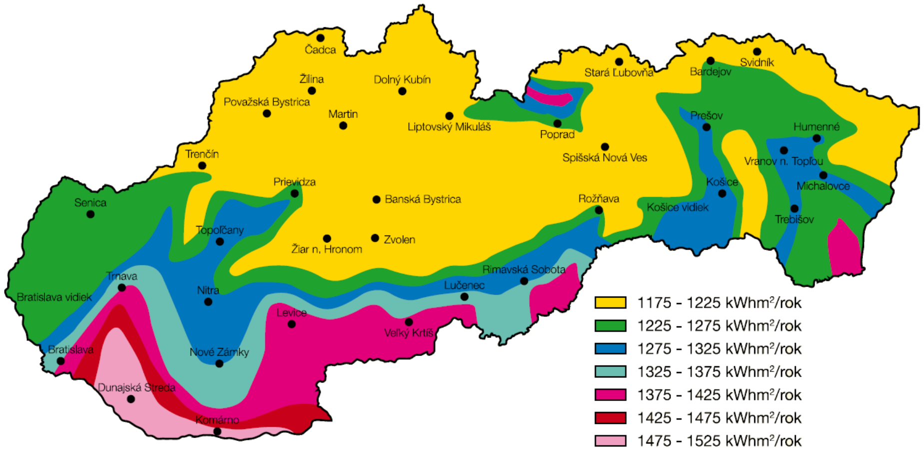
Dimensioning of a solar autonomous system with a battery, intended for powering free-standing telecommunication equipment in Slovakia.

The methodology can also be used for dimensioning island systems of buildings and other facilities

Step 1

Step 1 - determining the average value of solar radiation during the worst month in year



Komárno		**Kysucké Nové Mesto**	
Mesiac	Množstvo žiarenia pri optimálnom sklone [Wh/m²/deň]	Mesiac	Množstvo žiarenia pri optimálnom sklone [Wh/m²/deň]
Január	1476	Január	1442
Február	2368	Február	2263
Marec	3507	Marec	3246
Apríl	4777	Apríl	4156
Máj	5318	Máj	4715
Jún	5586	Jún	4662
Júl	5930	Júl	5059
August	5331	August	4519
September	4542	September	3657
Október	3250	Október	2926
November	1751	November	1563
December	1107	December	1066
Celoročný priemer	**3752**	**Celoročný priemer**	**3278**
Rozdiel: **13 %**			

Slovakia – worst month is December
1.066 kwh/m2/day

Step 2

Step 2 - creating a list of appliances and calculating the total energy consumtion - 24 hour method

Tag Number	Description	Load (W)	Power Factor	Load VA	Time On	Time Off	VA Hours
TLC-001	Telecommunications Cabinet	50	0.85	59	00:00	23:59	1,411
FB-002	Fibre Optic Panel	35	0.85	41	00:00	23:59	988
LP-001	Lighting - Enclosure	15	0.85	18	20:00	21:00	18
LP-002	Lighting - Security	60	0.85	71	18:00	07:00	776
MON-001	CCTV Camera #1	90	0.80	113	00:00	23:59	2,698
MON-002	CCTV Camera #2	90	0.80	113	00:00	23:59	2,698
MX-001	Multiplexer	20	0.80	25	00:00	23:59	600
			TOTAL LOAD VA	438	TOTAL VAh		9,188

Step 3

Step 3 - Calculate the computing power and the amount of required energy for which the system is dimensioned

$$S_d = S_p(1 + k_g)(1 + k_c) = 438(1 + 0{,}1)(1 + 0{,}1) = 529{,}98 \text{ VA}$$

$$E_d = E_t(1 + k_g)(1 + k_c) = 9188(1 + 0{,}1)(1 + 0{,}1) = 11117{,}48\ VAh$$

Kg - coefficient respecting the expansion of the device in the future (5-20%)

Kc - coefficient respecting the inaccuracy in the design and all other than standard conditions, caused by neglect of maintenance, ... (5-20%)

Step 4, 5

Step 4 - Select battery type and voltage selection
- lead accumulators, 120V DC

Step 5 - calculation of the maximum and minimum number of cells connected in series
1 cell parameters:
- charged cell voltage 2.25 V
- minimum cell voltage 1.8 V
- voltage tolerance Vmax = 20%, Vmin = 10%

$$N_{max} = \frac{V_{DC}(1+V_{max})}{V_C} = \frac{120*(1+0,2)}{2,25} = 64\ cells$$

$$N_{min} = \frac{V_{DC}(1+V_{min})}{V_{eod}} = \frac{120*(1-0,1)}{1,8} = 60\ cells$$

Step 6

Step 6 - Determine the battery capacity

It is necessary to first determine the coefficients:

- depth of battery discharge k_DOD = 80%
- battery aging factor k_a = 25%
- correction factor for temperature 30 ° C, k_t = 0,95
- load factor kc = 10%

$$C_{min} = \frac{E_d k_a k_c k_t}{V_{dc} k_{dod}} = \frac{11117{,}48 * 1{,}25 * 1{,}1 * 0{,}956}{120 * 0.8} = 152{,}23\ Ah$$

Step 7

Step 7 - selection of the type of photovoltaic panels

Parameters of the selected module:

- peak power P_peak = 300 Wp
- rated voltage V_n = 12 V
- temperature coefficient γ = 0.38% per ° C
- tolerance specified by the manufacturer f = 5%

- Assume an average temperature of 20 ° C: $T_{cell,eff} = T_{a,day} + 25 = 20 + 25 = 45\ °C$

- Temperature factor: $f_{temp} = 1 - \gamma\left(T_{cell,eff} - T_{STC} \right) = 1 - 0.0038 * (45 - 25) = 0{,}924$

Step 7, 8

- Dirt factor f_{dirt}=0,97
- Netto output power of the module : $P_{mod} = P_{stc} * f_{temp} * f_{man} * f_{dirt} = 300 * 0{,}924 * 0{,}95 * 0{,}97 = 255{,}43\ W$

Step 8 - calculation of the size of the photovoltaic field

When considering the overload coefficient f0 = 1.1 and the efficiency of the subsystems 85%, the number is possible modules within the field are calculated as follows:

$$N = \frac{E_d * f_0}{P_{mod} * G * \eta_{pvss}} = \frac{11117{,}48 * 1{,}1}{255{,}43 * 1{,}066 * 0{,}85} = 52 \text{ modules}$$