Local Levelised Cost of Energy

a financial indicator for decision-making on local energy systems

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Background

Piloting innovations

Policy

- Energy Community, PED

Economy

- Capacity as a Service

Societal

- Municipal one-stop-shops

Technology

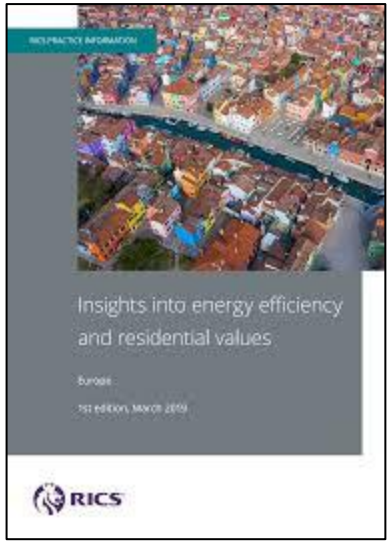
- ICT – Peer to Peer energy trading

Local Energy Systems

DUT Driving Urban Transitions

Smart Cities Marketplace

European Commission



Action Research

Research <> Practice

The Challenge for Local Energy System design

EU Policy

- Green, Smart, Decentral
- Local Energy Systems
  - Collective Self-consumption
  - Citizen Energy Community
  - Positive Energy District
  - …
- And building-level, grid energy

What level of action?

LCOE as Metric for Cost-effectiveness

Lifetime cost / lifetime output €/MWh

Across generation technologies

Benchmarking, PPA

"Levelised Cost" of Energy (LCOE):

"LCOE is defined as the ratio of the net present value of total capital and operating costs of a generic plant to the net present value of the net electricity generated by that plant over its operating life."

Simple...

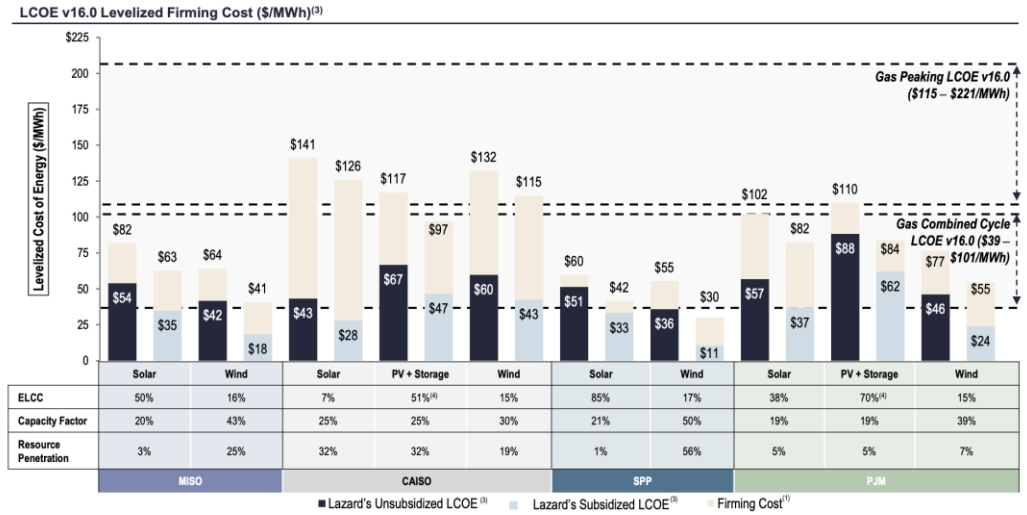
$$LCoE = \frac{\sum_{t=1}^{n} \frac{I_t + M_t + F_t}{(1+r)^t}}{\sum_{t=1}^{n} \frac{E_t}{(1+r)^t}}$$

Not so simple...!

Investment — Annual Operation — Energy

$$= \frac{PCI + \sum_{n=1}^{N} \frac{DEP}{(1+DR)^n} * TR + \sum_{n=1}^{N} \frac{LP}{(1+DR)^n} - \sum_{n=1}^{N} \frac{INT}{(1+DR)^n} * TR + \sum_{n=1}^{N} \frac{AO}{(1+DR)^n} * (1-TR) - \frac{RV}{(1+DR)^n}}{\sum_{n=1}^{N} \frac{Initia\ KWh\ X\ (1-System\ Degradation\ rate)^n}{(1+DR)^n}}$$

quote: www.gov.uk



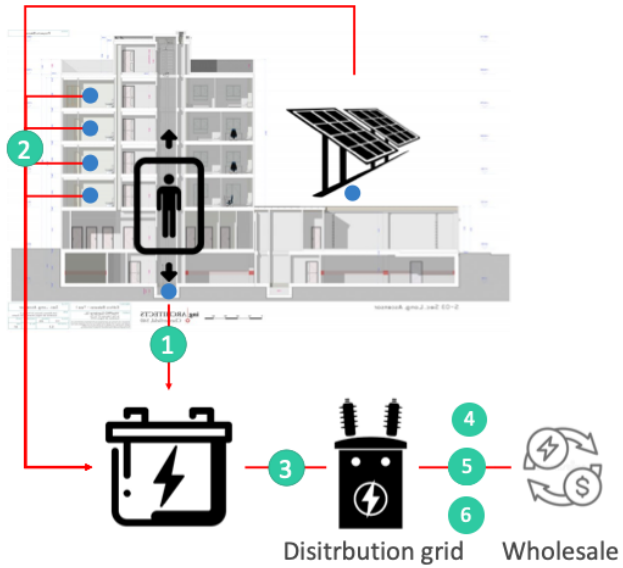
Case study: multi-family dwelling

- Amersfoort, the Netherlands
- PV + Storage + Grid flexibility
- 169 MWh/y, 110kVa, 100kWp PV, 160kWh/kW BESS

Building – grid interaction and convergence

- Deep renovation programmes
- Smart systems become available
  - VRE generation
  - BESS
  - Flexibility services

- Smart systems are complex
  - Integrated (not stand-alone)
  - Have value potential
  - Have dynamic outcomes



Self-consumption 1 2

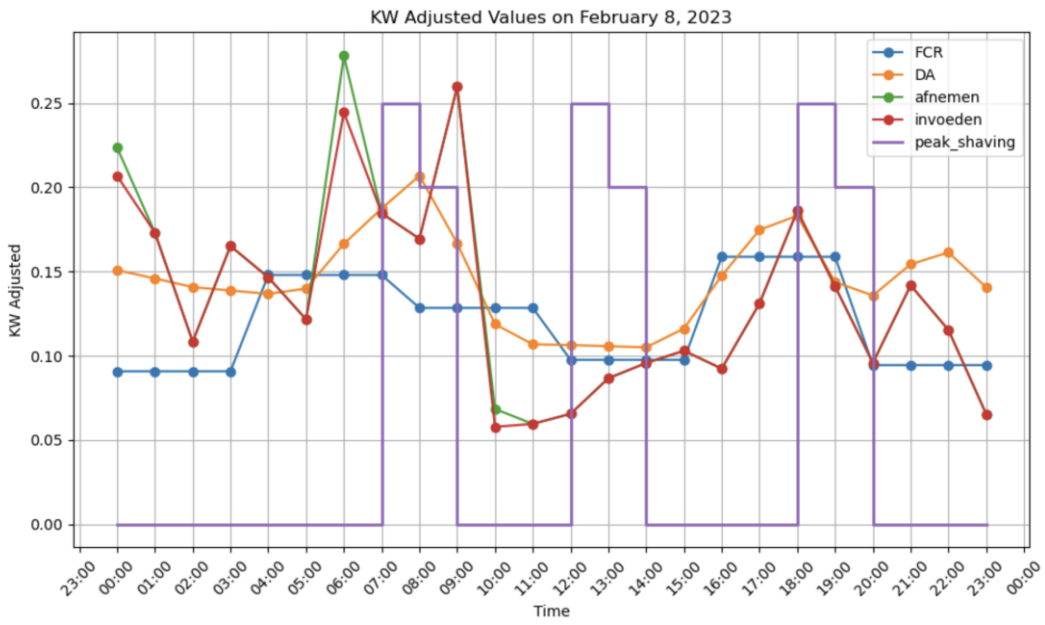
DSO capacity services 3

TSO capacity and wholesale 4 5 6

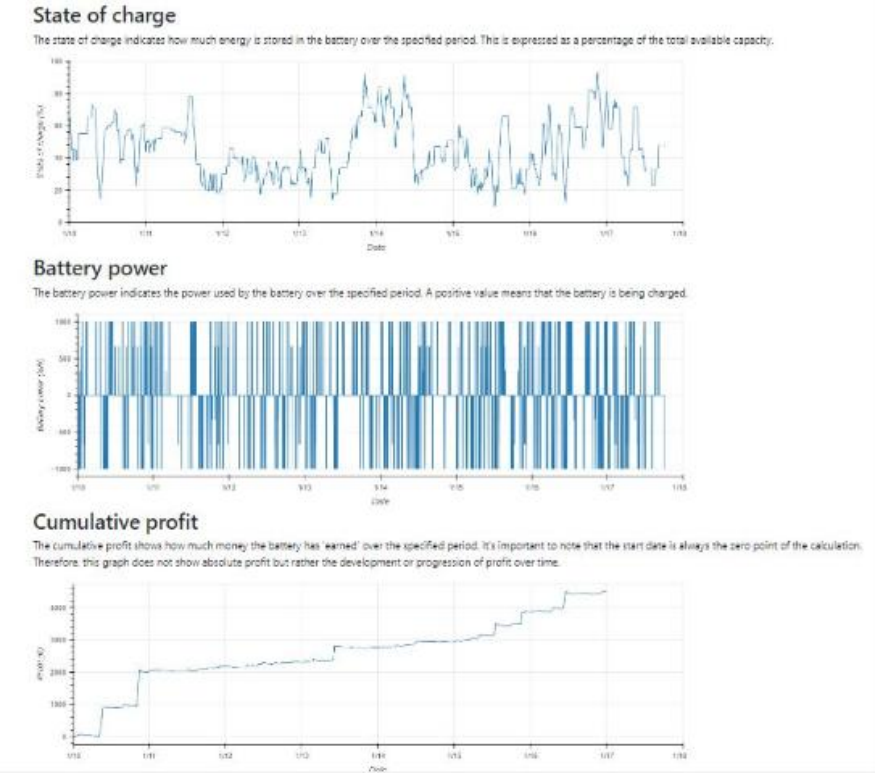
+ Integrated asset management

Flexibility Services drive the business case

€ / kW / 60 min



SoC + revenue potential



Labour is a hidden cost

Estimate baseline

- Employment, total cost
  - Support >€50.000
  - Specialised >€75.000
  - Specialised >€100.000

- External, per hour
  - Junior €75-100
  - Project mgr €150
  - Senior €200-250

Effort in pilot

- 500+ hours

- 100+ hours

Proposal
Local Levelised **Cost** of Energy

+ Revenue

+ Management Cost

Proposal
Local Levelised Cost of Energy

Governance Model

- In LES, significant spending on
  - Comparing alternative scales
  - Inclusive Development
    - Housholds, Local businesses

- Structural characteristics
  - Beyond current innovations

Pricing of inputs

- Hourly rates vary
  - Per organisation
  - Per region

- Grid services vary
  - Per DSO
    - Towards LV capacity pricing

Results Case study

LCOE

- Grid + Energy

LCOE: Scenario 1 grid-provided energy					
			Per year		15 years
Grid Connection (kVa)	110	€	6.633	€	99.489
Consumption (kWh)	167.926	€	25.088	€	376.322
WACC 2,5%				€	-
15-year Total cost	2.518.890	kWh		€	475.811
Cost of Energy (kWh)				**€**	**0,189**

SLCOE (1)

- + PV + BESS + WACC

SLCOE (1): LCOE + PV + Storage + Grid integration					
			Per year		15 years
Grid Connection (kVa)	110	€	6.633	€	99.489
PV system	100kWP			€	39.600
BESS system	80kW / 160kWh			€	100.000
Production PV (kWh/y)	85.000				
Net demand grid (kWh/y)	82.926	€	12.389	€	185.837
WACC 2,5%				€	52.350
15-year Total cost	2.518.890	kWh		€	477.276
Cost of Energy (kWh)				**€**	**0,189**

Results Case study

SLCOE (2)

- + Grid Services

SLCOE (2): SLCOE (1) + Grid integration				
			Per year	15 years
Grid Connection (kVa)		110	€ 6.633	€ 99.489
PV system	100kWP			€ 39.600
BESS system	80kW / 160kWh			€ 100.000
Maintenance, insurance			€ 1.500	€ 22.500
Production PV (kWh/y)		85.000		
Net demand grid (kWh/y)		82.926	€ 12.389	€ 185.837
WACC 2,5%				€ 52.350
Imbalance trade revenue			-€ 17.563	-€ 263.445
Imbalance trade cost			€ 7.346	€ 110.190
15-year Total cost		2.518.890	kWh	€ 346.521
Cost of Energy (kWh)				**€ 0,138**

LLCOE

- + Preparation, Management

LLCOE: SLCOE + management				
			Per year	15 years
Normalised professional prep (250 hour @ €100)				€ 25.000
Design study				€ 2.500
Volunteer prep (500 hours @ €20)				€ -
Grid Connection (kVa)		110	€ 6.633	€ 99.489
PV system	100kWP			€ 39.600
BESS system	80kW / 160kWh			€ 100.000
Maintenance, insurance			€ 1.500	€ 22.500
Production PV (kWh/y)		85.000		
Net demand grid (kWh/y)		82.926	€ 12.389	€ 185.837
WACC 2,5%				€ 52.350
Imbalance trade revenue			-€ 17.563	-€ 263.445
Imbalance trade cost			€ 7.346	€ 110.190
Annnual management (25 hours at €100)				€ 37.500
15-year Total cost		2.518.890	kWh	€ 411.521
Cost of Energy (kWh)				**€ 0,163**

Comparison

Indicator	LCOE	SLCOE (1)	SLCOE (2)	LLCOE
	Grid purchase	Mixed grid and PV		
Main additions		+ Cost of capital + Intermittence + Integration (BESS)	+ Flexibility services + Grid costs	+ PREPEX + OPEX
Cost of Energy	€0,189	€0,189	€0,138	€0,163
c. LCOE		0%	-27%	-14%
c. LLCOE	+14%	+14%	-19%	

Implications

Micro / business case

- More detailed metric
  - Significant Cost and Revenue
- 5-25% net lifetime €/kWh delta

- Main impact factors
  - Flexibility markets
  - Management (Labour cost)
  - External services (labour cost)

Macro / policy

- Energy prices will diverge
  - Locally, per Governance model

- Home with rooftop v Urban District

- LLCOE practical metric
  - Compare alternative models
  - Inform policy
    - Centralised to increase (grid cost)
    - Local needs to account for effort