LUT University

Energiamurroksen vaikutukset rakennuksiin

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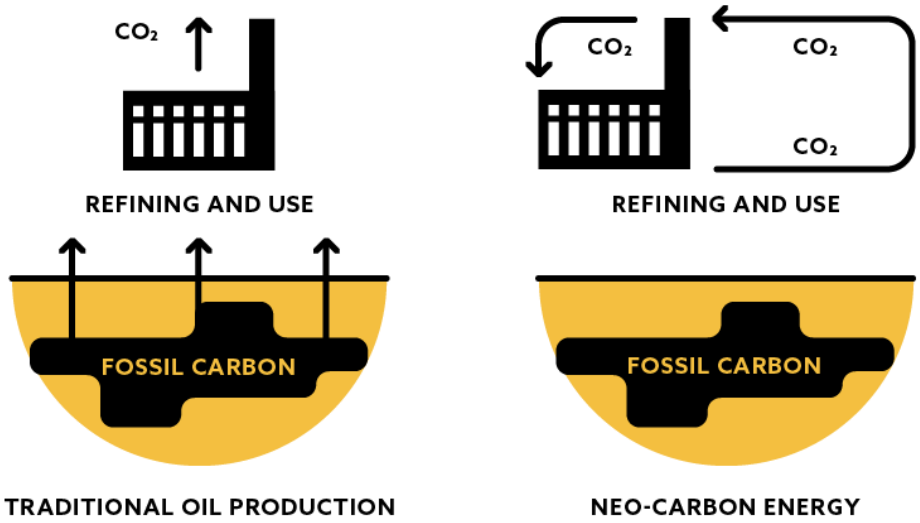
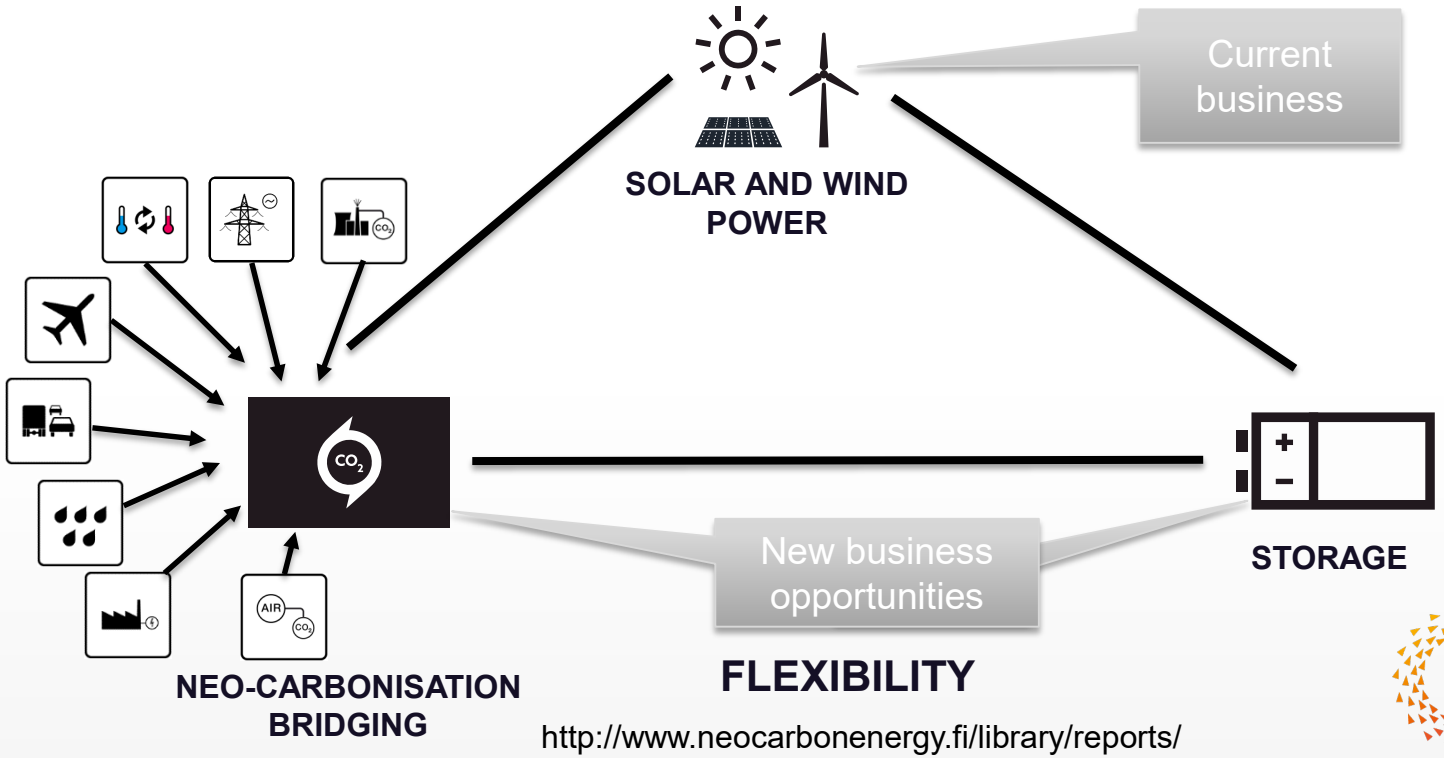
Fossiilisesta taloudesta hiilidioksidin kiertotalouteen

NEO CARBON ENERGY

No new CO_2 emissions – switching to a circular carbon economy



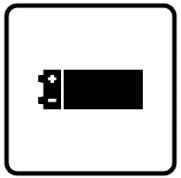
Sähköjärjestelmästä pääenergiajärjestelmä

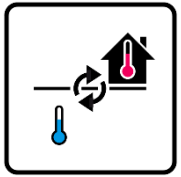


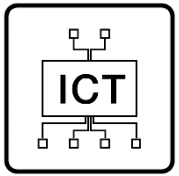
http://www.neocarbonenergy.fi/library/reports/

Rakennusten energiamurros perustuu sarjavalmistettuihin teknologioihin

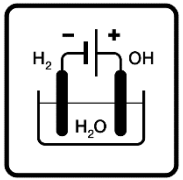
Solar PV


Battery

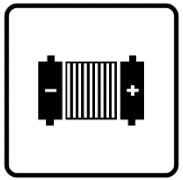

Heat pump

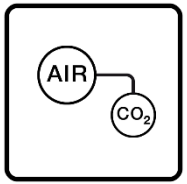


ICT technology

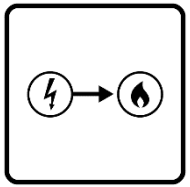


Water electrolysis


Fuel cell



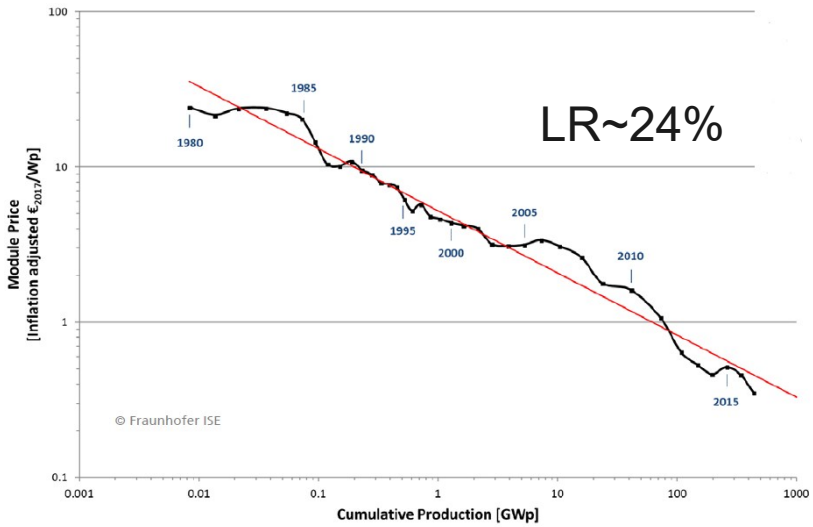
CO2 direct air capture


Power to gas

- Energiamuunnosteknologia mahdollistavat paikallisen sähkön tuotannon, lämmön & kylmän tuotannon, kysynnän jouston, vedyn & hiilivetyjen tuotannon ja energian varastoinnin eri aikajänteillä
- Tehoelektroniikka ja ICT ovat mahdollistavia teknologioita
- Rakennuksista tulee tuotantolaitosten lisäksi energiaverkkojen solmupisteitä

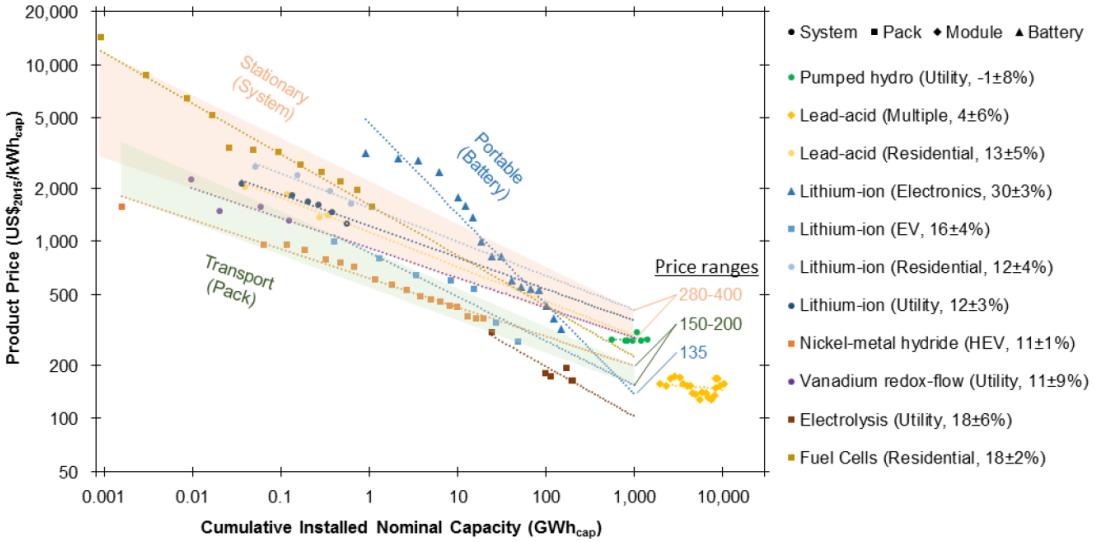
Sarjavalmistettujen energiateknologioiden hintakehitys

Solar PV module learning curve

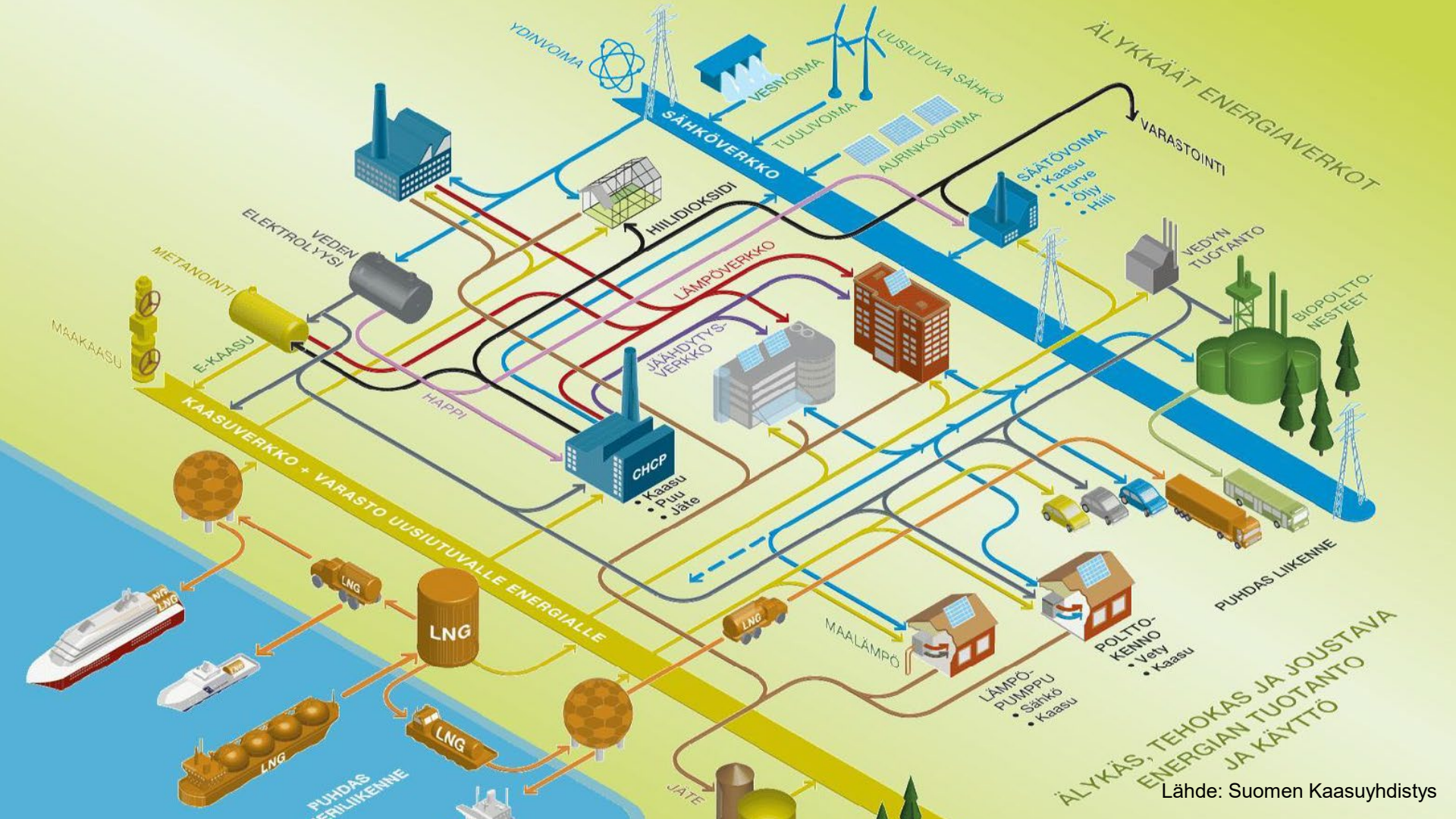


Photovoltaics Report, Fraunhofer-ISE, Germany, 27.8.2018

Electricity storage learning curves



O. Schmidt, A. Hawkes, A. Gambhir & I. Staffell, The future cost of electrical energy storage based on experience rates, Nature Energy volume 2, Article number: 17110 (2017)



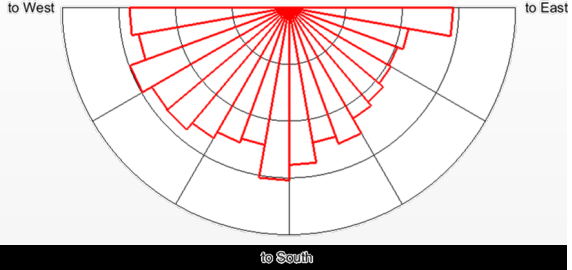
Lähde: Suomen Kaasuyhdistys

Suomessa asuinrakennusten kattojen aurinkosähköpotentiaali ~10 GWp

Building type	Number	Rooftop surfaces, m² (1)	Rooftop potential, S_n, MVA (2)	PV peak, P_{max}, MW (3)	Avg. roof, m²/roof
Residental	1 319 444	242 173 933	12 109	7 350	184
Public	71 685	62 197 484	3 110	1 880	868
Leisure	488 763	36 877 551	1 844	1 110	75
Industry	30 259	47 496 085	2 375	1 450	1 570
Other	3 127 670	299 327 488	14 966	9 033	574
Total	5 037 821	688 072 541	34 404	20 823	137

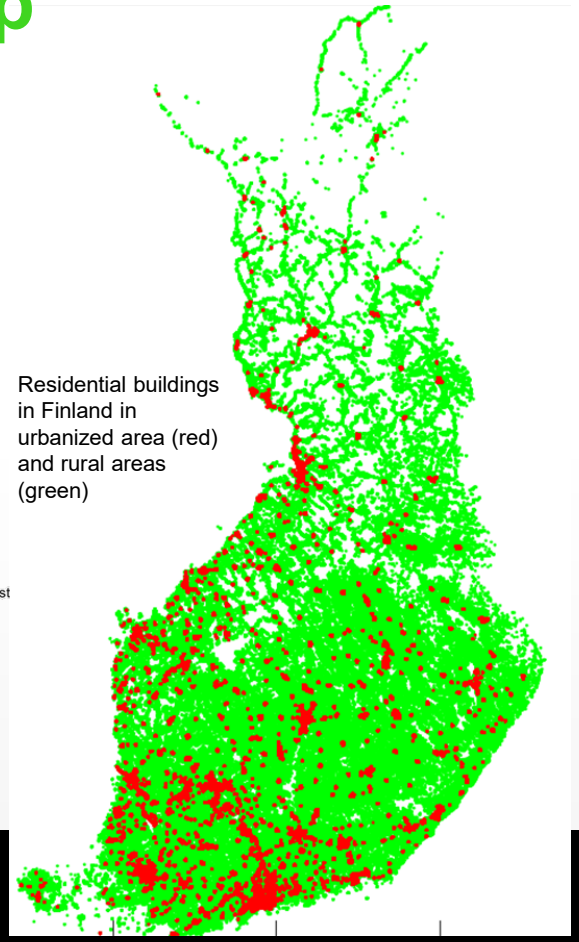
1) Total surface areas of buildings
2) Nominal power of panels. Based on assumption that only southern side of roofs (all ridge type) are utlized with 70% panel filling factor
3) Maximum power taking into account point of compass of buildings and geographical location in Finland

Rooftop areas, point of compass

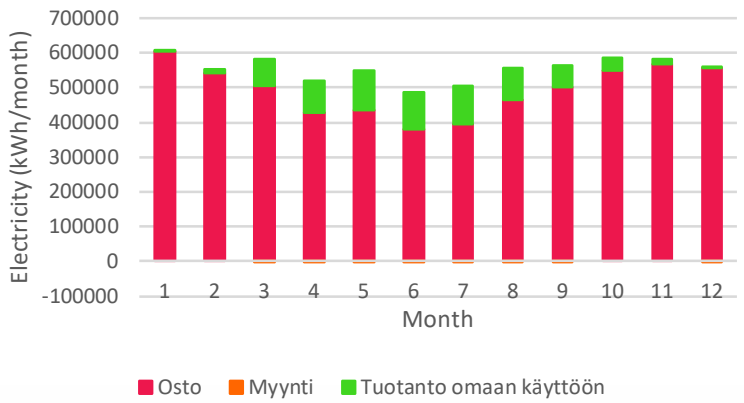


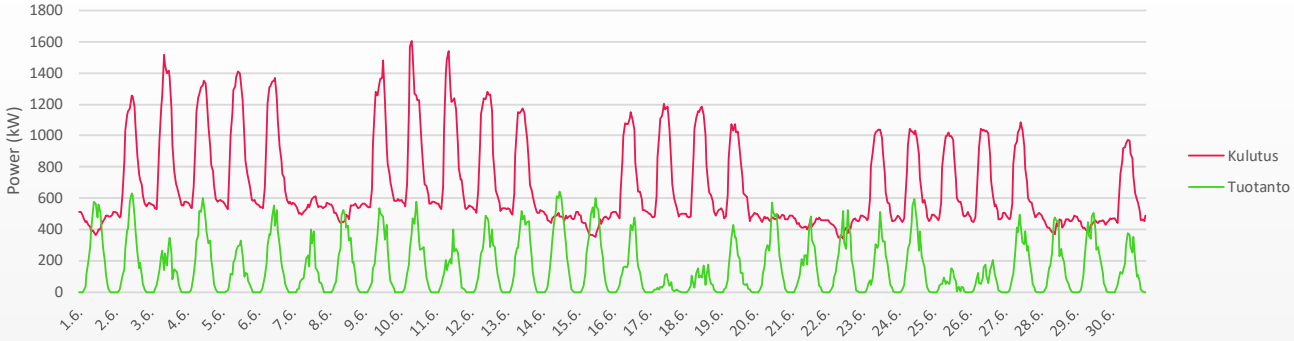
Lähde: Jukka Lassila, et. Al., Nationwide Photovoltaic Hosting Capacity in the Finnish Electricity Distribution System, EUPVSEC 2106, Munich, June 2016.

Residential buildings in Finland in urbanized area (red) and rural areas (green)



Esimerkki - Simuloitu aurinko-sähkötuotanto LUT:lla





Key facts:

- Public educational building
- Yearly consumption 7235 MWh
- Peak load at day time

Electricity production (max 1% of energy will be sold) -> PV plant size 867 kWp

- Simulated yearly generation 733 MWh
- ca 11 % of yearly electricity consumption

Halpenevaa aurinkopaneelia voidaan käyttää rakennuselementtinä, joka samalla tuottaa sähköä

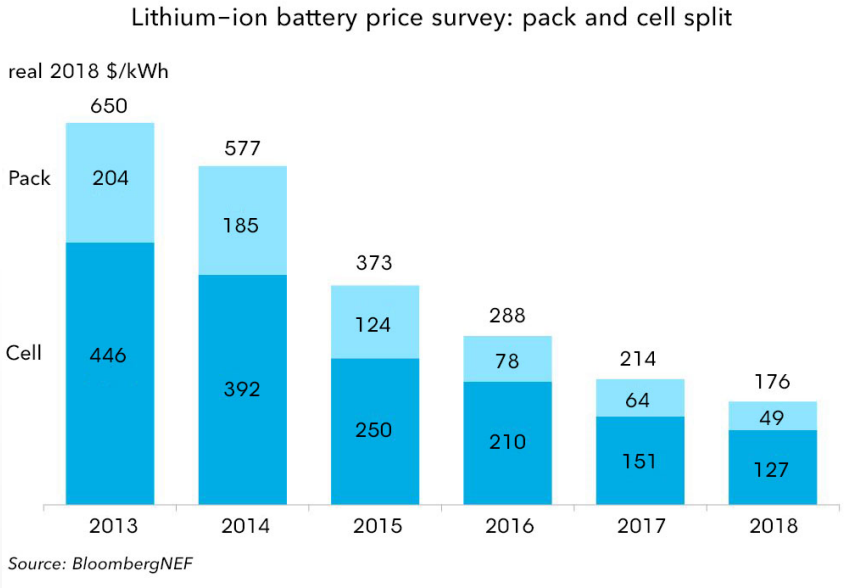
20 kpl Bi-facial moduuleja aitana, Ray Wills, Australia

LUT:n ~100 kW aurinkopaneeleilla katettu autokatos

Tampereen yliopiston kampusareena - aurinkopaneelijulkisivua

Sähköakut rakennuksissa: Akut tulevat mahdollisesti sähköautojen mukana

- Tarvitaan riittävän tehokas kaksisuuntainen latausinfra kiinteistöihin



Litiumakun kustannus sähköautossa

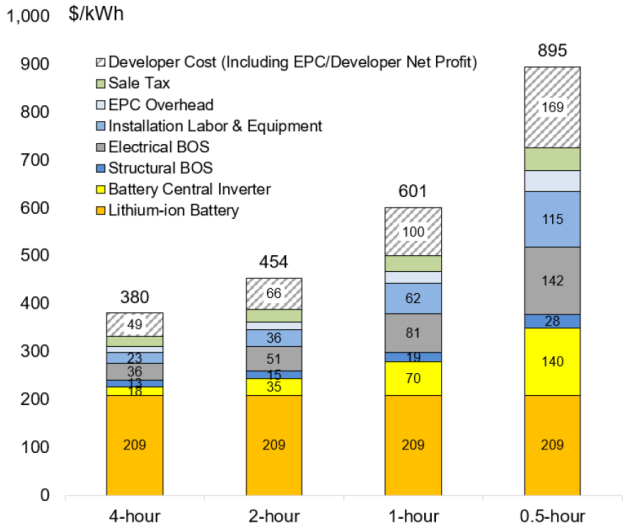
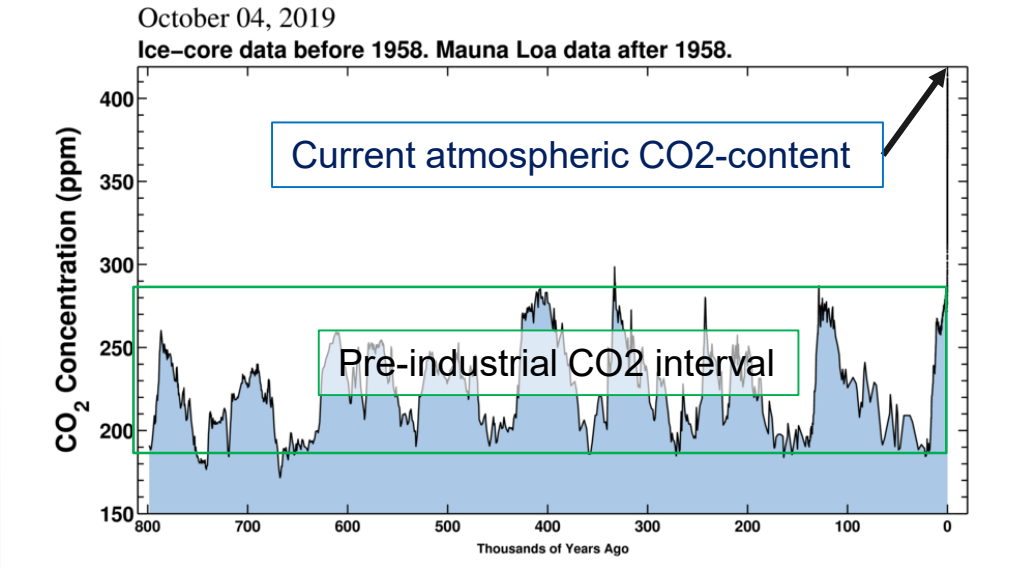


Figure 9. 2018 U.S. utility-scale Li-ion battery standalone storage costs for durations of 0.5–4 hours (60 MW_{DC})

Litiumakun hinta 60 MWdc verkkoakkuna

CO_2:n talteenotolla rakennuksen sisäilman CO_2-pitoisuuden alentaminen on myös mahdollista



Lähde: J. G. Allen, Associations of Cognitive Function scores with Carbon Dioxide, Ventilation, and Volatile Organic Compound Exposures in Office Workers: A Controlled Exposure Study of Green and Conventional Office Environments, Environmental Health Perspectives, vol. 124, No, 6, June 2016.

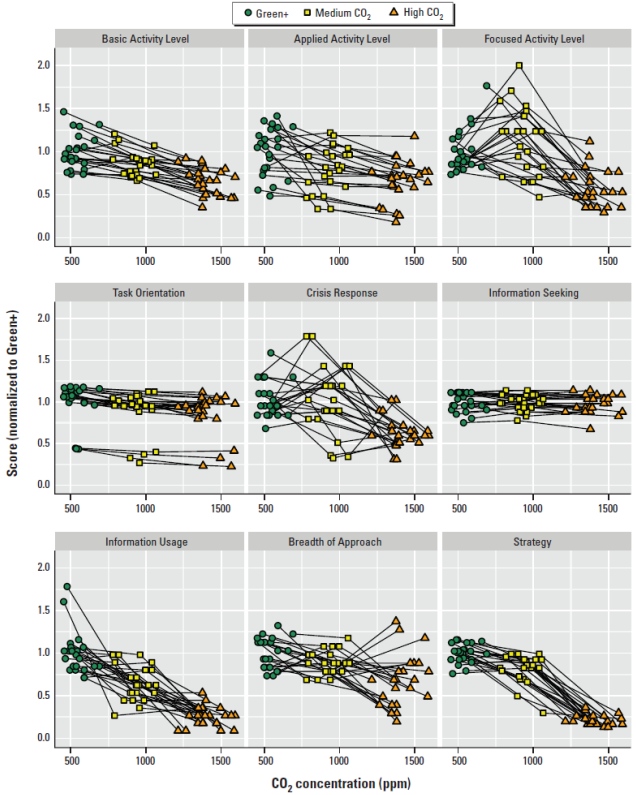
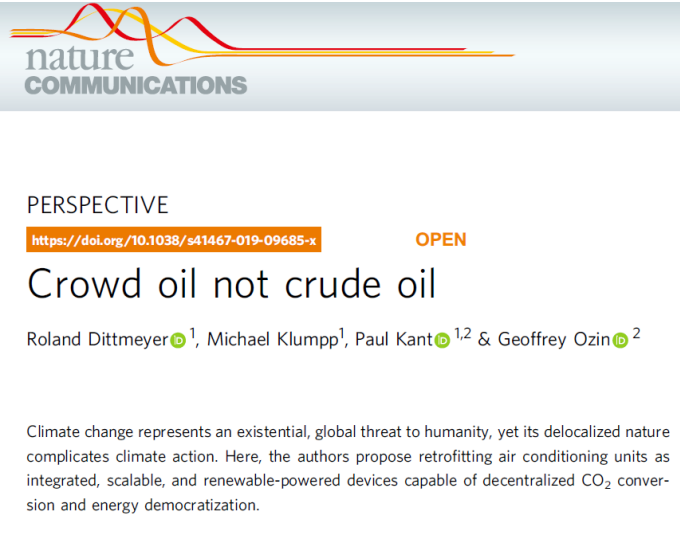


Figure 2. Cognitive function scores by domain and participant and the corresponding carbon dioxide concentration in their cubicles. Each line represents the change in an individual's CO_2 exposure and cognitive scores from one condition to the next, normalized to the average CO_2 exposure across all participants during the Green+ conditions.

”Joukkoöljyä” rakennusten ilmanvaihdosta talteen otetusta hiilidioksidista päästöttömällä sähköllä


nature COMMUNICATIONS

PERSPECTIVE

https://doi.org/10.1038/s41467-019-09685-x OPEN

Crowd oil not crude oil

Roland Dittmeyer[1], Michael Klumpp[1], Paul Kant[1,2] & Geoffrey Ozin[2]

Climate change represents an existential, global threat to humanity, yet its delocalized nature complicates climate action. Here, the authors propose retrofitting air conditioning units as integrated, scalable, and renewable-powered devices capable of decentralized CO_2 conversion and energy democratization.

Lähde: R. Dittmeyer, M. Klumpp, P. Kant, G, Ozin, Crowd oil not crude oil, Nature Communications, (2019) 10:1818.

Esimerkkinä Fair Tower, Frankfurt am Main, Saksa:

- 63 000 m^2 toimistotilaa, 200 000 m^3 tilavuutta 3 m huonekorkeudella
- Ilmanvaihto 5-10 kertaa/h, vaihdettu ilmamäärä 1-2 Mm^3/h
- Jos ilmassa 400 ppm CO_2:sta saadaan tästä hiilidioksidivirta 0.75-1.5 tCO_2/h
- CO_2-talteenottoon tonnia kohden tarvitaan lämpöenergiaa (100 °C) 1.43 MWh ja sähköä 0.37 MWh
- **Mahdollistaisi synteettisten sähköpolttoaineiden tuotannon (Fischer-Tropsch) 250-500 kg/h -> 2000-4000 t/a**
- **Tarvittava sähköteho noin 5-10 MW (oletettu hyötysuhde 50-60%)**

SOLETAIR – Polttoaineita hengitysilmasta?

1. Air

4. Electricity

2. CO_2

3. H_2O

5. H_2

6. Power-to-X products

SOLETAIR – Power-to-X site at LUT Lappeenranta campus in 2017

Products:

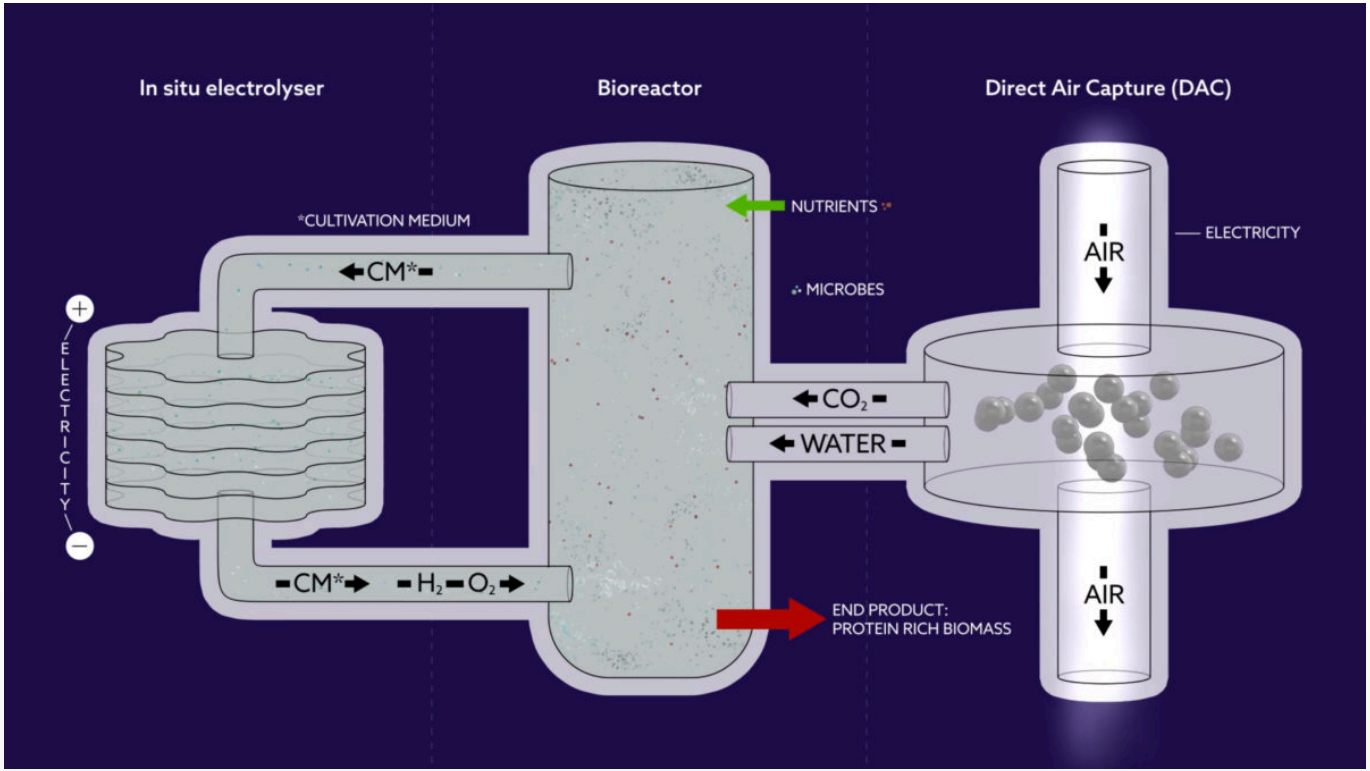
- fuels
- chemicals

replacing the ones currently refined from fossil oil & gas

LUT University

VTT

Yhtälailla hengitysilman hiilidioksidista voi tehdä sähköllä ravintoa



NEO CARBON FOOD

www.neocarbonfood.fi

Neo-Carbon Food – Food from electricity

NEO CARBON FOOD

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Neo-Carbon Food research pilot at LUT Campus in summer 2019

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