The integration of renewable energy sources, stationary batteries and vehicle-to-grid assets

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Cenex Introduction

Transport | **Innovation**

Energy | **Low Carbon Vehicle Show**

Based in Loughborough, Cenex was established in 2005 as the UK's first Centre of Excellence for Low Carbon and Fuel Cell technologies

Today, Cenex operates as an independent not-for-profit consultancy specialising in the delivery of projects, supporting innovation and market development, focused on low carbon vehicles and associated energy infrastructure

Reducing Emissions from Transport

Helping clients to assess, evaluate, implement and deliver low emission vehicle and associated infrastructure strategies

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CleanMobilEnergy Project

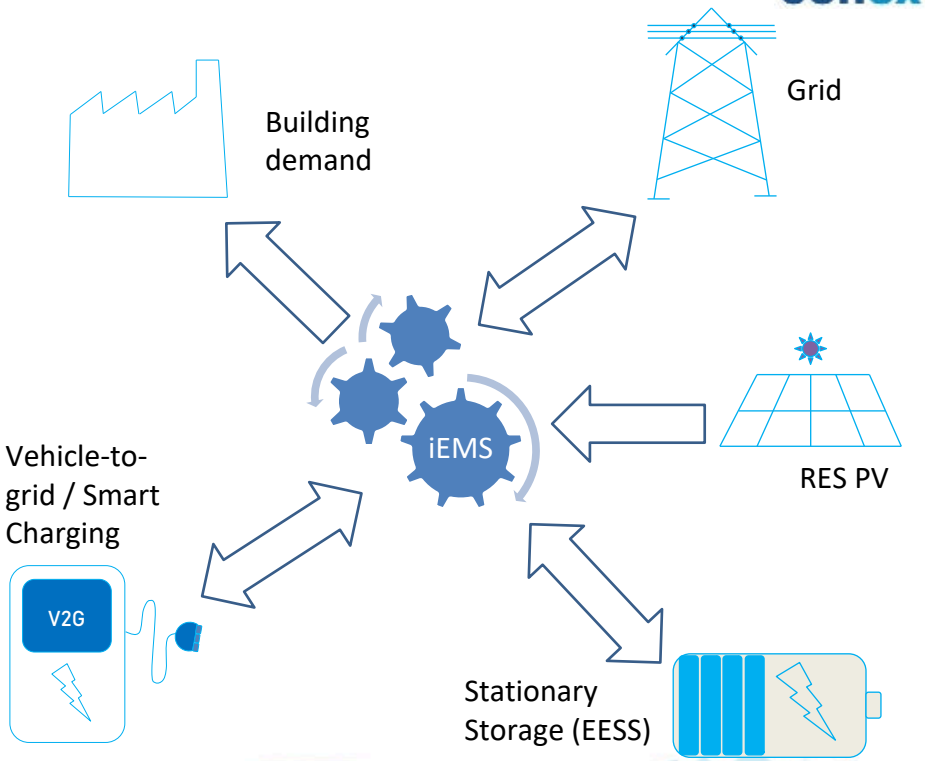
- CleanMobilEnergy (CME) is a €7m project with Interreg North-West Europe funding – running 09/2017 – 03/2021.
- 9 different partners in 6 countries.
- Smart Energy System Management to integrate renewable energy, storage and electric vehicles.
- 4 CME City Pilots:
  1) **Arnhem**: medium size city, large renewable energy production, large storage in industrial area;
  2) **Nottingham**: medium size city, large renewable energy production, medium size storage, electric vehicles and bi-directional chargers in a controlled area (depot);
  3) **London**: large city, large renewable energy production at multiple locations, large storage, electric vehicles and bi-directional chargers in controlled areas with separate grid (depot);
  4) **Schwäbisch Gmünd**: small city, small renewable energy production, storage facilities and electric bikes in residential area.

Europäisches Institut für Innovation - Technologie e. V.

http://www.nweurope.eu/projects/project-search/cleanmobilenergy-clean-mobility-and-energy-for-cities/

Project Objectives

- Significantly reduce greenhouse gas emissions in cities by coordinating:
  - Renewable energy sources (RES).
  - Energy storage.
  - EV charging.
- Achieved using an innovative interoperable energy management system (iEMS).
- The iEMS optimises energy usage and storage to increase economic value of RES.



Nottingham Eastcroft Depot

- Eastcroft is a city authority services depot in city of Nottingham, UK. Site includes some city council offices.
- CME project delivery plans:
  - Electrification of further 40 city services vans and council pool vehicles.
  - Installation of 40 Vehicle-to-Grid chargepoints.
  - Installation of 89 kWp (now 138 kWp) of PV.
  - Installation of stationary battery.
- Consolidation of multiple small electrical supplies into single larger supply.

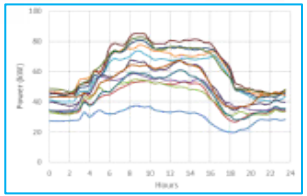
Energy Model

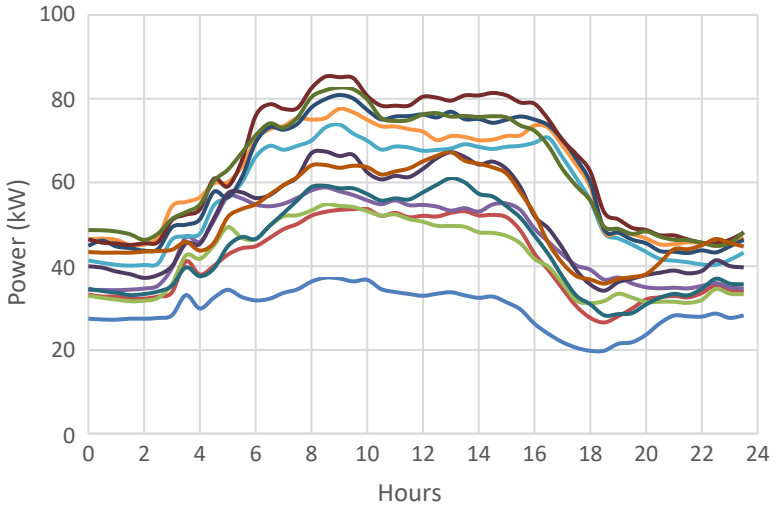
- Excel based tool to analyse energy flows between components.
- Inputs:
  - Existing metered half-hourly grid consumption for each supply.
  - Simulated PV generation profiles.
  - Transport usage and operational profiles.

Assumption	Value	Units
Electricity import from grid during day hours	13.964	p/kWh
Electricity import from grid during night hours	9.771	p/kWh
Export rate (grid feed in)	5.030	p/kwh
Climate Change Levy	0.847	p/kWh
Fixed costs supplier standing charge (p/ day)	34.000	p/day
CO_2 emissions per kWh during day hours*	0.335	$kgCO_2$/kWh
CO_2 emissions per kWh during night hours*	0.265	$kgCO_2$/kWh

* Based on 2018 half-hourly generation data by fuel type in UK. Data source ELEXON

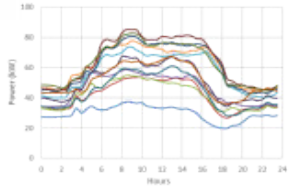
Baseline

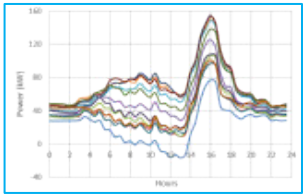


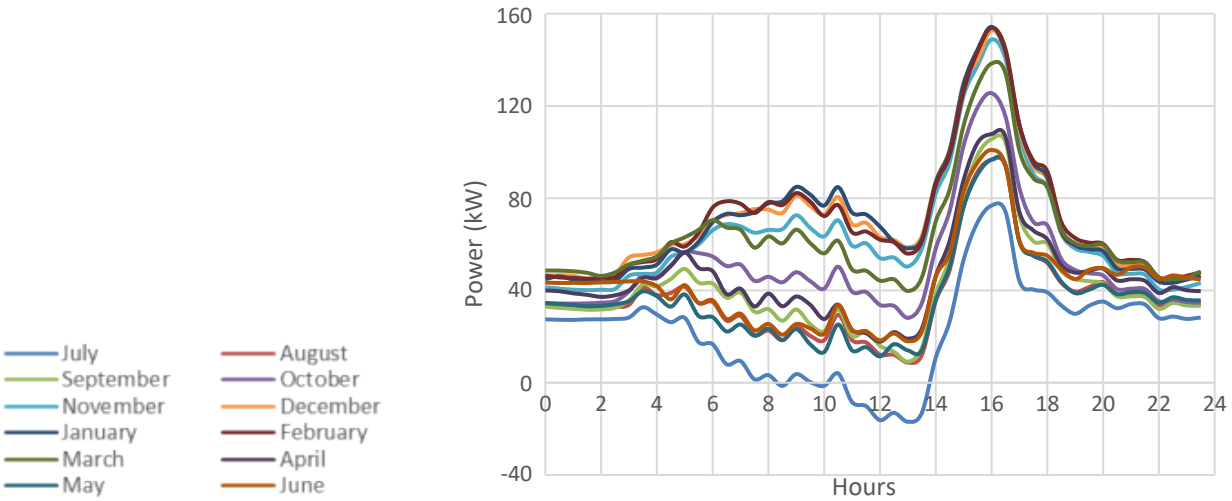


	Baseline
Annual Consumption (MWh)	446.8
Annual export (kWh)	-
Peak Demand (kW)	85.3
Load factor (%)	60.0
Peak Export (kW)	-
Electricity bill (£k)	53.8
Carbon Emissions (tCO_2)	141.0

Integration of PV & EV charging (unmanaged)

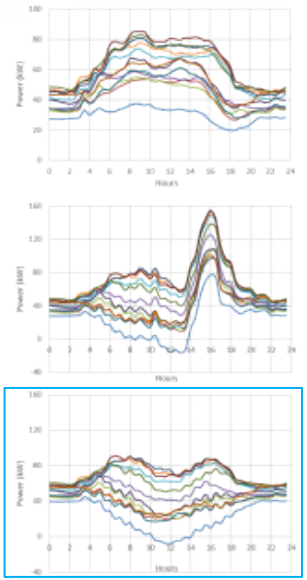


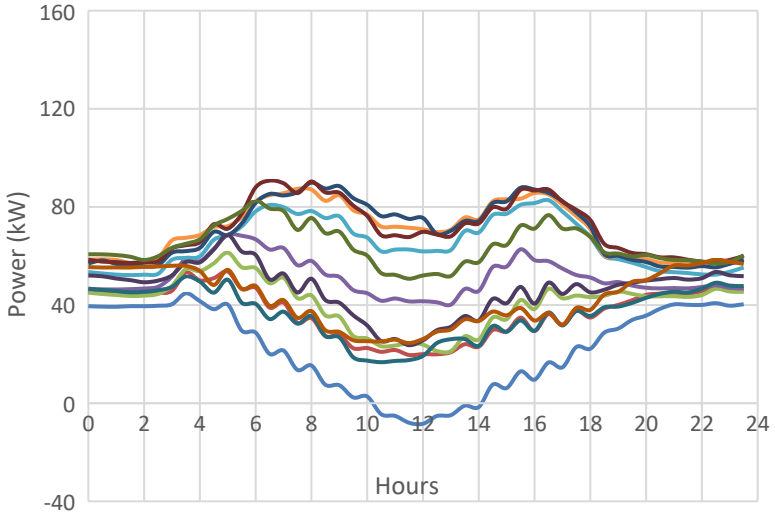




	Baseline	PVs & EVs
Annual Consumption (MWh)	446.8	451.6
Annual export (kWh)	-	612.4
Peak Demand (kW)	85.3	154.3
Load factor (%)	60.0	33.0
Peak Export (kW)	-	16.9
Electricity bill (£k)	53.8	54.5
Carbon Emissions (tCO_2)	141.0	121.0

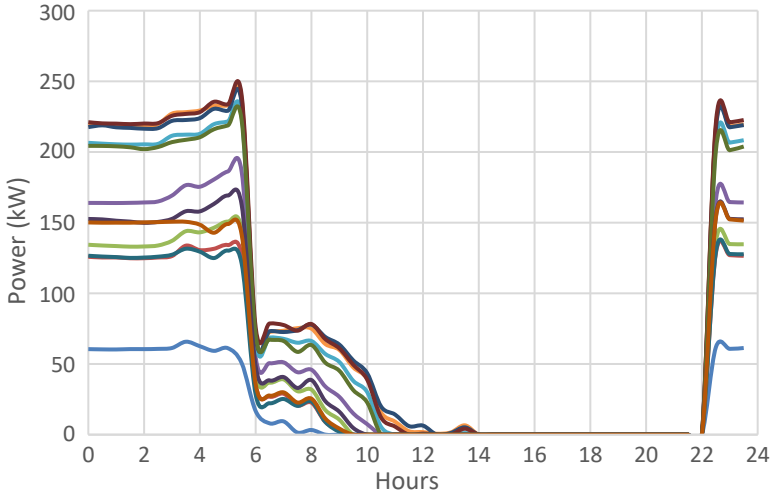
Adoption of smart charging

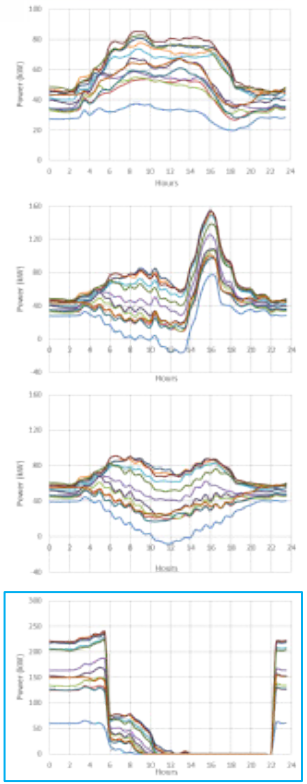




	Baseline	PVs & EVs	PVs & EVs (smart charging)
Annual Consumption (MWh)	446.8	451.6	451.6
Annual export (kWh)	-	612.4	294.1
Peak Demand (kW)	85.3	154.3	90.7
Load factor (%)	60.0	33.0	57.0
Peak Export (kW)	-	16.9	8.4
Electricity bill (£k)	53.8	54.5	53.1
Carbon Emissions (tCO_2)	141.0	121.0	119.0

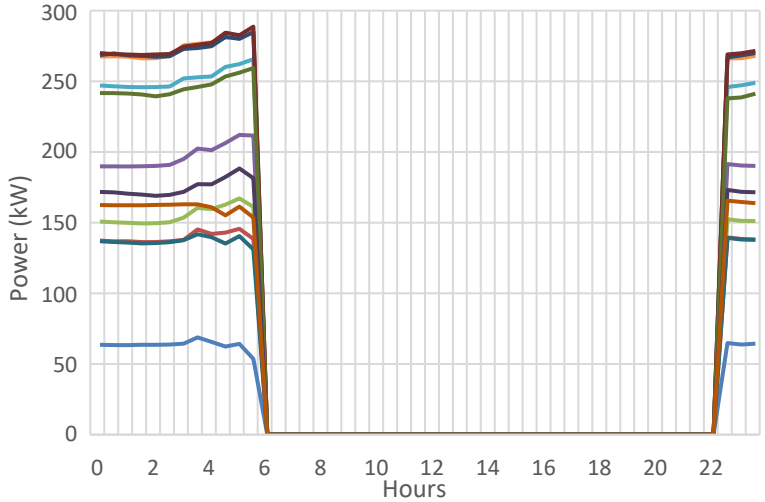
Introduction of V2G assets

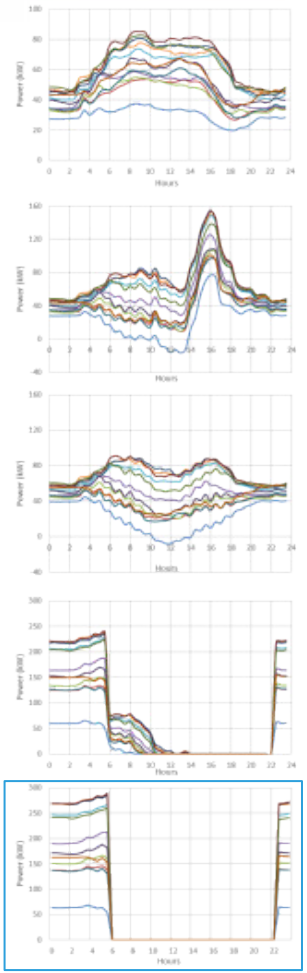




	Baseline	PVs & EVs	PVs & EVs (smart charging)	PVs & EVs & V2G
Annual Consumption (MWh)	446.8	451.6	451.6	522.9
Annual export (kWh)	-	612.4	294.1	-
Peak Demand (kW)	85.3	154.3	90.7	239.8
Load factor (%)	60.0	33.0	57.0	25.0
Peak Export (kW)	-	16.9	8.4	-
Electricity bill (£k)	53.8	54.5	53.1	49.4
Carbon Emissions (tCO_2)	141.0	121.0	119.0	121.0

Introduction of a Stationary Battery





	Baseline	PVs & EVs	PVs & EVs (smart charging)	PVs & EVs & V2G	PVs & EVs & V2G & Stationary Battery
Annual Consumption (MWh)	446.8	451.6	451.6	522.9	534.0
Annual export (kWh)	-	612.4	294.1	-	-
Peak Demand (kW)	85.3	154.3	90.7	239.8	288.7
Load factor (%)	60.0	33.0	57.0	25.0	21.0
Peak Export (kW)	-	16.9	8.4	-	-
Electricity bill (£k)	53.8	54.5	53.1	49.4	47.8
Carbon Emissions (tCO_2)	141.0	121.0	119.0	121.0	120.0

Conclusions & Future

- A model is developed to analyse the energy flows between the components of the Eastcroft Depot in Nottingham.
- Planned EV charging is mostly compensated by the generation of the proposed PV installations; yet, peak power demand is increased by 80%.
- Smart charging is a beneficial approach for reducing peak power demand.
- V2G and stationary batteries can bring grid consumption to zero during the day; economic savings and reductions in CO_2 emissions; peak power demand overnight is increased significantly.
- Energy only model to complement business case models and optimisation based approaches.

Thank you for listening

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