Aalto-yliopisto
Perustieteiden
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The effect of CO2 tax level on the renewable energy production share using a capacity expansion model (presentation of the finished work)

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Content of this presentation

- Background
- Literature review
- The model
- The results
- What does this mean in practise?

Notation in this presentation

- CT – Carbon tax
- RES – Renewable energy sources
- RESS – Renewable energy sources share

Background 1/2

- The increase of CO2-emission awareness has lead to the will of decommissioning coal-based, mainly base-load, energy sources and deploy the generally high-variance renewable energy sources (RES).
- In general, the limitation policies rely on either carbon caps, a cap-and-trade system, or carbon taxes (CT).
- According to many economists, the CT is the ultimate way of limting emissions without losing on economy.

Background 2/2

- The adaption of such limitations varies a lot: Finland and Sweden were the first to start using CT and currently the prices in these countries are among the highest in the world (over 100€/tonne of CO2).
- Other than that, the CT policies are still widely under consideration and for example in Poland the taxes are only 7 cents/tonne of CO2.

Literature review 1/2

- Different studies have tried to determine the true results of CT
- Suggestions:
  - An ideal level of CT does not affect the economic welfare
  - Too high CTs can make RES economically unfeasible due to the total taxation of energy production on the national level.
- On the other hand, the level needs to make RES financially attractive and support greener path in investments.
  - Generally the idea is to tag a price on the environmental damage or make RES financially as attractive to investors as carbon might be.

Literature review 2/2, Case Estonia

- The effects of national carbon policies on the global scale do not always result in less CO2 emissions.
- A case of Finland and Estonia is presented in a study made in Aalto University
- In the study the fear of even growing CO2 emissions caused by Estonia is a result of the Finnish decarbonization policy that simultaneously limits the possibility of exporting electricity to the currently coal-dependent Estonia.

The main conclusions drawn from the literature review

- International climate politics, energy systems and taxations form an complex system which should be considered as a whole, not only on the national scale.

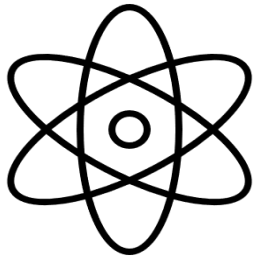
- CTs are a great way of making RES investments financially attractive and the profits can be used in investing in new RES

The model

- A capacity expansion model mainly based on a Swedish REX –study was implemented and ran following 4 different methods for increasing carbon taxes.
- The model involves Finland, Estonia, Sweden, Germany, Spain and Poland with their real-life capacity and demand data from year 2018.
- The model ensures that the demand is met at all times and minimizes the total costs and investments caused by a year of energy production

The carbon tax analysis

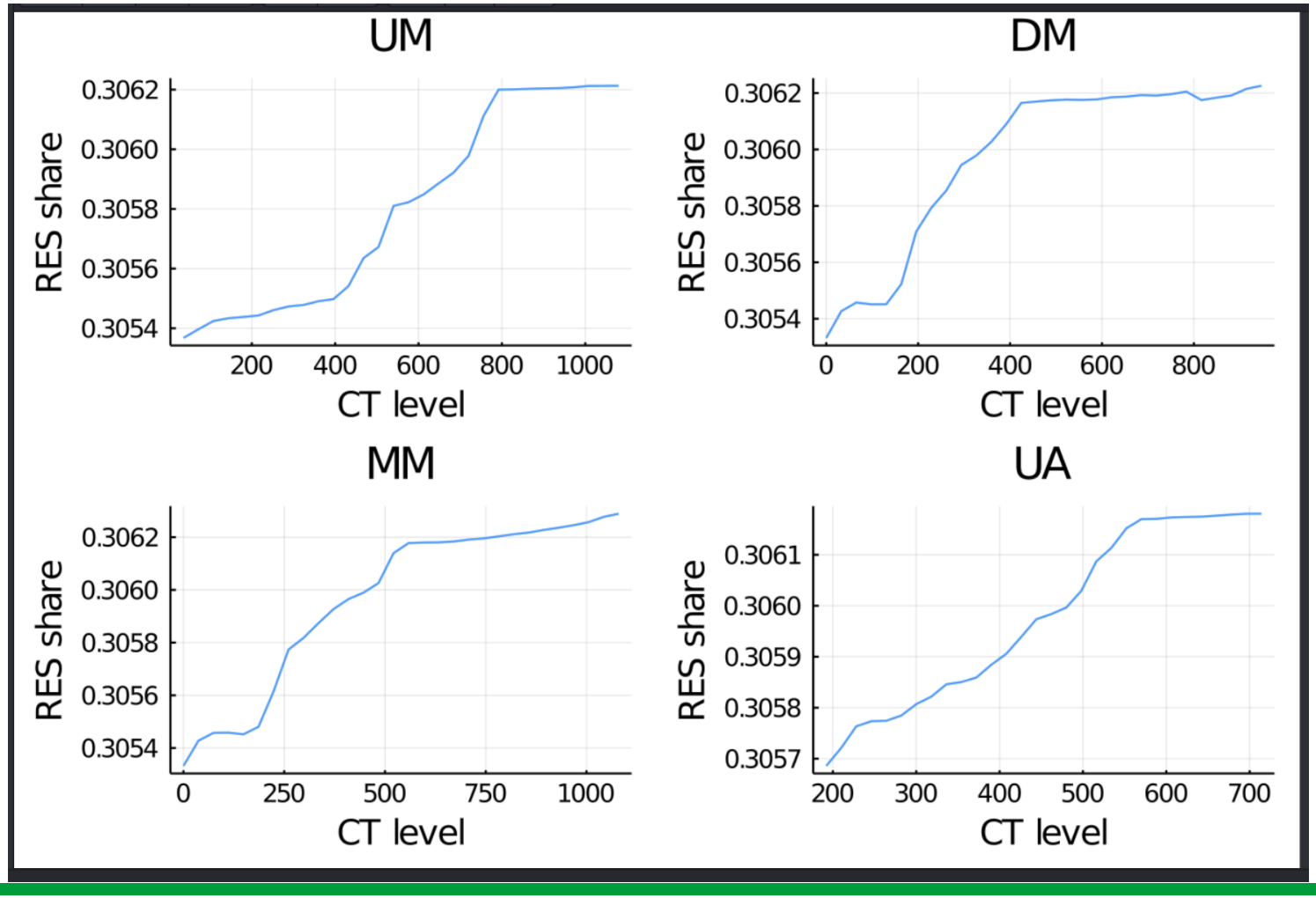
- To make the model a capacity expansion model, a scenario of 30% reduce in combustion capacity is laid.
- Also, the prospects of decommissioning nuclear power in some countries is taken into account and new investments in nuclear are not possible to make, since the politics involved in deploying such capacity are not straight-forward.



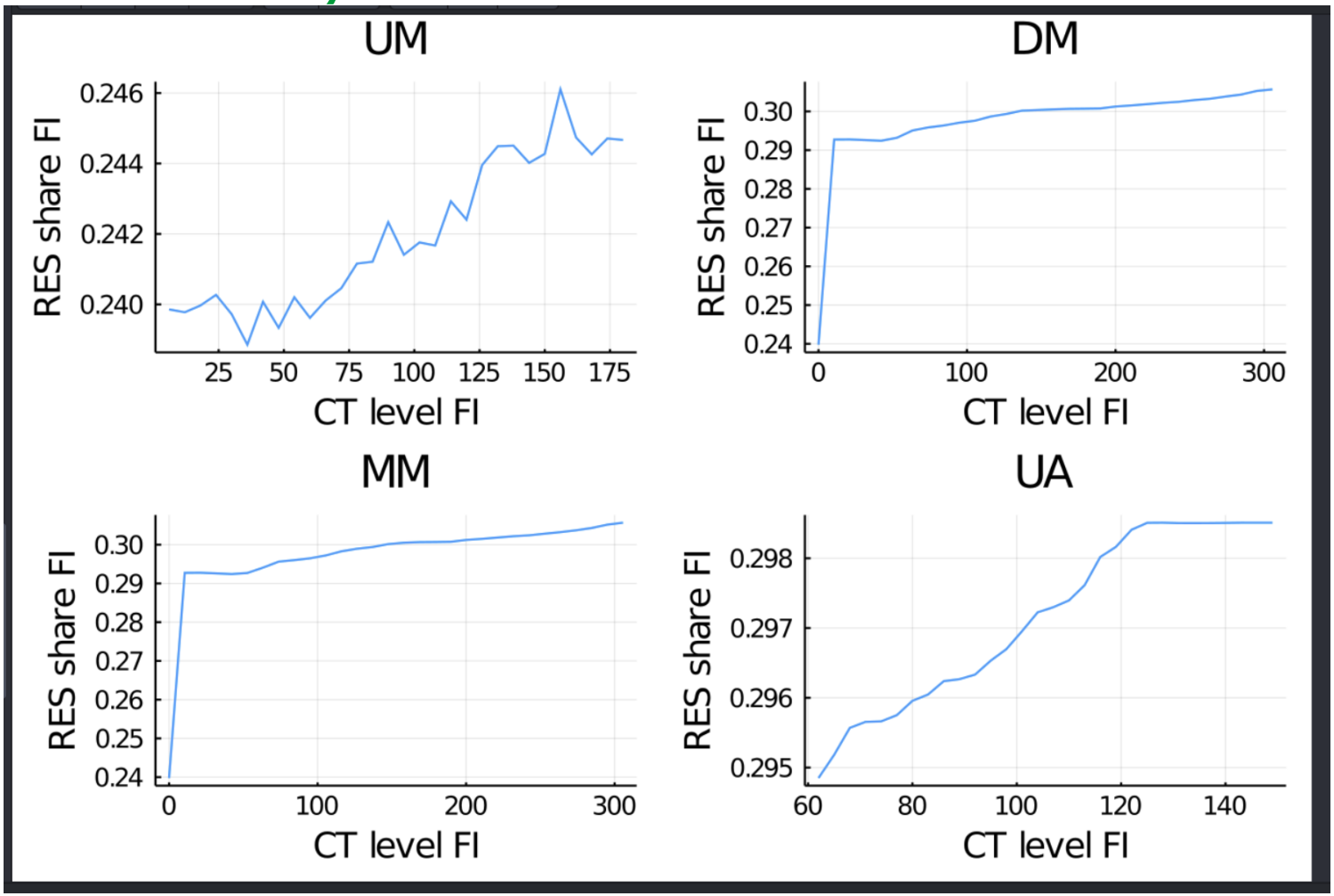
Notation specific to the following figures

- **UM** – Uniform tax on all countries, multiplied by an unifrom and increasing value
- **DM** – Data based tax multiplication with an uniform and increasing value
- **MM** – Mixed multiply: a base level of 10€/tonneCO2 multiplied as in DM
- **UA** – Unifrom adding: adding uniform and increasing value to the data based tax levels

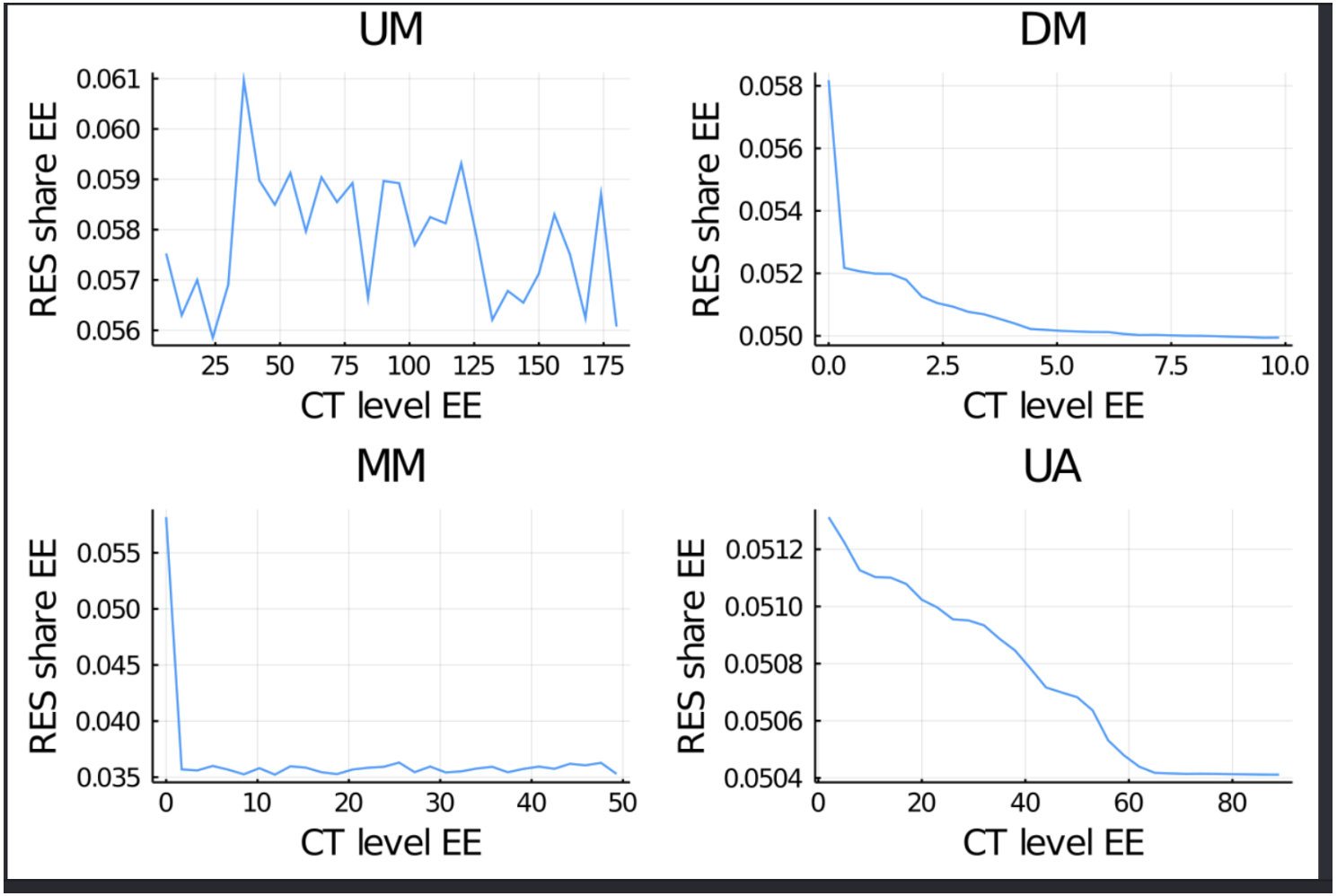
The results, total RESS vs rising CT



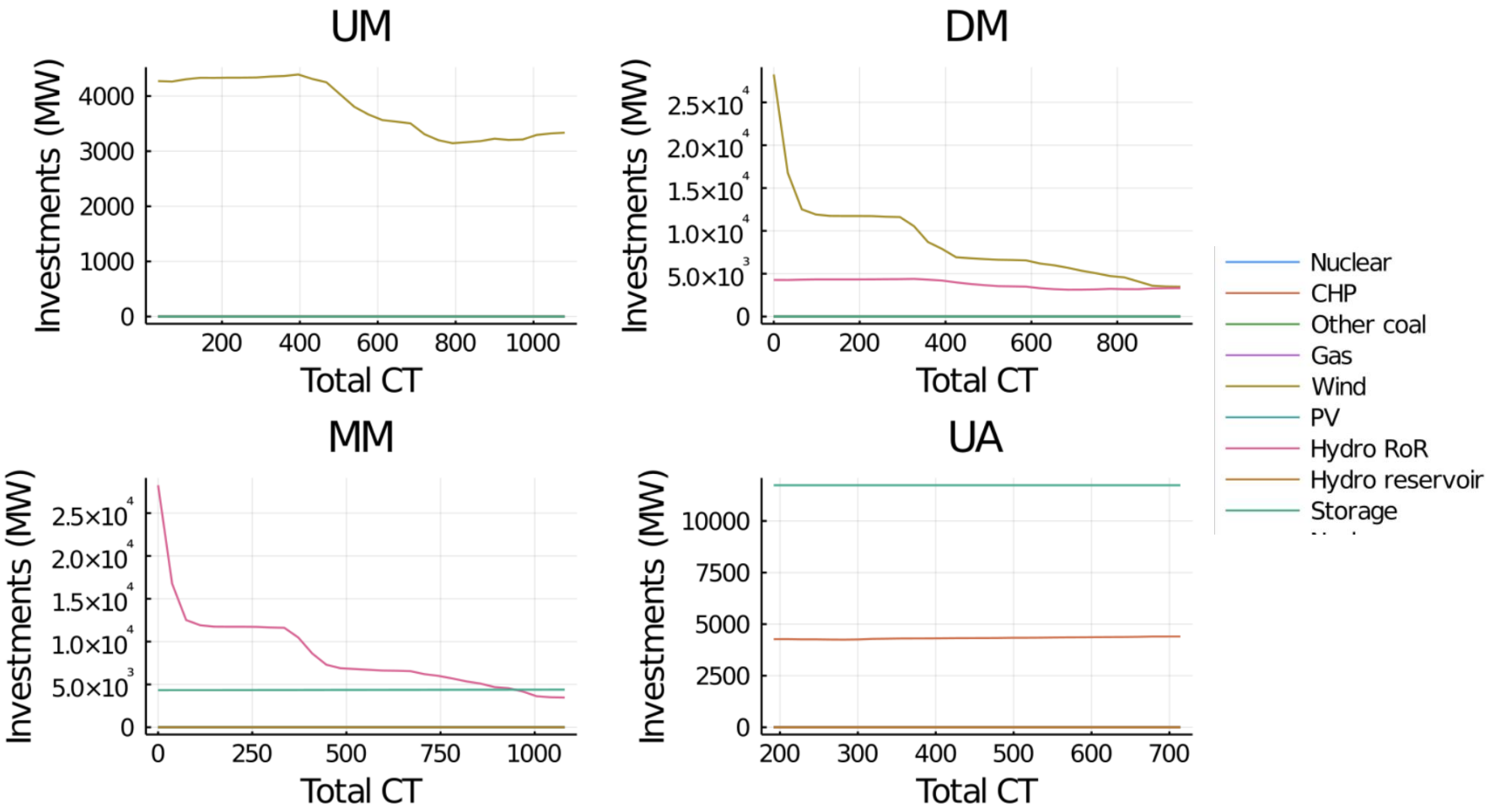
The results, RESS Finland



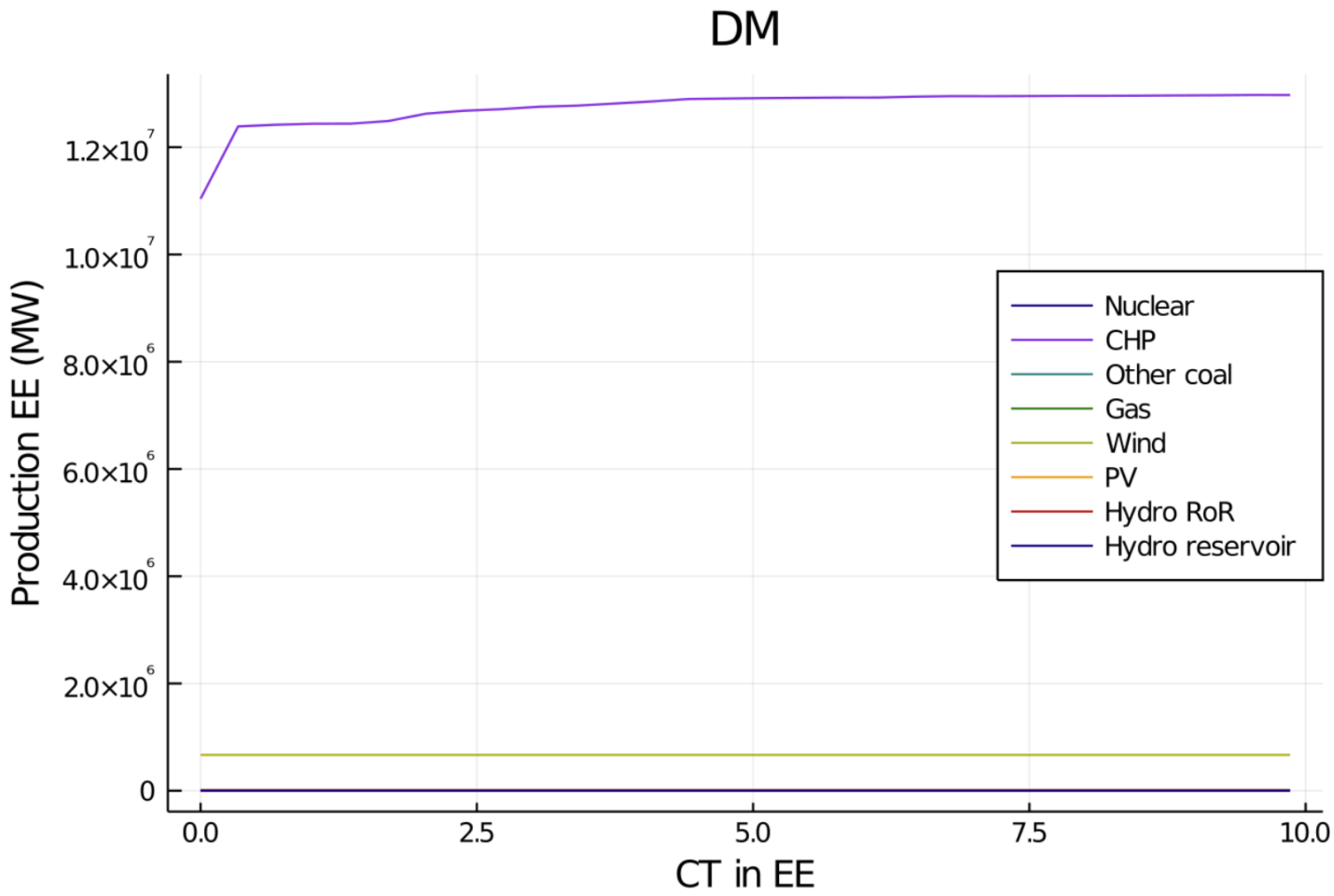
The results, RESS Estonia



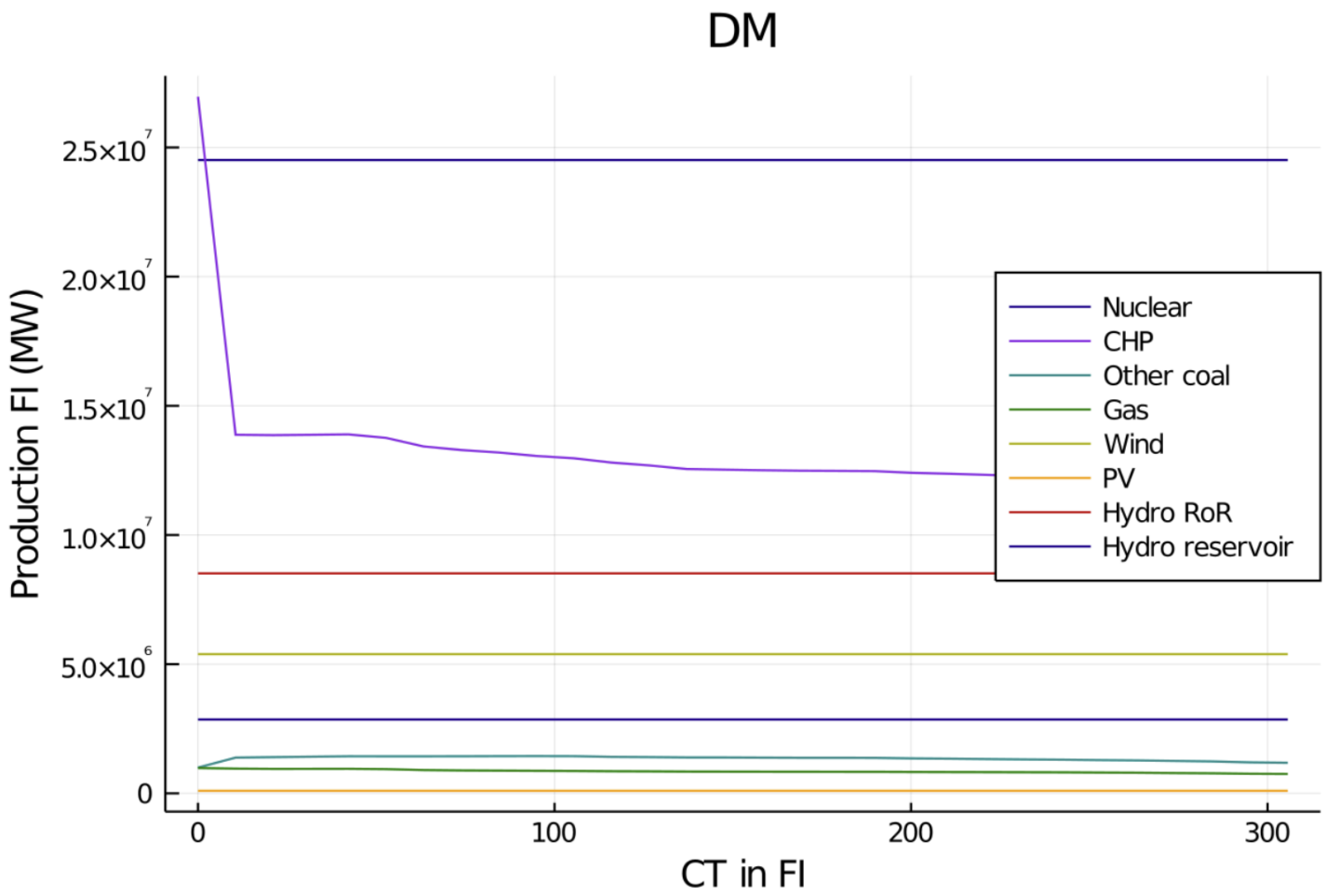
Total investments in new capacity



The results, DM Production in Estonia



The results, DM Production Finland



The results

- The model show a global increase in renewables production when increasing carbon tax.
  - The increase is not massive, but it is an increase
- Especially Finnish and Swedish coal production was remarkably decreased but meanwile increased in Estonia and Poland.
- New investments in RES were very modedate. Only hydro power was attractive enough to get more investments but for a surprise, it was decreased while the CT rose.

What do the results mean

- Overall, the results highlight the need for well-analyzed climate politics, since the high-emitting production may only change location in case of increasing local

- According to the model, replacing coal based production with RES is not directly profitable, at least within a year of production. This means that at least for one year, the interest for replacing the coal based production seen in the scenario with RES must emerge from other policies as well.