Tariff Simulator

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Scope

Context of the project …

- Energy transition
- Integration of decentralised electricity generation resources (DER)
- **Regulatory frameworks** enabling such an integration: how to promote, in an "efficient" way, the deployment of DER?

This part of the project deals with …

- **Regulation**, in particular, regulation at the distribution level
- **Interactions** between the agents **is simulated** through **multi-agent modelling**
  - Based on the observed behaviour of the agents (first part of the project)
  - Agents of the system are the electricity users, and the distribution system operator (DSO)

What is this work about?

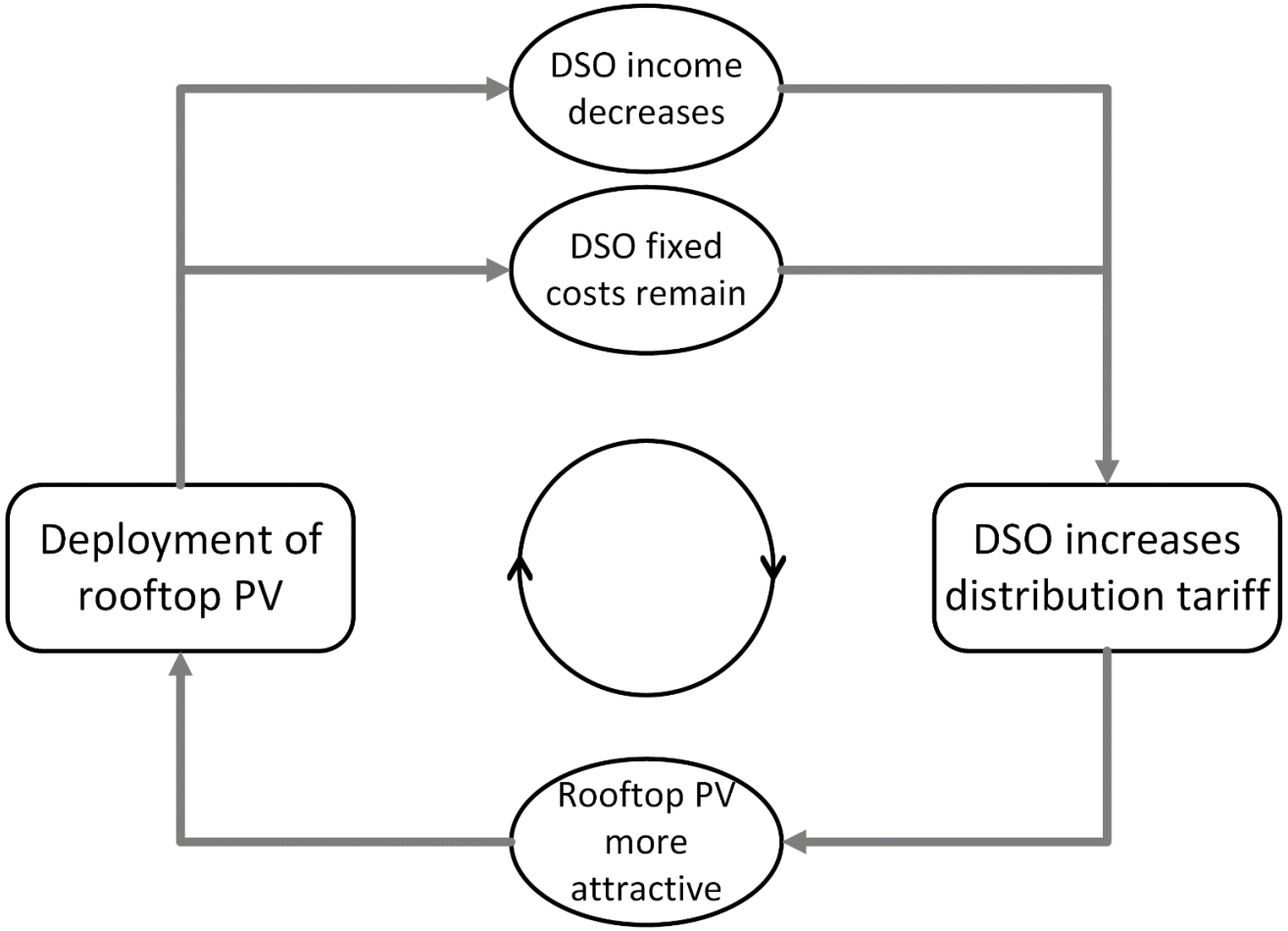
This work consists of …

- Evaluating various regulatory framework's impact on the interactions between the different agents of the distribution network through simulation

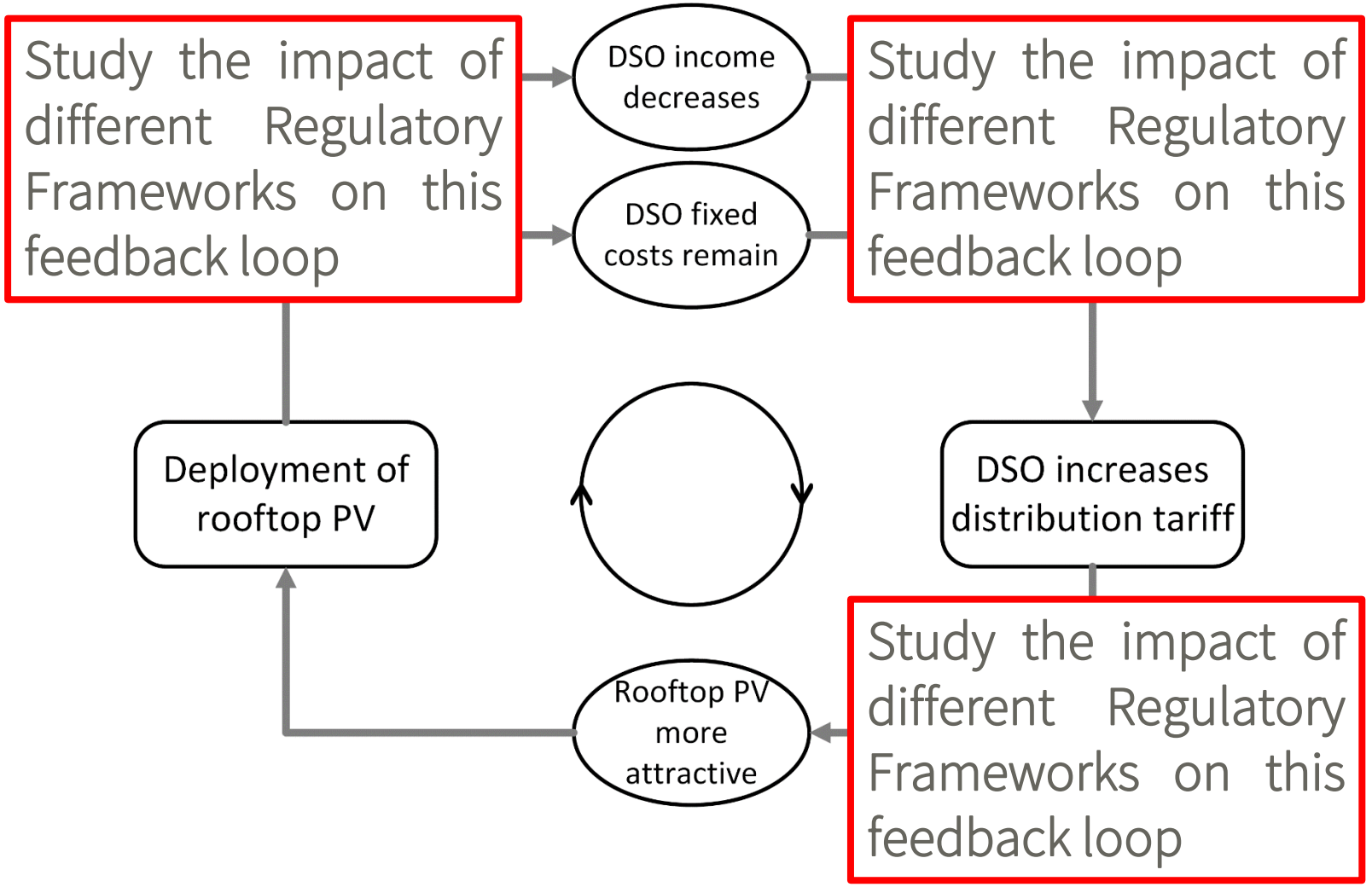
Outputs …

- A tariff simulator has been developed
- Many indicators can be extracted from the simulator, including the evolution of the distribution tariff, and the deployment of DER

Motivation – Feedback loop



Motivation – Feedback loop



Main assumptions

Assumptions related with the DSO

One single DSO, about 6000 households connected to this DSO, from which about 1000 may become "prosumers". Total costs of the DSO assumed to be constant over time. Network constraints are not taken into account (no congestions or overvoltage problems)

Assumptions related with the households

Each "potential prosumer" has **its own load curve**, and **a potential PV production**. "Potential prosumers" act so as to minimize (costs - revenues). The probability to invest in a DER installation increases as the "profitability to invest" does. Perfect forecast.

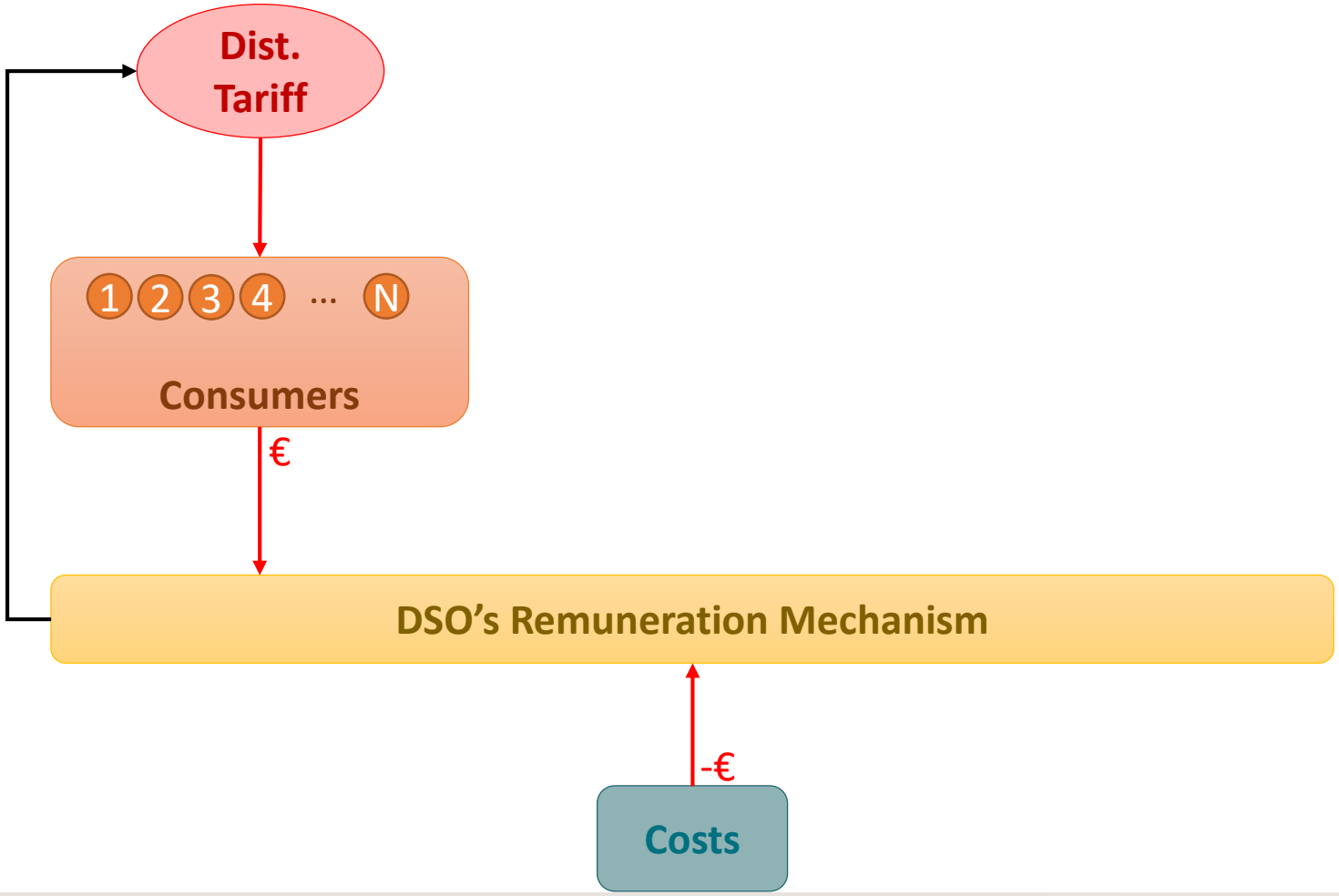
Assumptions regarding costs for technologies: PV panels & batteries

Decrease of 50% from today's costs (1.5 €/Wp, 300 €/kWh) to the simulation horizon (10 years ahead)

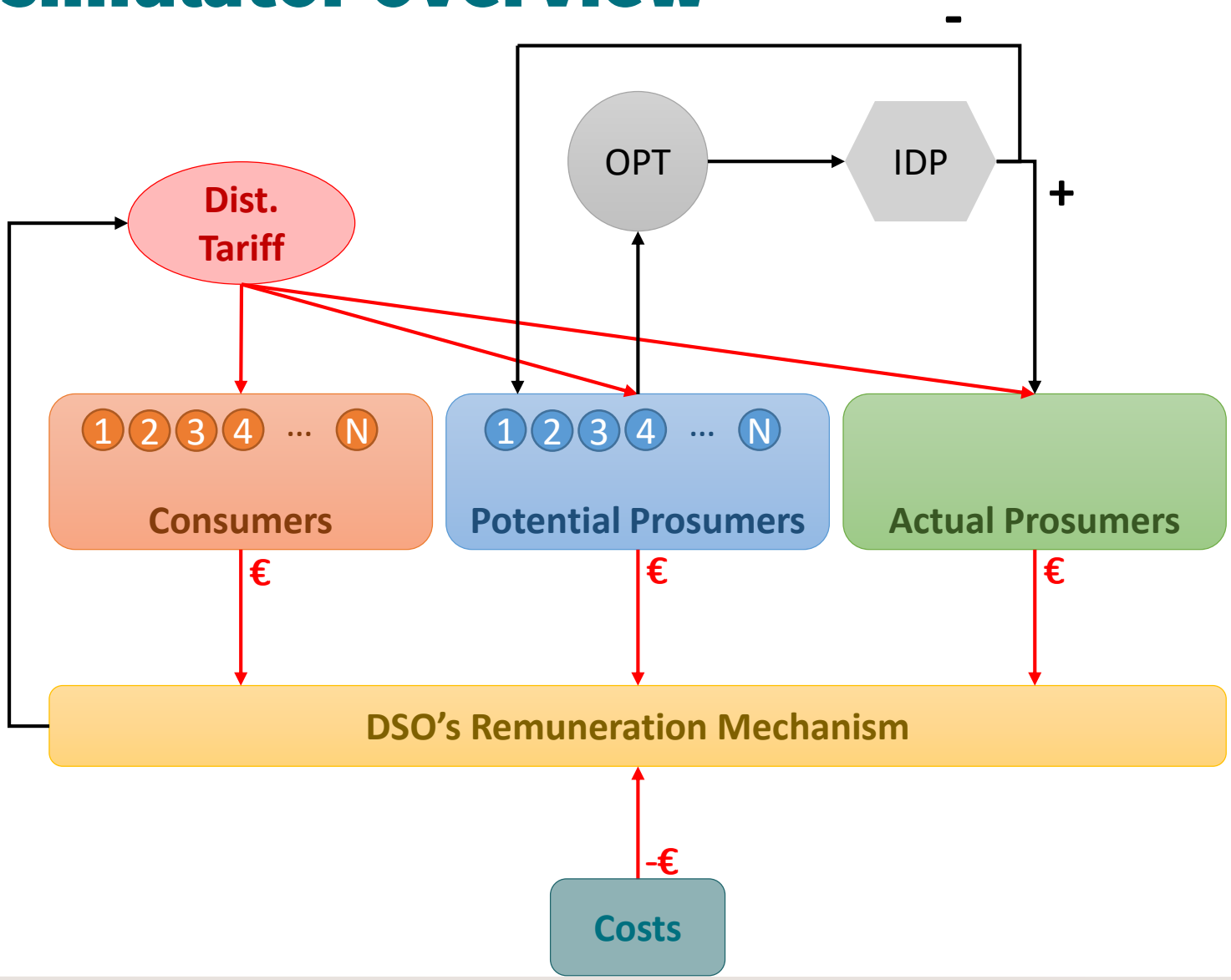
Focus on the distribution part of the end-users' bills

Other parts (commodity, transmission, taxes and contributions, etc) are kept constant

Tariff simulator overview



Tariff simulator overview



OPT:

Computation of …

- LVOE
- Optimally sized DER

s.t.

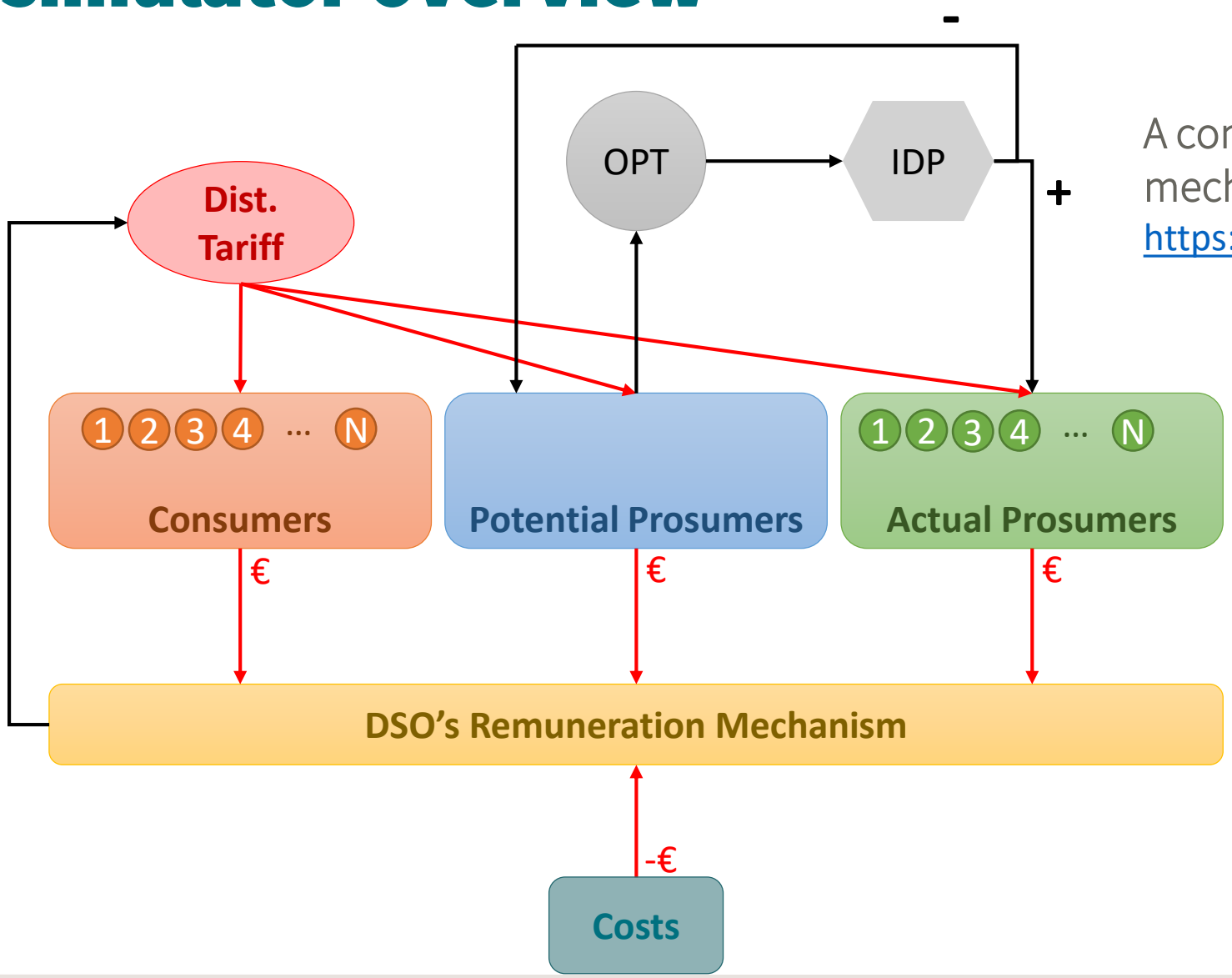
Sizing constraints,
Operational constraints
Regulatory constraints

IDP:

Comparison between …

- Costs with DER
- Costs without DER

Tariff simulator overview



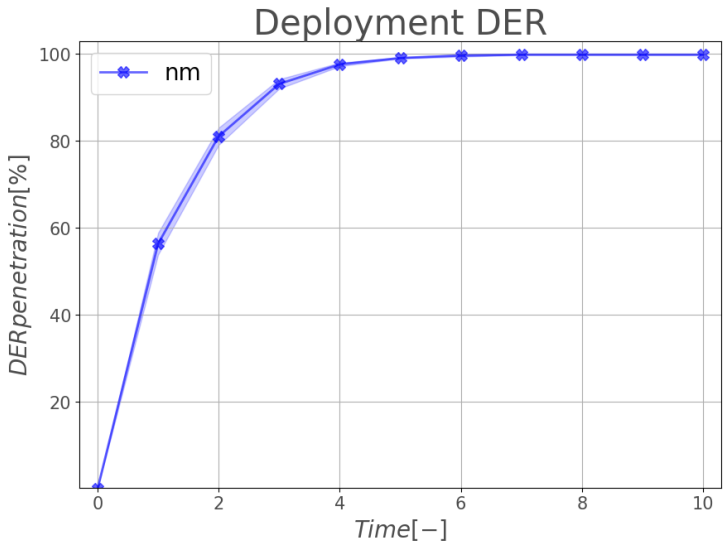
A complete explanation of this mechanism can be found in: https://youtu.be/0KKL1Z5WA1Q

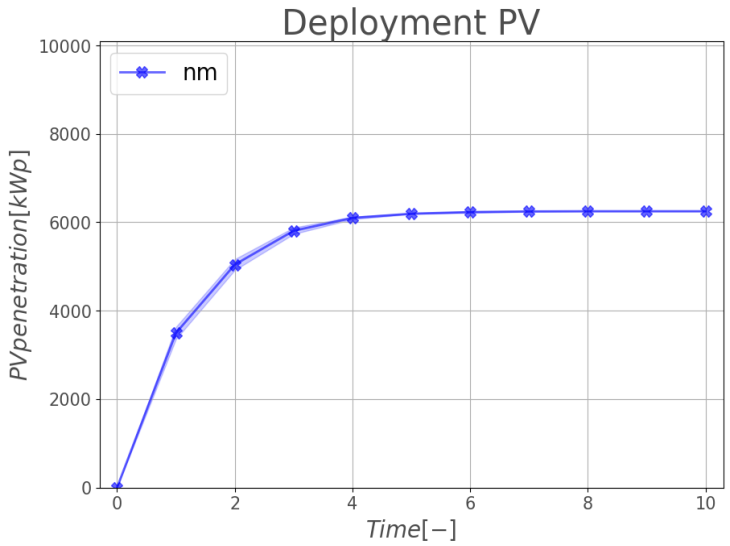
Case study: scenarios

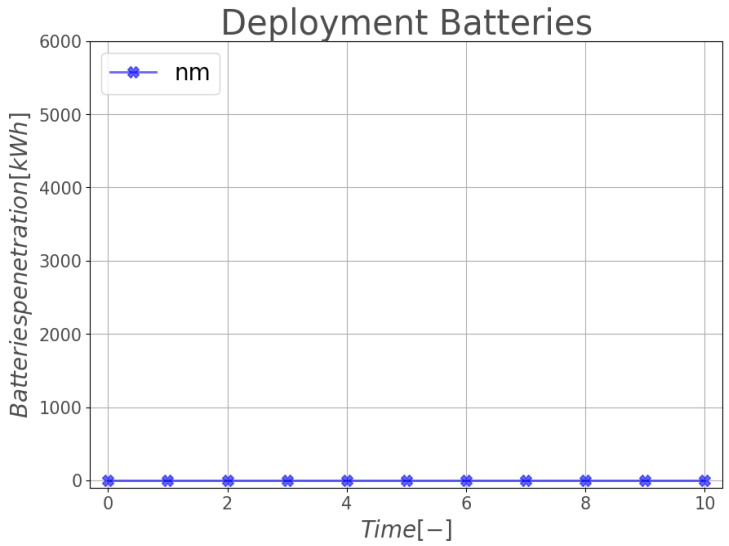
Scenario	Metering System	Tariff Design	Selling Price
AsIf (nm)	Net Metering	100% Volumetric	Retail Tariff
NB (vol4)	Net Billing	100% Volumetric	4c€
NB+ (vol10)	Net Billing	100% Volumetric	10c€
CAP (cap)	Net Billing	100% Capacity	4c€
NBCAP (vol_cap)	Net Billing	50% Volumetric & 50% Capacity	4c€
Fix (fix)	Net Billing	100% Constant	4c€

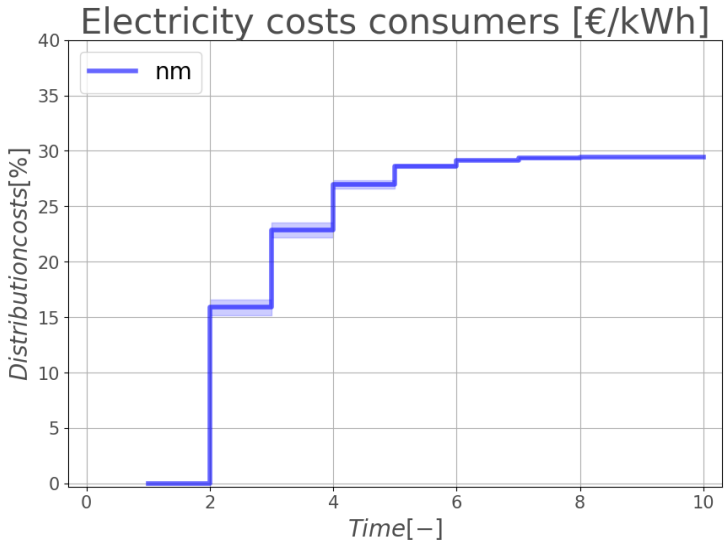
Volumetric: end-users are charged in €/kWh (energy consumption)
Capacity: end-users are charged in €/kWp (power consumption)
Constant: end-users are charged at a constant rate that does not depend on capacity nor consumption

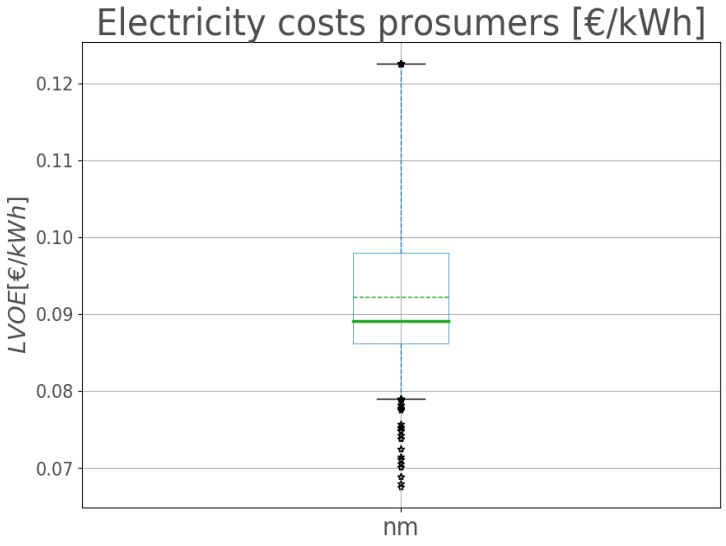
Result: AsIf (nm) (net metering + 100% vol. + Ret. Tariff)



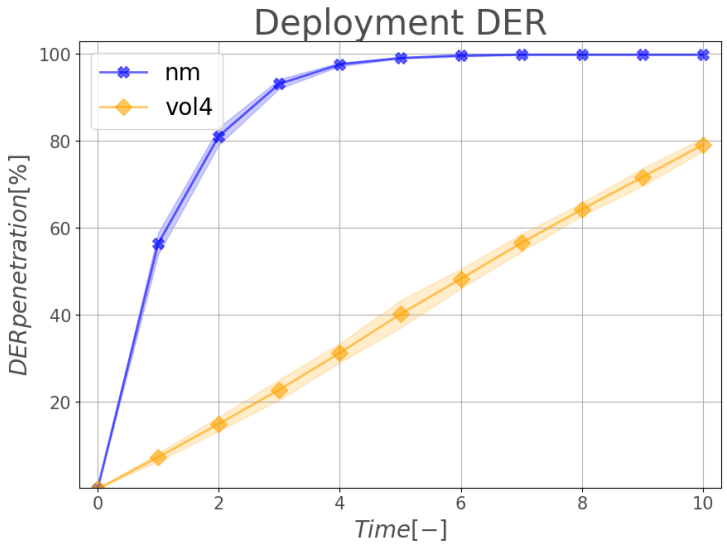


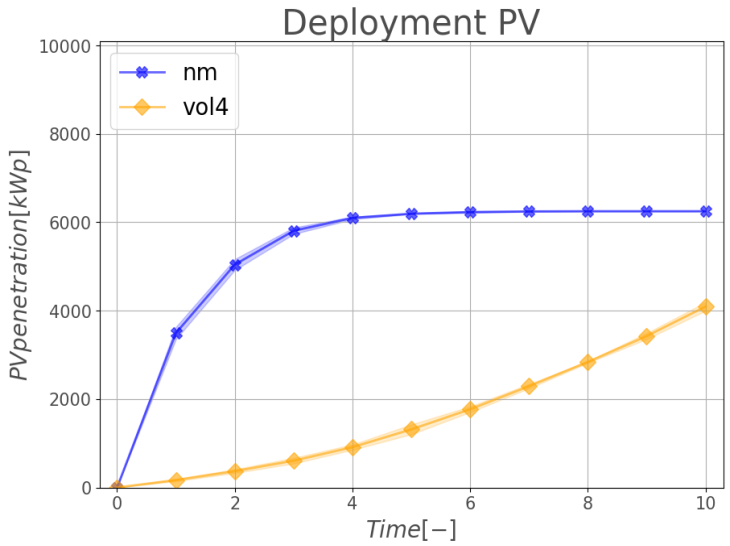


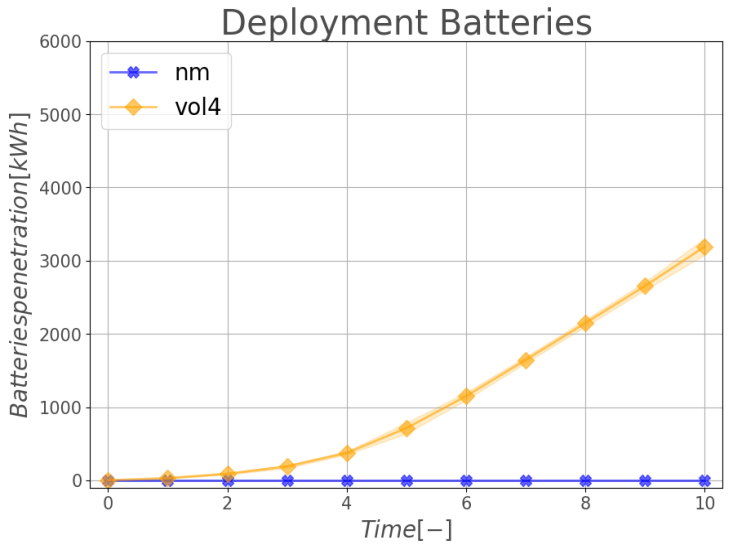


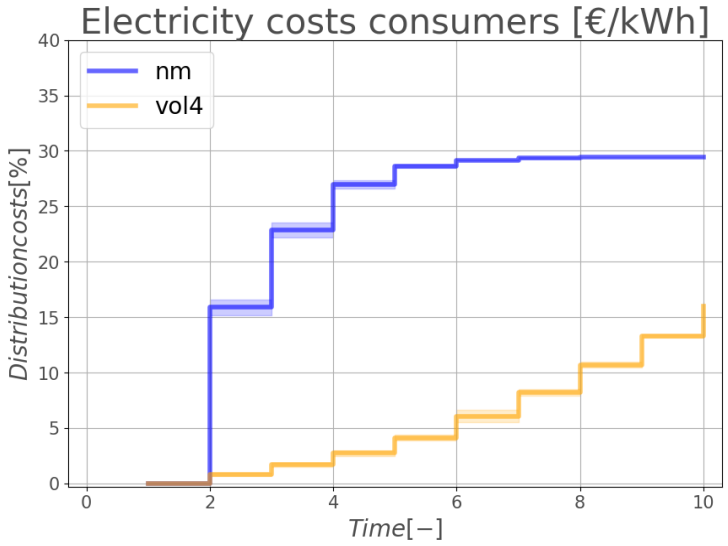


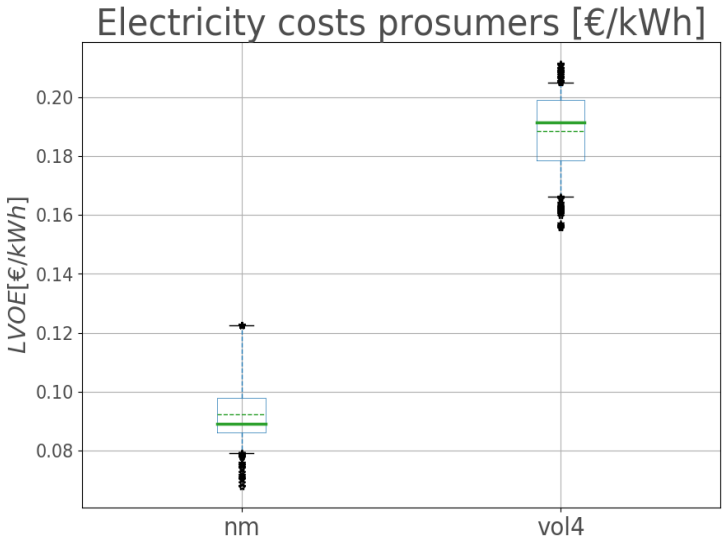
Results: NB (vol4) (net billing + 100% vol. + 4c€)



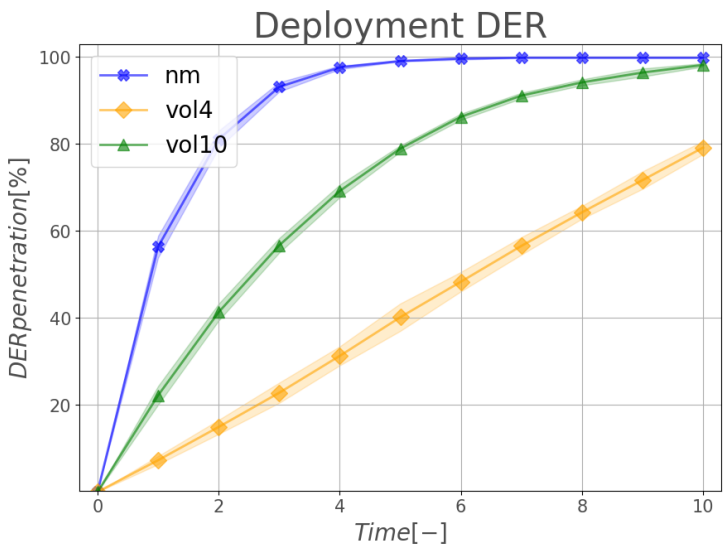


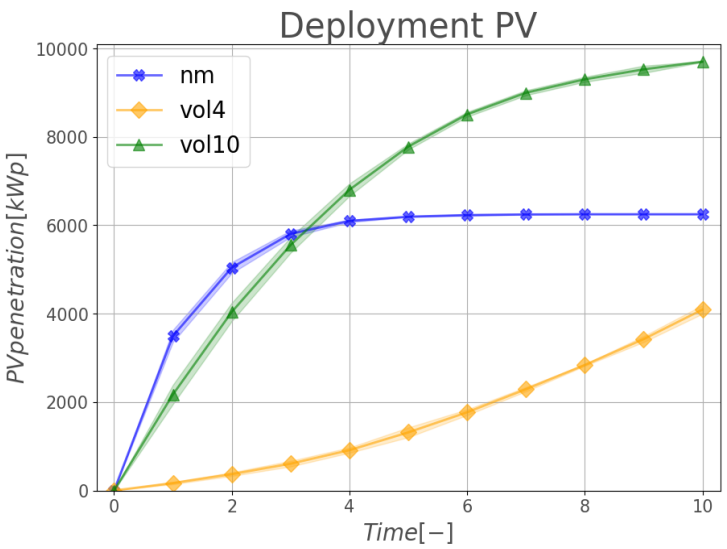


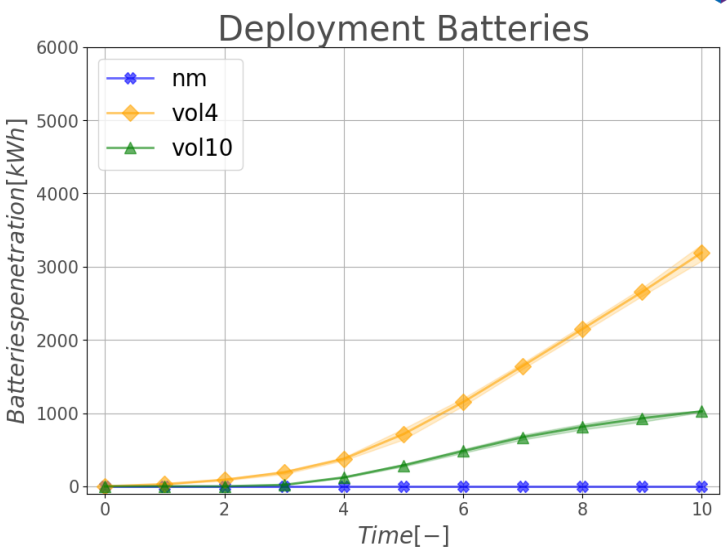


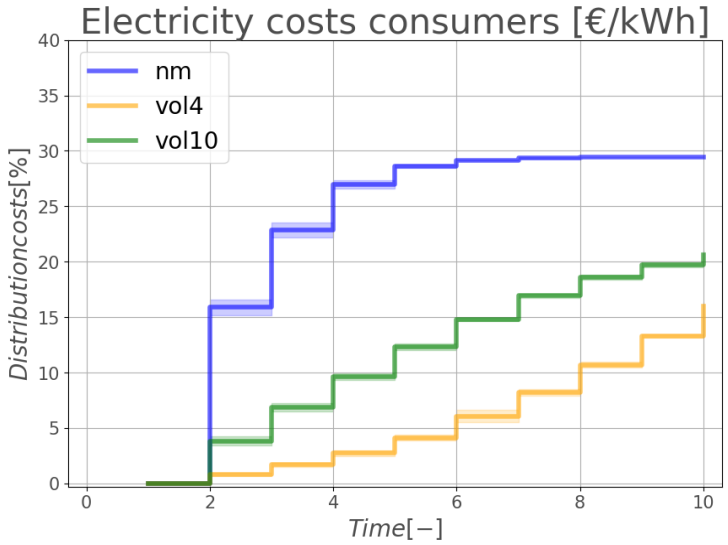


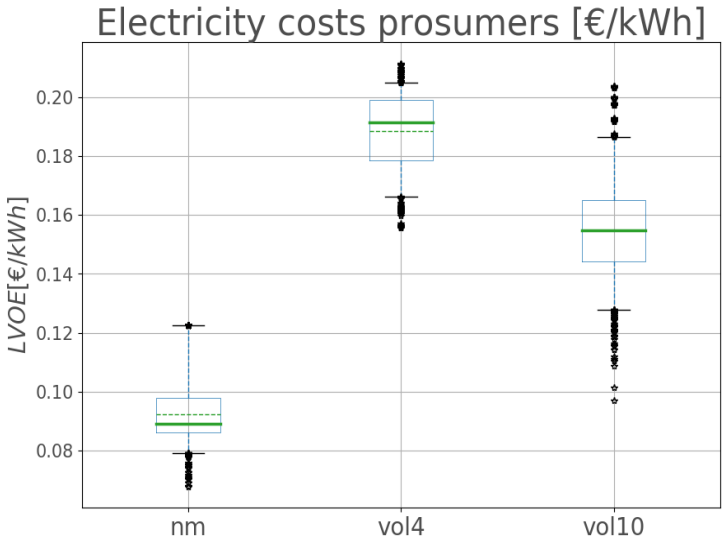
Results: NB+ (vol10) (net billing + 100% vol. + 10c€)



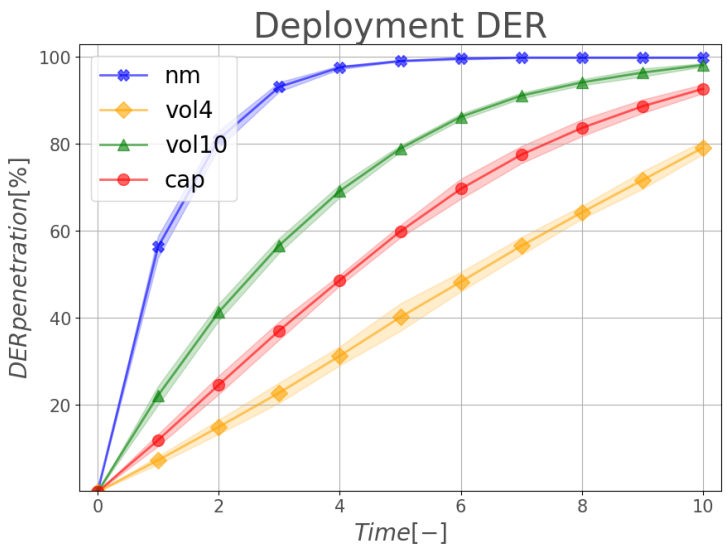


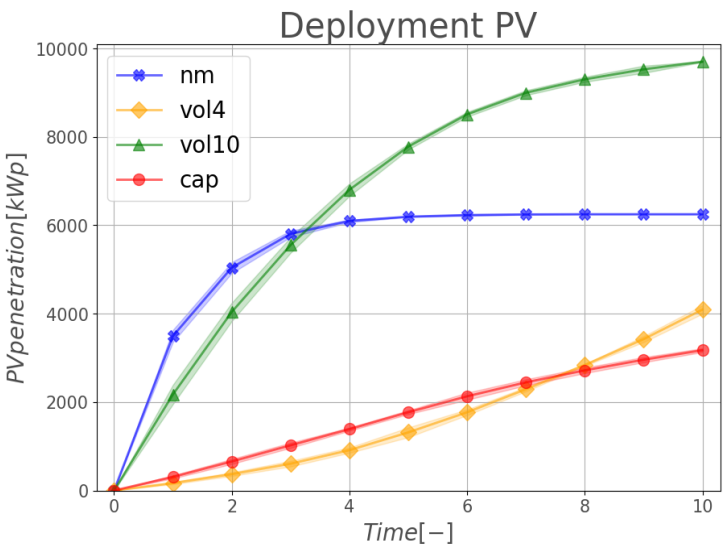


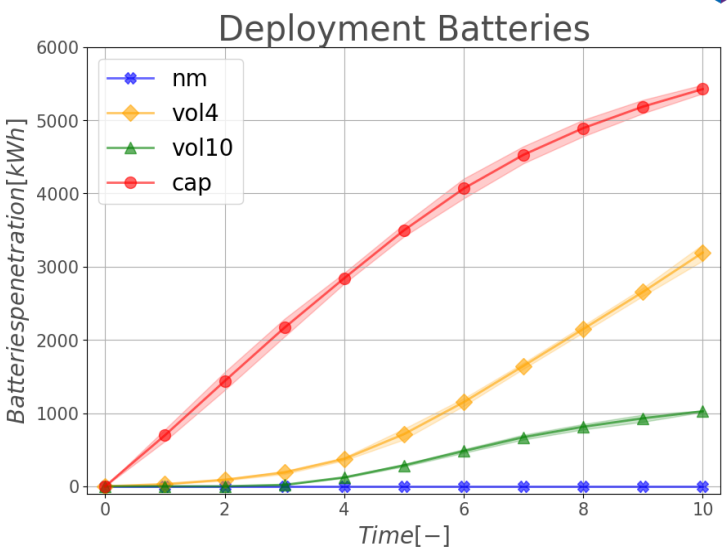


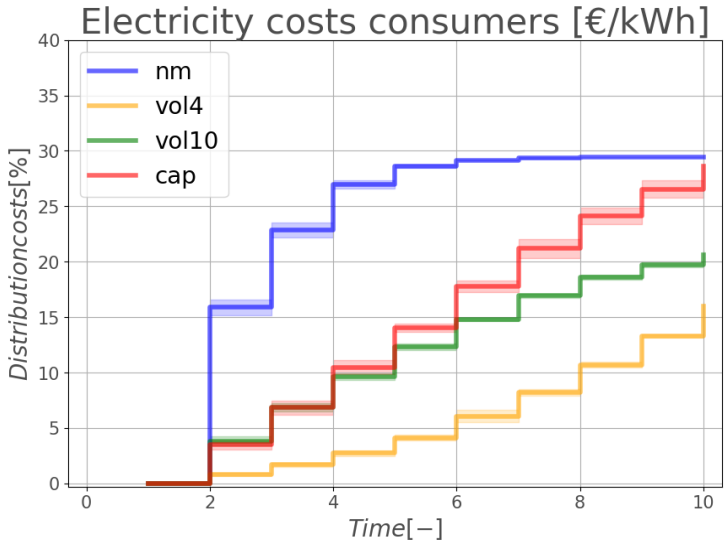


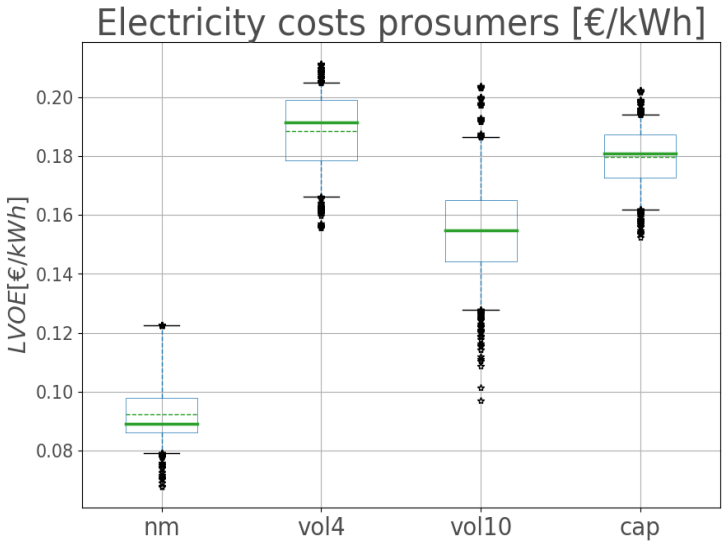
Results: CAP (cap) (net billing + 100% cap. + 4c€)



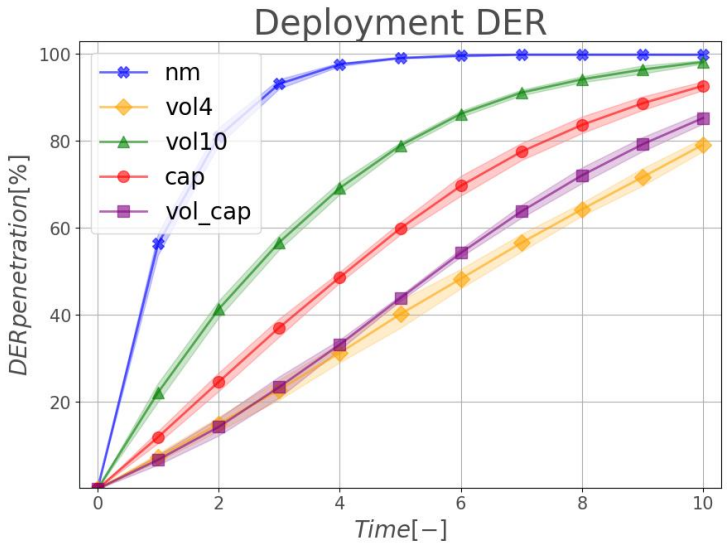


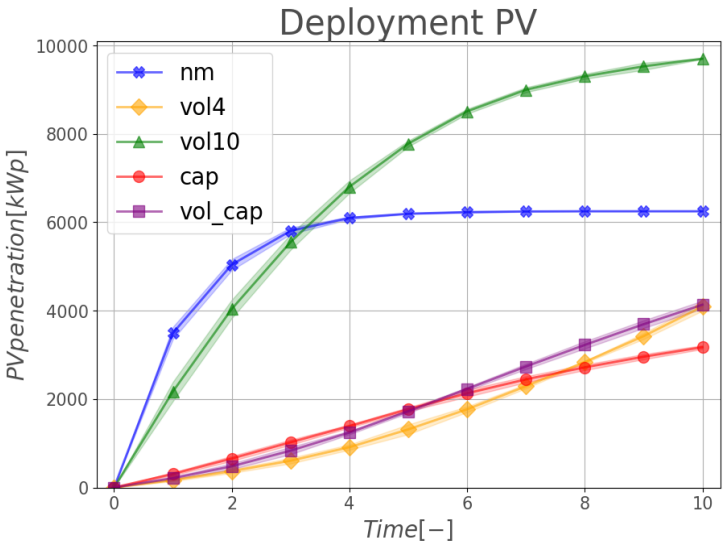


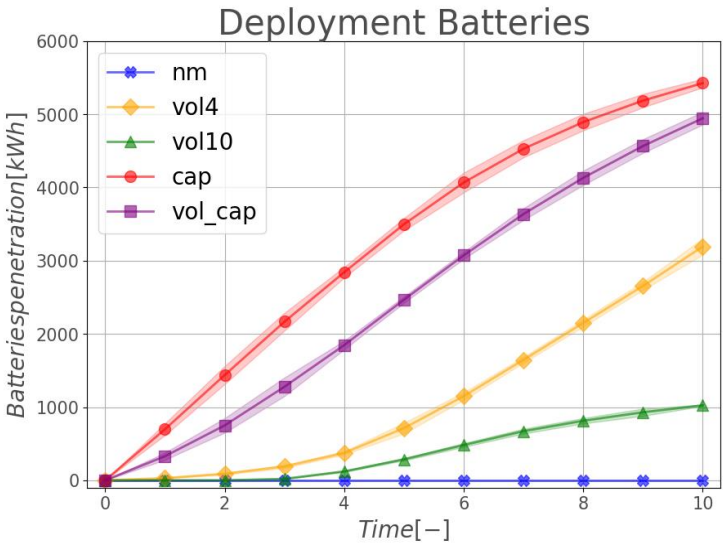


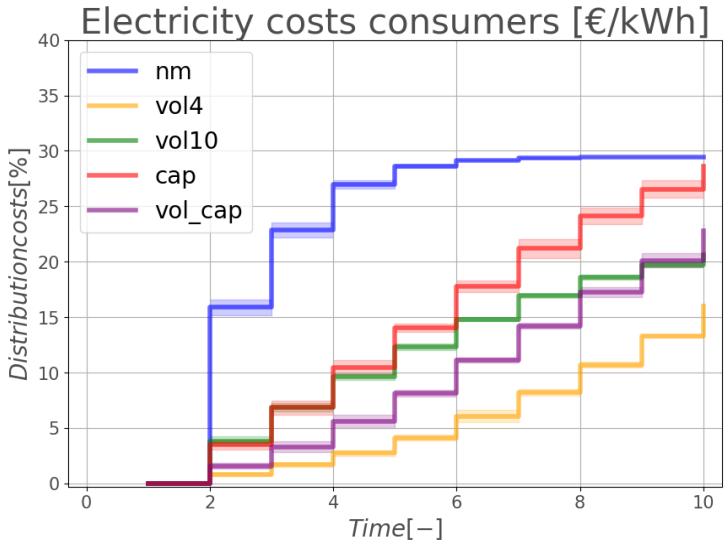


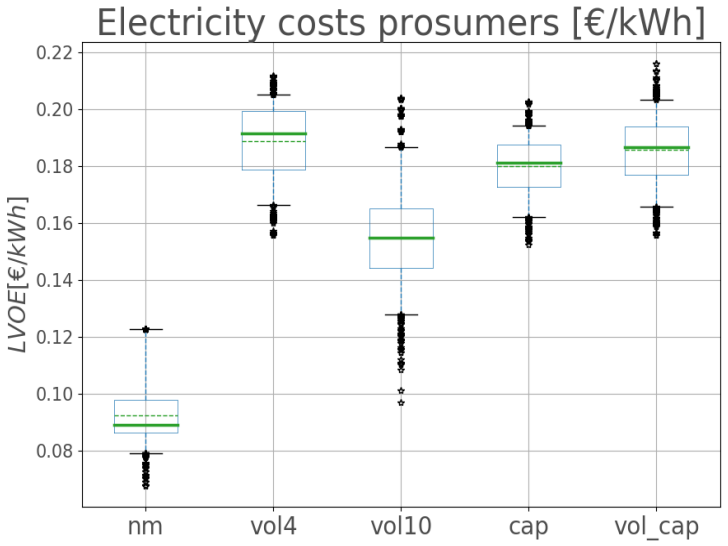
Results: NBCap (vol_cap) (net billing + 50% vol 50% cap + 4c€)



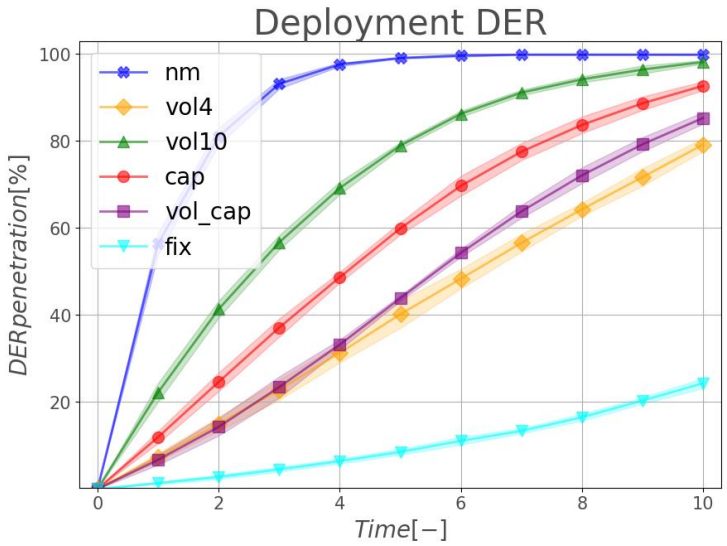


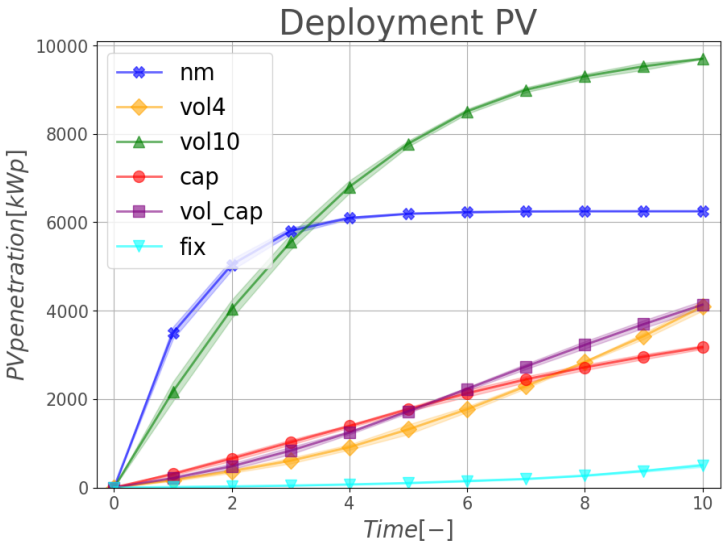


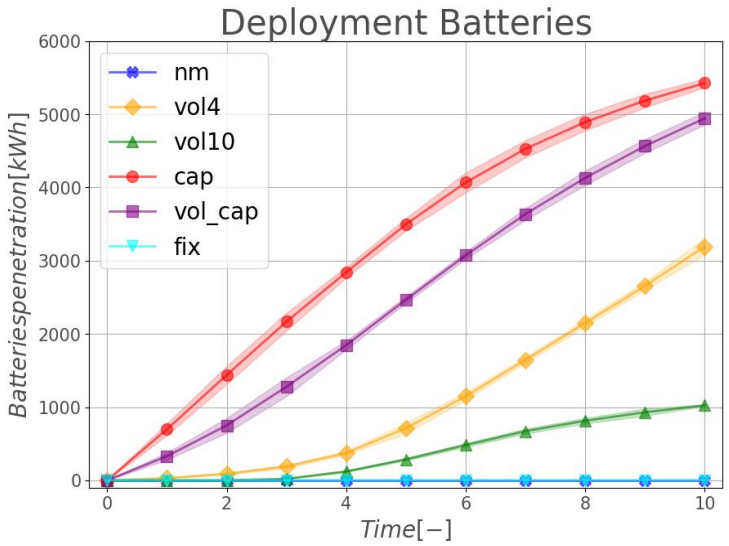


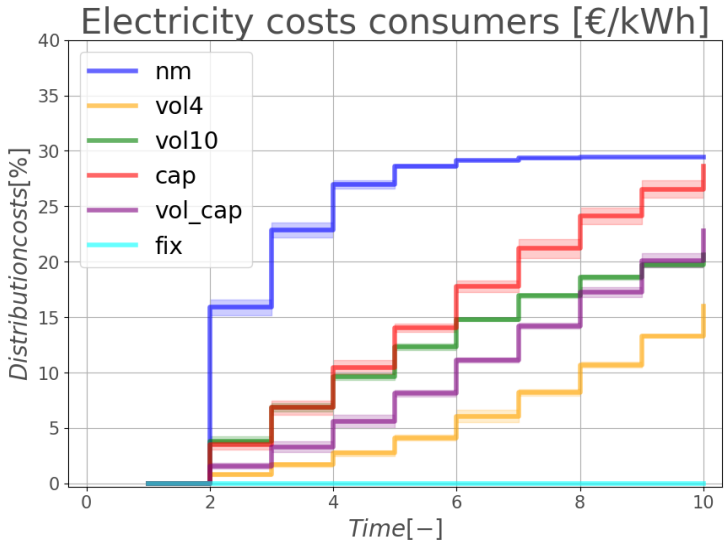


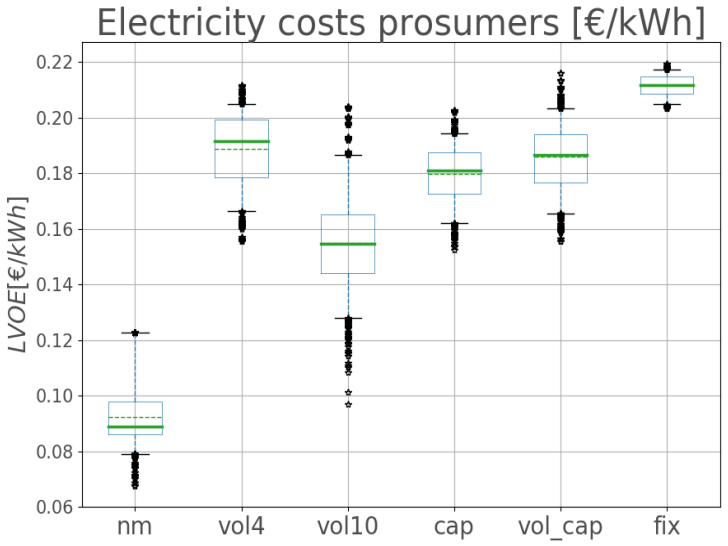
Results: Fix (fix) (net billing + 100% fix + 4c€)











Results: take home messages

The net-metering simulation, the closest to the Walloon situation, is the most profitable for prosumers

Three scenarios favour the deployment of batteries. Two of them, leading to the highest installed capacities, include a capacity term in the distribution tariff (peak shaving). The third one uses batteries to increase self-consumption, as it appears to be more profitable than selling at 4c€

In the fix-fee scenario nearly no DER installations are deployed, featuring only (little) PV and no batteries

A higher selling price induces more DER, with higher installed PV capacity than in the NM scenario. The 10c€ can be seen as an extra, exogenous Feed-in-Premium

Also, note that **any scenario may lead to the *Death spiral***, except for the fix-fee scenario

Concluding remarks

The tariff simulator allows to evaluate short to middle run effects of (any) regulatory framework, in particular in terms of DRE deployment, and distribution tariff evolution

Results show …

- Incentive mechanisms play a major role
- Net-metering incentivises the deployment of generation, but not storage
- Adding a capacity component allows for the emergence of storage
- Net billing, selling at wholesale price, results in an intermediate outcome

Concluding remarks (TECR)

La structure et le niveau du tarif de distribution influencent les investissements des consommateurs

- Ces choix ont des conséquences sur le déploiement des technologies décentralisées

Le Project TECR s'est concentré sur le les investissements individuels. Demain, certains investissements seront collectifs

- La tarification doit intégrer ces nouvelles manières de produire / consommer / stocker / échanger de l'énergie

Les prix doivent guider les choix des consommateurs de manière à concilier les intérêts individuels avec l'intérêt collectif

- Importance de valoriser les services rendus
- Les prix doivent être orientés vers les coûts

List of publications

- Manuel de Villena, M., Fonteneau, R., Gautier, A., Ernst, D. (2019) Evaluating the Evolution of Distribution Networks under Different Regulatory Frameworks with Multi-Agent Modelling. *Energies*, *12*, 1203. https://www.mdpi.com/1996-1073/12/7/1203
- Gautier, A., Hoet, B., Jacqmin, J., & Van Driessche, S. (2019). Self-consumption choice of residential PV owners under net-metering. *Energy Policy, 128*, 648-653. http://hdl.handle.net/2268/233036
- Gautier, A., Jacqmin, J., & Poudou, J.-C. (2018). The prosumers and the grid. *Journal of Regulatory Economics, 53*, 100-126. http://hdl.handle.net/2268/208969
- Manuel de Villena Millan, M., Gautier, A., Fonteneau, R., & Ernst, D. (2018). A multi-agent system approach to model the interaction between distributed generation deployment and the grid. *Proc. of CIRED Workshop 2018*. http://hdl.handle.net/2268/223038
- Manuel de Villena Millan, M., Fonteneau, R., Gautier, A., & Ernst, D. (2018). Exploring Regulation Policies in Distribution Networks through a Multi-Agent Simulator. *Proc. of YRS2018*. http://hdl.handle.net/2268/223745
- Gautier, A., & Jacqmin, J. (2019). Une nouvelle tarification des réseaux pour favoriser la transition énergétique, Regards économiques 145. https://www.regards-economiques.be/index.php?option=com_reco&view=article&cid=188
- Gautier, A., & Jacqmin, J. (2018). *PV adoption in Wallonia: The role of distribution tariffs under net metering*. Eprint/Working paper http://hdl.handle.net/2268/225412
- Boccard, N., & Gautier, A. (2019). *Photovoltaic solar panel in Wallonia: Estimating the rebound effect*. Eprint/Working paper http://hdl.handle.net/2268/232427
- Manuel de Villena Millan, M., Ernst, D., Gautier, A., & Fonteneau, R. (2019). *Simulation-based Assessment of the Impact of Regulatory Frameworks on the Interactions between Electricity Users and Distribution System Operator*. Eprint/Working paper http://hdl.handle.net/2268/229747