Citizen's energy literacy enabling and challenging energy business

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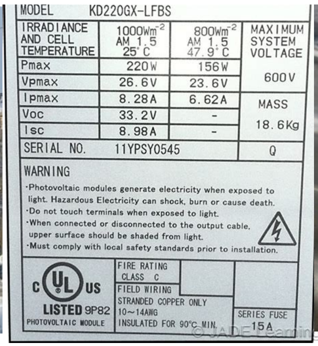
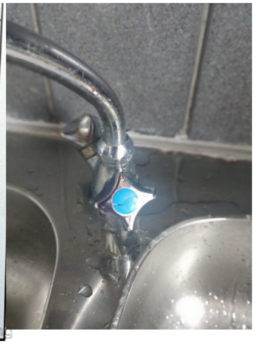
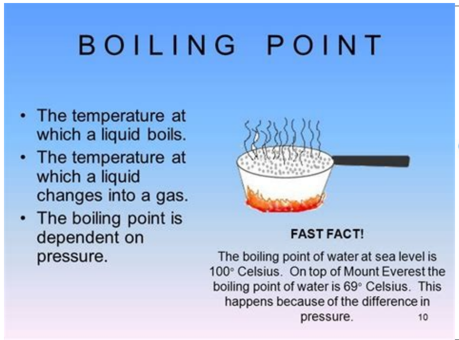
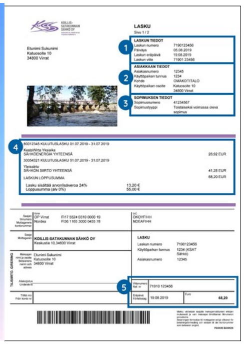
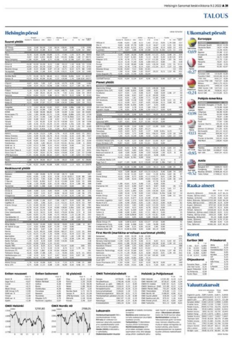
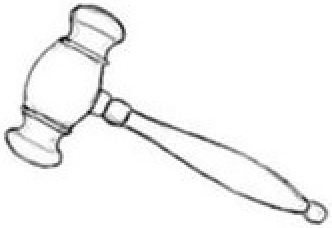








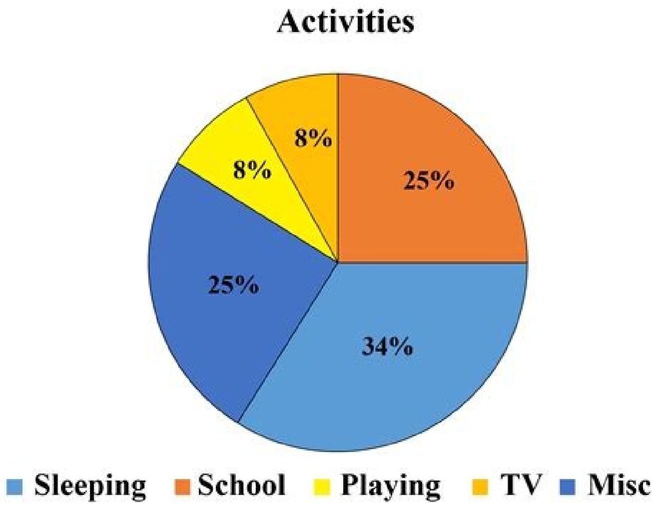




- **Introduction**
  - Energy literacy and different definitions
- **Survey: what should a regular citizen know about energy and energy sector?**
- **Some implications to the power retail sector**

Some regular energy choises

- Behaving at home (e.g. adjusting indoor temperature, ventilating, preparing and heating food, using warm water)
- Purchasing an electrical device having certain consumption values and profiles (e.g. fridge, heat pump)
- Choosing energy supplier and ta
- Commuting
- Exercising a hobby or free-time activity



Energy literacy

- **Financial literacy**
  - “combination of cognitive ability and investment in human capital related to understanding financial decisions. Poor financial literacy has been linked to lower rates of financial planning for retirement, increased mortgage default, lower participation in the stock market, and increased likelihood of taking out high-cost loans” (reference to Lusardi & Mitchell 2014 by Kalmi et al 2021).
- **Energy literacy as energy awareness leading to energy conservation behaviour at home**

  EL is desirable because energy literate people have been found to save energy at home and behave energy frugal.
- **Energy literacy as energy-related knowledge, attitudes and behavior**
  - Broadest, normative. also incorporates desirable zero-carbon attitudes and behaviours directly and indirectly related with energy. Energy literate individual “has a sound conceptual knowledge base as well as a thorough understanding of how energy is used in everyday life, understands the impact that energy production and consumption have on all spheres of our environment and society, is sympathetic to the need for energy conservation and the need to develop alternatives to fossil fuel-based energy resources, is cognizant of the impact that personal energy-related decisions and actions have on the global community, and – most importantly – strives to make choices and exhibit behaviors that reflect these attitudes with respect to energy resource development and energy consumption” (reference to DeWaters and Power 2011 by Keränen et al
  - Self-assessments on cognitive abilities and knowledge on “energy” (ambiguously defnited) such as “It is important to be informed about energy issues.” or “I apply energy related information to my own life---.” (Keränen, Hirvonen, and Huotari 2018)
- **Energy-related financial literacy: (energy investment literacy, financial literacy, and cost awareness) Blasch et al 2021**

Kalmi, Panu, Gianluca Trotta, and Andrius Kažukauskas. 2021. “Energy-Related Financial Literacy and Electricity Consumption: Survey-Based Evidence from Finland.” Journal of Consumer Affairs 55(3): 1062–89.
Keränen, Teija, Noora Hirvonen, and Maija-Leena Huotari. 2018. “Examining Energy Information Literacy with an Adaptation of the Everyday Health Information Literacy Screening Tool.” In Information Literacy in the Workplace: 5th European Conference, ECIL 2017, Saint Malo, France, September 18-21, 2017, Revised Selected Papers, Communications in Computer and Information Science, eds. Serap Kurbanoğlu et al. Cham: Springer International Publishing, 470–80. http://link.springer.com/10.1007/978-3-319-74334-9 (April 7, 2022).
Blasch, Julia, Nina Boogen, Claudio Daminato, and Massimo Filippini. 2021. “Empower the Consumer! Energy-Related Financial Literacy and Its Implications for Economic Decision Making.” Economics of Energy & Environmental Policy 10(2). https://www.proquest.com/docview/2563485532/abstract/7C78F714987F4048PQ/1 (April 27, 2022).

Carbon capability

- **“Carbon capable” citizen should have critical understanding of**
  - Causes and implications of carbon emissions
  - The role of single individuals in producing emissions
  - The extent of adopting a low-carbon lifestyle (and benefits)
  - The realistic possibilities of achieving carbon reductions via individual choices
  - Which reduction activities require collective actions and infrastructural change
  - Governance of carbon budgeting (planning and implementing low-carbon activities)
  - Reliability of information (biases, agendas, incertanties etc) in achieving low-carbon lifestyles
  - Broader structural limitations and possibilitis to sustainable consumption

Adopted from: Whitmarsh, Lorraine, Gill Seyfang, and Saffron O’Neill. 2011. “Public Engagement with Carbon and Climate Change: To What Extent Is the Public ‘Carbon Capable’?” Global Environmental Change 21(1): 56–65.

Survey

https://link.webropol.com/s/EL20220512

How important is that a regular citizen

1=Irrelevant; 2=Maybe relevant; 3=Somewhat important; 4=Important; 5=Very important

Fluently reads energy-units i.e. kW, kWh, barrel, gCO2eq, snt/kWh, €/MWh and makes unit conversions

Can compare energy-intensities between different activities (e.g. hot-showering versus LED-lighting) using some/any personal heuristics

Knows realistic possibilities for energy-saving at home

Actively seeks to reduce energy consumption, whenever possible

Actively seeks solutions to be “wiser” with energy at home

Actively seeks to realize meaningful energy renovations at home

Knows how to count the payback time of an energy investment (e.g. a heat pump)

Is able to assess the environmental impact of an energy investment (ability to e.g. count LCA of a heating option to home)

Cooking: is aware of energy and carbon intensity of different cooking methods and meals

Cooking: actively seeks to reduce environmental burden from cooking and eating at home

Understands the extents and nuances to which advocacy group (interest groups) thinking impacts the presentation of energy topics in media

Understands differences between nominal energy and consumed energy

Understands price formation and basic electricity market functions

Understands differences between electricity contracts

Actively picks an electricity contract after careful consideration, also considering one’s values

Actively follows energy market prices for electricity and fuels that concern themself

Knows that electricity consumption during peak hours pollutes, as a rule-of-thumb, more than other times

Actively seeks to reduce peak-hour consumption

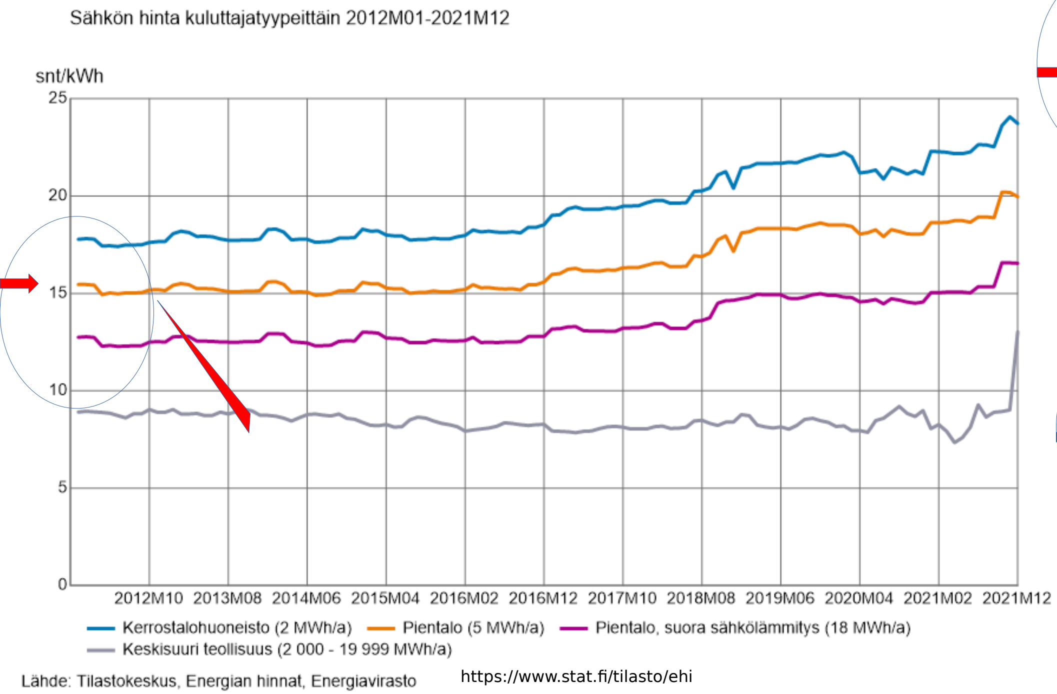
Discussion

Types of business sectors impacted

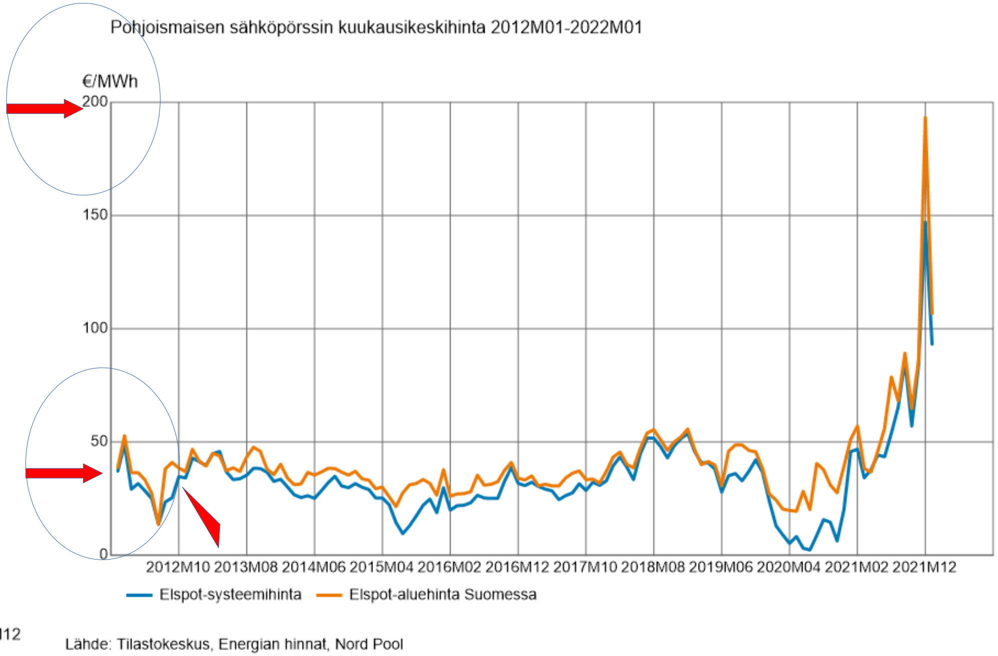
- **Energy supply**
- **Energy retail and distribution**
- **Energy solutions**
  - Energy optimization and management
  - Energy communication
  - Distributed energy solutions
  - Power electronics and installation
- **Communication and design**
- **Housing sector**
- **Household renovation sector**
- **Household device manufacture and sales**

Energy literacy

Look at the orange lines, x=2012M10



https://www.stat.fi/tilasto/ehi



15 snt/kWh = 0.15 €/kWh
This includes network costs and taxes, nicely calclulated for an explamplary small home consuming 5 MWh/year! From https://energiavirasto.fi/sahkon-hintatilastot, file “Sähkön toimitusvelvollisuus- ja siirtohintojen kehitys (aikasarja)(xls)”
E.g. 2012M10: 7.49 (energy) + 5.6 (network) + 2.095 (taxes) = 15.18 snt/kWh

40 €/MWh = 0.04 €/kWh = 4 snt/kWh

Seems way more affordable

e.g. 2012M10: 3.857 (spot) + 5.6 (network) + 2.095 (taxes) = 11.552 snt/kWh
+ retailer marginal 0.16-0.95 snt/kWh, let’s say 0.4 snt/kWh

Leads to 12 snt/kWh

Energy literacy and electricity retail

- **For most people, the kWh-unit price which is the primary motivation to choosing a contract. Secondary criteria: energy security, locality, greenness, consumer service, simplicity.**
- **But largely people are non-interested**
  - According to Finnish electricity retailers interviewed in April/May 2021 for their electricity products for residential customers

Under review: Locked in flat tariffs? Energy retailers struggle with attracting customers to demand response through dynamic pricing - Numminen, S., Ruggiero, S. and Jalas, M. (2022)

Selling electricity contracts

“--- kun tehdään näit kampanjoita kuluttajille niin --- sillon ruvetaan puhumaan jo, sentin sadasosista ku ihmiset alkaa vertailemaan et onko se nyt 5,43 vai onko se nyt 5,39. Se on ihan oikeestaan nolla se ero mutta, sillä sitte kuitenki ehkä on joilleki ihmisille ainaki se ratkaseva päätös ---”

“---When a retailer designs an offer campaign, it goes down to single euro cents because people compare 5.43 €/kWh with 5.39 €/kWh. While in the end the [invoice impact] might be zero, still, for some people it [unit price] is crucial”

“--- Ja osa vaan tuijottaa et onks siellä jossain 0 euroa, eli joku tämmönen psykologinen summa tai luku kuten 0 euroa niin se sitte, kiinnittää huomiota --- mut se energiahinta on hiukan korkeempi. Siin on eri komponenttei minkä kanssa voi pelata, jotta saa sen tarjouksen näyttämään hyvältä.”

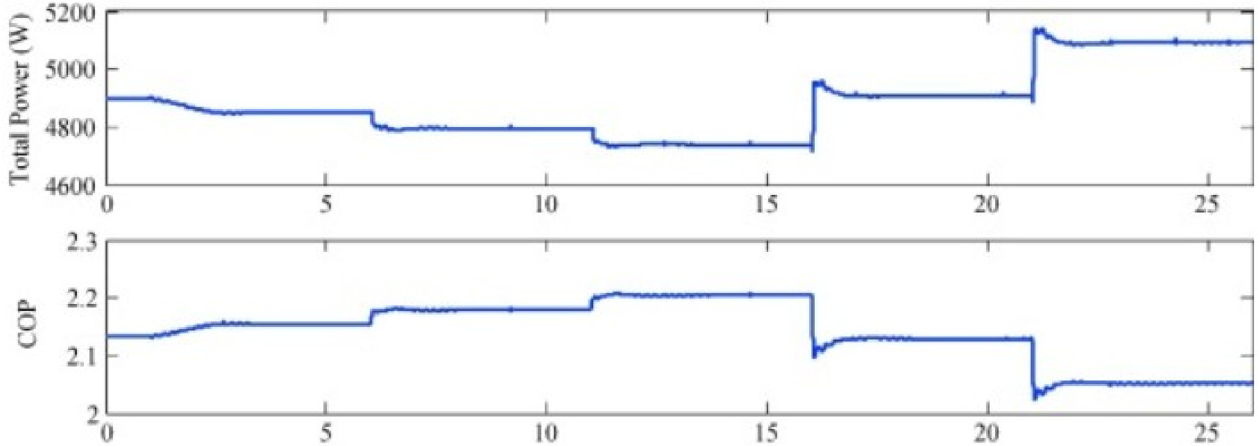
“---And others just look for a “0 €” anywhere in the offer. It seems to be sort of a psychologic factor which draws attention, despite the unit price of electricity might be higher. There are components with which to play to make the offer appear lucractive”

Selling electricity contracts

“

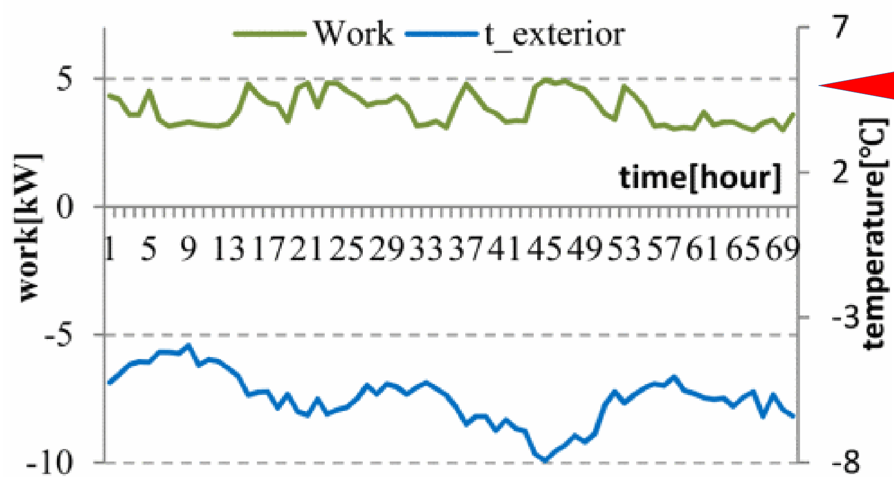
Does a common citizen need to know, understand or practise the following

- **power consumption profile of an air-source heat pump**



5 kW equals 2 sauna stoves!!!

Wang, Wenyi, and Yaoyu Li. 2019. “Intermediate Pressure Optimization for Two-Stage Air-Source Heat Pump with Flash Tank Cycle Vapor Injection via Extremum Seeking.” Applied Energy 238: 612–26.

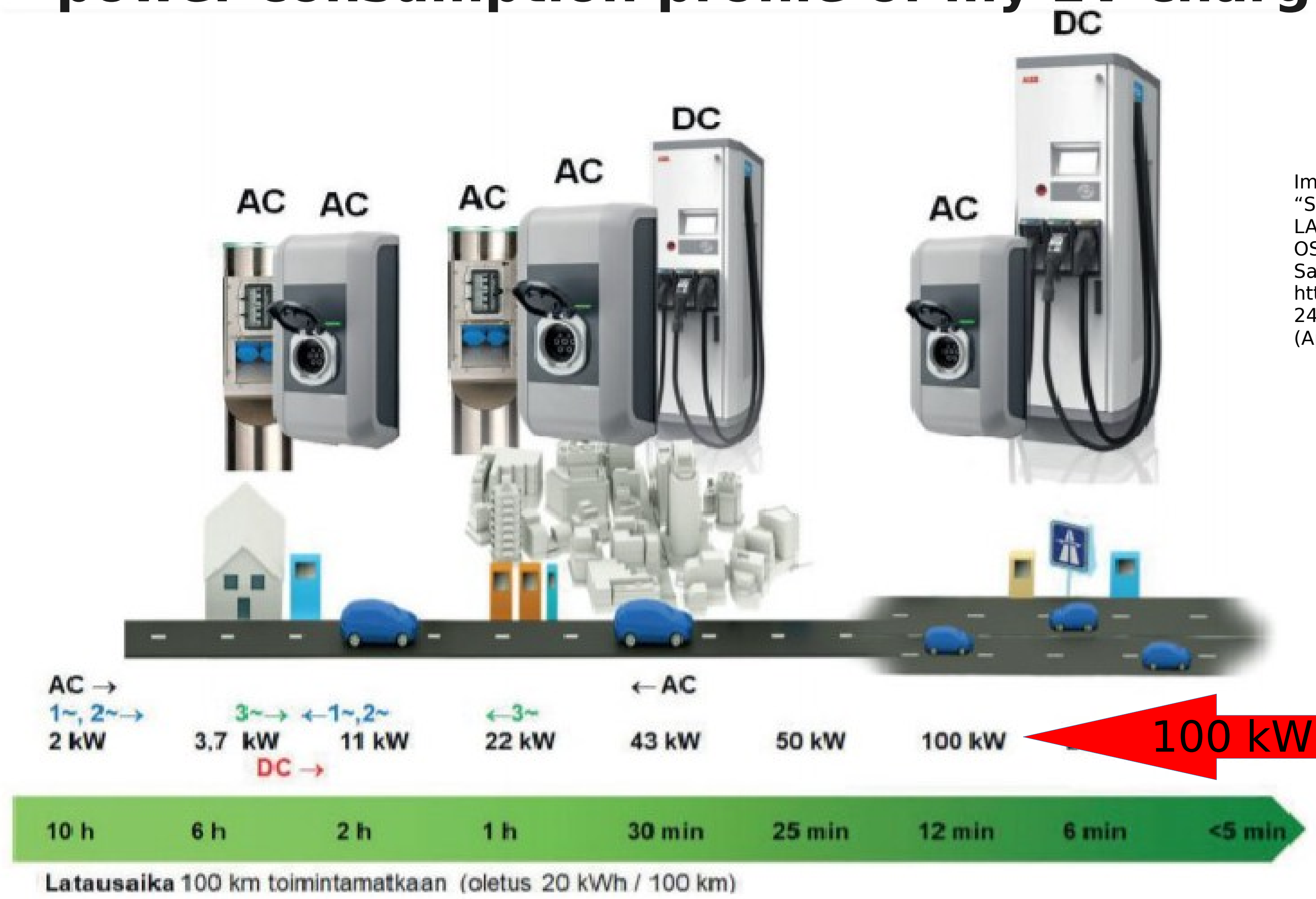


5 kW equals 2 sauna stoves!!!

Florin, Talpiga Mugurel, and Iordache Florin. 2020. “Air Source Heat Pump Performance Evaluation Based on Experimental Measurements and Neural Network.” In 2020 7th International Conference on Energy Efficiency and Agricultural Engineering (EE AE), , 1–4.

Does a common citizen need to know, understand or practice the following

- **power consumption profile of my EV charger**



100 kW = 50 sauna stoves!!!

Image: Wahlberg, Henri. 2021. “SÄHKÖAUTON ÄLYKKÄÄN LATAUSJÄRJESTELMÄN KONFIGUROINTI OSANA TOIMITUSPROSESSIA.” Opinnäytetyö. Satakunnan ammattikorkeakoulu. https://www.theseus.fi/bitstream/handle/10024/496889/Wahlberg_Henri.pdf?sequence=2 (April 23, 2022).

Does a common citizen need to know, understand or practice the following

- **dynamic CO2 intensity of power production**

RTP Shift	Peak Hour [Time]	On-Peak Cost [¢]	On-Peak CO2 footprint [gCO2eq]	Off-Peak Min Hour [Time]	Off-Peak Cost [¢]	Off-Peak CO2 footprint [gCO2eq]	Cost Change [¢]	CO2 footprint change [gCO2eq]
2012-12-10	5pm	28,97	168	3am	14,41	76	-14,56	-92
2012-12-11	5pm	29,51	171	2am	17,93	74	-11,58	-98
2012-12-12	5pm	52,78	165	2am	20,36	71	-32,42	-94
2012-12-13	5pm	28,84	146	3am	14,32	59	-14,52	-87
⋮								⋮
2013-05-31	5pm	34,52	125	3am	-3,62	37	-38,14	-89
2013-06-01	5pm	23,85	70	7am	-15,06	41	-38,91	-29
2013-06-02	5pm	11,00	39	11pm	-4,68	43	-15,68	3
2013-06-03	5pm	15,41	57	11pm	8,86	45	-6,55	-12
Sum		**$36**	**12 kg**				**$-22**	**-3,6 kg**
							-61%	**-30%**

Shifting 1 kWh load daily from peak-hour to next off-peak hour produced 30% savings in CO2 footprint and 60% savings in costs in 2012-2013 in Ontario

Off-peak and windy: 0.05kgCO2/kWh

On-peak and fossil: 0.2kgCO2/kWh

Stoll, Pia, Nils Brandt, and Lars Nordström. 2014. “Including Dynamic CO2 Intensity with Demand Response.” Energy Policy 65: 490–500.

Does a common citizen need to know, understand or practice the following

- **dynamic CO2 intensity of power production**

RTP Shift	Peak Hour [Time]	On-Peak Cost [pence]	On-Peak CO2 footprint [gCO2eq]	Off-Peak Min Hour [Time]	Off-Peak Min Hour Cost [pence]	Off-Peak Min Hour CO2 footprint [gCO2eq]	Cost Diff [pence]	CO2 footprint diff [gCO2eq]
01-01-2011	5pm	6,88	632	7am	4,15	612	-2,73	-20
02-01-2011	5pm	7,67	621	4am	4,24	550	-3,43	-71
03-01-2011	5pm	7,27	581	3am	3,99	556	-3,28	-25
04-01-2011	5pm	6,55	595	4am	3,86	544	-2,69	-52
⋮								⋮
28-12-2011	5pm	4,99	607	4am	3	567	-2,04	-40
29-12-2011	5pm	5,74	609	4am	3	565	-2,59	-44
30-12-2011	5pm	6,27	611	5am	3	512	-2,96	-100
31-12-2011	5pm	5,71	568	11pm	4	535	-2,03	-34
Sum		£21	201kg				£-7,55	-24kg
							-36%	-12%

Shifting 1 kWh load daily from peak-hour to next off-peak hour produced 12% savings in CO2 footprint and 36% savings in costs in 2011 in UK

Stoll, Pia, Nils Brandt, and Lars Nordström. 2014. “Including Dynamic CO2 Intensity with Demand Response.” Energy Policy 65: 490–500.

Does a common citizen need to know, understand or practice the following

- **dynamic CO2 intensity of power production**

RTP Shift	Peak Hour [Time]	On-Peak Cost [öre]	On-Peak CO2 footprint [gCO2eq]	Off-Peak Min Hour [Time]	Off-Peak Min Hour Cost [öre]	Off-Peak Min Hour CO2 footprint [gCO2eq]	Cost Diff [öre]	CO2 footprint diff [gCO2eq]
01-01-2011	5pm	763	44	8pm	720	48	-43	6
02-01-2011	5pm	814	41	2am	764	63	-51	29
03-01-2011	5pm	832	32	2am	774	52	-58	31
04-01-2011	5pm	810	41	2am	748	47	-62	14
⋮								⋮
27-12-2011	5pm	304	14	3am	248	29	-57	22
28-12-2011	5pm	293	10	3am	109	35	-183	32
29-12-2011	5pm	287	10	2am	177	35	-111	31
30-12-2011	5pm	319	10	3am	242	41	-76	45
Sum		**SEK168**	**7.6kg**				**SEK-38**	**2.7kg**
							-23%	**36%**

Shifting 1 kWh load daily from price peak-hour to next off-peak hour produced 36% **higher** CO2 footprint but 23% cost savings in 2011 in Sweden.

→ Swedish dynamic CO2 intensity is seasonally fluctuating and sensitive carbon intensity of power imports → RTP prices did not correlate with CO2 intensity similarly than in UK and Canada

Stoll, Pia, Nils Brandt, and Lars Nordström. 2014. “Including Dynamic CO2 Intensity with Demand Response.” Energy Policy 65: 490–500.

Does a common citizen need to know, understand or practice the following

- **energy and environmental impacts of various household features, devices or use practices such as**
  - indoor temperature level.
  - Shutting down heating while keeping windows open during heating season.
  - 10 minute hot shower in morning peak-hour
  - power consumption profile of my air-source heat pump, TV screen or EV charger
- **energy, environmental and political impacts of:**
  - energy imports and exports in Europe
  - heating practices and traditions in Central Europe
  - national grid electricity consumption in Northern India
- **dynamics in energy systems and energy markets**
  - dynamic CO2 intensity of power production
  - power price formation logics in intra-day markets
  - reasons for increased residential electricity price in January 2022
  - demand side management of industrial vs residential loads
- **energy sources**
  - distributed energy (kW scale) and benefits and weaknesses
  - centralized energy (MW scale) and benefits and weaknesses
- **energy policy**
  - consumer rights in energy markets
  - impats of different political decisions
- **how to**
  - choose the best energy-related solution or device at home
  - lead energy renovation project at home
  - read technical plate information of electrical loads and supplies
  - choose an energy supply contract
- **SDG7**
  - number of people (billions) globally not having access to clean cooking facilities
  - number of people (tens of millions) in Europe categorized as energy poor

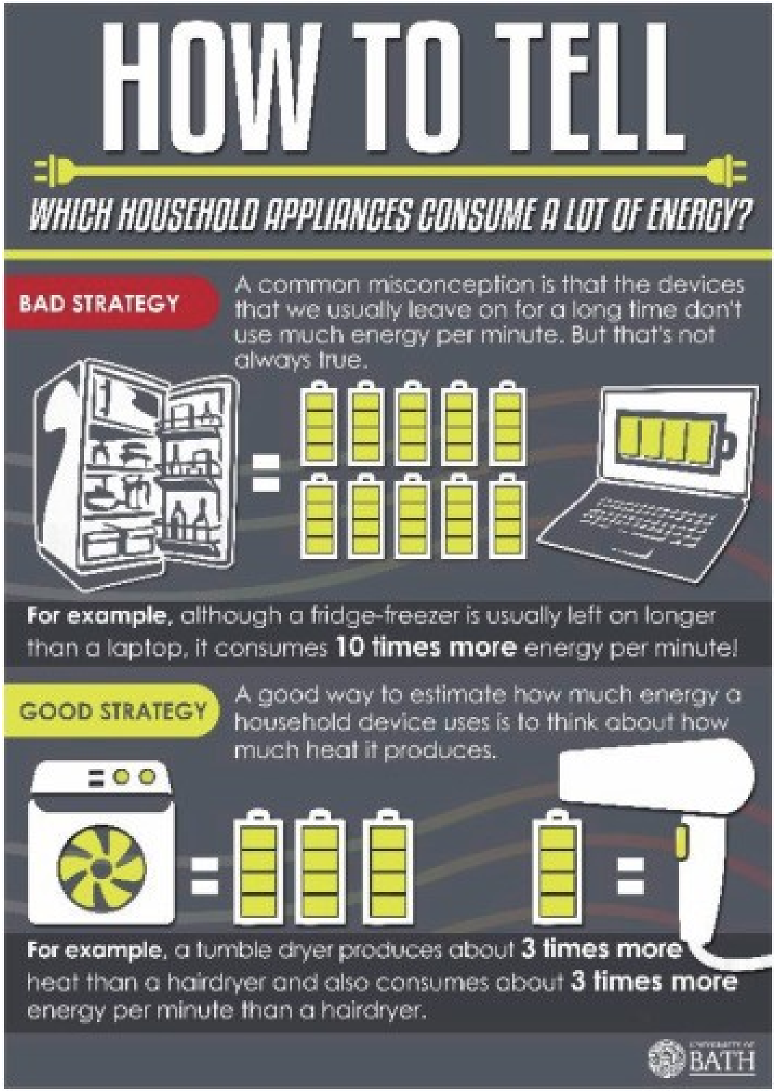


Image from: van den Broek, Karlijn L., and Ian Walker. 2019. "Heuristics in Energy Judgement Tasks." Journal of Environmental Psychology 62: 95–104.