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**Multi-objective Evaluation of Renewable Technology  
Subsidy Portfolios Under Covid19 Recovery Packages**

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## 1. Context of study

- EU Recovery Plan

## 2. Methods

## 3. Overview of results

- Portfolios €100 billion
- Portfolios €150 billion
- Portfolios €200 billion

## 4. Main findings – Discussion

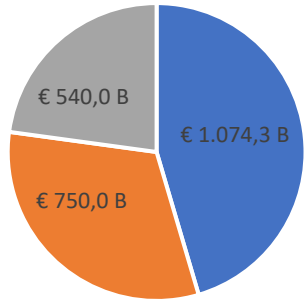
- Interesting dynamics



# Context of study - EU Recovery Plan

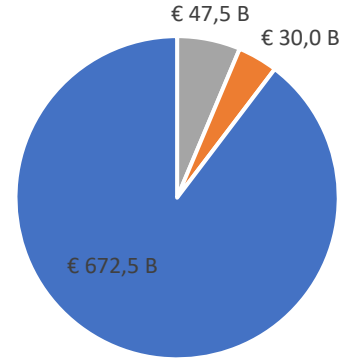
In line with the European Green Deal Targets (30% of all financial plans should focus on green transition)

## Recovery Plan



- Multi-Financial Framework 2021-2027
- NextGenerationEU
- Safety Nets for workers, businesses and member states

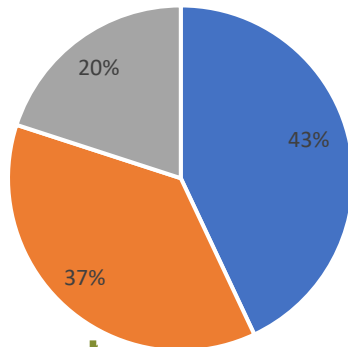
## NextGenerationEU



- ReactEU
- Additional Funds to other EU Programs
- Recovery and Resilience Facility

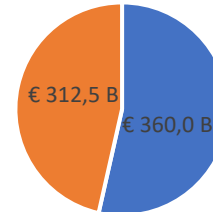
## Recovery and Resilience Facility

- National Economic Policy Challenges
- Green Transition
- Digital Transition



## Recovery and Resilience Facility

- Loans
- Grants



€250 billion towards green transition

- RES
- Sustainable Transport
- Energy Efficiency

€100-200 billion\*  
\*Depending on National Plans



The PARIS REINFORCE project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under grant agreement No 820846.

**Input data for the multi-objective optimization**

Integrated Assessment model

**GCAM**Performance of the 8 technologies to the 2  
optimization criteria**8 Technologies:**

- Biofuels
- Solid Biomass
- CSP
- Geothermal
- Photovoltaics (PV)
- Electric Vehicles
- Wind
- Biogas

**Multi-objective portfolio optimization**

2 optimization criteria

Maximize (a) further emissions cuts, (b) new jobs from the transition, on top of CP scenario

**Optimization with AUGMECON – R**

- Successful in finding the exact Pareto set of a problem
- Powerful algorithm for solving multi-objective integer programming (MOIP) problems
- Highly reduced computation time

**Robustness Analysis**

Monte Carlo Simulations

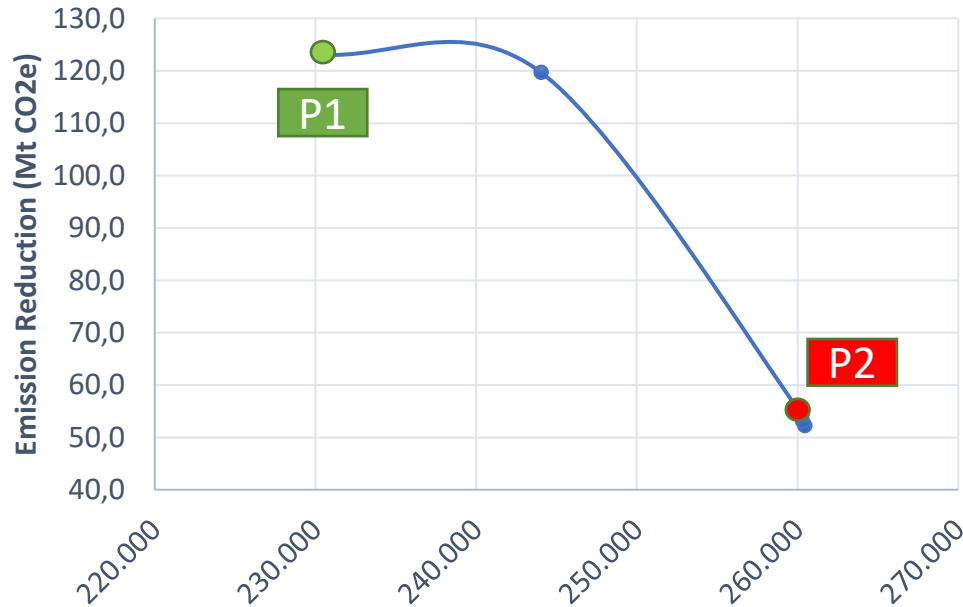


Portfolio Budget	Jobs Created (2025)	Emissions Cuts (2030)	Technologies
€100 billion	230-260 thousand	50-123 Mt CO <sub>2</sub> equivalent	Combinations of: <ul style="list-style-type: none"> <li>• <b>Wind</b></li> <li>• <b>Biogas</b></li> <li>• <b>Biofuels</b></li> <li>• <b>Geothermal</b></li> </ul>
€150 billion	300-350 thousand	134-160 Mt CO <sub>2</sub> equivalent	
€200 billion	415-432 thousand	154-233Mt CO <sub>2</sub> equivalent	



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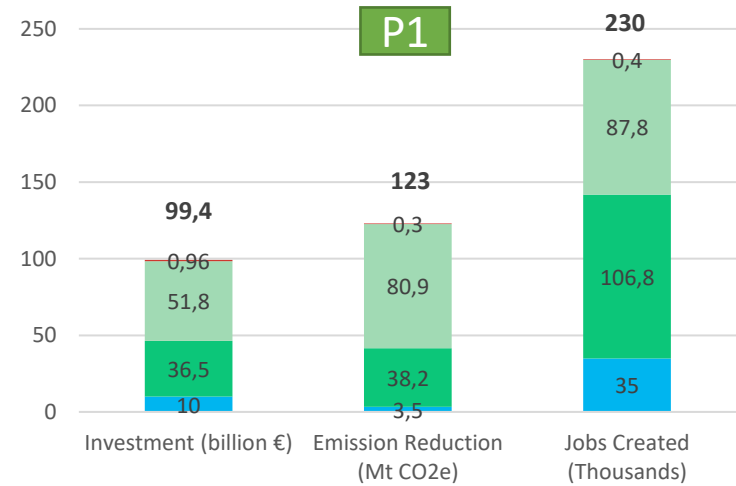
# Portfolios €100 billion



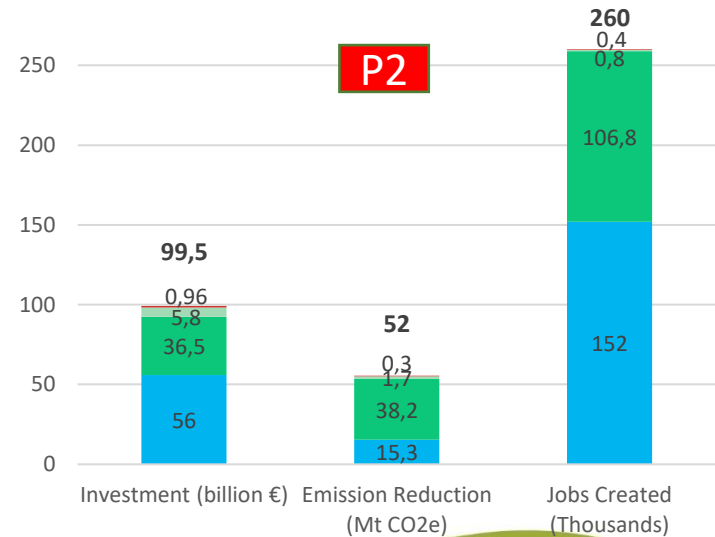
Jobs created



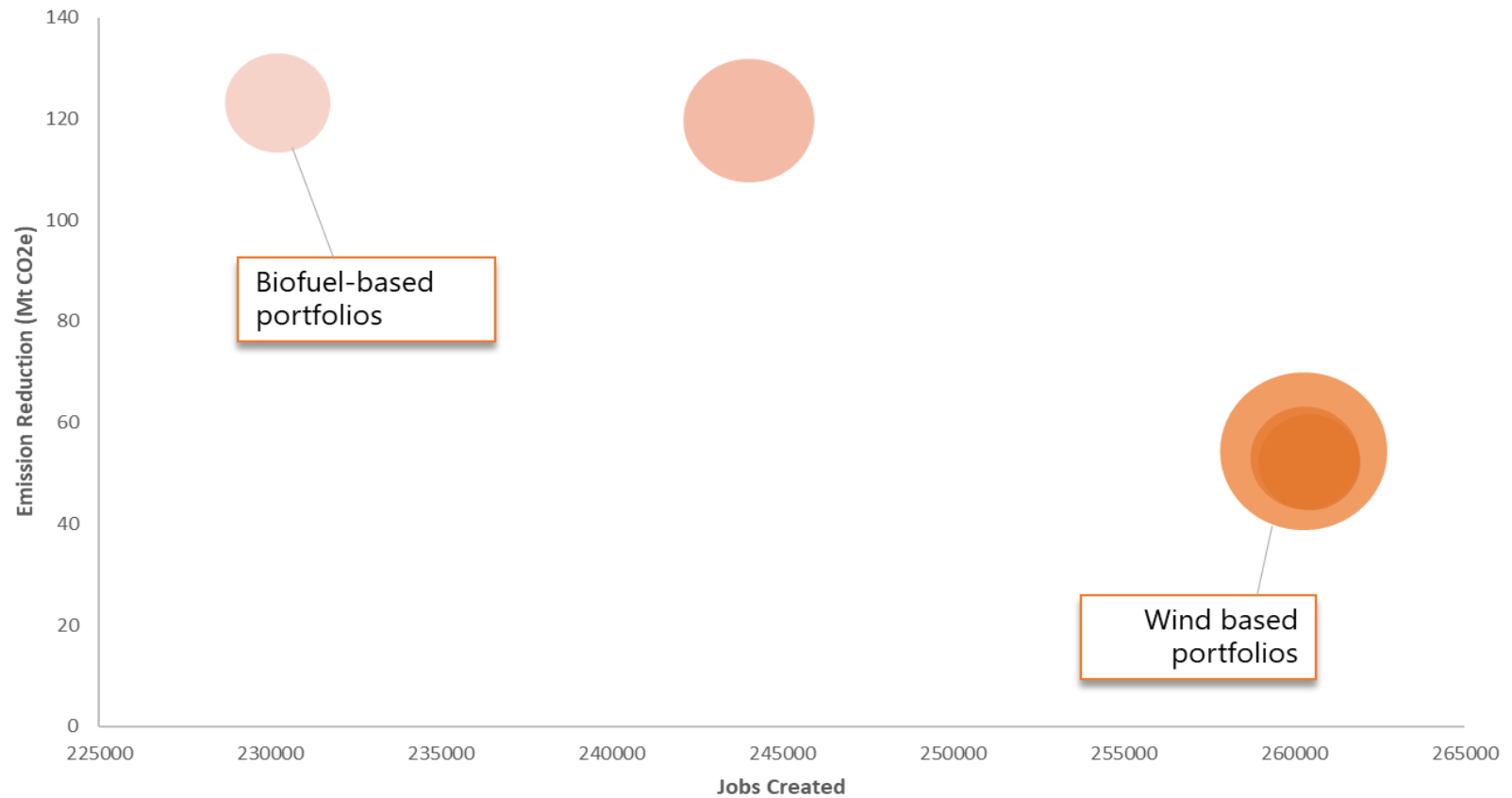
Move from P1 to P2 there is a shift from **biofuel to wind investments** which **increases jobs but limits emission reduction**



Wind Biogas Biofuels Geothermal

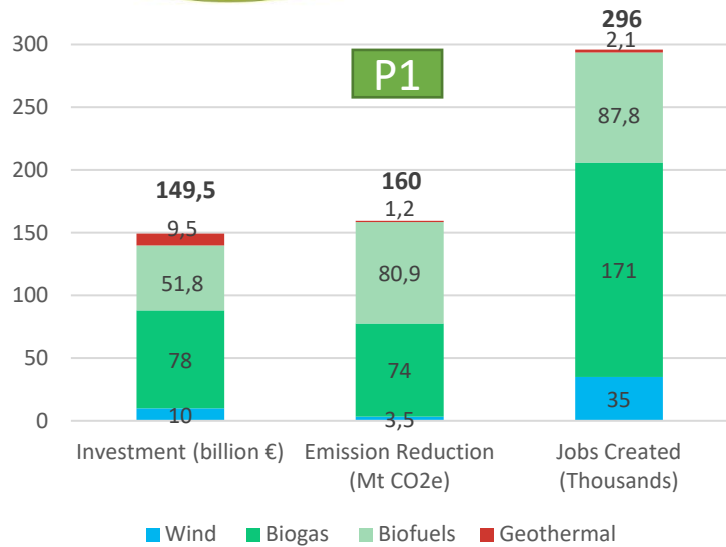


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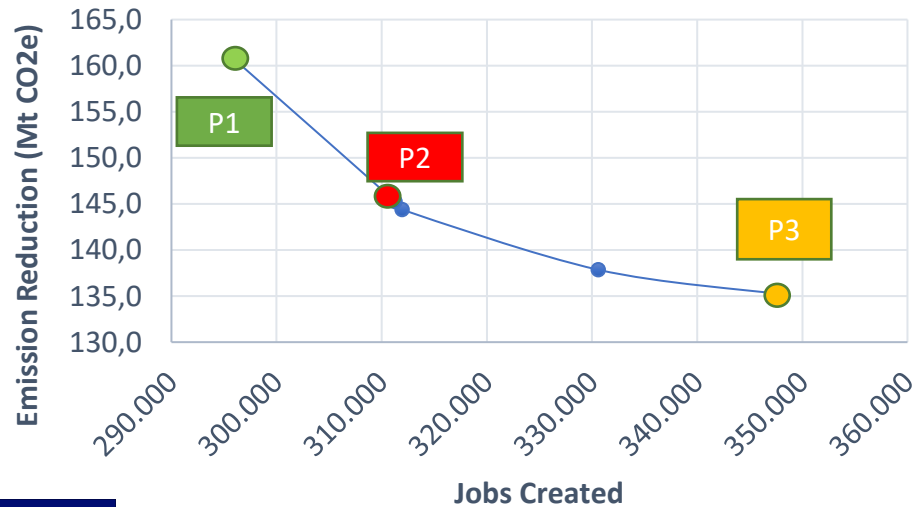
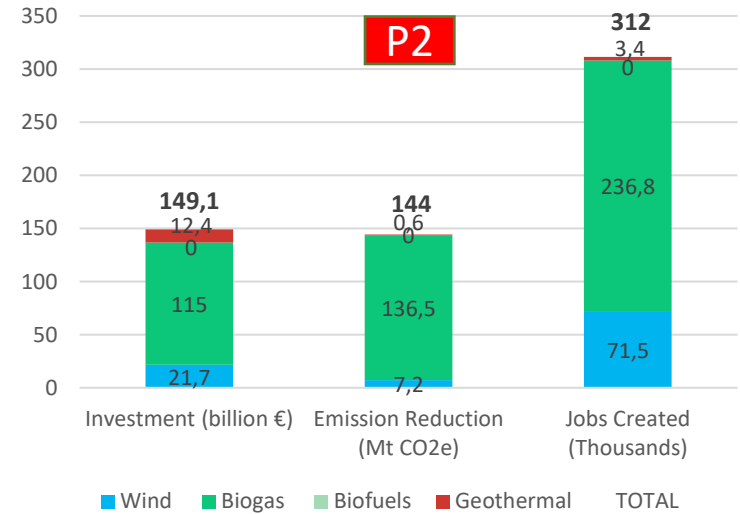


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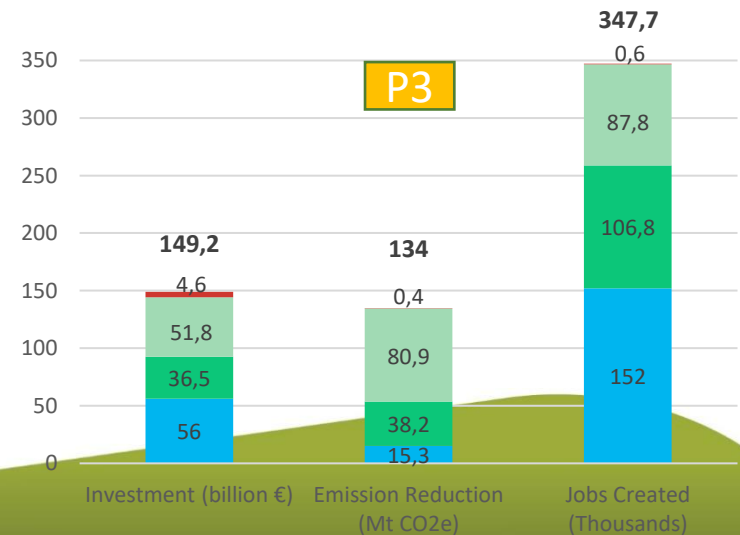




Replacement of biofuel investment increases jobs, limits emission reduction

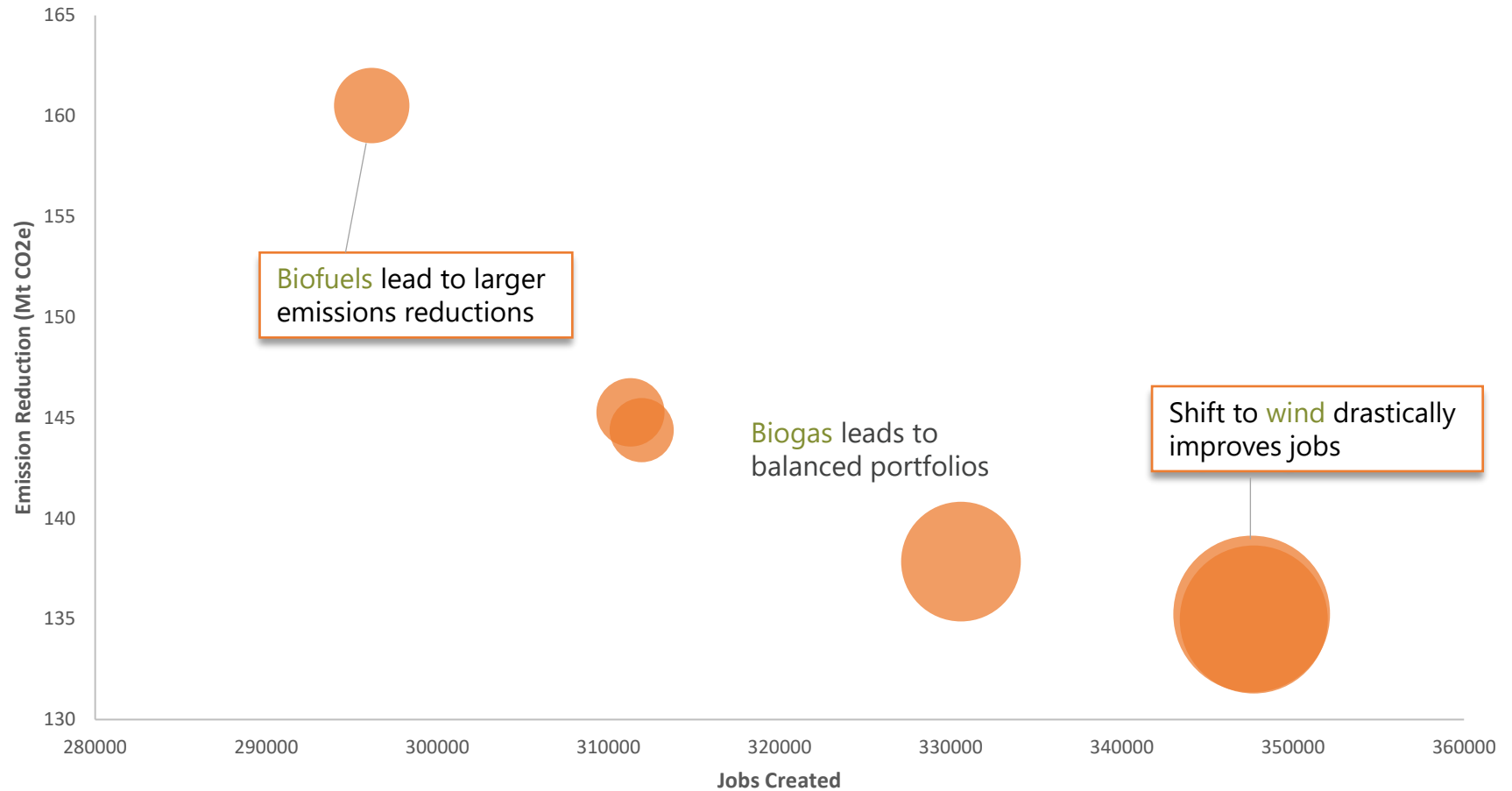


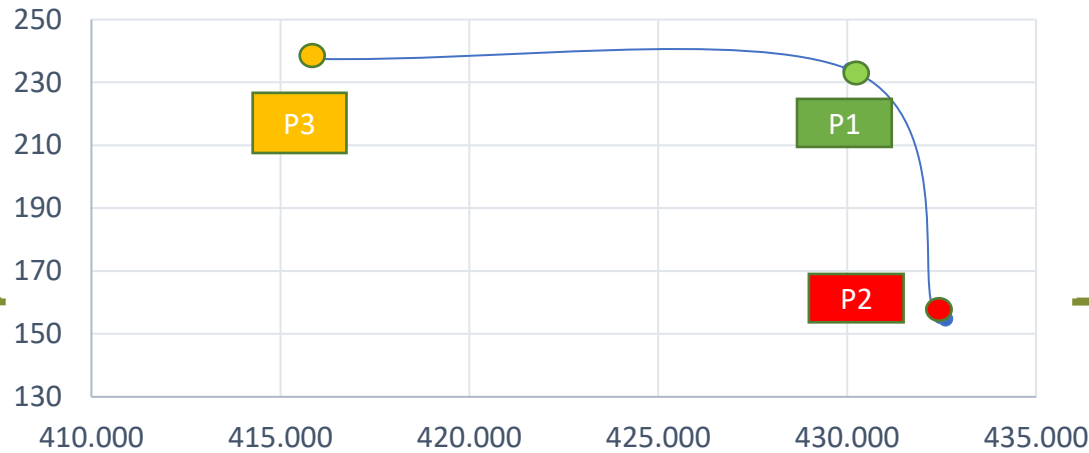
Shift to wind drastically improves jobs



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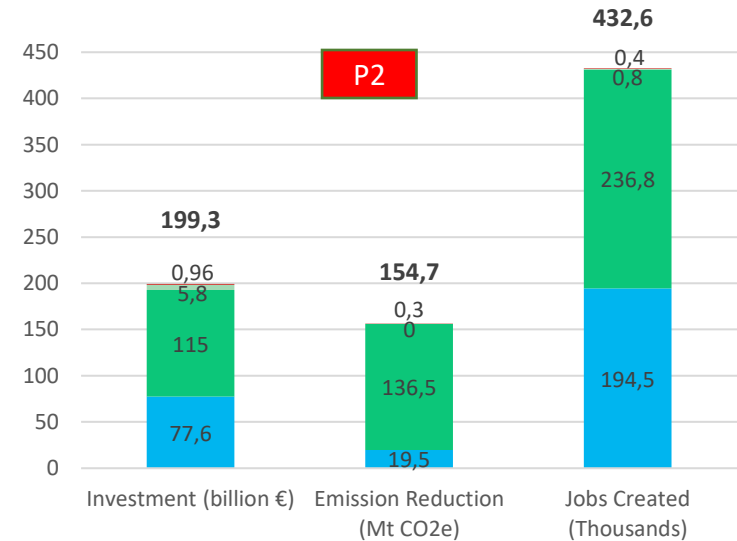
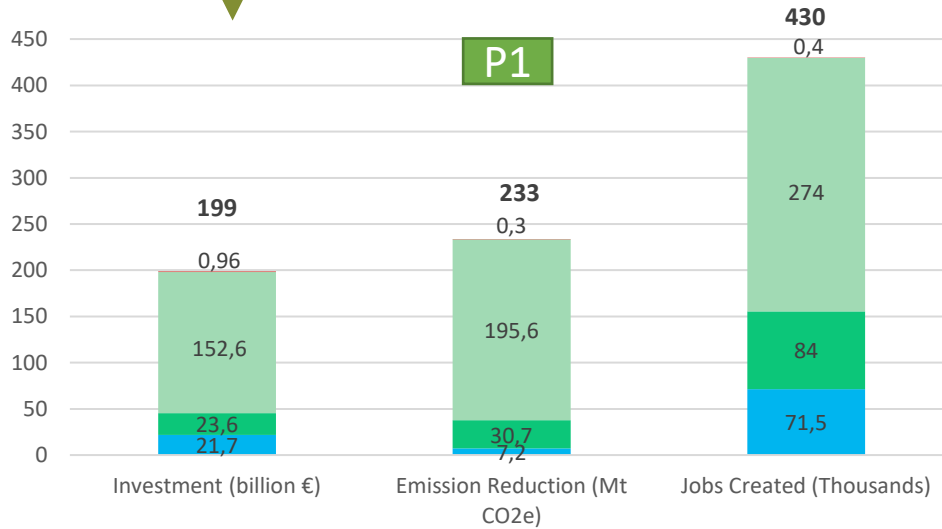


**Efficient Portfolio:**  
Large investments in  
biofuels

High emission  
reductions and  
many new jobs

**Alternative:**  
Smaller biofuel  
investment and larger  
wind & biogas

Sacrifice in  
emission reduction



Wind Biogas Biofuels Geothermal

Wind Biogas Biofuels Geothermal

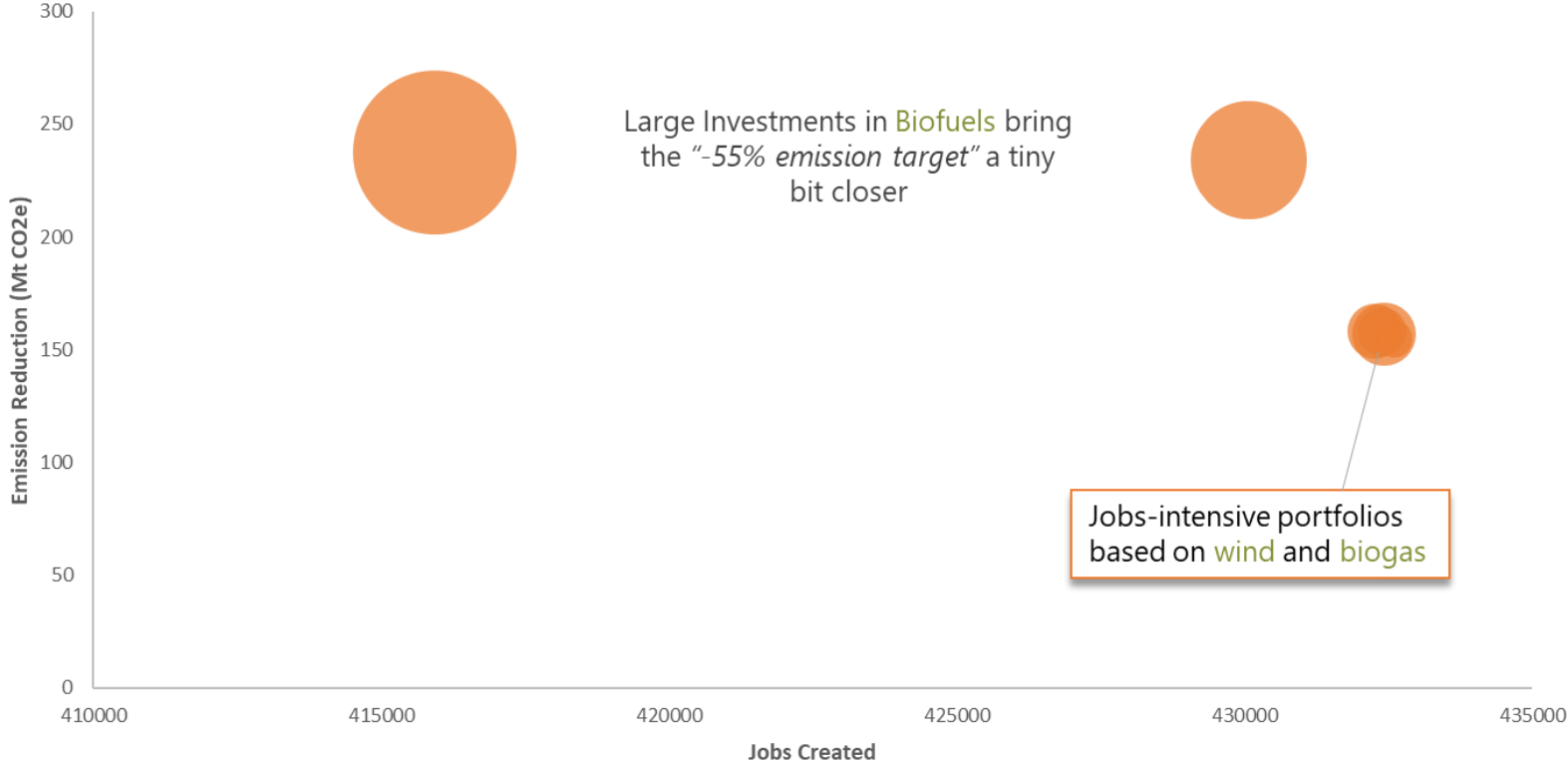
P3

Small shift in investments from wind to biogas compared to P1 causing reduction of jobs created



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# Robustness Analysis (€200 b.)



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- Recovery plan potential to **support employment** in green transition
  - 230k – 432k new jobs (2025) in energy sector
- Support package could also bring EU a bit closer to new 2030 climate target, cheap
  - Up to 233 Mt CO<sub>2e</sub> cumulative emissions cuts (2030)
  - ~0.2-1% cut on top of Current Policies (cumulative CO<sub>2</sub>), depending
  - BUT: gaining on investments: **pushing down costs** of existing EU climate policies
- Overall optimal (against both criteria):
  - **Biogas, biofuels, wind**
  - Uncertainty shocks play out differently depending on budget
- CP already good job in cutting emissions in power (ETS, decreasing capital costs), much less in transport/buildings, in which subsidies turn out more cost-effective



- Emphasis on emissions (biofuels): significant **LUC** emissions outside EU?
- **Small geothermal** investments complementary
- Solar:
  - already **high penetration of solar in CP** electricity mix
  - additional subsidies increase emissions (gas for balancing grid load)
- EVs: expensive emissions cuts, negligible job impact
- Same subsidies (EU), different dynamics globally:
  - wind/solar improve
  - contrary to biofuels/biogas





Thank you!

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