UNIVERSITY OF OSLO

Energy Modelling - Master Thesis at ITS - Nov2022

Communication and Modelling for a Sustainability Future

Vi må omstille energisystemet vårt og produsere store mengder ny fornybar kraft, skriver Ole Erik Almlid. *Foto: Terje H.T. Andersen*

Josef, Marianne, Mathias, Meysam, Jonathan, …

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Energy & Digital Equity

Sustainable Empowerment -
what are the catalysts for the SDGs?

SDG 1.4 Equal access to basic services

SDG 4.A Education facilities for effective learning for all

SDG 5.B Use of enabling technologies

SDG 9.C universal and affordable access

SDG 16.10 ensure public access to information

SDG 17 Partnerships for the Goals

International Labour Organization

Just Transition

1.
In tackling critical environmental challenges like climate change, pollution and plummeting biodiversity, nations and businesses must transition towards greener, resilient and climate-neutral economies and societies.

2.
A Just Transition is greening the economy that is as fair and inclusive to all, creating decent work opportunities and leaving no one behind.

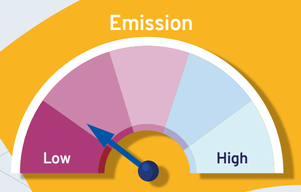
3.
A Just Transition maximizes economic opportunities of climate action, minimizes and manages challenges – It does this through effective social dialogue among all stakeholders impacted, and respects fundamental labour principles and rights.

4.
Ensuring a Just Transition is key for all countries, rural and urban communities at all levels of development as well as all economic sectors – not only limited to energy supply chain.

5.
A Just Transition is both a process and a goal to undertake climate change actions that equally advance: **job creation, social justice and fair transitions for workers, enterprises and communities** on an equal footing.

Green Jobs

6.
Green jobs limit greenhouse gas emissions, minimize waste and pollution, protect and restore ecosystems, improve energy and raw material efficiency, and support the adaptation to the effects of climate change.



7.
Green jobs propel the preservation and restoration of the environment across sectors such as agriculture, manufacturing and energy.

8.
Decent jobs, are a co-benefit of a green and just transition due to the fact that such jobs entail practices such as cleaner production & consumption and energy efficiency that improve occupational safety and health (OSH) in the workplace.

9.
At the enterprise level, green jobs can produce goods and services that benefit the environment, for example green buildings or clean transportation.

10.
Green jobs also contribute to more environmentally friendly processes. For example, green jobs can reduce water consumption or improve recycling systems.

11.
Green Jobs are jobs that are good for people, good for the economy and good for the environment.

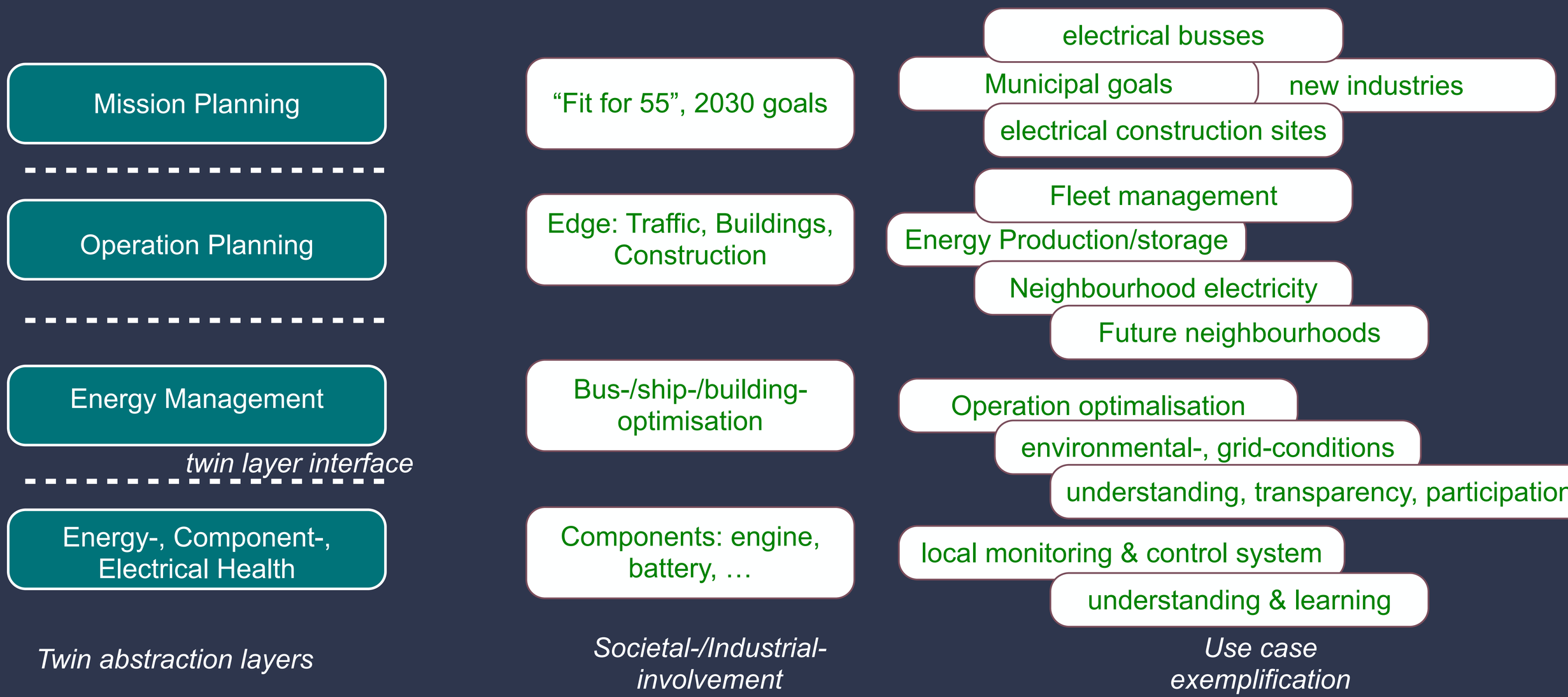
Digital Empowerment

Participatory transition

Market place

Neighbourhood

TwinEnergy Overarching Architecture



Africa
“Connect The Future”

https://www.mylifeelsewhere.com/country-size-comparison/tanzania/norway

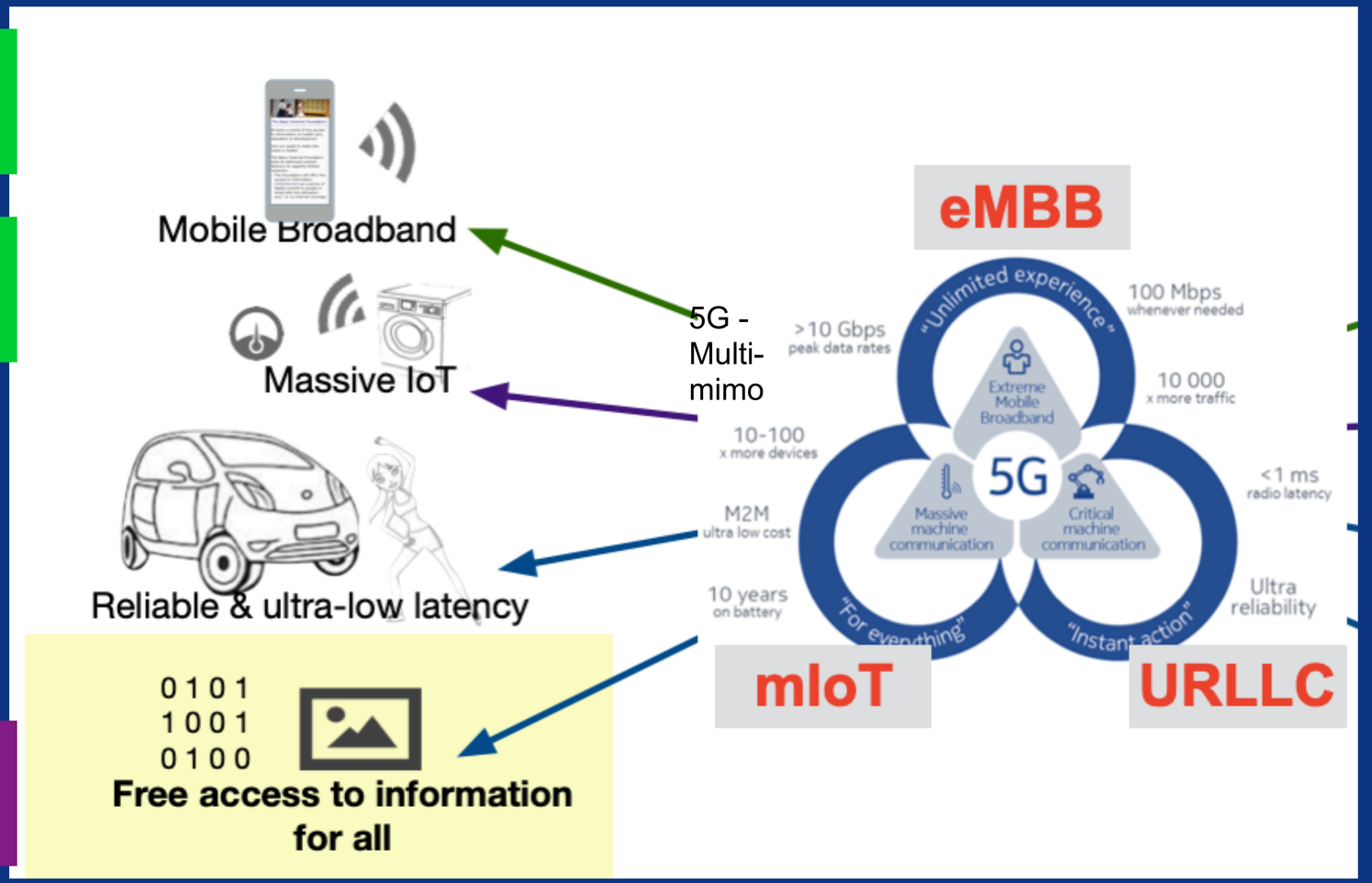
Communications

What do we need to change?

Road model: pedestrians & cyclists

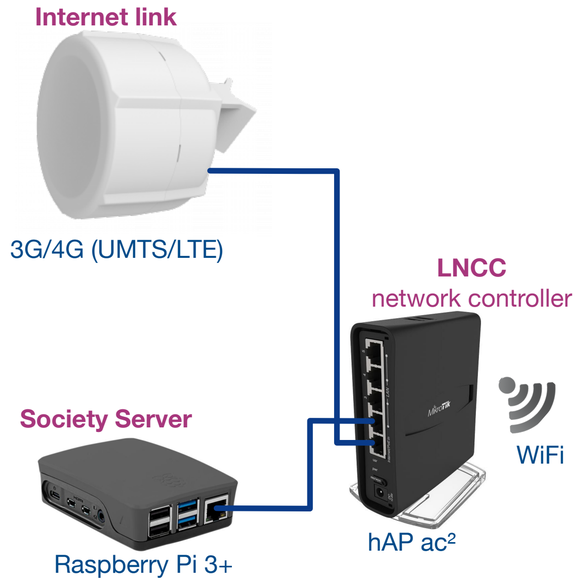
Internet: text & pictures

Internet Lite

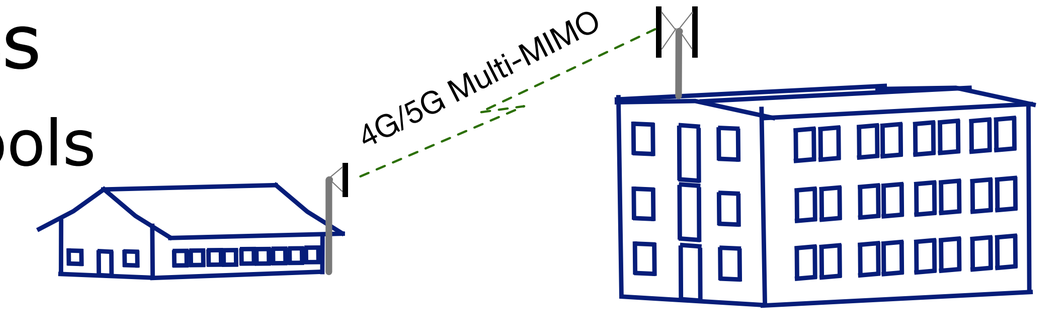


Solving the Challenge of Access

- Wireless information spot (InfoSpot)
  - Reaching out >20 km to 3G/ 4G network
  - Affordable solution: OPEX <20 USD/month



- Next: 5G access
  - University to schools



Electrical systems

- Device level: Sensor, Mobile phone,
- Micro-grid:
  - House, Shed
  - Village-/Neighbourhood network
  - Industrial system (Power box)
- Region/country/international grid
  - Nordic Net

Hospital – Galkayo, Somalia

Project: Hospital Size (kWp): 36,0 System: Energy Save

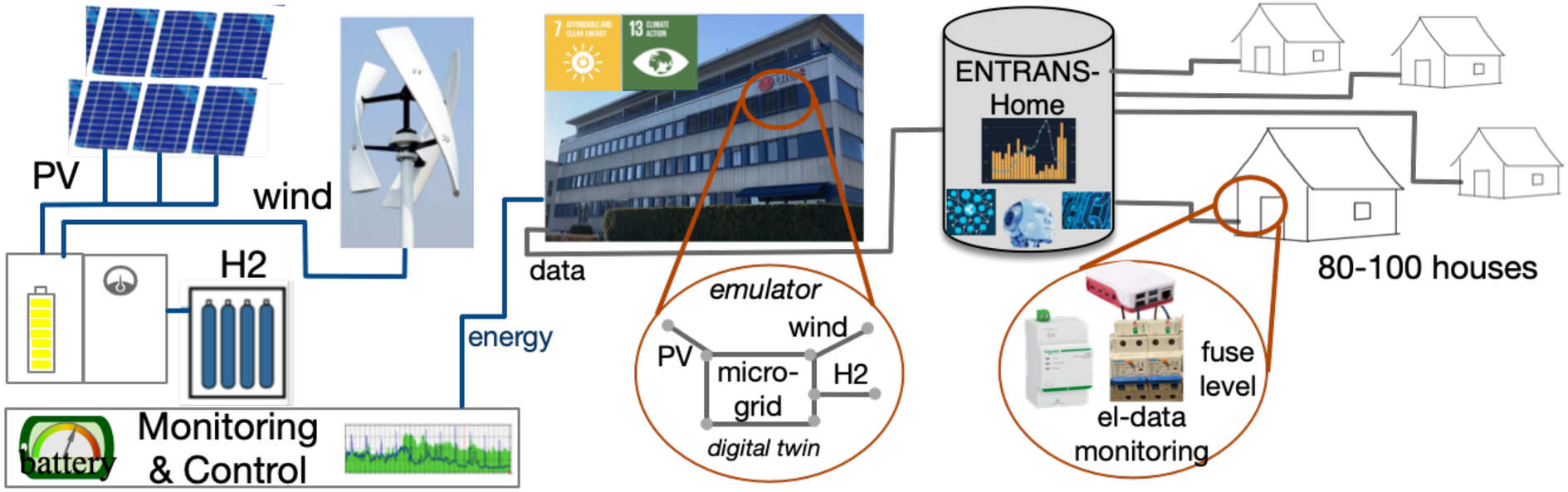
Waterpump – Mwingi, Kenya

Project: Waterpump Size (kWp): 2,7 System: Off-grid

Energy Infrastructure & Data

Distributed Energy System and Security Infrastructure (DESSI)

- Physical infrastructure (PC, H2, wind)
- Digital Twin (Simulator)
- ENTRANS-Home scientific database



Home infrastructure

- Grid-stabilisation
  - frequency stabilisation through battery or home demand
  - given grid demand and solar-/wind-variation

- Home monitoring & control
  - Integrated solutions using Raspberry Pi
  -

Topics for Master Thesis

- Electrical transition as driver for data-driven municipalities (Jonas)
  - ➡digital infrastruktur for el. monitoring og kontrolle
  - ➡ forbedringspotensialet

- Contribution of PV-empowered municipality buildings
  - ➡analysere dagens modeller for PV energy
  - ➡ sammenligne med utvalgte bygninger i Lillestrøm

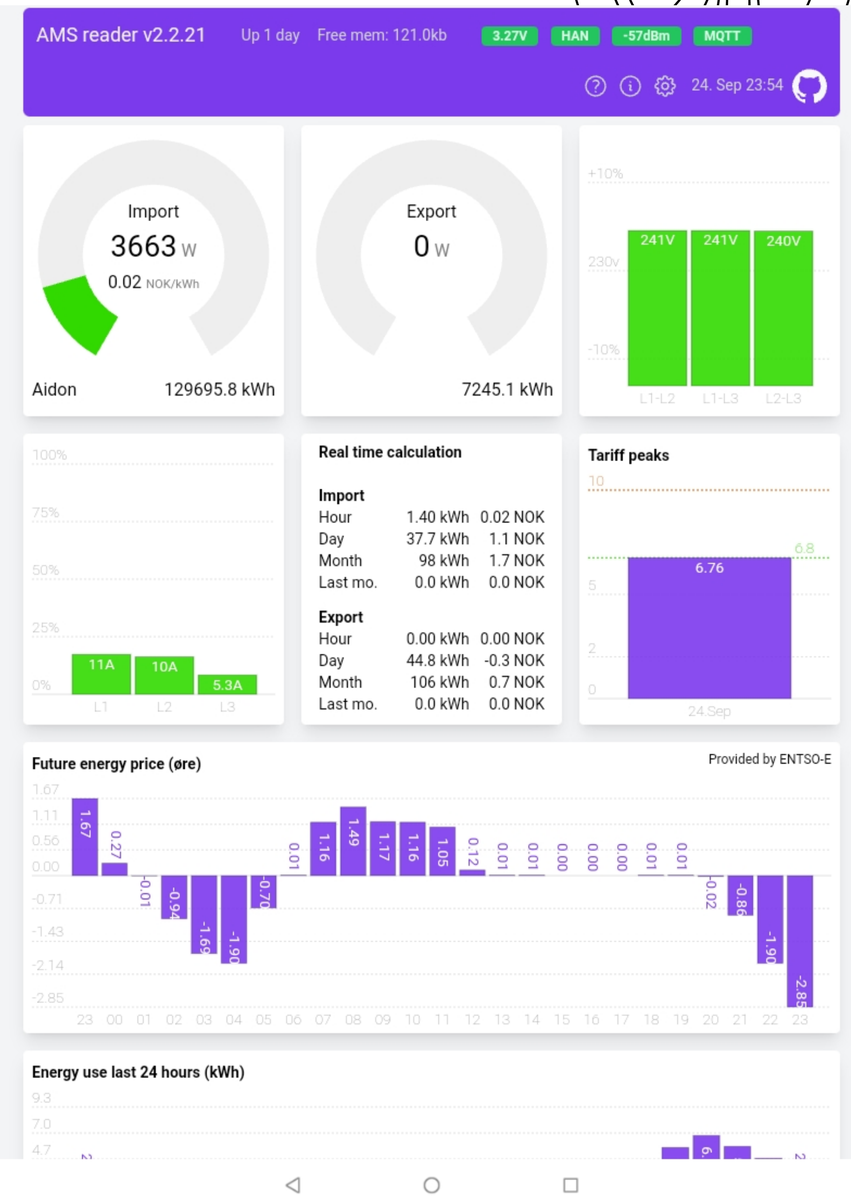
- Digital Twins for large scale car charging infrastructures
  - ➡ Eksempel: 83 stasjoner i bygning til Lillestrøm kommune
  - ➡ Vehicle-to-Grid (V2G) standard (ISO…): hva er potensialet
  - ➡ muligheter med dagens bilpark, og framtidsperspektivet

2. HAN port reading with AMSleser.no

- Use the HAN port reader from your smart home to receive the current energy readings, and integrate in HomeAssistant
  - read the energy consumption from the AMSreader and export to SQLite files
  - see other application examples and see what is possible to implement (direct MQTT access)

- Integrate the AMSleser into Home Assistant (Package for RPI): Home Assistant med Pow-K (amsleser.no) (video) and Homey-integration (wiki, Homey-integrasjon (amsleser.no))

- Examples of applicability are on BLOG (amsleser.no), e.g. the hardware reset Emergency factory reset (amsleser.no)



4. Optimise electricity tariffs for prosumer home

- Given the Energy production, consumption and sales as presented in Canvas / Stromdata / Energy_108x...xlsx, address
  - a) the earning given different energy tariffs
  - b) the impact of a virtual battery ("solbanken")
  - c) dimension a battery for the home
- Provide a model for the energy consumption, production and sales based on the available .xlsx data, and evaluate the alternatives.

	Oct2023		832,0	Sep2023		1068,4	Aug2023		943,6	Jul2023		895,6	Jun2023		984,6	May2023		1266
Day	buy	sell	prod	buy	sell	prod	buy	sell	prod	buy	sell	prod	buy	sell	prod	buy	sell	prod
	609,6	362,1	584,5	726,5	816,1	1158	582,1	1119,9	1481,4	408,0	1421,8	1909,4	422,2	1958,9	2521,3	644	1737	2358
1	24,1	18,1	32,4	23,8	45,0	59,2	7,5	43,1	53	20,5	56,4	76,7	10,0	78,4	97,7	35,6	0,0	71,9
2	18,9	21,8	34,9	18,1	43,4	60,7	8,0	47,1	57,3	19,7	15,9	35,4	11,8	88,9	107,0	30,5	0,0	71,9
3	29,8	25,5	38,6	23,8	27,9	38,2	11,2	61,8	71,8	16,0	43,5	58,7	17,5	79,7	98,3	35,1	35,3	71,9
4	28,3	33,2	46,6	12,6	65,1	75,9	12,0	41,2	51,1	31,6	11,2	35,7	13,2	82,5	106,8	28,2	56,7	71,9

Industrial Example

History of Nordic Booster - From Marine to Land-based charging

First certified marine battery packs made in Northern Europe

2016

World First encapsulated high power charger with batteries

2020

World First mobile high power charger with batteries

2022

Third generation mobile charger with batteries

2023

Delivered batteries for the first line of commercial electric excavators, (2018).

Prototype containerized high power charger for Oslo Municipality, (2020).

Opened factory in Norway, (2022).

We were the first to produce a commercial line of mobile chargers with integrated battery systems

Fast Charging between battery systems (CCS Inlet)

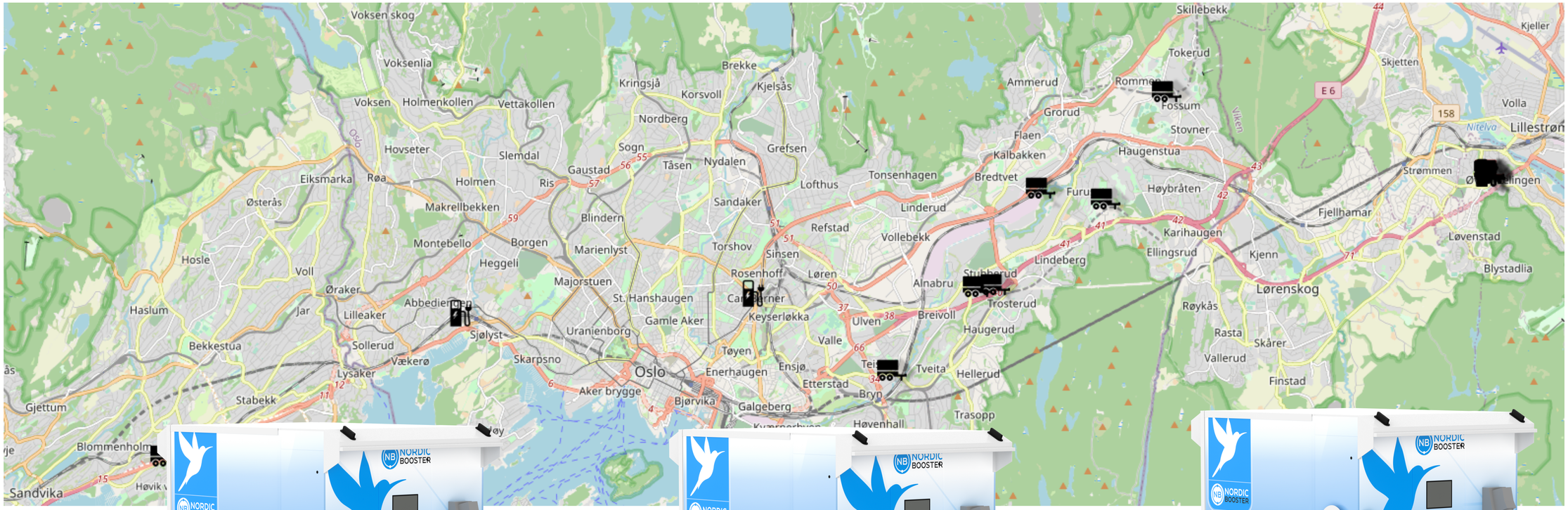
DC fast charging between chargers. How chargers can charge each other. CCS Outlet Exists.

Elektrisk design(komponenter, oppkobling, beregninger av effekt+++),

Programmering(Styre inlet i samspill med batteribank og DC lader, integrasjon mot eksisterende systemer), mekanisk integrasjon(hvordan kan CCS inlet integreres i eksisterende produkter).

Virtual Aggregated Grid Support

What is required to participate in the grid market?
How to virtual aggregate multiple chargers for a grid response system?
How can a virtually aggregated system function towards the grid?



Municipality Example

Thema til Masteravhandlinger

- Electrical transition as driver for data-driven municipalities (Jonas)
  - ➡digital infrastruktur for el. monitoring og kontrolle
  - ➡ forbedringspotensialet
  - ➡
- Contribution of PV-empowered municipality buildings
  - ➡analysere dagens modeller for PV energy
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- Digital Twins for large scale car charging infrastructures
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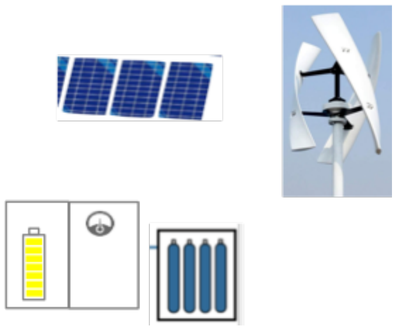
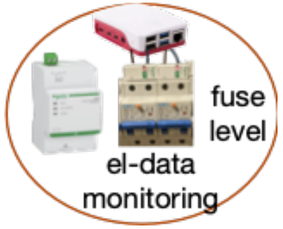
Topics for Masterthesis

- Contribution of swimming pools to the flexibility market
  - ➡ Utgangspunkt: kommunale bygninger med svømmebasseng (f.eks. skoler)
  - ➡ modellering av potensialet basert på real-life verdier

- Fostering the energy transition of homes
  - ➡ fra “Minimum viable product” (MVP) til controlled infrastruktur
  - ➡ økonomisk optimalisering i forhold til investering, batteri, oppgradering av el
  - ➡bruk av app og “low-cost” infrastruktur



- AI-based assessment of quality of houses/buildings (A-G) from energy monitoring
  - ➡ hvilken verdier kan vi hente direkte
  - ➡ hvordan øker vi kunnskapen gjennom “rapportering” (Norge: egenrapporteringsskjema om husholdningens kvalitet)



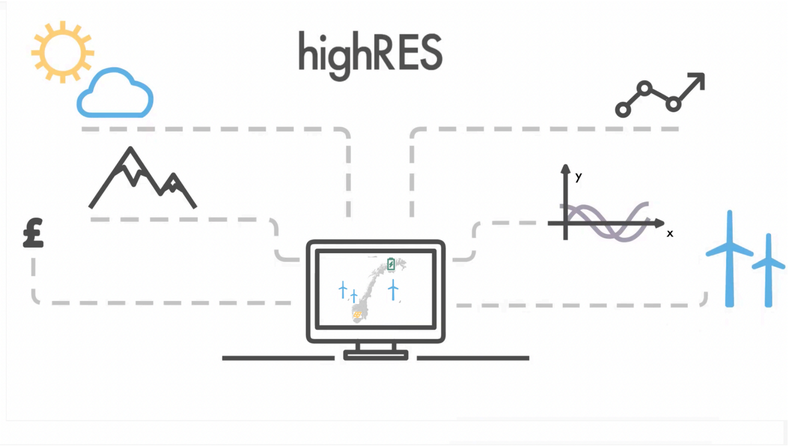
Climate Modelling

Energy systems modelling at ITS
by Marianne Zeyringer and her team

Why modeling of the energy system?

- Decisions are based on models: mental models, complex mathematical tools
- Can’t do experiments with the real energy system over decades → need virtual laboratories

➡ Energy systems model at high spatial and temporal resolution for Norway in an interconnected Europe



Research foci:

Socially accepted and just energy system design including societal security

Weather and climate-resilient planning

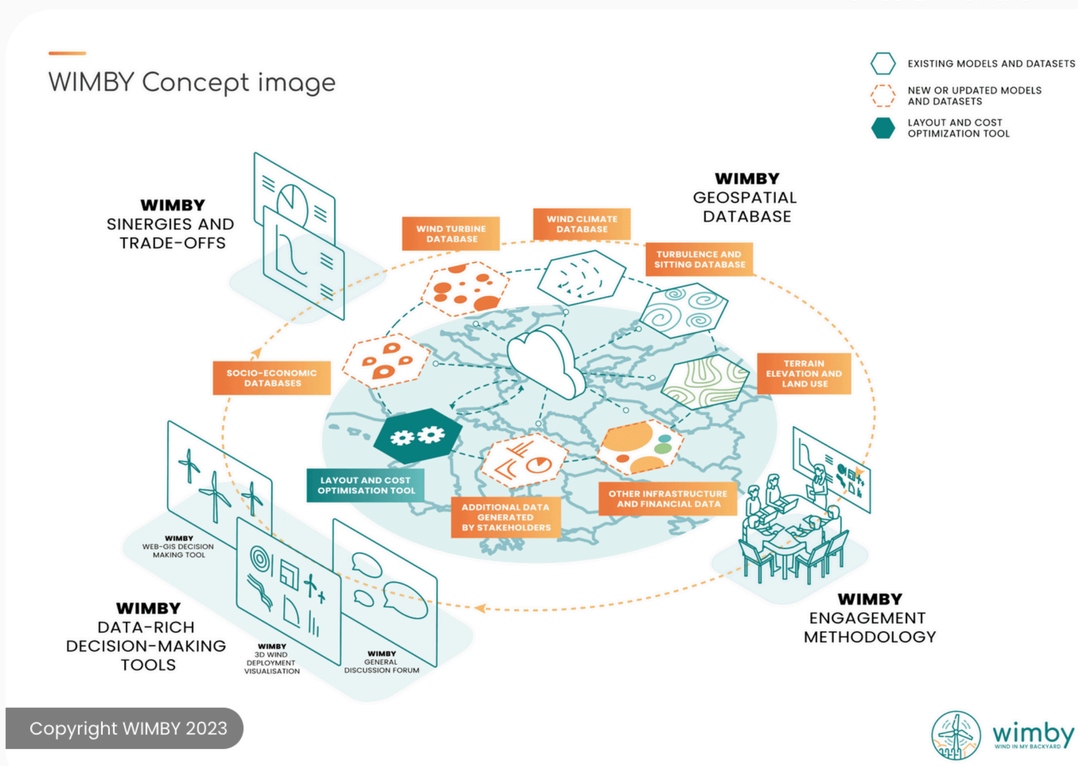
New extreme weather risks for the energy system:

- Operational
- Infrastructure
- Compound events

Some example research questions that we work with:

How to design energy systems for 2050 that reach net-zero?

- What are the effects on the energy system design and total costs if offshore wind costs decrease or there, if there is no acceptance for onshore wind or if Norway decides not to trade to trade electricity?
- How to design an energy system that is resilient to weather and climate change?
- How does an energy system look like that has minimum impact on nature and biodiversity?



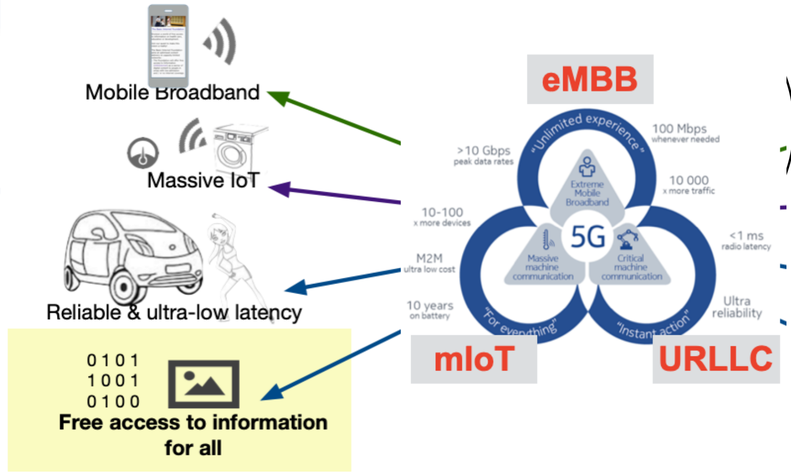
One good example is the EU-project “WIMBY- Wind in my background” supporting the adoption and acceptance of wind-power in the European Union and Norway where we use our European energy system model and lead a case study in Rogaland.

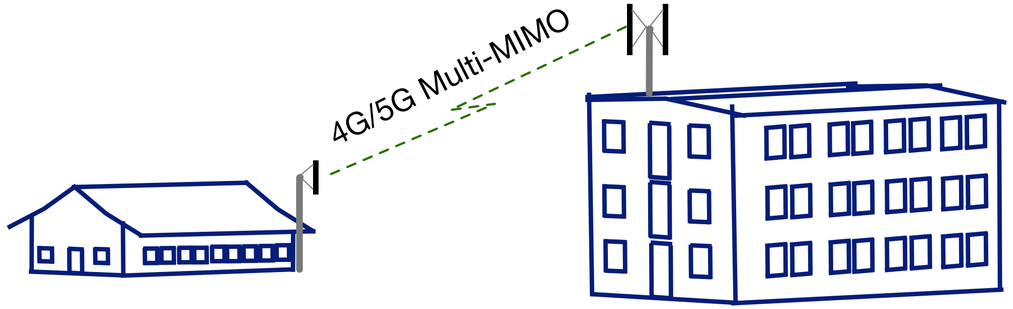
Conclusion - Master Thesis opportunities Digital for Sustainable Internet Connectivity

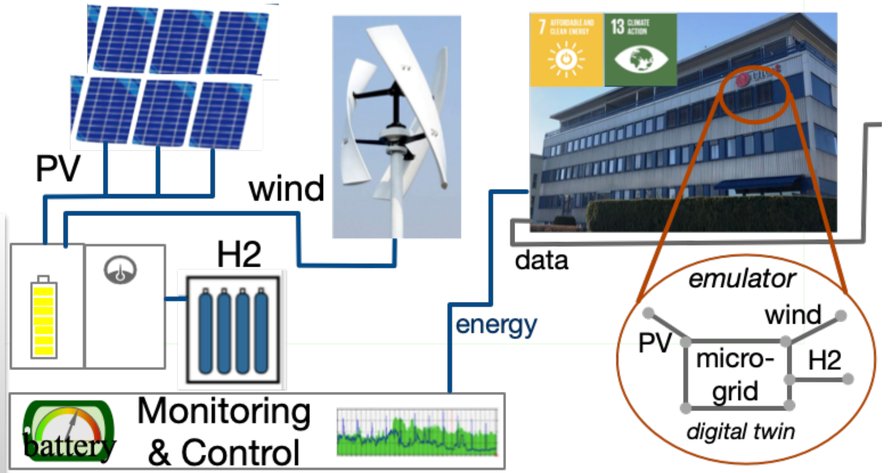
- Communications
  - Internet Lite - “Digital Pedestrians & Cyclists”
  - 5G InfoSpot - Universities connecting schools

- Energy, Industrial- and Home-Modelling
  - physical infrastructure (H2, wind, solar)
  - digital twin, home-, municipality-, industrial system

- Climate Modelling
  - high-spatial resolution models
  - Just transition







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- Marianne.Zeyringer, Mathias Hudoba de Badyn, ….

slides: https://its-wiki.no/images/2/26/Masteroppgaver-ITS.pdf