Predavanje
Zajem podatkov iz sistema za upravljanje z energijo in ostalih sistemov za nadzor procesov

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Cyprus University of Technology

GOLEA

Gospodarjenje z energijo – sistematičen proces

UČINKOVITA OPIMIZACIJA

- Podpora odločanju
- Sistem merjenja
- Nadzor in prilagajanje porabe energije dejanskim potrebam
- Dinamično vrednotenje
- Verifikacija doseženih prihrankov

ZNANJE

- Pravilno razumevanje porabe energije in vode
- Povezovanje porabe in konteksta
- Vrednotenje (eng. *benchmarking*)
- Ocena (napoved) bodoče porabe energije in vode

INFORMACIJE

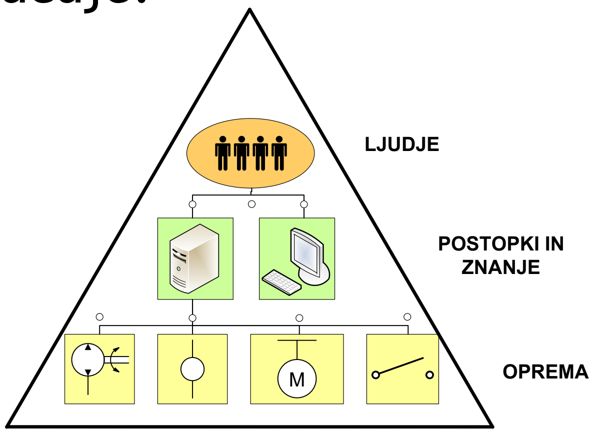
- Kazalniki
- Stroški za energijo in vodo
- Obdelani kontekstualni parametri
- Razni alarmi

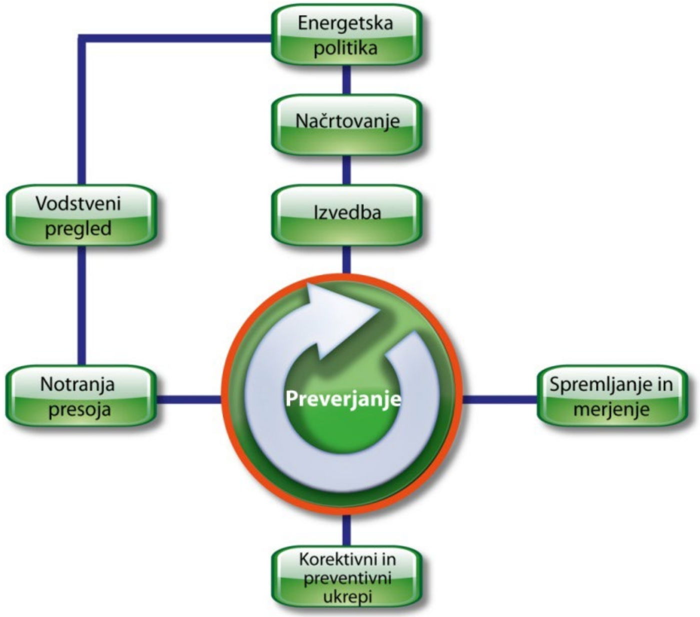
PODATKI

- Poraba energije in vode
- Zunanja temperatura
- Osončenost
- Notranja temperatura
- Prisotnost na delovnem mestu
- Cena energije

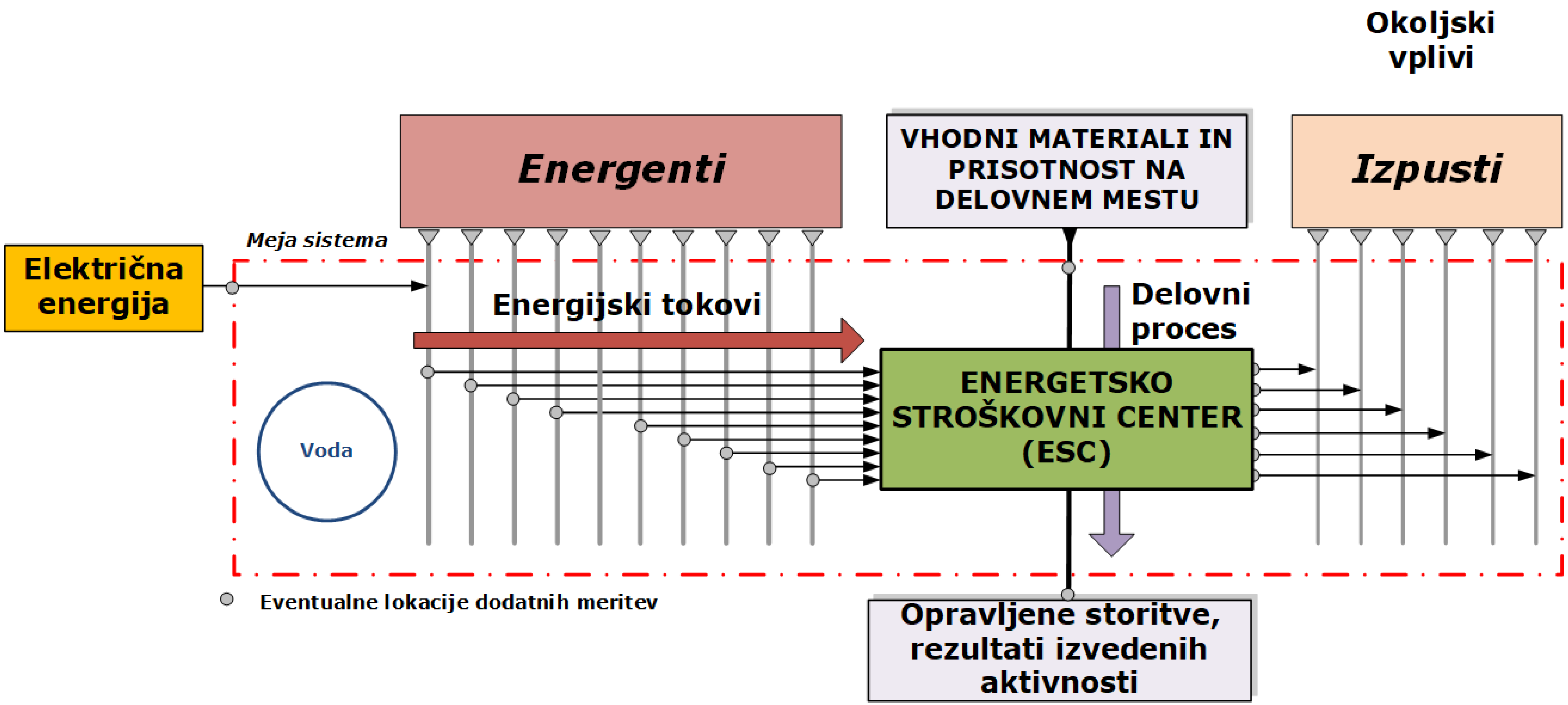
Kaj pomeni aktivno gospodarjenje z energijo?

- Stalen proces spremljanja rabe energije in vode ter učinkovitosti izvajanja optimizacijskih ukrepov
- Povezati rabo električne energije z aktivnostjo na lokaciji – jasna slika kako, zakaj in koliko energije se porabi v analiziranem objektu
- Sistem za gospodarjenje z energijo vključuje:
    - Organizacijo (odgovornosti in cilje)
    - Izobražene in motivirane ljudi
    - Analitičen postopek in *know-how*
    - Informacijsko infrastrukturo

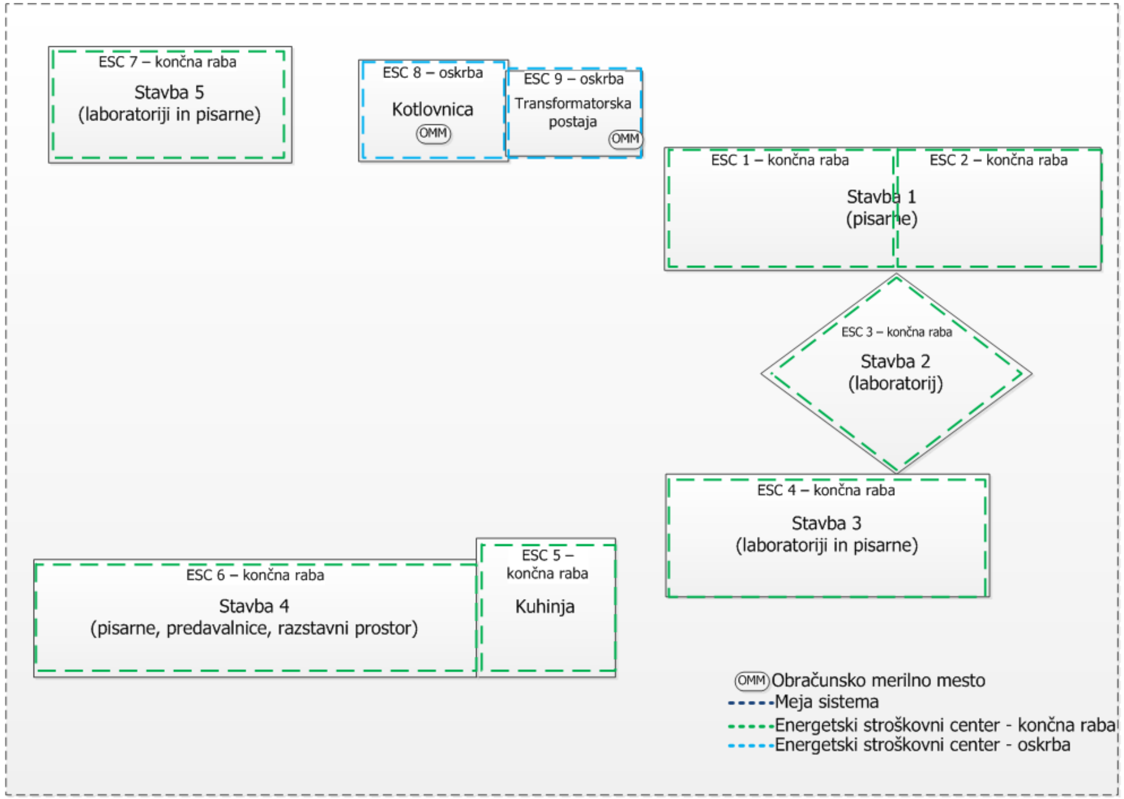




Integracija procesov - model, ki temelji na energetsko stroškovnih centrih

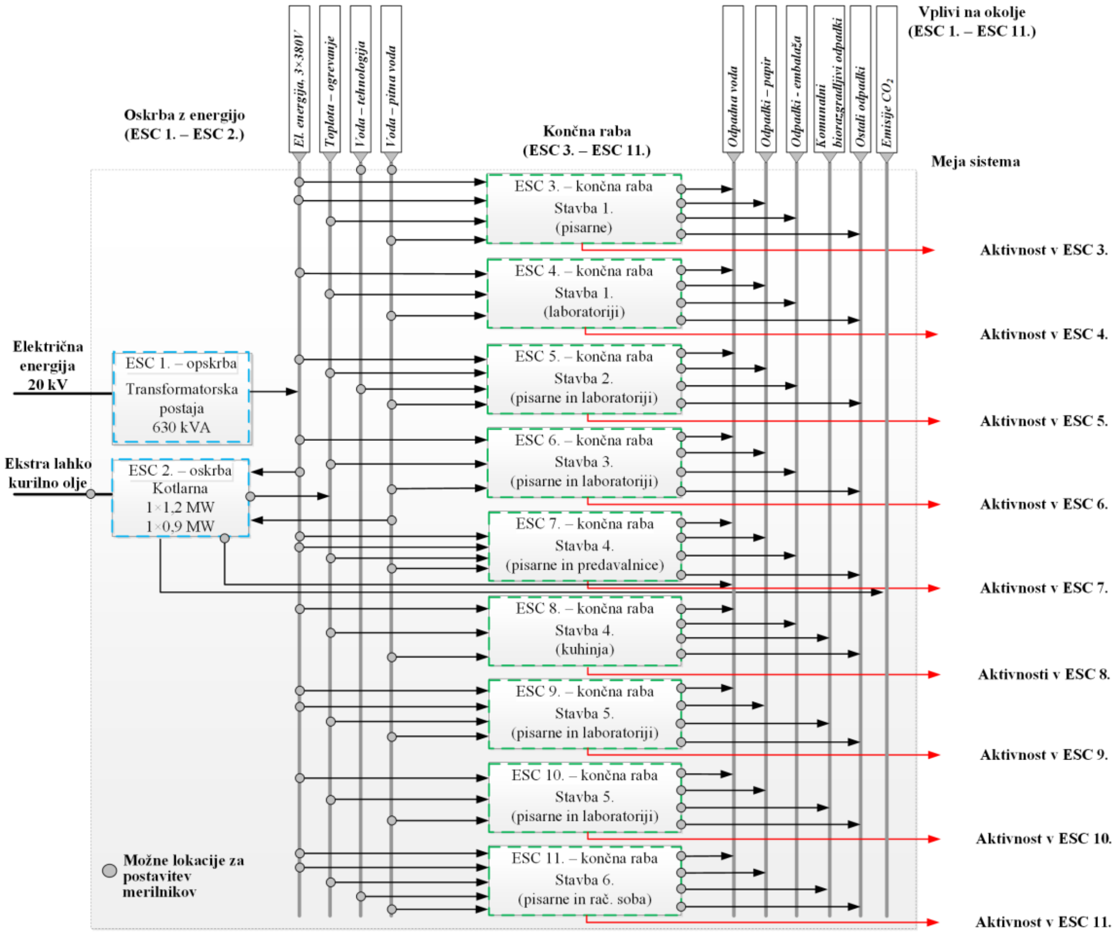


Za uvajanje EM potrebno veliko časa!
IJS – po več letih napora stopil v ta proces



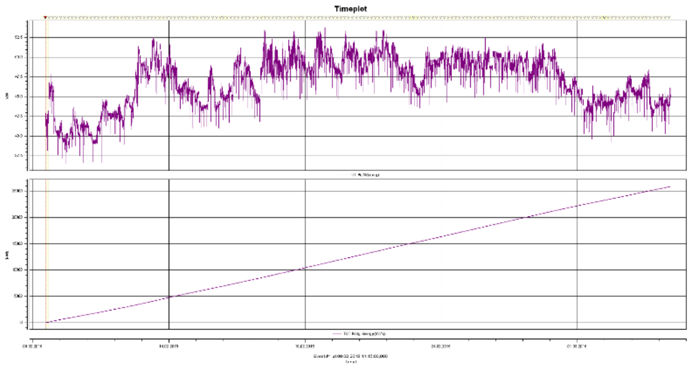
Energetsko stroškovni centri na IJS - RCP (1/3)

Začetna struktura ESC - dinamičen delovni dokument, ki se kontinuirano nadgrajuje

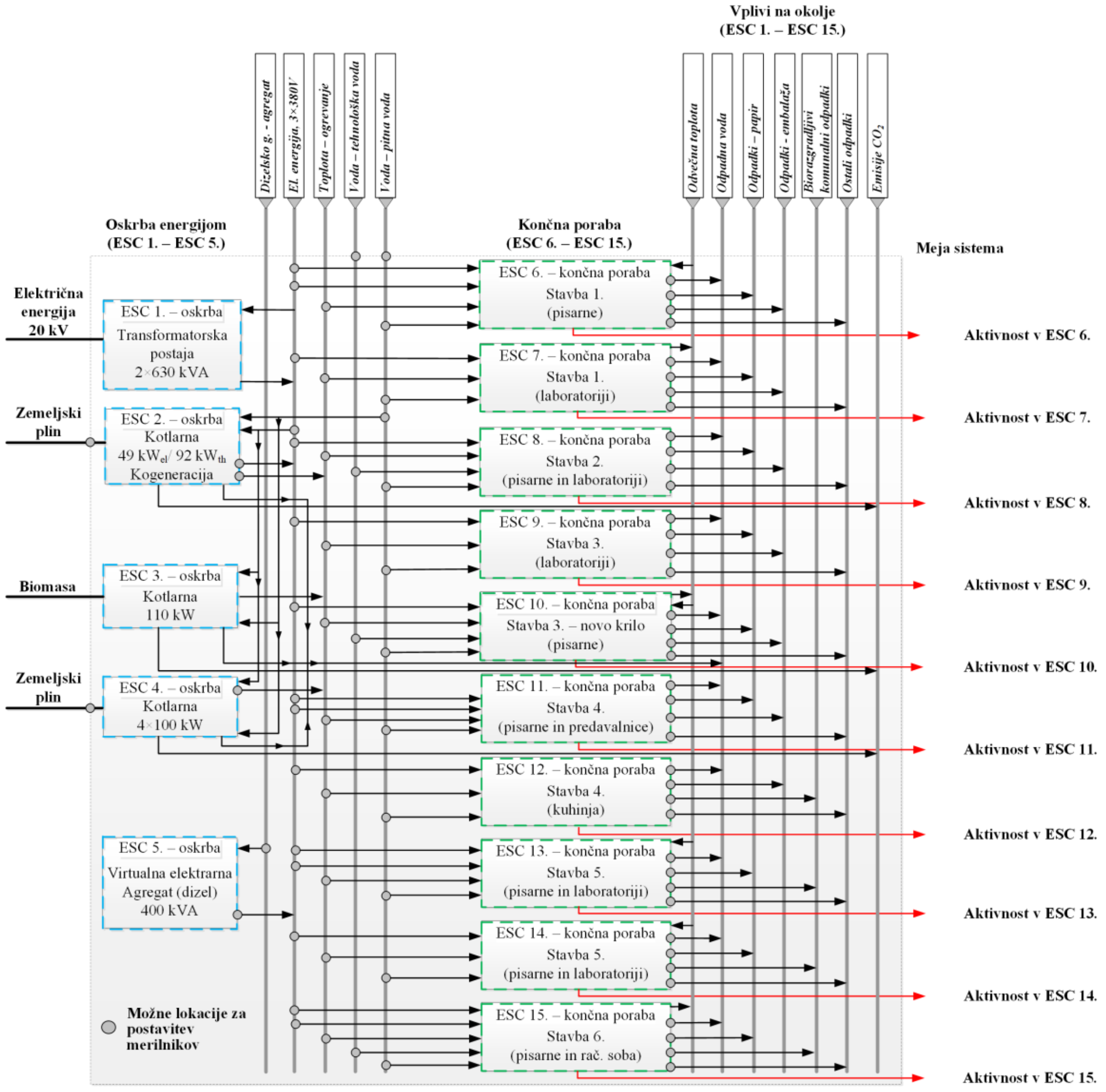


Energetsko stroškovni centri na IJS - RCP (2/3)

- **Dodatni fiksni merilniki!**
- Več različnih individualnih tedenskih meritev



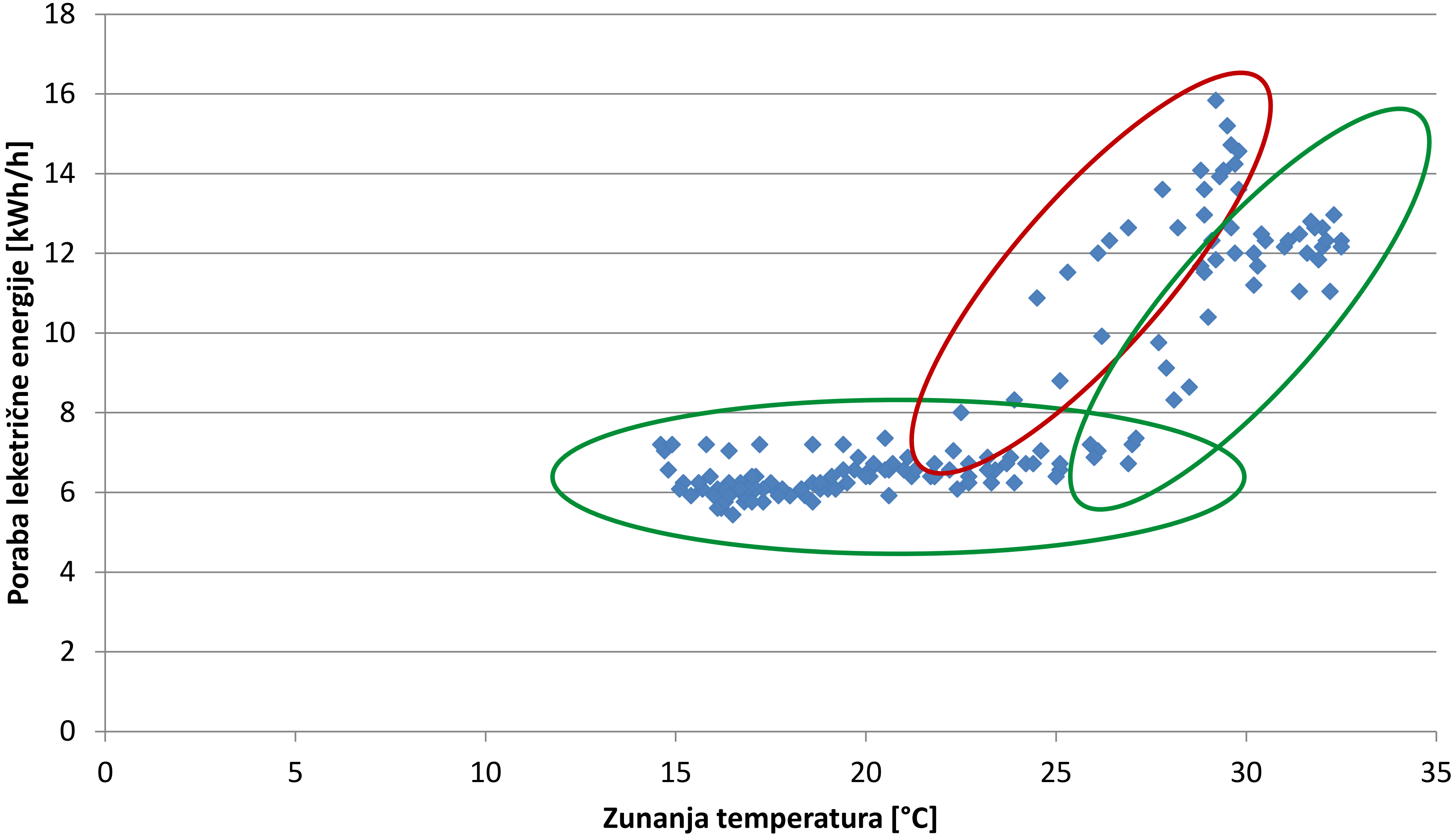
Energetsko stroškovni centri na IJS - RCP (3/3)



Samo meritve niso dovolj!

- **Vgradnja ustreznih dodatnih meritev in daljinsko odčitavanje/spremljanje le prvi potrebni korak!**
- Veliko podjetij že danes spremlja in meri ogromno energijskih in procesnih tokov v svojih SCADA sistemih
    - **So ti podatki res koristno uporabljeni?**
    - **Ali utečeno poročanje daje ustrezne rezultate?**
- Varčevanje pri implementaciji sistema za gospodarjenje z energijo se po navadi odrazi z manjšimi in predvsem ne-trajnimi prihranki!
    - **Brez ustreznega nabora kazalcev in poročanja?**
    - **Brez vzpostavitve ciljnega spremljanja rabe virov?**

Ali pravilno razumemo zbrane podatke?

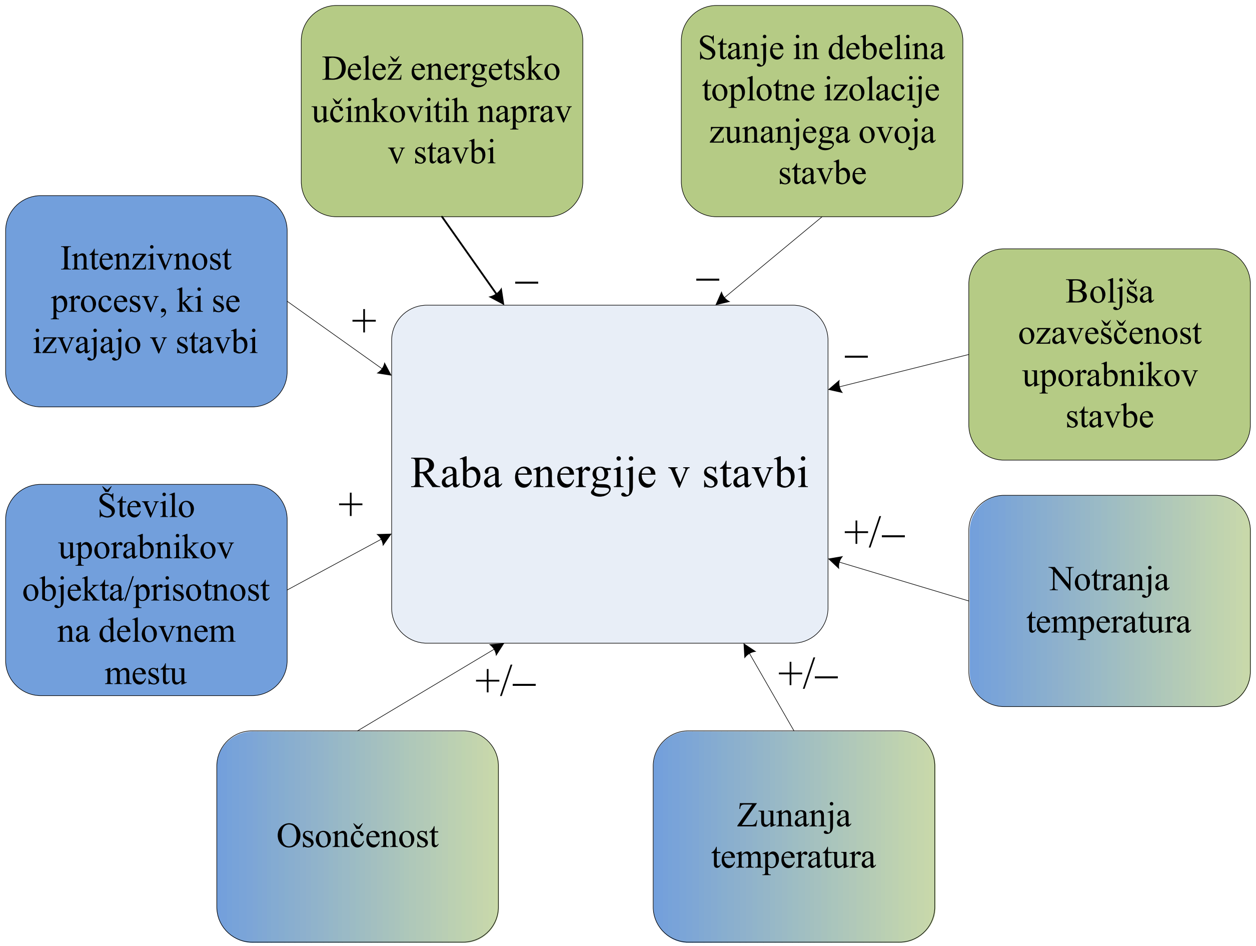


Zmanjšati okoljski odtis za 1 tCO_2/leto

- Promet (100 namesto 120 km/h ~ -20 %)
- Ogrevanje, hlajenje in prezračevanje
  - -1 °C ~ -5 % energije (ogrevanje 20 °C, hlajenje 27 °C)
  - Dnevno-nočni režimi obratovanja
- Pisarniški material – 1 t papirja = 100 EUR
- Izklapljati računalnik ter ostale naprave v pisarni
- Prenosnik porabi manj! (30 W v primerjavi s 100 W)
- Energetsko učinkovitejši gospodinjski aparati
- Rolete zmanjšujejo izgube pri ogrevanju – cca 10 %

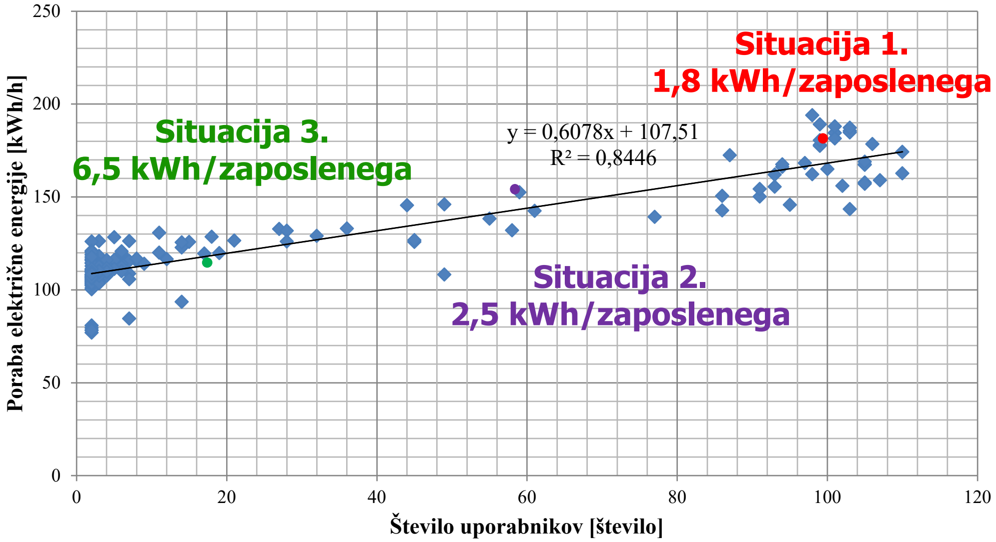
Podatki, ki potrebni za optimalno delovanje modernih stavb

- Energetski podatki
  - Poraba energije in vode
- Kontekstualni podatki
  - Vsi ostali neenergetski podatki



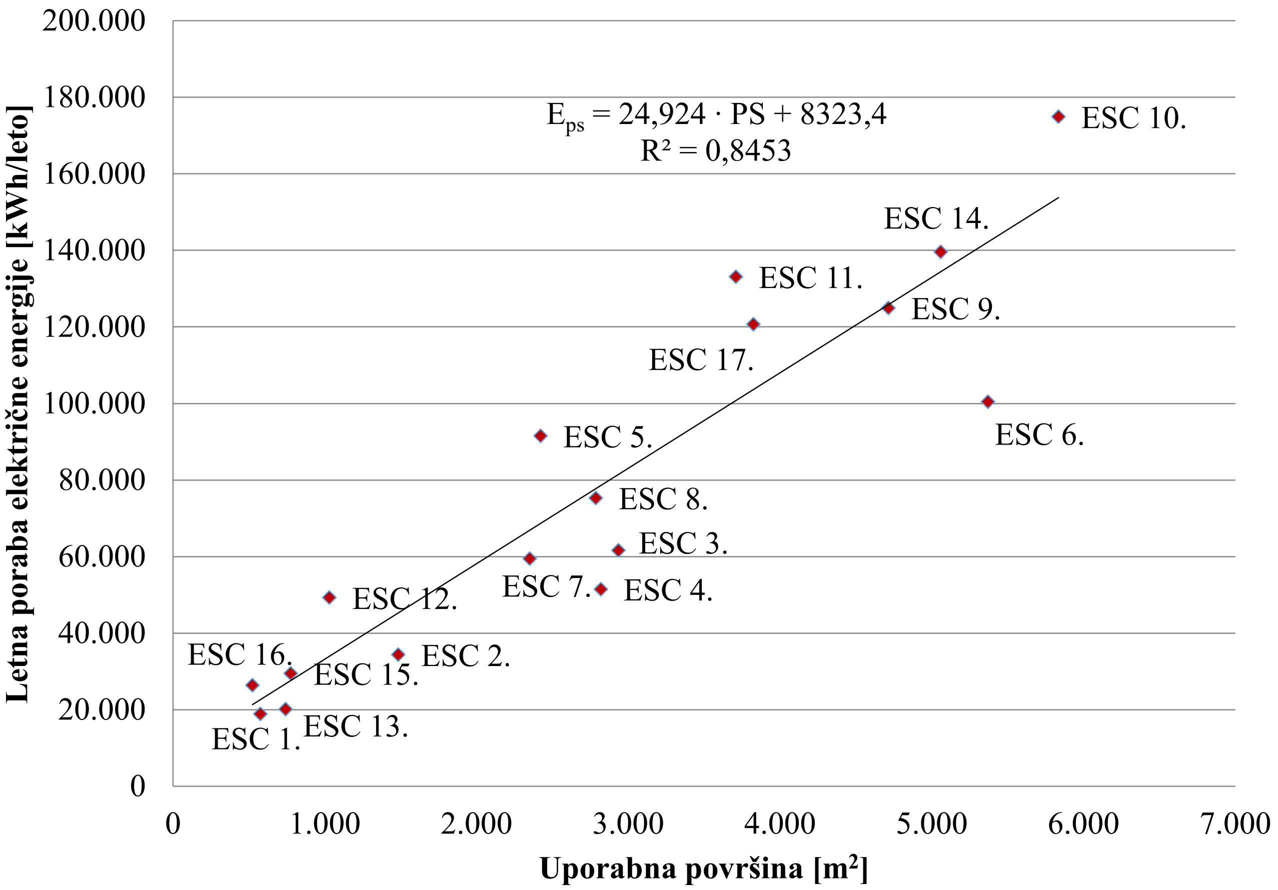
Poraba energije in kontekst

- Kontekstualni parametri – neenergetski podatki, ki so nujni za pravilno razumevanje porabe energije (prisotnost na delovnem mestu, urnik predavanj, zunanja/notranja temperatura ali socialni status končnega uporabnika)
- Kazalniki – morajo vsebovati informacijo o kontekstu porabe energije
- Specifična urna poraba električne energije na lokaciji:
  - Situacija 1: 1,8 kWh/zaposlenega
  - Situacija 2: 2,5 kWh/zaposlenega
  - Situacija 3: 6,5 kWh/zaposlenega
- V kateri situaciji smo bili najbolj učinkoviti?



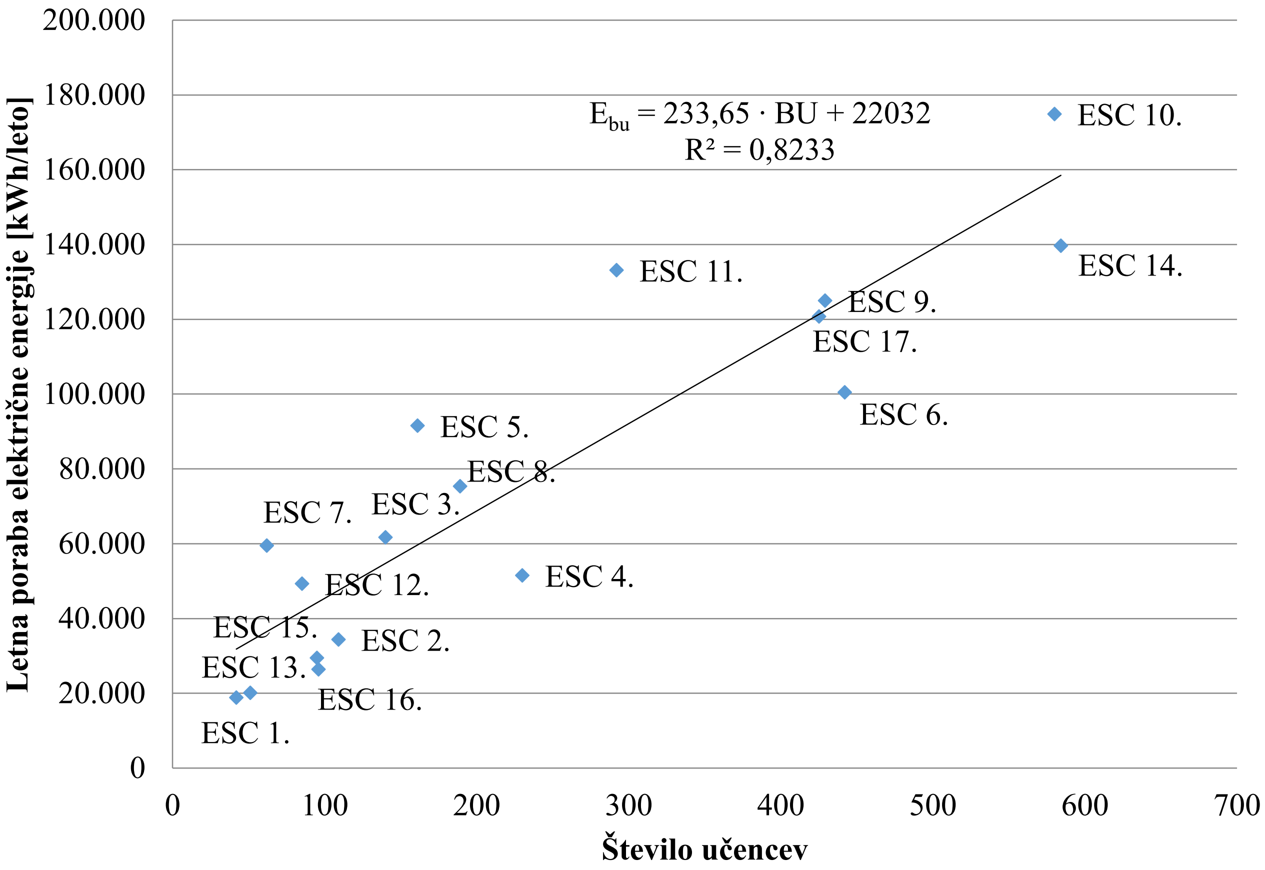
Analiza podatkov in ciljno spremljanje rabe energije (1/5)

- Regresijska analiza



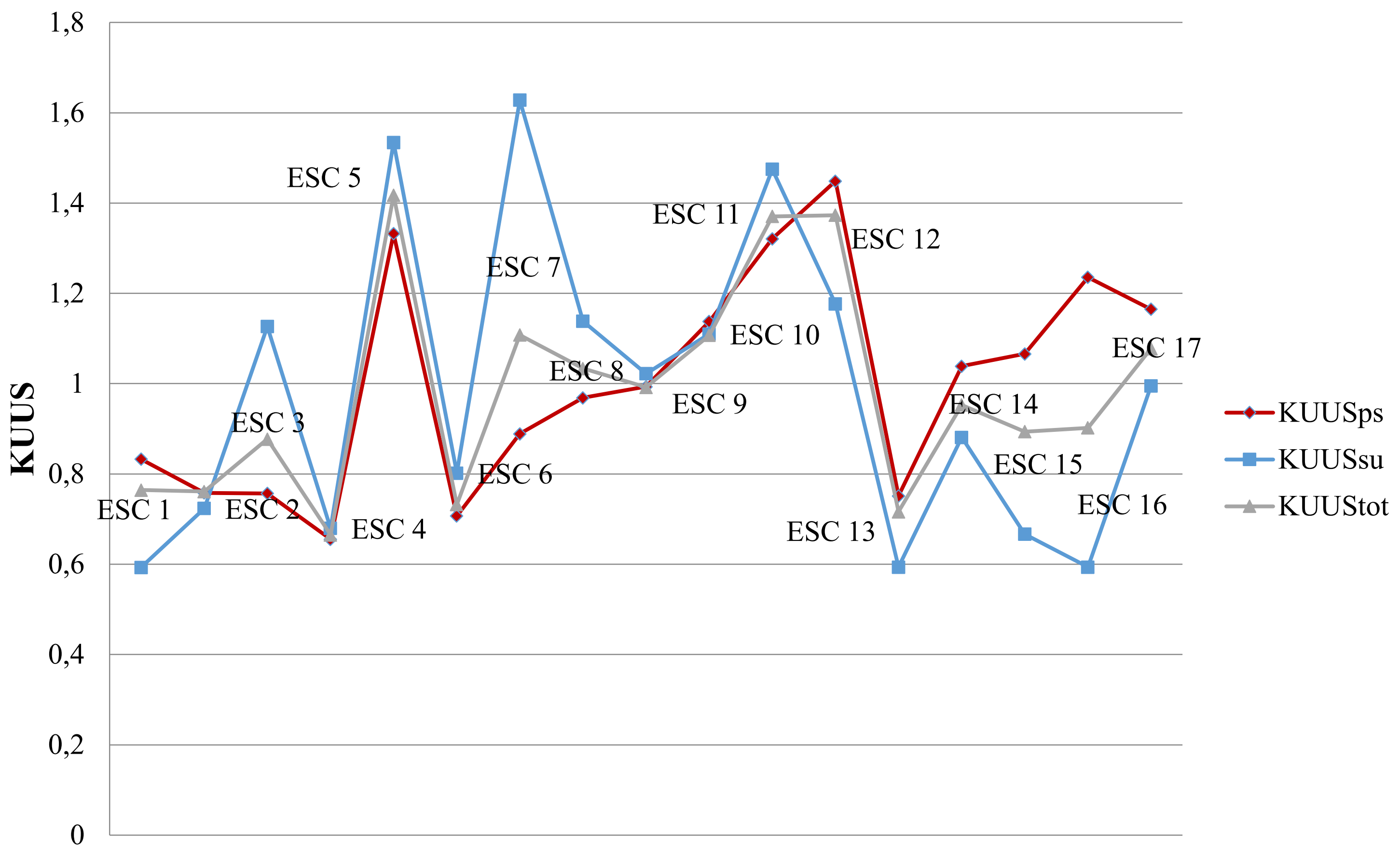
Analiza podatkov in ciljno spremljanje rabe energije (2/5)

- Regresijska analiza



Analiza podatkov in ciljno spremljanje rabe energije (3/5)

- Uporaba kazalnika KUUS

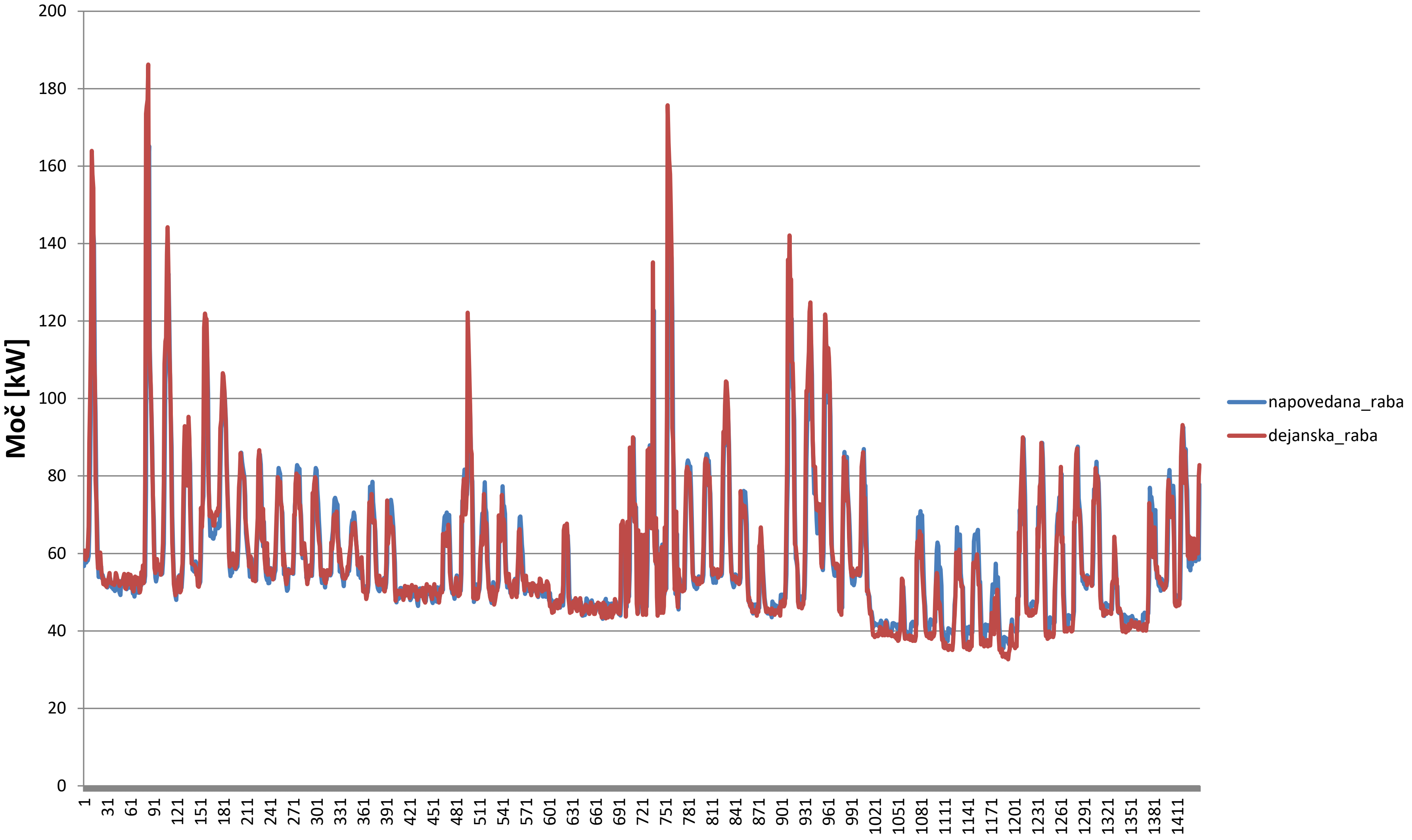


Analiza podatkov in ciljno spremljanje rabe energije (5/5)

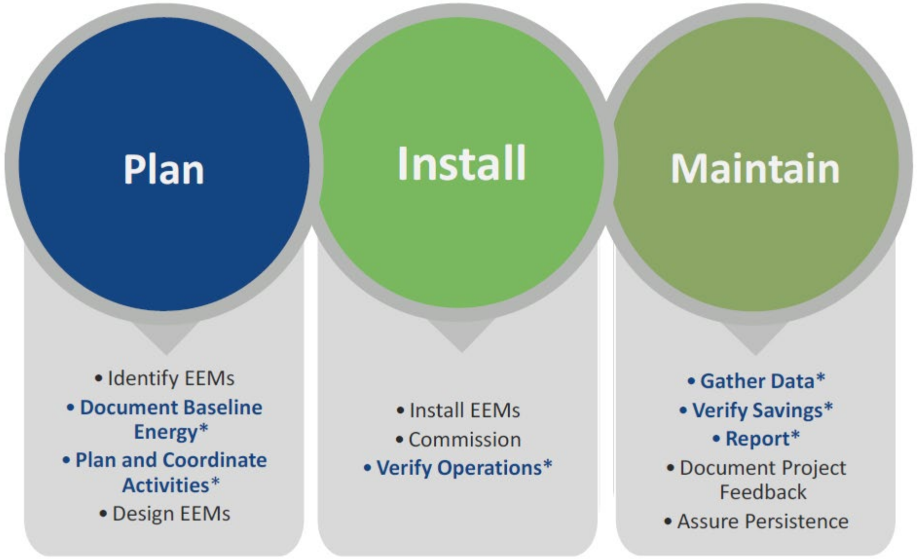
- **Struktura energetskih stroškovnih centrov**
- Možno je tudi kombinirati različne metode, npr. regresijsko analizo, KUUS, strukturo stroškovnih centrov, metodo ovijanja podatkov (angl. data envelopment analysis), različne večkriterijske metode, itn.

	CRS model	VRS model	ESC-i za primerjavo po VRS modelu in koeficijent λ
ESC 1	0,557	**1,000**	ESC 1 je na VRS meji
ESC 2	0,789	0,913	ESC 13 (λ = 0,642) in ESC 4 (λ = 0,358)
ESC 3	0,870	0,872	ESC 4 (λ = 0,954) in ESC 6 (λ = 0,046)
ESC 4	**1,000**	**1,000**	**ESC 4 je najbolj učinkovit ESC (nahaja se na CRS in VRS meji)**
ESC 5	0,484	0,497	ESC 4 (λ = 0,809) in ESC 13 (λ = 0,191)
ESC 6	0,985	**1,000**	ESC 6 je na VRS meji
ESC 7	0,722	0,747	ESC 4 (λ = 0,774) in ESC 13 (λ = 0,226)
ESC 8	0,676	0,677	ESC 4 (λ = 0,985) in ESC 4 (λ = 0,015)
ESC 9	0,769	0,780	ESC 6 (λ = 0,939) in ESC 4 (λ = 0,061)
ESC 10	0,743	**1,000**	ESC 10 je na VRS meji
ESC 11	0,509	0,515	ESC 4 (λ = 0,651) in ESC 6 (λ = 0,349)
ESC 12	0,386	0,525	ESC 13 (λ = 0,703), ESC 4 (λ = 0,154) in ESC 16 (λ = 0,142)
ESC 13	0,673	**1,000**	ESC 13 je na VRS meji
ESC 14	0,937	**1,000**	ESC 14 je na VRS meji
ESC 15	0,722	0,909	ESC 16 (λ = 0,643), ESC 13 (λ = 0,273) in ESC 4 (λ = 0,084)
ESC 16	0,815	**1,000**	ESC 16 je na VRS meji
EsC 17	0,788	0,800	ESC 6 (λ = 0,920) in ESC 4 (λ = 0,080)
Srednja vrednost	0,731	0,837	-

Vaja – analiza in napoved porabe električne energije



Osnovni elementi merjenja in verifikacije prihrankov (1/4)



*M&V Activities

Step 1: Determine Goals for M&V Efforts	*Baseline Period*
Step 2: Select IPMVP Option(s) and Approaches	
Step 3: Document Baseline Data	
Step 4: Develop M&V Plan	
Step 5: Set-up Metering and Ongoing Data Collection Processes	
Step 6: Monitor for Changes in Site Conditions	*Installation Period*
Step 7: Confirm Operational Verification	
Step 8: Ongoing Data Collection	*Reporting Period*
Step 9: Determine Savings for Period	
Step 10: M&V Report for Period	
Step 11: Track Energy Performance and Savings	

Type of Savings	Basis of Adjustment	Routine Adjustment Method	Description
Avoided Energy Consumption	Reporting Period Conditions	Forecasting	Baseline period energy is adjusted to reporting period conditions
	Baseline Period Conditions	Backcasting	Reporting period energy is adjusted to baseline period conditions
Normalized Energy Savings	"Normal" or Fixed Conditions	Normalizing	Both the baseline and reporting period energy are adjusted to standard conditions, e.g., Typical Meteorological Year (TMY) conditions

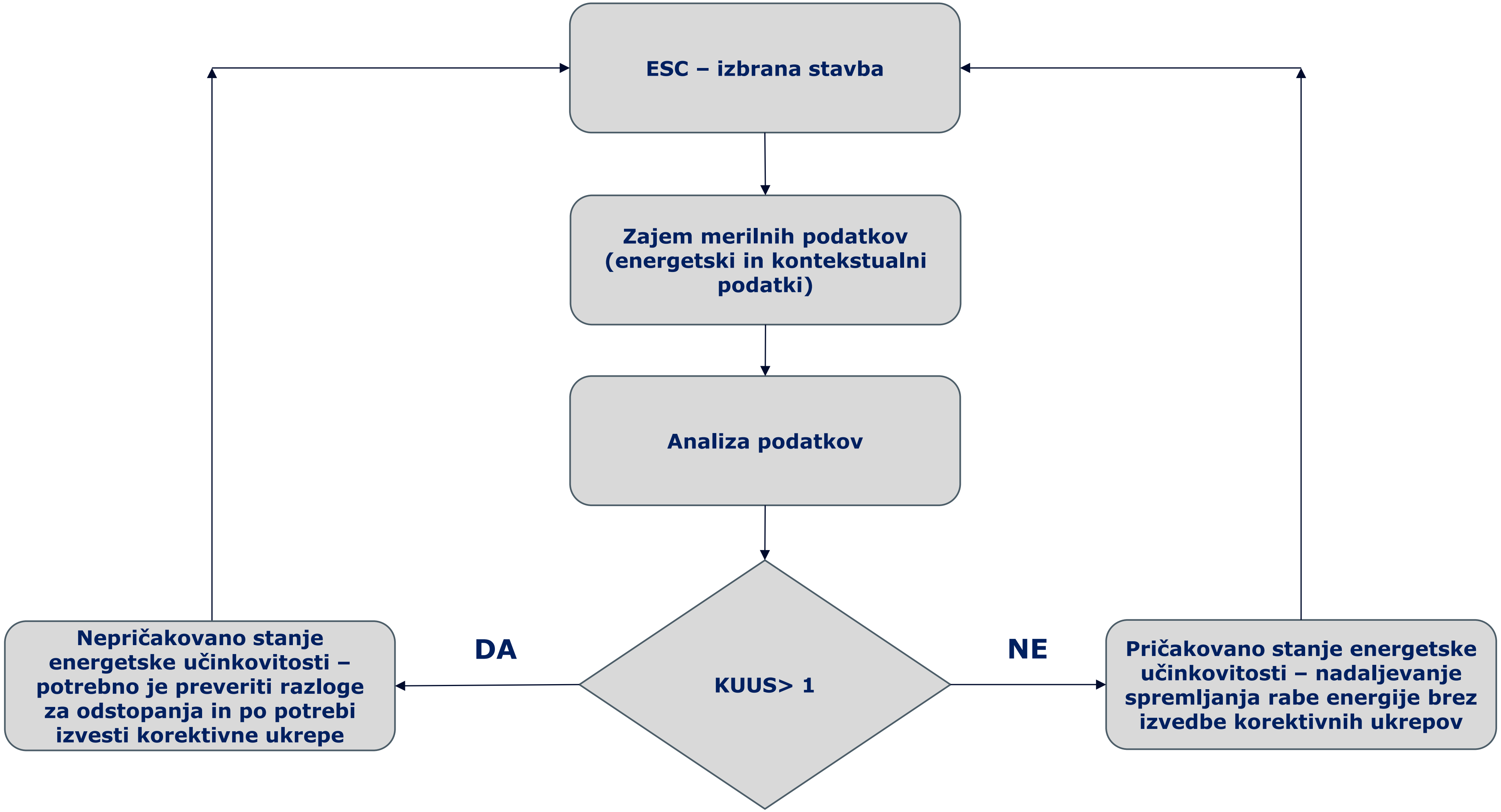
Osnovni elementi merjenja in verifikacije prihrankov (2/4)

IPMVP Option	Definition	How Savings are Calculated	Typical Applications
A. **Retrofit Isolation: Key Parameter(s) Measurement**	Savings are determined by field measurement of the key parameter(s), which define the energy consumption and/or demand of the EEM's affected system(s). Performance indicators may also be defined and measured to ensure the success of the project. Measurements range from periodic short-term to continuous long-term, depending on the expected variations in the key parameter(s). Parameters not selected for field measurements are estimated values. Estimates can be based on historical data, manufacturer specifications, or engineering judgment. Documentation of the source and justification of the estimated value is required. The plausible savings error arising from estimation rather than measurement is evaluated and is acceptable to stakeholders.	Calculation of baseline period energy and reporting period energy from periodic short-term energy measurements, or from periodic short-term or continuous measurements of key parameter(s) and from estimated values. Routine and non-routine adjustments as required. Key parameter(s) must be measured during both baseline and reporting period.	A lighting retrofit where the change in power drawn by the lighting system is the most uncertain parameter and is measured, and secondly, lighting operating hours are estimated based on facility schedules and occupant behavior. Notes: Multiple key parameters often exist, and selection of key parameters to measure is an important consideration.
B. **Retrofit Isolation: All Parameter Measurement**	Savings are determined by continuous field measurement of the energy consumption and/or demand or validated proxy variables and the related independent variables of the EEM affected system. Measurements range from periodic short-term to continuous long-term, depending on the expected variations in the key parameters.	Determination of baseline period energy based on short-term or continuous measurements of baseline and reporting period energy, or on engineering computations using measurements of proven proxies of energy consumption or demand. Routine and non-routine adjustments as required.	Installation of a variable-frequency drive and controls to a motor to adjust pump flow. Measure electric power with a kW meter installed on the electrical supply to the motor, which reads the power demand every minute. In the baseline period, this meter is in place for a month and system testing was conducted to verify constant loading across a full range of operating conditions. The meter remains in place throughout the reporting period to measure energy consumption and demand.

Osnovni elementi merjenja in verifikacije prihrankov (3/4)

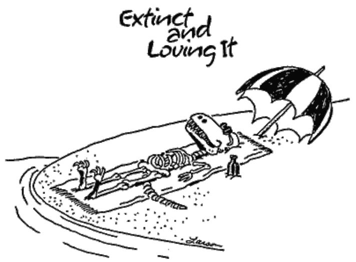
IPMVP Option	Definition	How Savings are Calculated	Typical Applications
C. **Whole Facility**	Savings are determined by measuring energy consumption and/or demand at the whole facility or sub-facility level, often using utility meter data. Continuous measurements of the entire facility's or sub-facility's energy consumption and/or demand are taken throughout the baseline period and the reporting period.	Analysis of the whole facility or sub-facility baseline and reporting period energy data (e.g., utility meter) and independent variables. Routine adjustments as required, typically using models based on regression analysis techniques. Non-routine adjustments as required.	Multifaceted energy management programs affecting many systems in a facility. Measure energy consumption and/or demand with the gas and electric utility meters for a twelve-month baseline period and throughout the reporting period.
D. **Calibrated Simulation**	Savings are determined through simulation of the energy consumption and demand of the whole facility, or of a sub-system in the facility and comparing results with actual energy consumption and demand. Simulation models are demonstrated to adequately model actual energy performance in the facility. This option requires considerable skill in calibrated simulation and experience with the equipment and processes being modeled.	Actual energy consumption and demand and results from simulation model(s). Energy consumption and demand from the simulation, calibrated with hourly, daily or monthly energy data. Energy sub-metering and metered performance data including processes may be used in further model calibration. Non-routine adjustments as required.	Multifaceted energy management programs affecting many systems in a facility but where no meter existed in the baseline period. Energy consumption and demand measurement, after installation of natural gas, electric or other energy meters, is used to calibrate a simulation model.

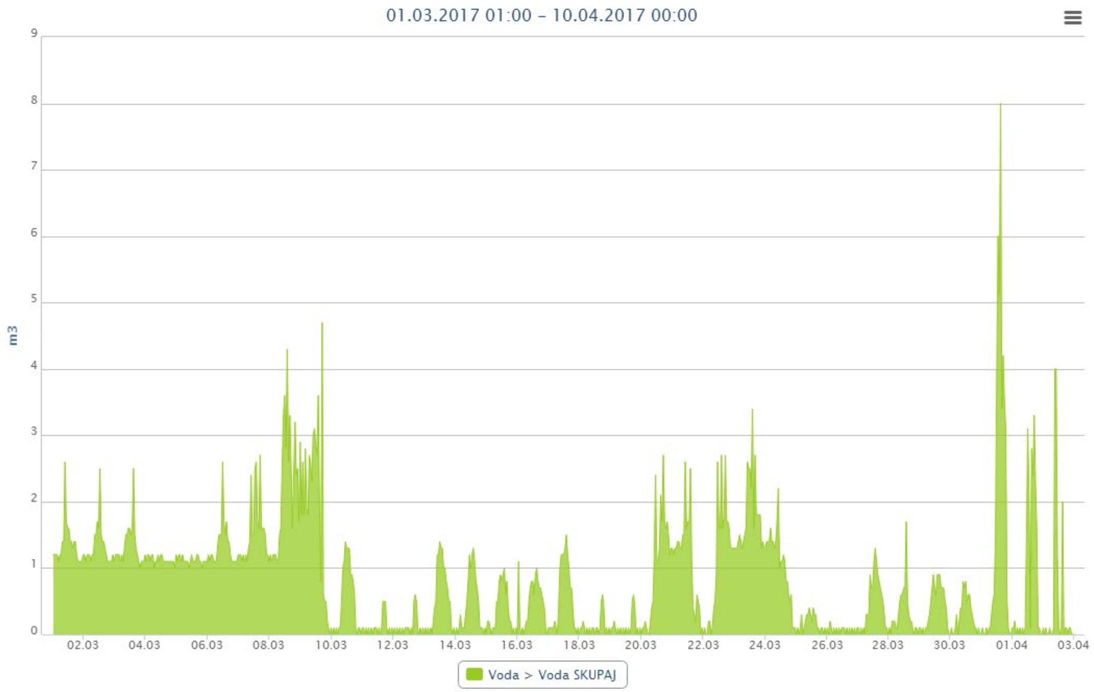
Osnovni elementi merjenja in verifikacije prihrankov (4/4)



Zaključek

- Bodimo **zahtevni pri uvajanju ukrepov URE in zahtevajmo celovite rešitve**!
- Znanje in dobro poznavanje procesov na lokaciji je ključno za uspešno uvajanje novih rešitev – **ciklični proces izboljšav!**
- Dobra praksa – zakaj plačati več?





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