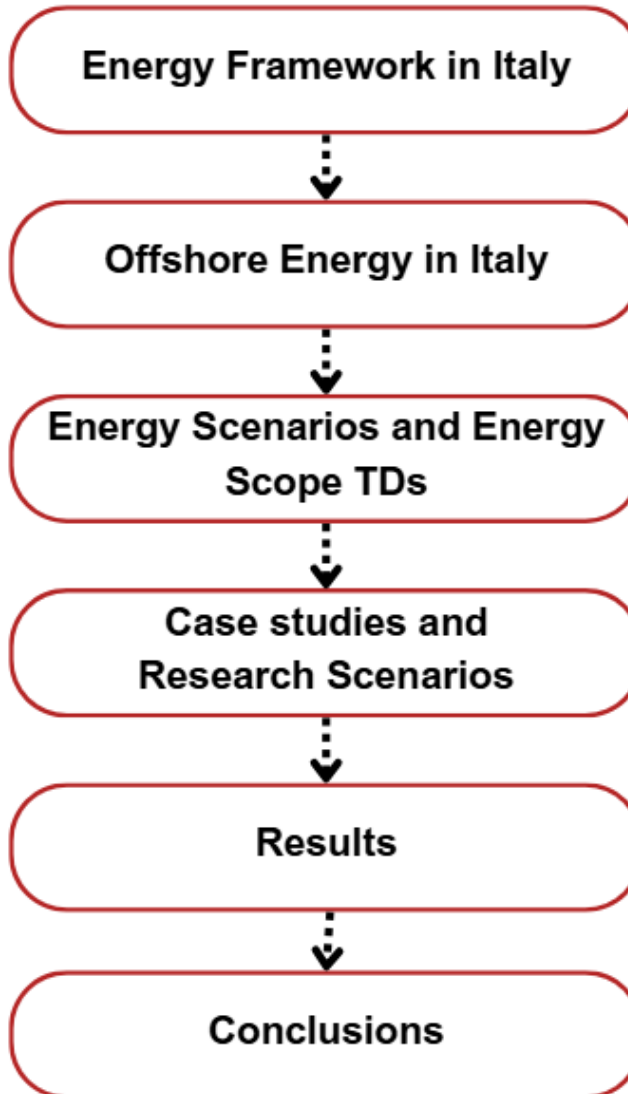
*Giovanni Cappena - University of Padua*

**Research Supervision:**

*Arturo Lorenzoni – Professor, University of Padua*



# Agenda



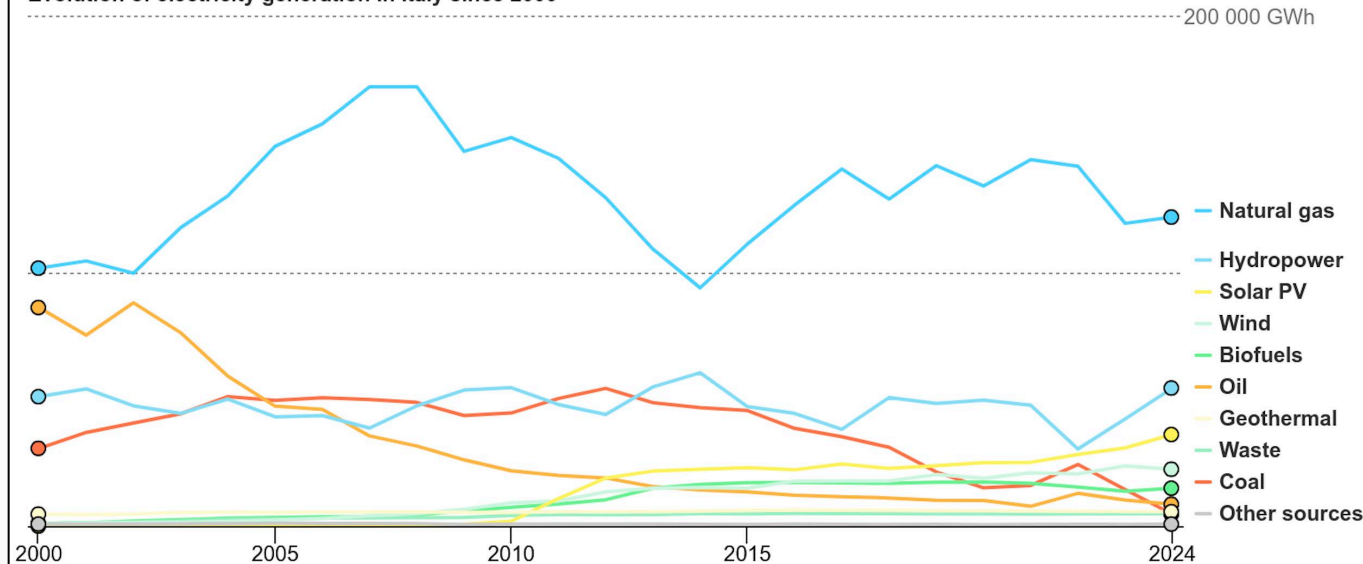


# Energy Framework in Italy

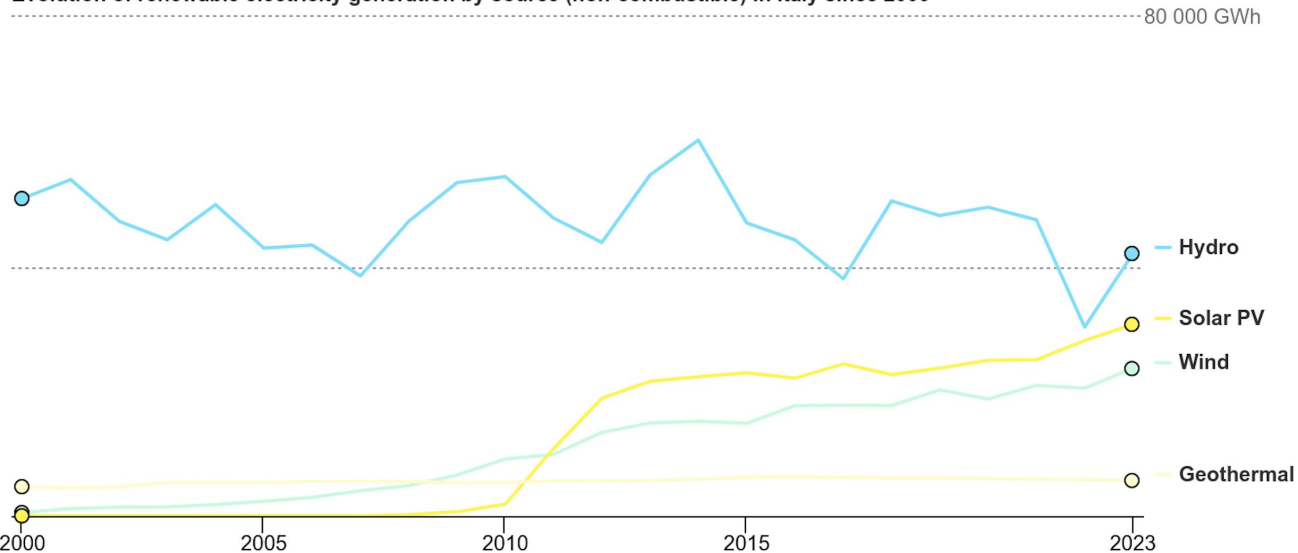
## Share of Electricity Generation Source (2023)

- *Natural gas*: 44.9 % ←
- *Hydro*: 15,9 %
- *Solar*: 11,6 %
- *Wind*: 8,9 %
- *Coal*: 5,6 %
- *Biofuels*: 5,2 %
- *Oil*: 3,8 %
- *Geothermal*: 2,1 %

Evolution of electricity generation in Italy since 2000



Evolution of renewable electricity generation by source (non-combustible) in Italy since 2000



Source: International Energy Agency. Licence: CC BY 4.0

## Share of Renewable Electricity Generation (2023)

- *Hydro*: 41,2 %
- *Solar*: 30,1 %
- *Wind*: 23,2 %
- *Geothermal*: 5,6 %

Source: International Energy Agency. Licence: CC BY 4.0



# Offshore Energy in Italy

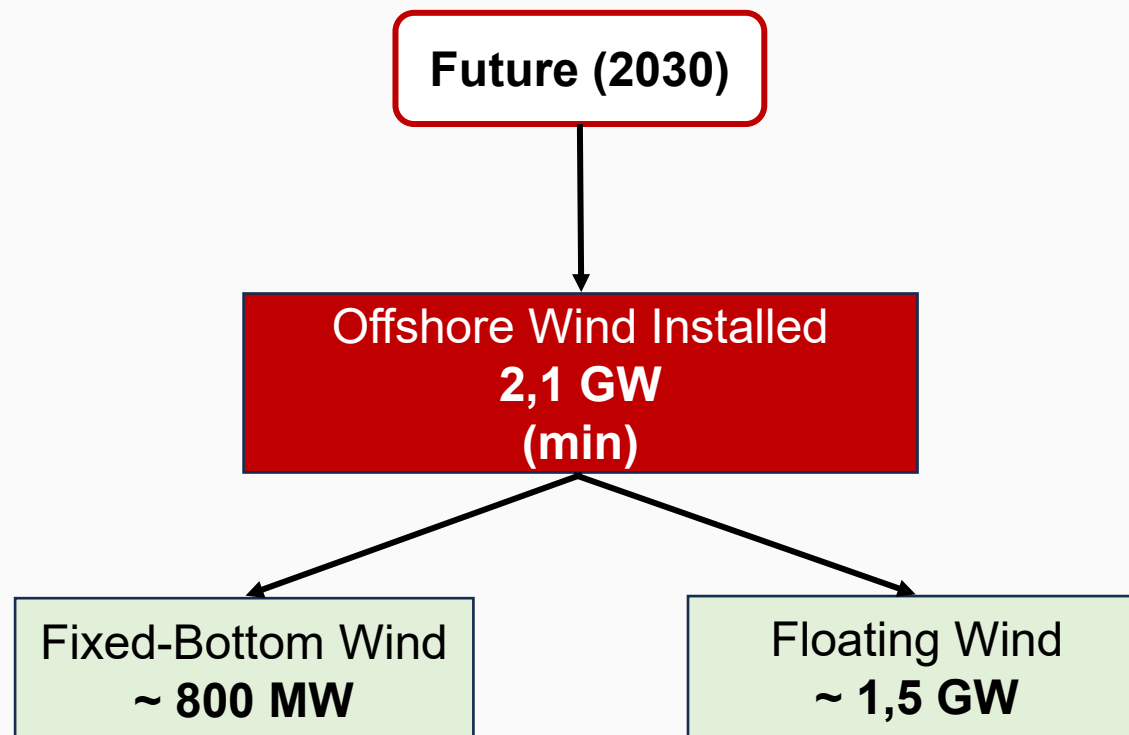
## Present

	Present Installed Capacity	Estimated Potential Capacity
Wind Fixed-Bottom	30 MW	~ 8 GW
Wind Floating	0	~ 200 GW
Wave Converters	0	~ 20 GW
Tidal Converters	0	~ 0,5 GW
PV Floating	0	~ 10 GW

### Sources:

- Ambrosetti Report (2023) - "The contribution of floating offshore wind power for the decarbonization of Italy" & MOREnergy Lab Politecnico di Torino
- Green Giraffe Advisory - "Is FER 2 the beginning of the offshore wind era in Italy?"
- ENEA, University of Florence - "Wave Energy Assessment and Performance Estimation of State-of-the-Art Wave Energy Converters in Italian Hotspots"
- ENEA, "Marine Renewable Energy in the Mediterranean Sea: Status and Perspectives"
- Sustainability - "Analysis of Sites' Suitability for Floating Photovoltaic Plants on a National Scale and Assessment of the Decarbonization Potential"

## Future (2030)



### Sources:

- PNIEC, Italy (2024)

# Energy System Models and EnergyScope TDs

**Energy System Models (ESMs)** are mathematical models that are developed to represent as reliably as possible various (complex) energy-related problems.

The analysis often considers the interactions with other systems, especially the economy and the environment.

ESMs usually provide quantitative results, which are used for energy planning and policy impact assessment.

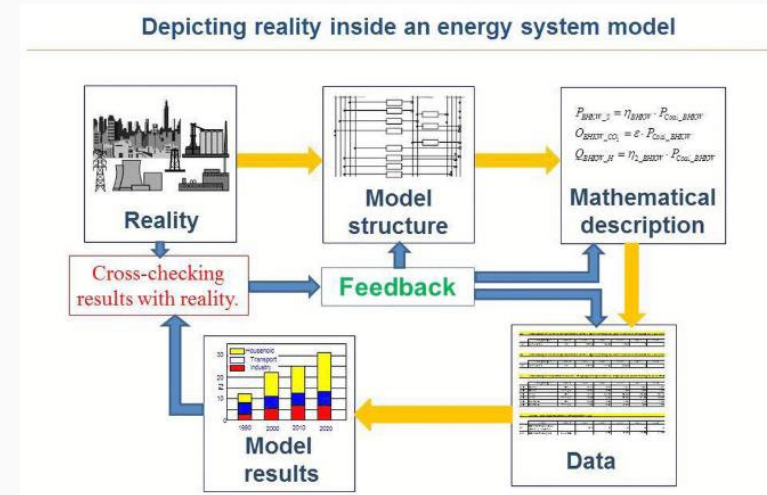
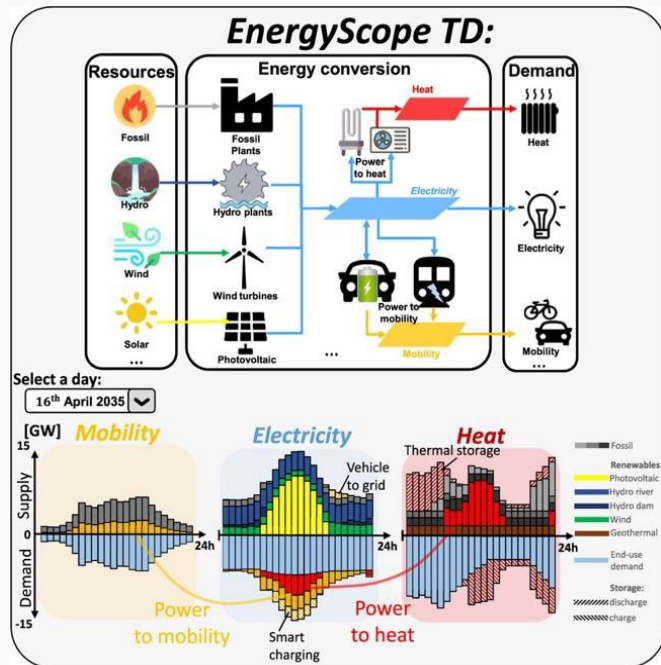


Image: Gargiulo and Gallachóir(2013)



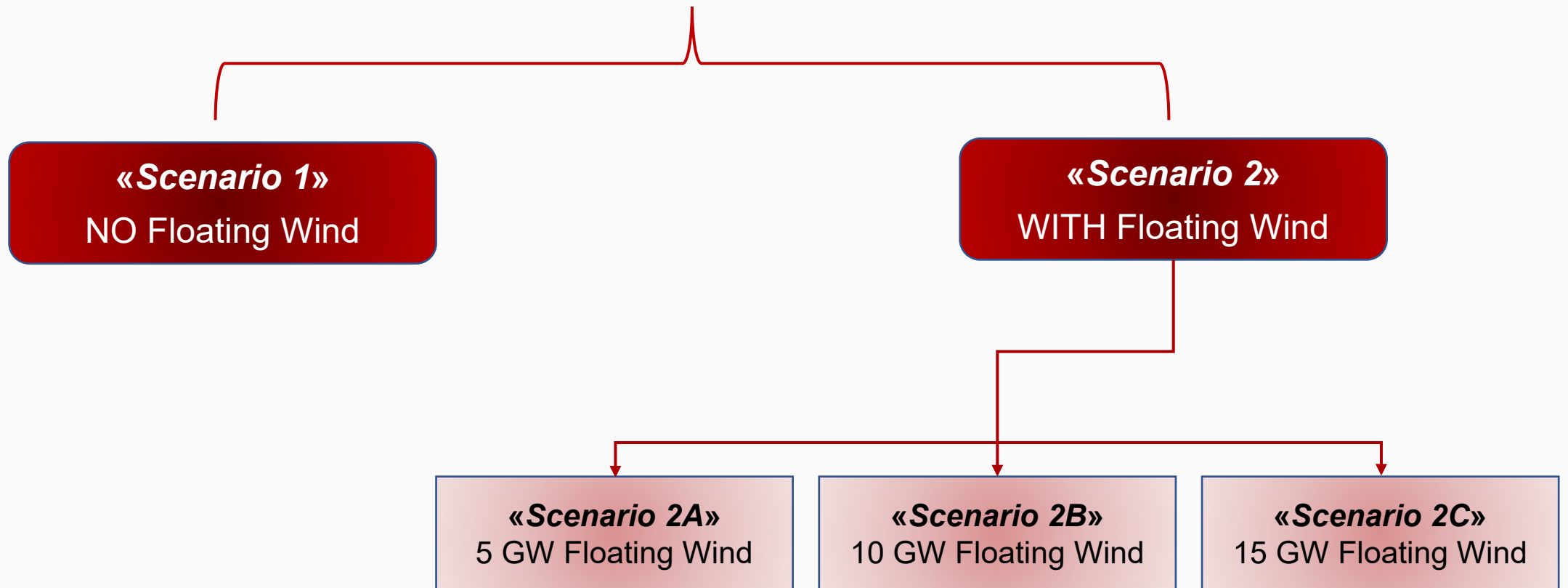
## EnergyScope TDs – “Italy” version:

- *Analytical approach:* Bottom-up (BU)
- *Underlying methodology:* Optimization model
- *Geographical coverage:* 6 Zones of the Italian Electricity Market
- *Sectoral coverage:* Multiple (Electricity, Heat, Mobility)
- *Time horizon:* Long-term
- *Time resolution:* 1 Hour, 12 Typical Days (TD)
- *Model approach:* Snapshot (Modelling of a single future target year)
- *Software type:* Open-source



# Case Studies and Research Scenarios (1/2)

## Research Energy Scenarios



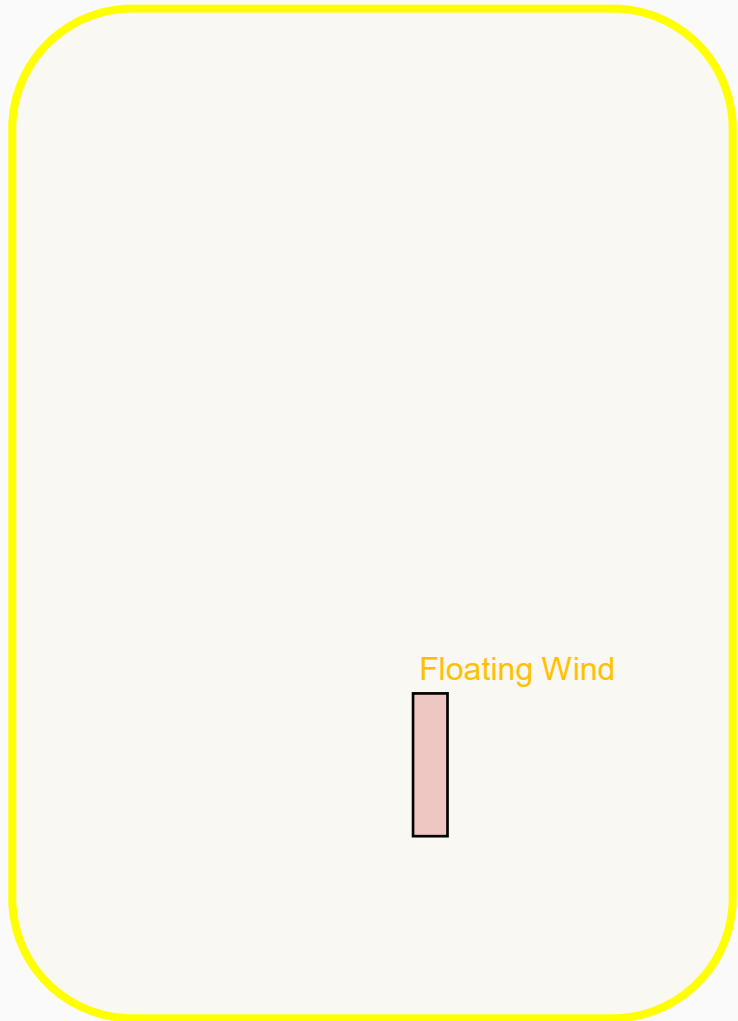


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# Case Studies and Research Scenarios (2/2)

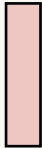


# Results – Installed Power Capacity (1/5)



Electricity  
Generation  
Technologies

Floating Wind





# Results – Installed Power Capacity (2/5)

Electricity  
Generation  
Technologies



## Results – Installed Power Capacity (3/5)

- **NO Increases** in other Electricity Generation Technologies
- Negligible Increases in other Technologies

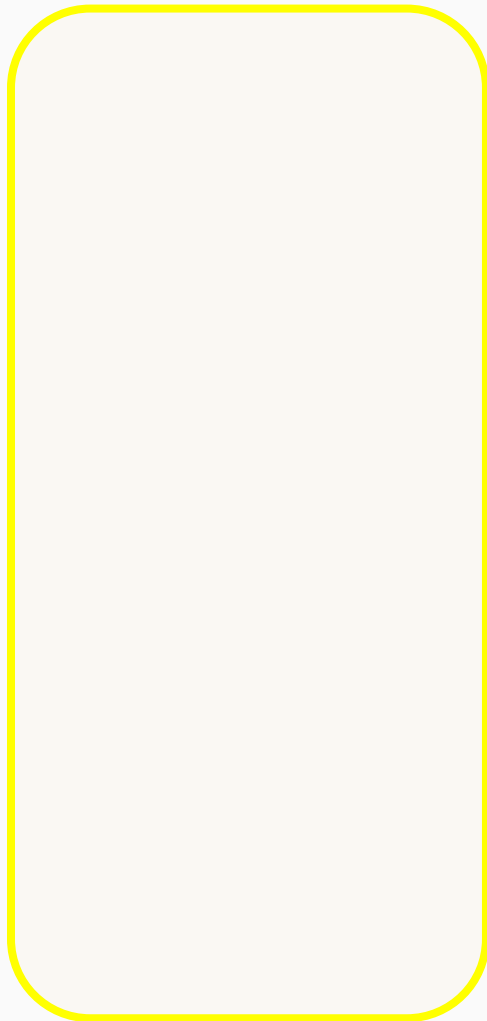


## Results – Installed Power Capacity (4/5)

- **SIGNIFICANT Decreases** in other Electricity Generation Technologies
- In particular: **Wind Onshore** (-16 GW) and **PV Utility** (-4 GW)
- 15 GW Scenario: Even **Nuclear** slightly decreases



# Results – Installed Power Capacity (5/5)



Electro-Chemical Storage  
(Lithium Batteries)

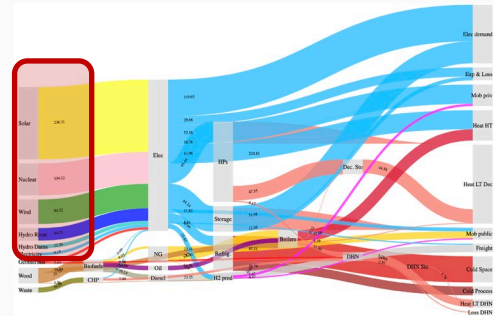
- **Decreases** in Installed Storages
- In particular: Lithium Batteries (Electro-chemical storage)



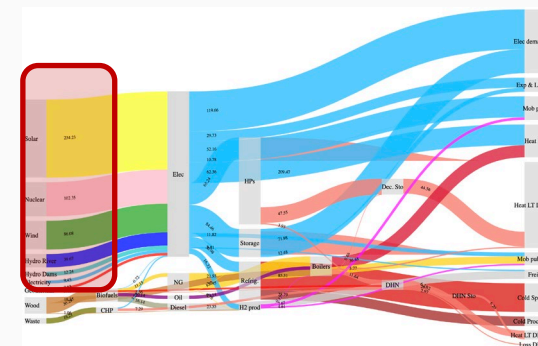


# Results – Sankey Diagrams

**NO FLOAT**  
(Scenario 1)



**15 GW**  
(Scenario 2C)





# Results – Energy Flows (1/4)

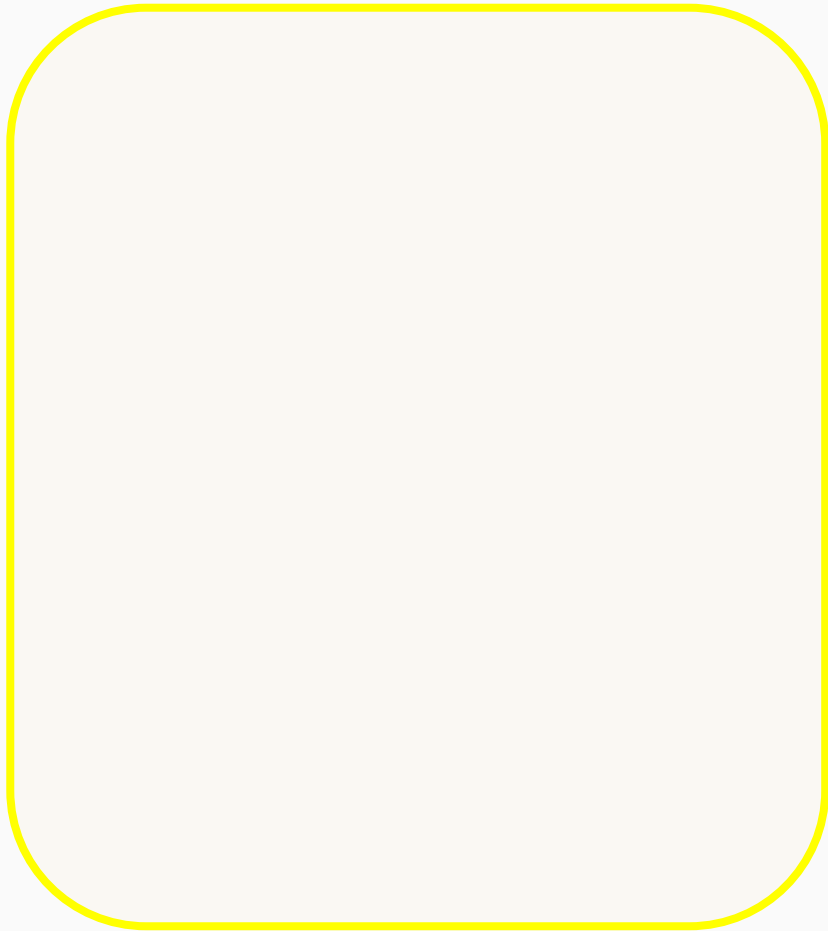
Electricity  
Generation  
Technologies

Floating Wind





# Results – Energy Flows (2/4)



Electricity  
Generation  
Technologies



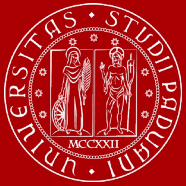
## Results – Energy Flows (3/4)

➤ **NO Increases** in other Generation Technologies' Energy Flows



## Results – Energy Flows (4/4)

- **SIGNIFICANT Decreases** in other Electricity Generation Technologies
- In particular: **Wind Onshore** (-30k GWh) and **PV Utility** (-5k GWh)
- 15 GW Scenario: **Nuclear** decreases (-2.5k GWh)



## Results – Additional Scenario (1/2)

- **Significantly higher decrease** of all kinds of PV installed capacity (-24 GW)
- **NO Changes in Nuclear**



## Results – Additional Scenario (2/2)

- **Remarkable increase of Pumping-Hydro Storages (+120 GWh) and Thermal Storages from Heat Pump**
- **Decreasing trend for the installed Electro-Chemical Storage**



# Conclusions

Scenarios analysis of the progressive introduction of Floating Offshore Wind (FOW) into the Italian energy mix in 2050 scenarios, shows in particular, with respect to the case without FOW:

- NO increase in installed power or energy flows of other electricity generation technologies > **NO need of additional power from non-intermittent/predictable generators**
- Significant decrease in installed power and energy flows for Wind Onshore (- 40%) and PV (- 3%) (more than the new Floating) > **Peak demand covered from installed Floating Wind, lower need of land-use**
- Decrease in Nuclear's energy flows and installed power (in highest FOW penetration scenario)
- Decrease in the installed electro-chemical storages (Lithium Batteries) > **Due to lower PV installed, being more discontinuos then Wind**



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*Thank you for your attention*