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Challenge

From research to innovation: Experience from Innovation Scholarship and Discovery funding to bring PhD results towards commercialization

NTNU IEL: Salman Zaferanlouei and Magnus Korpås
Innovation Manager: Ida Fuchs

NTNU TTO: Mads Reiten and Vetle Engesbak

NTNU

Feb. 25, 2021



Purpose

- **Purpose:** To share my experiences from Research to Innovation.
- **Phase I:** The idea
- **Phase II:** Path from research to commercialization
- **Phase III:** Opportunities and challenges

Project Name:	Battpower
Time Spent:	Five Years

Electricity Grid

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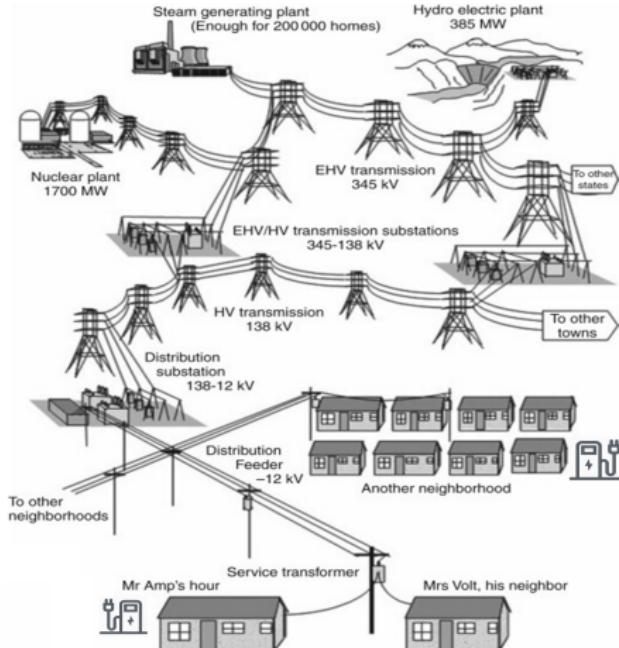


Figure 1: [www.sciencedirect.com/science/article/pii/B9781845697846500019]

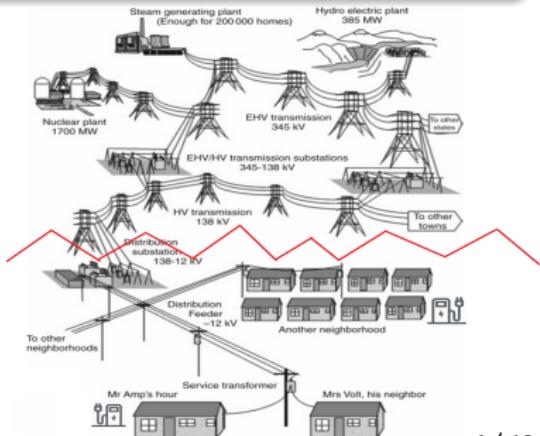


Sustainability/Green shift/CO₂ reduction

For many reasons power electricity grid is facing decentralization

- Phasing out nuclear power plants
- Increase penetration of solar and wind production
- Many other points ...

This chain between large power producers and consumers is weakened.



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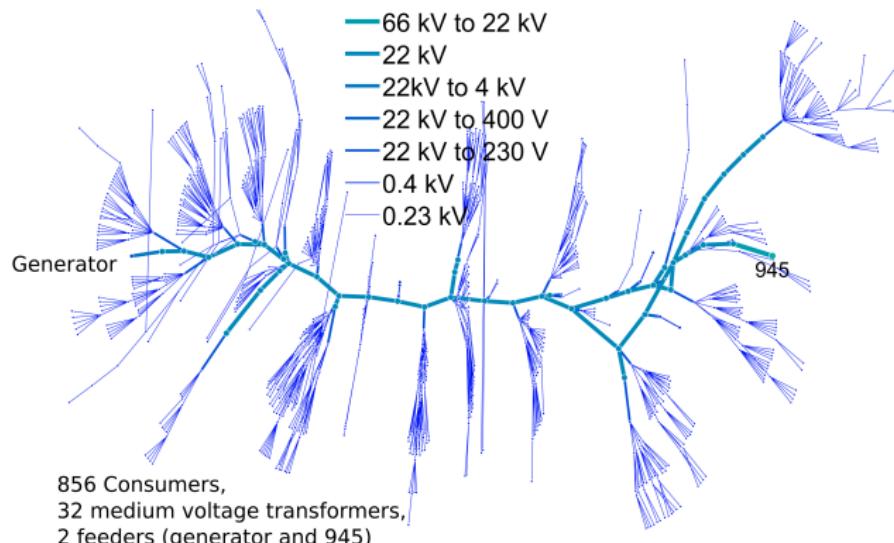


Figure 2: Local distribution grid located in Norway with 856 costumers

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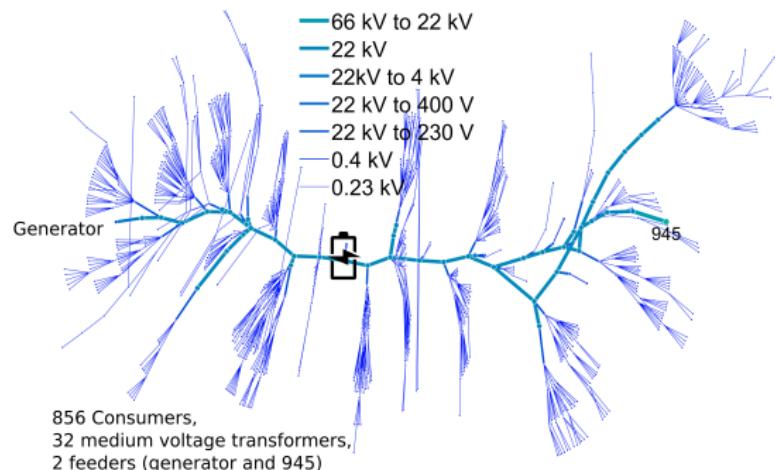


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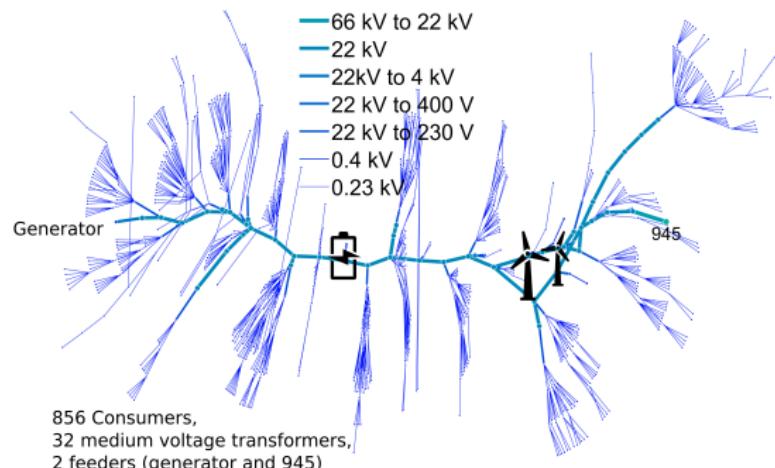


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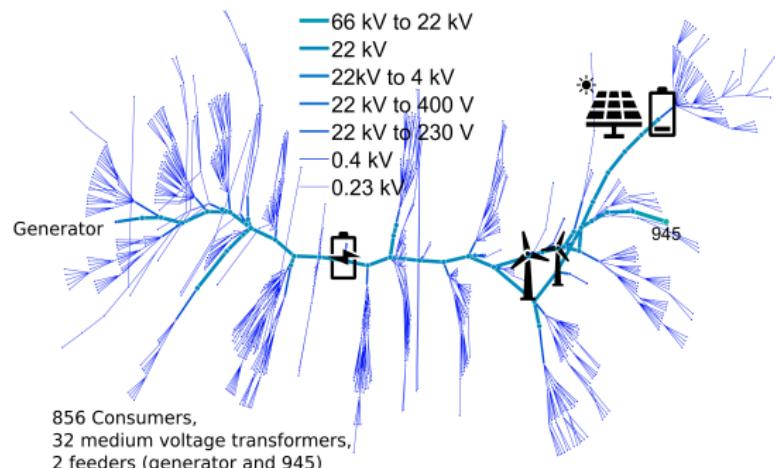


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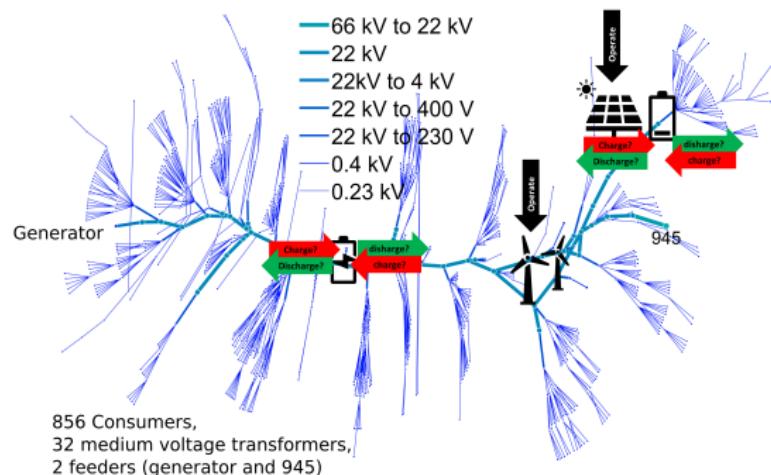


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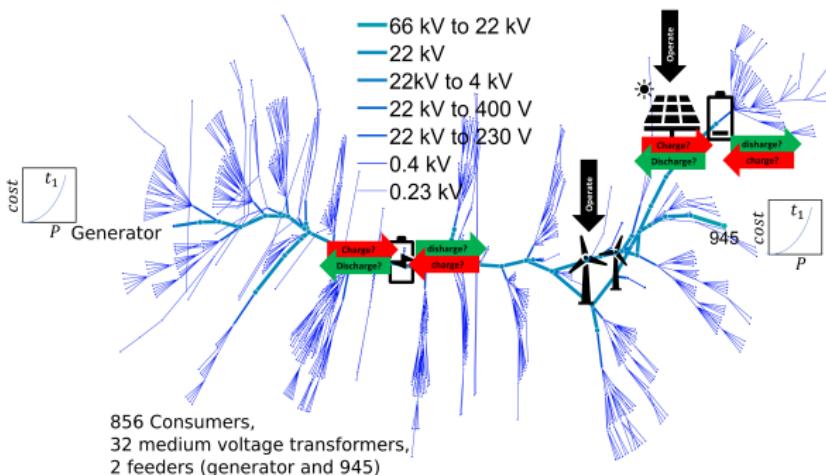


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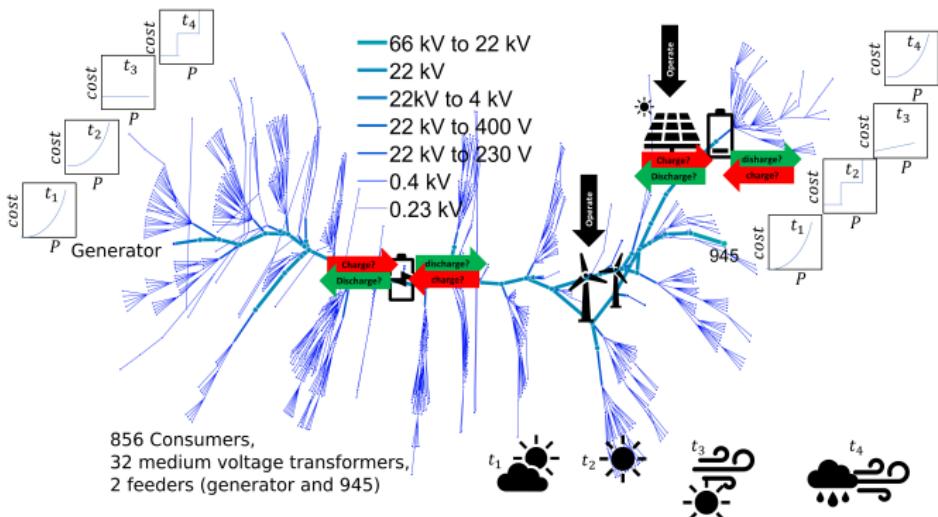


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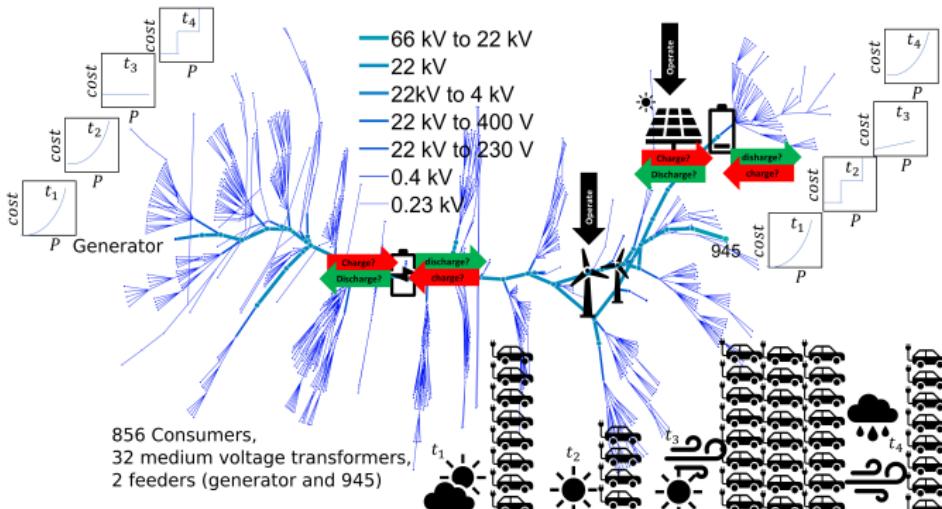


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■ **Paper I:** Zaferanlouei, S., Farahmand, H., Vadlamudi, V. V., & Korpas, M. (2021). BATTPOWER Toolbox: Memory-Efficient and High-Performance MultiPeriod AC Optimal Power Flow Solver. *IEEE Transactions on Power Systems*.

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■ **Paper II:** Zaferanlouei, S., Lakshmanan, V., Bjarghov, S., Farahmand, H., & Korpås, M. (2021). BATTPOWER Application: Large-Scale Integration of EVs in an Active Distribution Grid—A Norwegian Case Study. *arXiv preprint arXiv:2102.02677*.

Path from Research to Innovation

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- I sent the "Disclosure of Innovation" (DOFI) form to Technology Transfer Office (TTO)

Path from Research to Innovation

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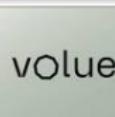
Commercialization

Path

- I sent the "Disclosure of Innovation" (DOFI) form to Technology Transfer Office (TTO)
- Meeting with Technology Transfer Office (TTO)
- Innovation Stipend Application
- Meetings with Agder Energi, Norgesnett and Value.



agder energi



value

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- Meeting with Technology Transfer Office (TTO)
- Innovation Stipend Application
- Meetings with Agder Energi, Norgesnett and Value.
- Discovery Project.



DOFI is submitted on 27-08-2019

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Technology Transfer as

DISCLOSURE OF INNOVATION/INVENTION

Please use this form to disclose any of your Innovations/inventions

Checklist

- I Title of your idea
- II Short description of Idea
- III Potential Market
- IV What is the current stage of you idea? [a. Concept
b. Preliminary c. Tested in practice d. Prototype]

This form fulfills the requirements of the Norwegian law of "Arbeidstakeroppfinnelser" and NTNU's internal Guidelines and policy for IPR.

The innovation/invention

Title/Short name:

Date of innovation/
invention:



First Meeting with TTO: Sep 2019

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Flow

Introduction to a new Multi- Period ACOPF Solver



period

Everything started from here:

The core Battpower idea is presented for TTO.

Optimal
RUI
OP
C++
FORTRAN
MATLAB



and MEMORY EFFICIENT

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Innovation Grant (Innovasjonsstipend)

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Introduction to BATTPOWER Toolbox: Memory Efficient and High-

Milestones

- aim to release a preliminary version of the prototype solver in near future

This research aims to develop a numerical solver for nonlinear problems that is several order of magnitude faster than current existing nonlinear solvers. The main methodology is based on 1) analytic and exact calculation of partial differential equations of the sub-problem 2) exploiting the shape and pattern of the coefficient matrix of Newton-Raphson approach existing in interior point method algorithm [1].

Introduction



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Introduction to BATTPOWER Toolbox: Memory Efficient and High-

Milestones

- aim to release a preliminary version of the prototype solver in near future
- benchmark the work with state of art commercial and open source solvers such as KNITRO, CONOPT and IPOPT

This research aims to develop a solver for large scale optimization problems which is several order of magnitude faster than current existing nonlinear solvers. The main methodology is based on 1) analytic and exact calculation of partial differential equations of the sub-problem 2) exploiting the shape and pattern of the coefficient matrix of Newton-Raphson approach existing in interior point method algorithm [1].

Introduction

Innovation Grant (Innovasjonsstipend)

Introduction to BATTPOWER Toolbox: Memory Efficient and High-

Milestones

- aim to release a preliminary version of the prototype solver in near future
- benchmark the work with state of art commercial and open source solvers such as KNITRO, CONOPT and IPOPT
- Apply for more funding

This toolbox is designed to solve large scale nonlinear optimization problems. It is several order of magnitude faster than current existing nonlinear solvers. The main methodology is based on 1) analytic and exact calculation of partial differential equations of the sub-problem 2) exploiting the shape and pattern of the coefficient matrix of Newton-Raphson approach existing in interior point method algorithm [1].

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Achievements

- Managed to get in contact with different companies: Agder Energi, Norgesnett and Value.



[1] S. Zaferanlouei, H. Farahmand, V. V. Vadlamudi and M. Korpås, "BATTPOWER Toolbox: Memory-Efficient and High-Performance Multi-Period AC Optimal Power Flow Solver", Accepted for publication in IEEE Transactions on Power Systems, Jan. 16th, 2021.

* The MATPOWER Interior Point Solver (MIPS) (<https://matpower.org/>)

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- Managed to get in contact with different companies: Agder Energi, Norgesnett and Value.
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[1] S. Zafaraniouei, H. Farahmand, V. V. Vadlamudi and
Optimal Power Flow Solver", Accepted for publication
* The MATPOWER Interior Point Solver (MIPS) (<https://>

NTNU Norwegian University of Science and Technology

and High-Performance Multi-Period AC
Optimization, 2021.

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Achievements

- Managed to get in contact with different companies: Agder Energi, Norgesnett and Value.
- We are currently collaborating with Value.
- Wrote an application for Radical Research Frontier (NFR application)
www.forskningsrådet.no/en/call-for-proposals/2020/radical-frontier-research/



[1] S. Zafaraniouei, H. Farahmand, V. V. Vadlamudi and
Optimal Power Flow Solver", Accepted for publication
* The MATPOWER Interior Point Solver (MIPS) (<https://matpower.org>)

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- We are currently writing an (**Innovasjonsprosjekt i næringslivet**) **IPN** application to build a partnership research collaboration between NTNU and Value.
- Applied for NTNU Discovery Project and managed to receive it 200,000 NOK.



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We are now on this stage

Discovery Project on board

Milestone

- Move our codes to C++
- Benchmark our final codes on a real distribution grid data.
- Finalize the IPN proposal with Value

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Opportunities

- The process (TTO collaboration) is an excellent way to learn marketing. TTO provides hands on experience.
- Real cases might have details you have not considered in your research.
- Real cases are practiced differently in different locations. For example electricity market is running differently in Nordic countries than US.



The challenges when you start to learn new things?

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Challenges

■ Where to start?



The challenges when you start to learn new things?

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Challenges

- Where to start?
- What to do?

Commercialization has also a similar route

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■ Where to start?

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- Where to start?
- What to do?

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Challenges

- Where to start?
- What to do?
- How to do marketing?

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TTO helps you to learn this process!

- Is the idea valuable?

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Challenge

TTO helps you to learn this process!

- Is the idea valuable?
- What is the Technology readiness level of your idea?



TTO

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TTO helps you to learn this process!

- Is the idea valuable?
- What is the Technology readiness level of your idea?
- Intellectual Property Right (IPR).

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Secure Funding

- Apply for different calls.
- You might end up without funding in between different projects grants.



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Any Questions?

This presentation is recorded, therefore please contact me if you see this video later, and if you have any question: salman.zaf@ntnu.no

Link to my presentation:

https://github.com/KavehZaf/NTNU_Presentations/tree/master/WebinarInnovation

Thank you for your attention!