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Teesside University

Network Tariffs and Energy Positive Neighbourhoods:

Can Energy Positive Neighbourhoods help enable the integration of distributed generation?

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Overview

- Motivation
- Energy Positive Neighbourhoods
- Distribution Network Charges
- Exploring Differential Charges in an EPN
- Conclusions

Motivation

- European governments aim to meet ambitious CO2 reduction targets by applying financial instruments and other polices to encourage Distributed Renewable Energy (DREG) uptake.

- Moving from large scale centralised controllable energy generation, which is largely fossil-fuelled, to small scale intermittent DREG is problematic for existing energy networks.

- An approach which could contribute to resolving the integration of DREG into current electricity networks lies in the concept of an energy positive neighbourhood (EPN).

- This paper presents simulations which explore the sensitivity and efficiency of DREG with respect to the introduction of differential electricity distribution network charges applied to an EPN.

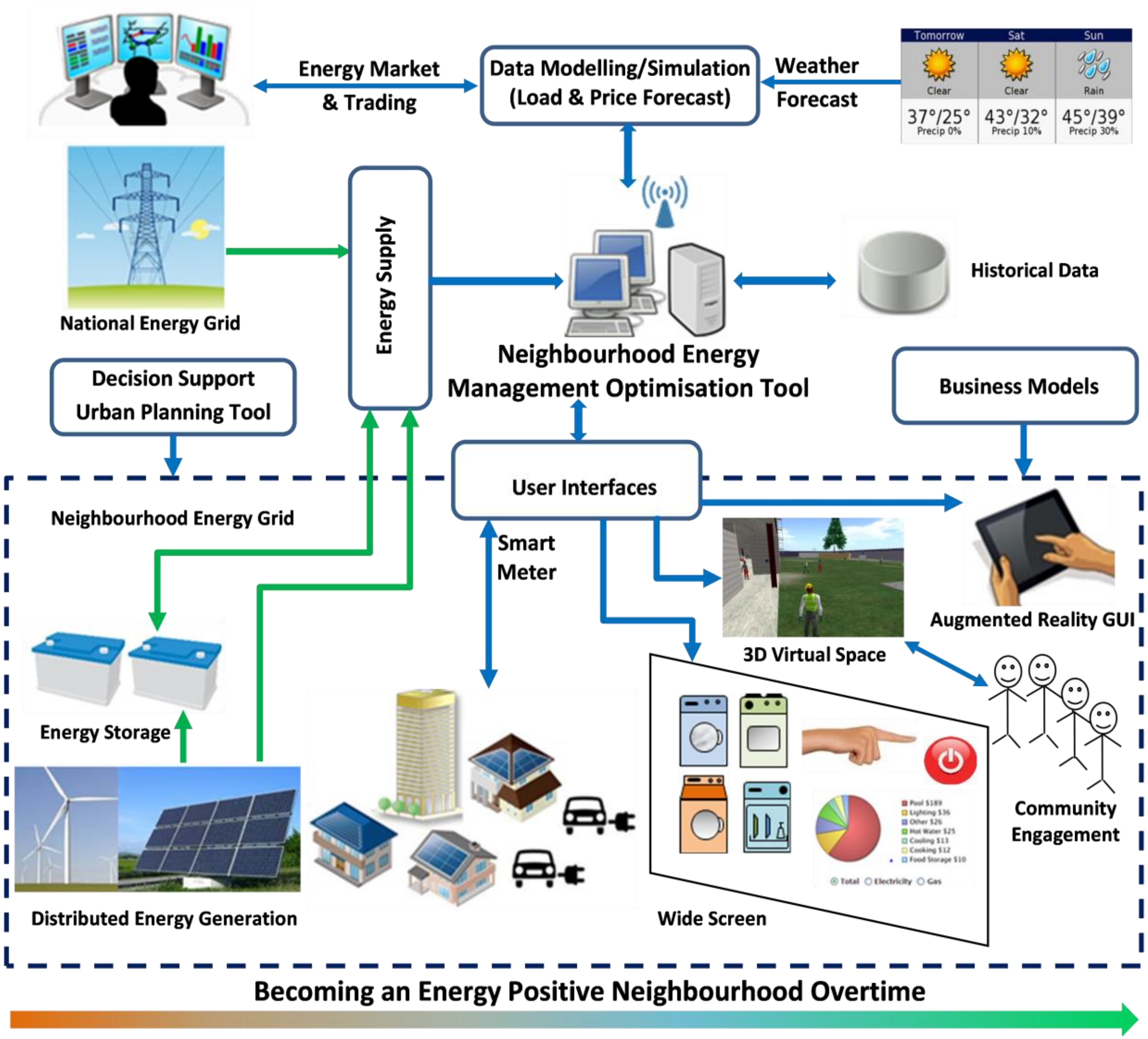
Energy Positive Neighbourhoods

- What is an Energy Positive Neighbourhood ?
  - An area in which the annual energy demand is lower than the annual energy supply from local renewable energy sources

- To implement an EPN it is necessary to optimise the production, storage /retrieval & selling of renewable energy at the neighbourhood level.

- IDEAS project main outcomes:
  - Reduction of energy demand & CO_2 at two pilot sites
  - Validated IDEAS business models & tools
  - Informing Energy Policy

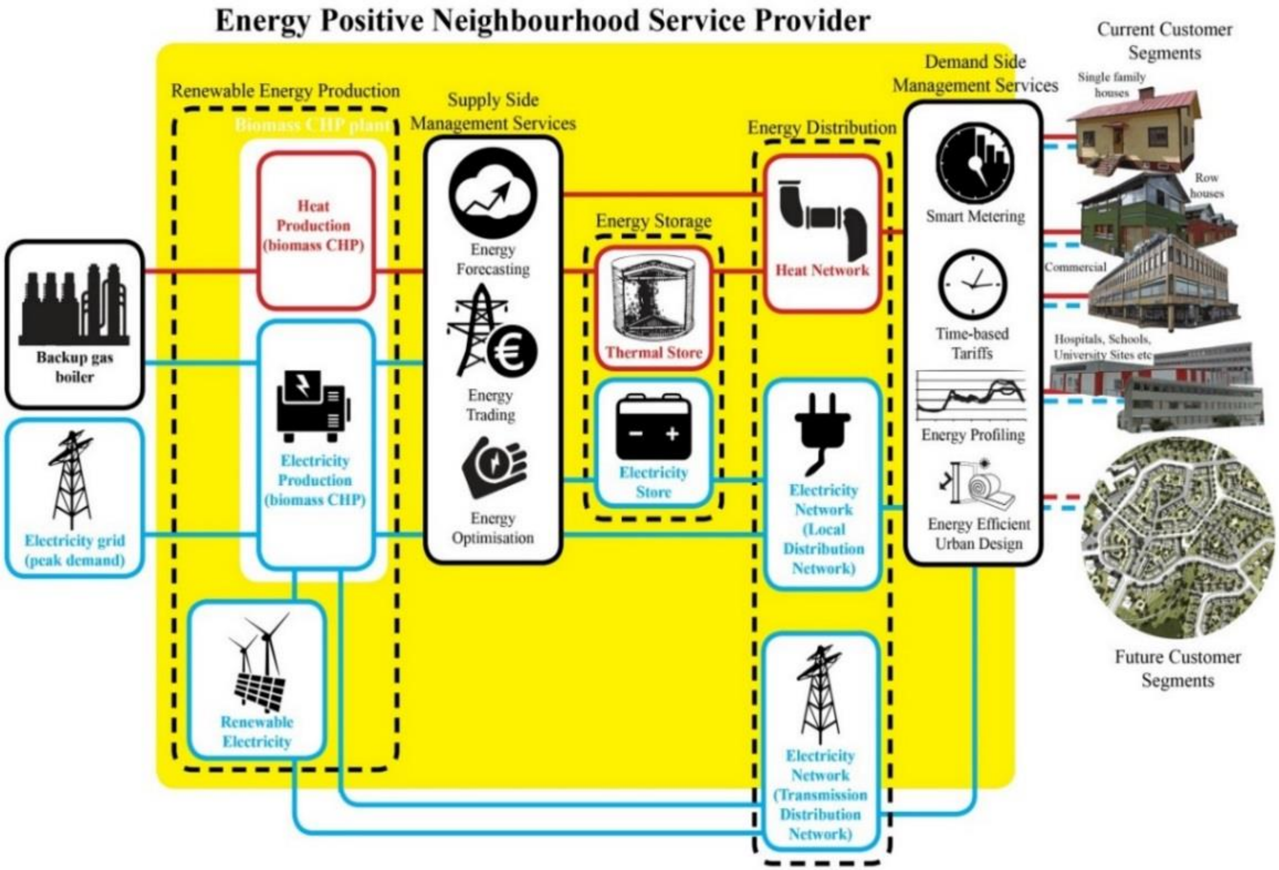
EPN Components



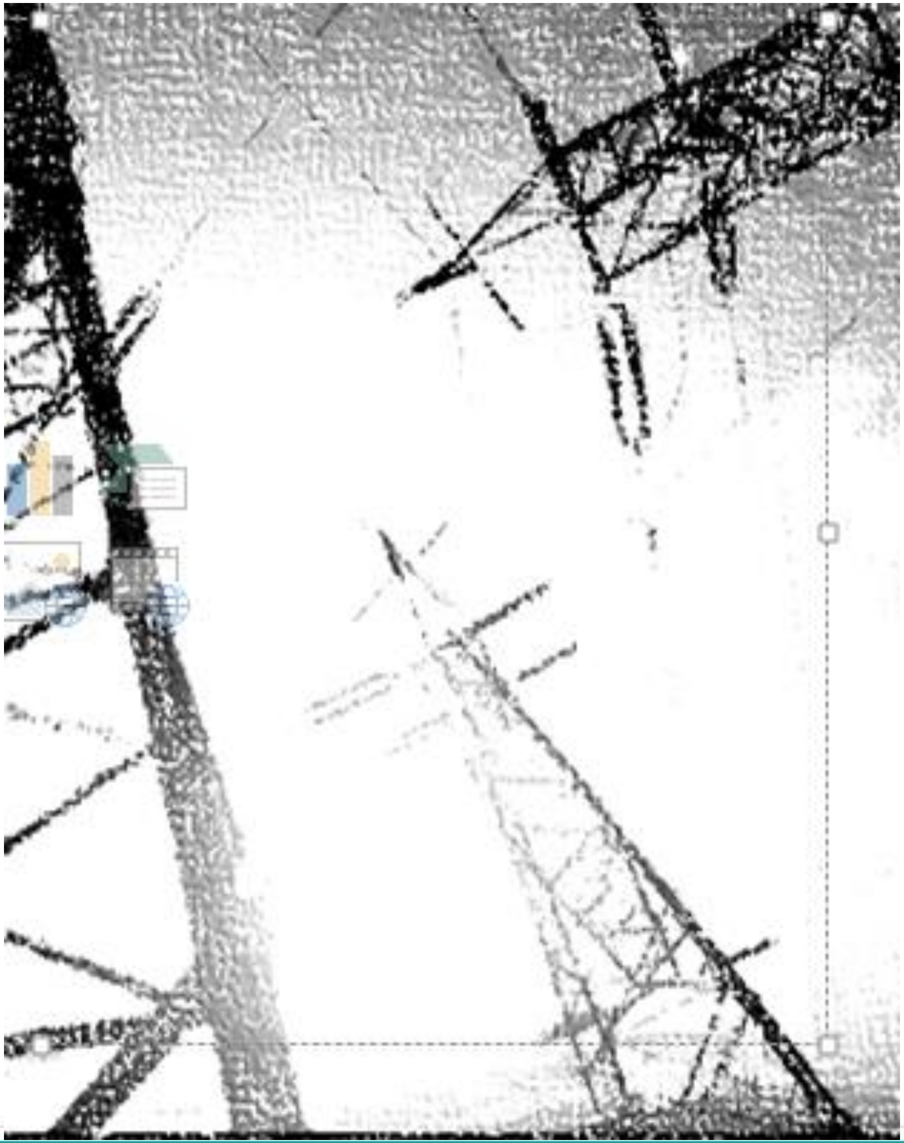
- **A Neighbourhood energy management tool** to optimise energy production & consumption
- **User interfaces** that engage communities & individuals
- **A decision support urban planning tool** to optimise the planning of energy infrastructures
- **Business models** that support the incremental rollout of the infrastructures required for EPNs

EPN Service Provider

- **IDEAS business models** focus on supporting companies with expertise in the energy industry to evolve into **Energy Positive Neighbourhood Service Providers** that generate, distribute and sell energy within an EPN



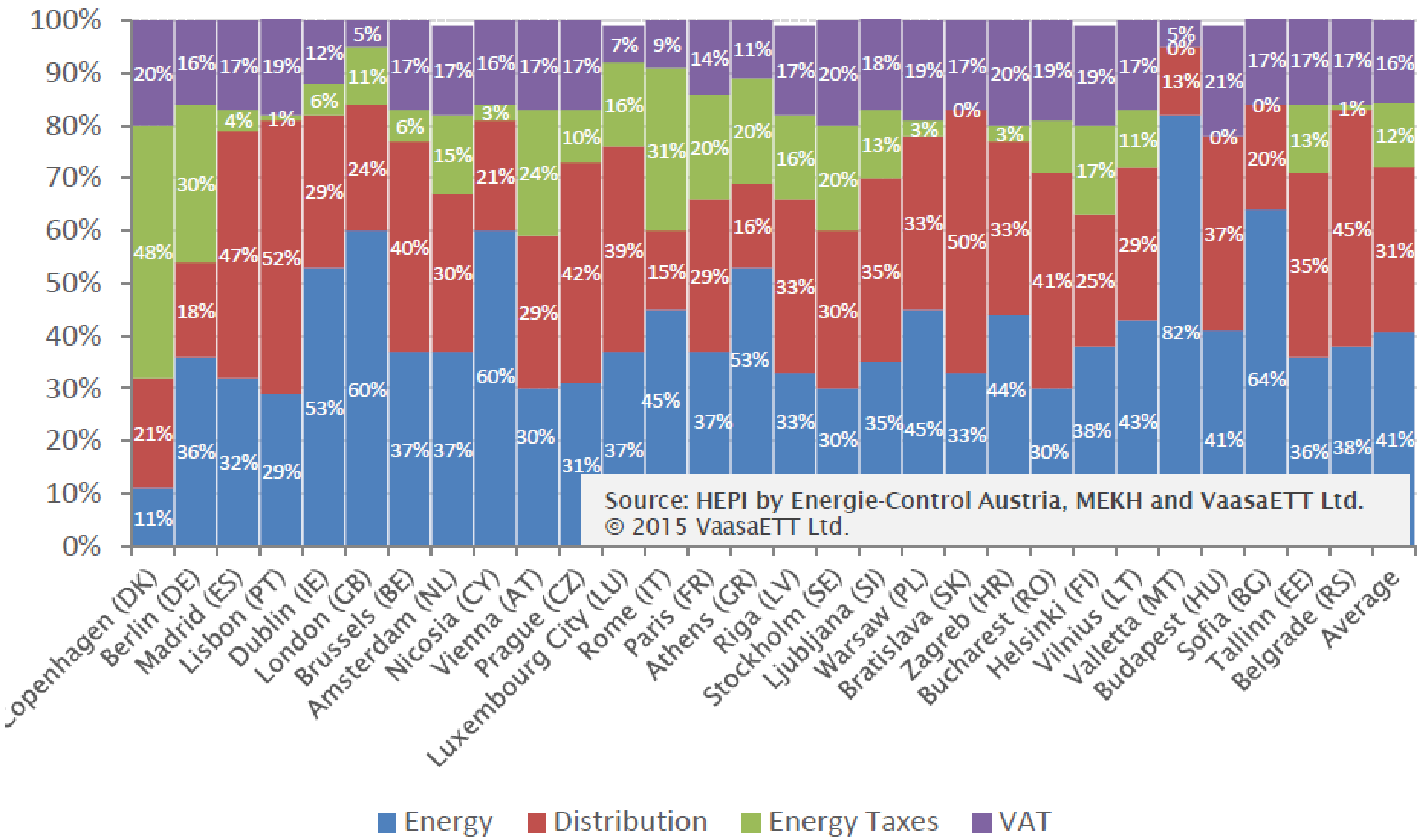
EPNSP Distribution Network Charges



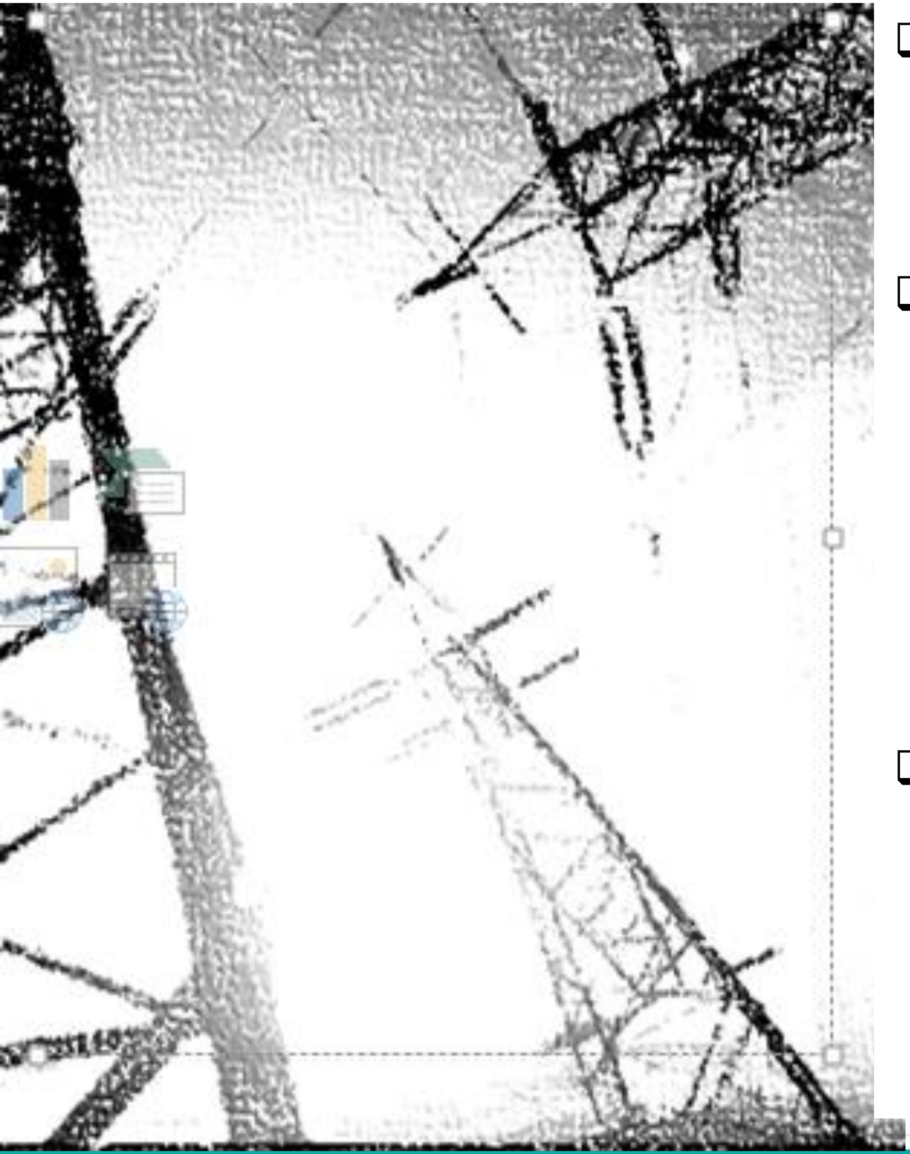
- To support the local consumption of DREG requires a economical method of transporting electricity to local customers currently
  - It can be transported over the wires of the local DNO & sold directly to local users incurring a standard network ‘use of system’ charge.
  - It can be transported over a PWN incurring a charge set by the owner of the PWN.
- Investment costs for PWN are high & they are wasteful duplication of current EDNS
- **Would a differentiated approach to DNO charges, reflecting the distance electricity is physically transported, be advantageous?**

Static Distribution Network Charges

DNOs have set a volumetric charge for the use of their EDNs which usually makes up between 22 and 50 percent of a customers bill.



Differential Distribution Network Charges



- An EPNSP could be charged an appropriate cost-reflective tariff for the use they actually make of a DNO's network!
- A simple two tiered distribution charge:
  - which differentiates between 'locally generated electricity' and 'non-locally generated electricity'
  - based upon transactions remaining inside or crossing a defined EPN geographical boundary
- **Preliminary** Research suggests that this:
  - encourages the use of local generation
  - reduces the net amount of electricity handled wholesale & requiring transportation over transmission and distribution networks by up to 50%

Feed In Tariff?

- When techno-economic optimisation is applied to energy management, current Feed in Tariffs (FITs) distort the results.
- It is always cost-optimal to sell to the grid and take advantage of the FIT; reducing the amount of locally produced renewable electricity that is consumed locally in an EPN.
- This has a wider effect of distorting wholesale energy markets.
- This proposal is conceptually a little different.

Large-Scale Simulation Study

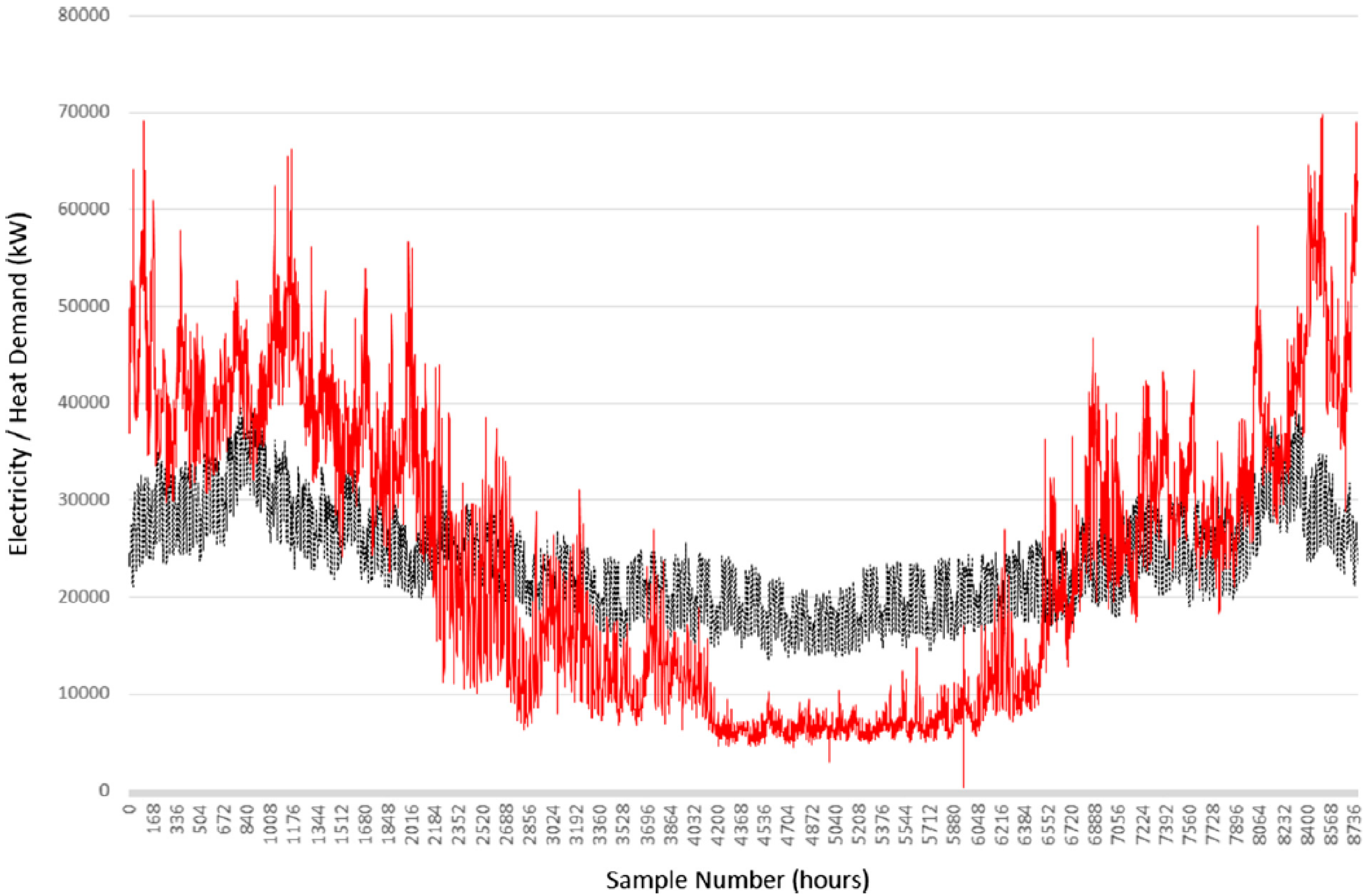
- **What impact do the proposed changes to distribution charges have upon the optimization of a small to medium sized EPN over the course of a full year?**

- To help answer this question (and several others), a dataset was obtained for a representative district heating system in Sweden.

- Hourly data for heat demand and the corresponding electricity demand, plus outdoor temperatures and wholesale electricity prices, were used to carry out a series of experiments.

- The EPN optimization was simulated assuming static (regular) DNO charges, and differential DNO charges (50% reduction for local use).

Test Data



80000
70000
60000
50000
40000
30000
20000
10000
0
Electricity / Heat Demand (kW)
0 168 336 504 672 840 1008 1176 1344 1512 1680 1848 2016 2184 2352 2520 2688 2856 3024 3192 3360 3528 3696 3864 4032 4200 4368 4536 4704 4872 5040 5208 5376 5544 5712 5880 6048 6216 6384 6552 6720 6888 7056 7224 7392 7560 7728 7896 8064 8232 8400 8568 8736
Sample Number (hours)

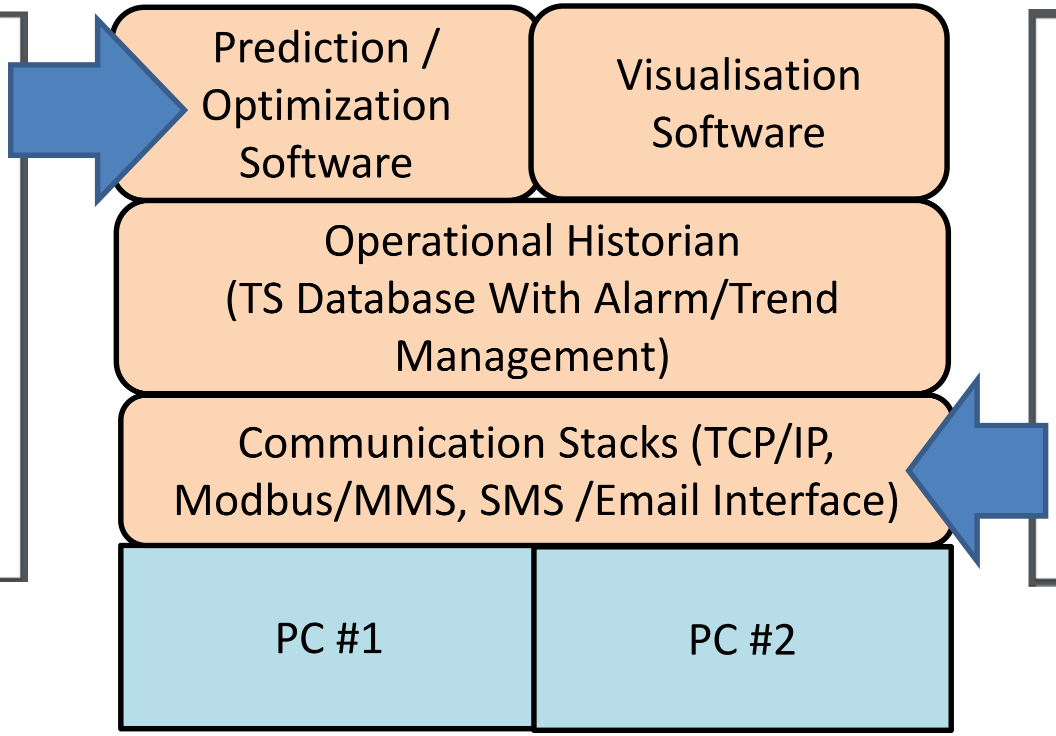
ICT Infrastructure

- It has been estimated that for approx. 50 k€ installation and 50 k€ yearly running costs, a small EPN can use an ICT infrastructure build out of mainly open-source components:


Applied Energy

Load forecasting and dispatch optimisation for decentralised co-generation plant with dual energy storage

Michael Short *, Tracey Crosbie, Muneeb Dawood, Nashwan Dawood




energies

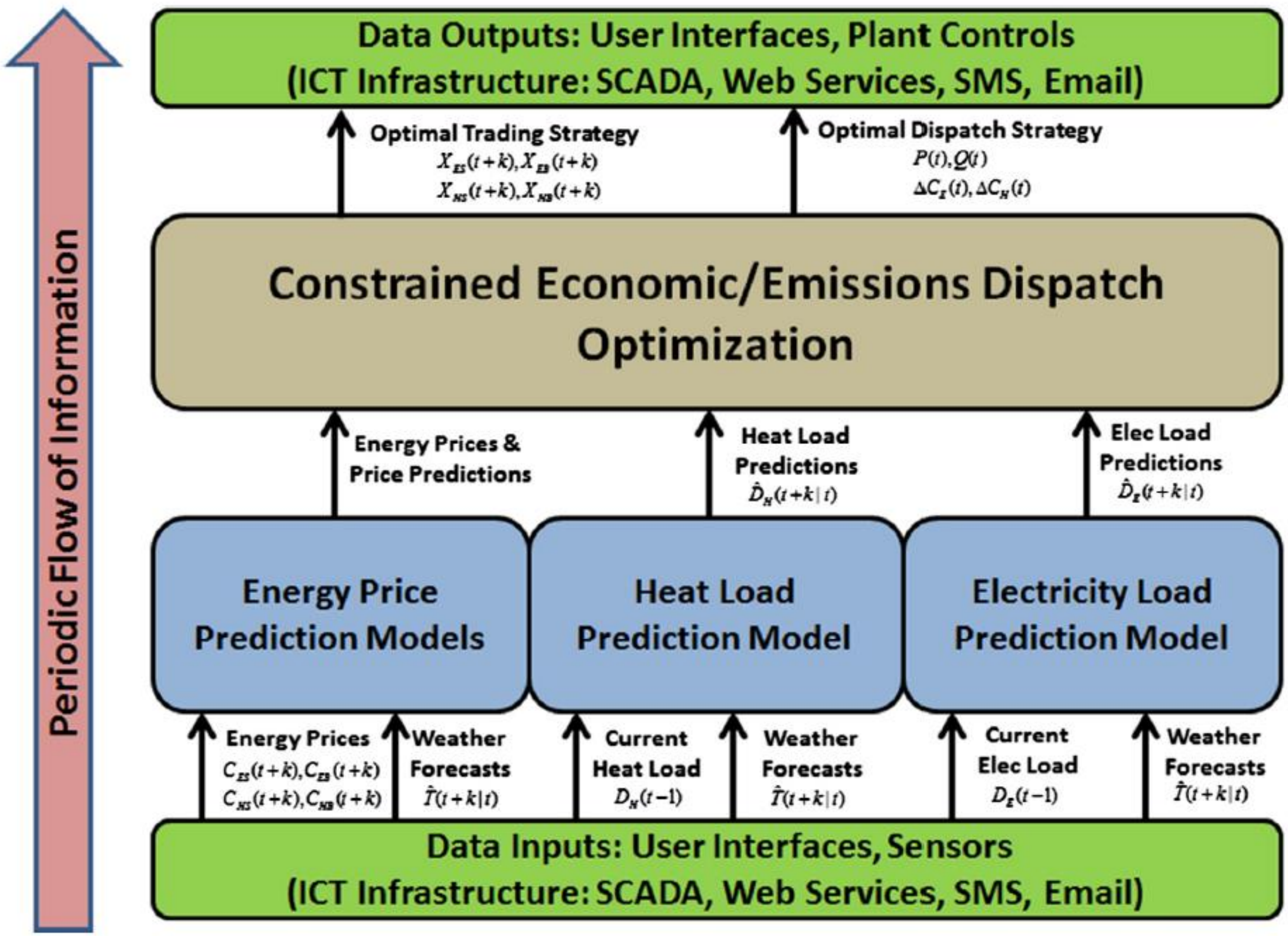
MDPI

Article

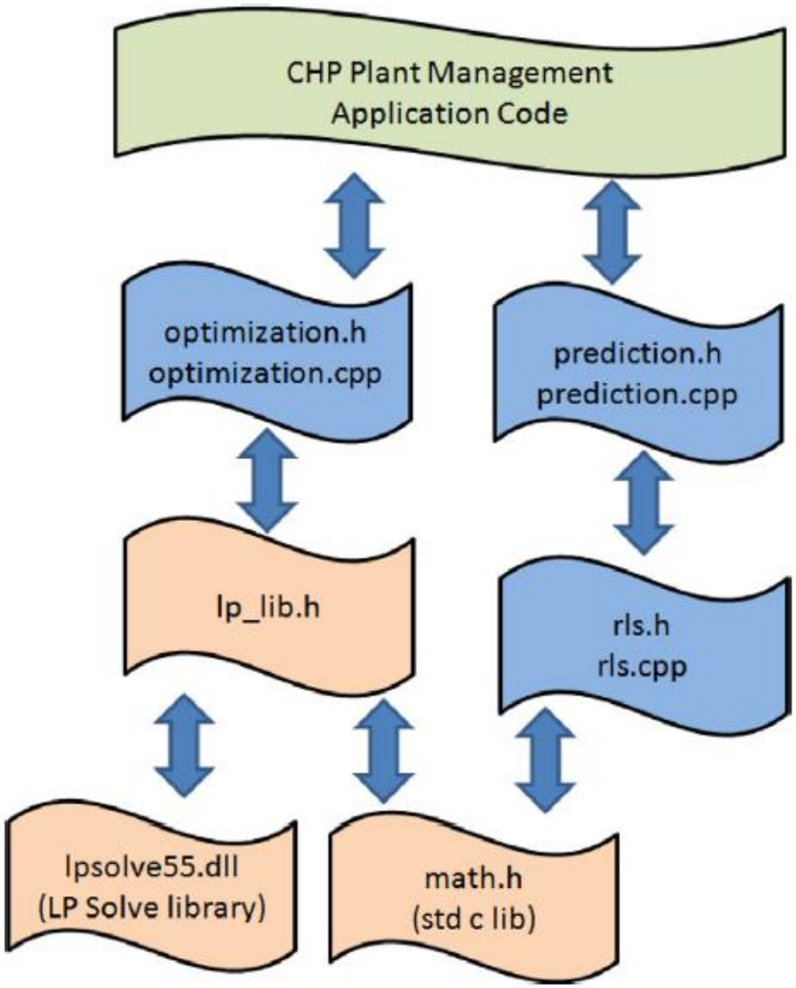
Tunneling Horizontal IEC 61850 Traffic through Audio Video Bridging Streams for Flexible Microgrid Control and Protection

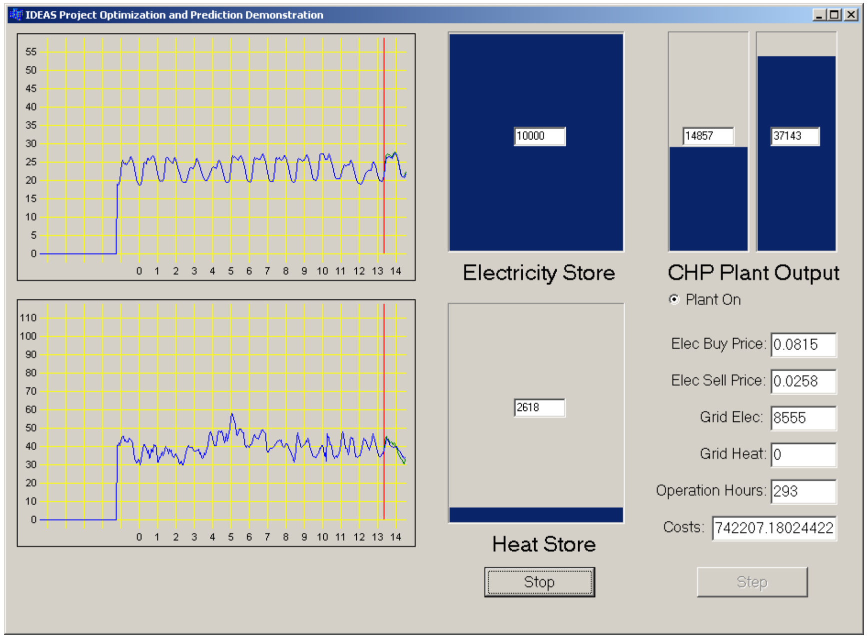
Michael Short *, Fathi Abugchem and Muneeb Dawood

Rolling-Horizon Optimal Dispatch



Software Architecture / Interface





Simulation Results

- What impact do the proposed changes to distribution charges have upon the optimization of a small to medium sized EPN?

Metric	Baseline Costs	Modified Costs
Net Acquisition Cost (€ / kWh)	0.045869	0.030071
Equivalent Cutomer Cost (€ / kWh)	0.045869	0.036737
Shutdown Events (#)	111	33
Average CHP Plant Load / Hour (%)	73.98	74.7
Average Aquired Elec/ Hour (kWh)	5626.41	2799.69
CHP Plant Utilization Factor (%)	98.61	99.62

Key Observations

- It becomes more economically viable to run the plant for longer, and a significantly lower reliance is placed upon grid energy resources. Cost savings may also be passed onto consumers.

- The energy bought from the grid is reduced by an average of over 50%; this is compensated by the plant remaining operational for more hours over the course of the year and being operated at higher (> 0.7% average) heat and output power levels.

- The data indicate that there were 70% fewer plant shutdowns over the course of the year (in each case, it was more economical to keep the plant running rather than purchase electricity) resulting in a 1% increase in the CHP plant utilization.

Conclusions

- DNO charges which reflect the distance of electricity transported:

  - Help to ensure that techno-economic optimization carried out within an EPN favours the local consumption of DREG

  - Provide an alternative to Feed In Tariffs which do not distort wider wholesale energy markets in the presence of techno-economic DREG optimization

  - Are not currently implemented in the EU, but provide an area of market regulation that could be further explored