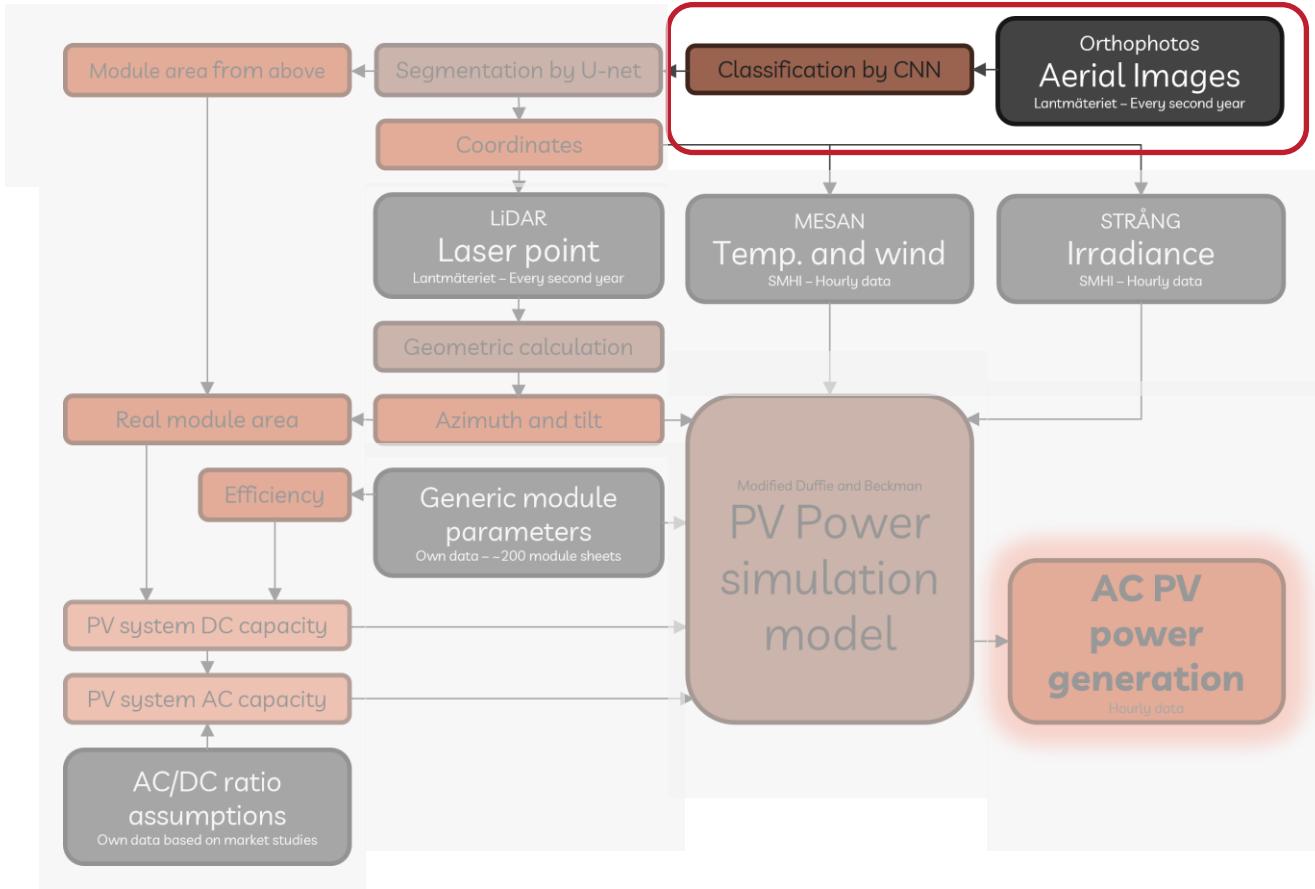


Frigörande av nätkapacitet och generering av marknadsstatistik genom identifiering av solceller via flygfoton

Amelia Oller Westerberg, Becquerel Sweden
15 februari, Elmia Solar

Alfrödull — Modelldesign

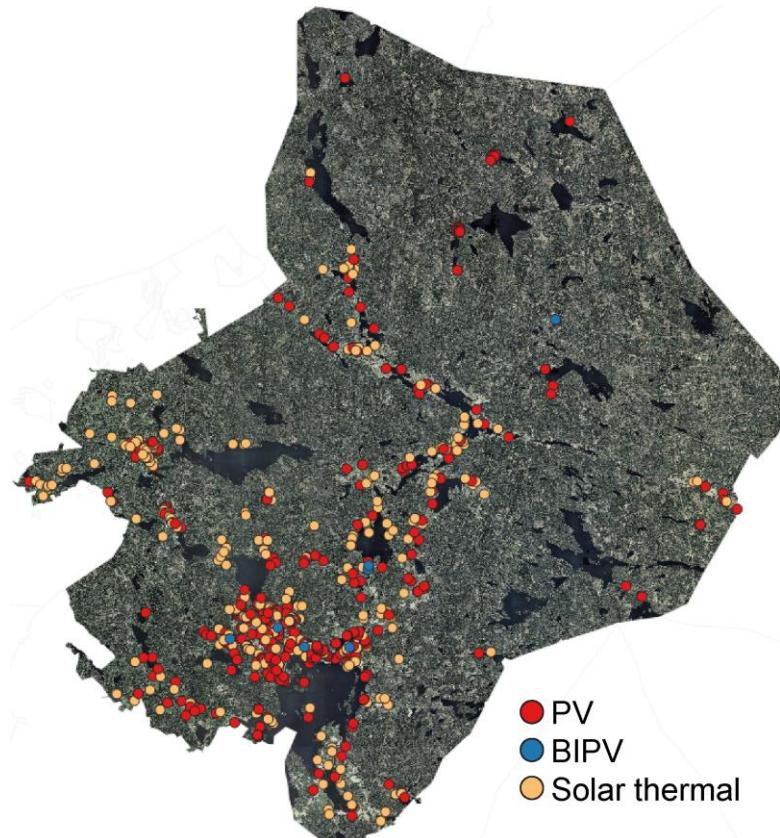


Alfrödull — Metodik



1. Ortofotot delas in i små bilder
2. Identifiering sker → solenergisystem eller inte
3. Manuell verifiering (med elnätsägare och genom visuell inspektion)
4. Ett polygon skapas och klassificering sker mellan solceller och solvärme
5. Solenergisystemet matchas med typkoder i Lantmäteriets geodataservice. BY-polygonlagret har 49 detaljerade typkoder.

Alfrödull — Databas över solenergisystem i Sverige



Alfrödull

Resultat - Marknadssegentering

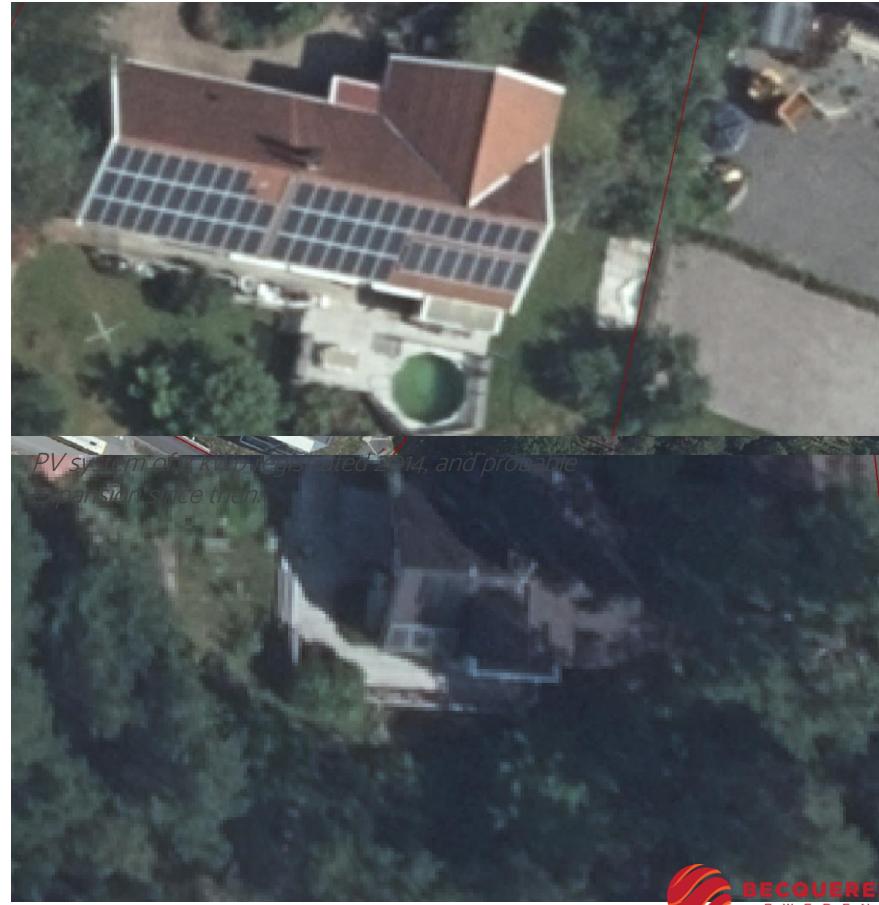
General building purpose	Detailed building purpose	Property purpose	Number of systems			
			Uppvid unge 2020*	Falun 2020**	Knivsta 2019***	Knivsta 2021**
Ground	-	Single-family dwelling units		1		
		Agriculture units		3	1	
		Single-family dwelling units	27	198	73	
		Tenement building units	1			
	Small house, detached	Agriculture units	6	12		
		Industrial premises units		1		
		Special units		1		
	Small house, chain linked house	Single-family dwelling units		18	4	
Residential	Single family houses, terraced houses	Single-family dwelling units		2	1	
		Tenement building units			1	
	Small house with several apartments	Tenement building units		1		
		Tenement building units	3	12	3	
	Multi-family house	Single-family dwelling units	1			
		Special units	1			
	Unspecified	Single-family dwelling units	3			
		Agriculture units	1	1		
		Single-family dwelling units	20	41	14	
		Tenement building units	1	2	1	
		Agriculture units	31	48	17	
		Industrial premises units	2	2	1	
		Power-generation units	1			
		Special units	3			
Agricultural	Unspecified	Single-family dwelling units		2		
		Agriculture units		3		
	Wood industry	Industrial premises units	1			
Industrial	Other manufacturing industry	Tenement building units	1	1		
	Other industrial building	Industrial premises units	1			
	Unspecified	Industrial premises units	1	1	1	
		Single-family dwelling units		1		
	School	Special units		5	3	
	Higher education institution	Industrial premises units		1		
	Hospital	Special units		2		
	Healthcare centre	Tenement building units	1			
	Fire station	Special units		1		
	Town hall	Special units		1		
	Cultural building	Special units	1			
	Administrative building	Tenement building units		1		

Alfrödull

Resultat - Kontroll mot elnätsägarens databas

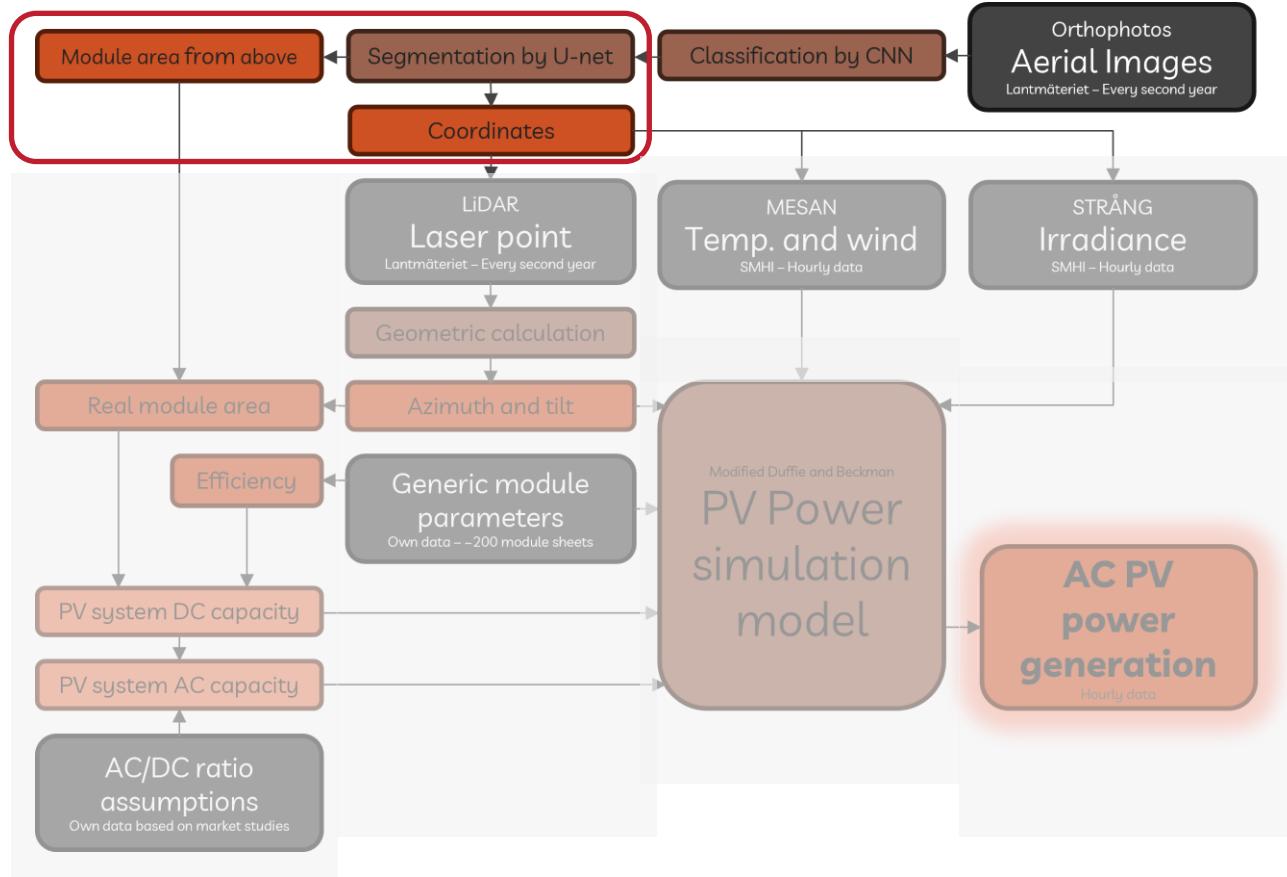
Upptäckta fel	Knivsta	Falun	~diff
För gammalt system för att ha registrerats	2	0	+4.8 kW
Troligen solenergi, men saknas eller är inte korrekt registrerad hos elnätsägaren	3	2	+54.9 kW
Avvecklat utan att ha meddelat nätagaren	0	1	-3.2 kW
Registrerat med fel fastighetsbeteckning	9	2	-
Större DC-kapacitet än registrerat hos nätagaren	4	2	+125.6 kW
<i>Trolig expansion</i>	2	1	+32.4 kW
<i>Troligen för att förbli mikroproducent</i>	1	0	+29.9 kW
<i>Troligen för att förbli under 255 kW gränsen</i>	1	0	+62.2 kW
<i>Okänd anledning</i>	0	1	+1.1 kW
Icke nätanslutna system	2	45	+12 kW
Totalt			+194 kW

Den faktiska solcellsproduktionen i de här två kommunerna är troligen 3% högre!



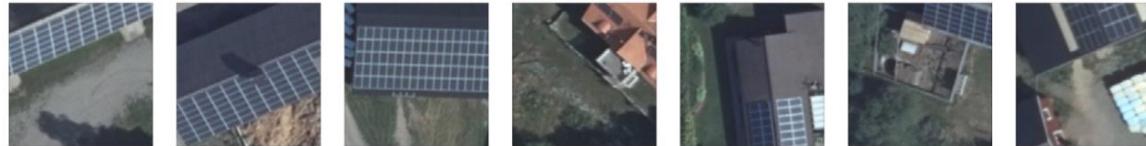
Missing PV system of approximately 1 kWp

Alfrödull – Modelldesign

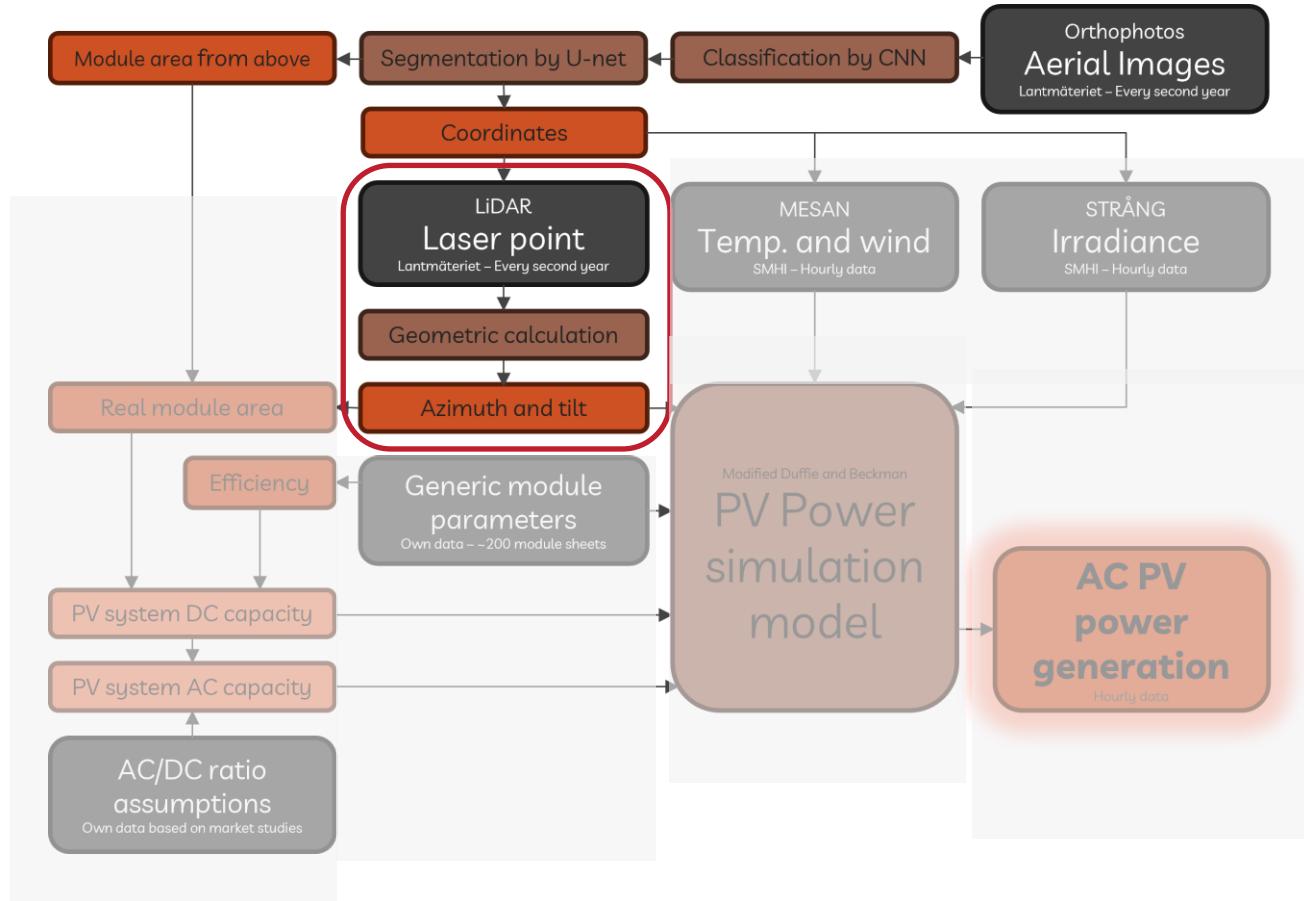


Alfrödull

Automatisk segmentering är under utveckling med en s.k. U-netmodell

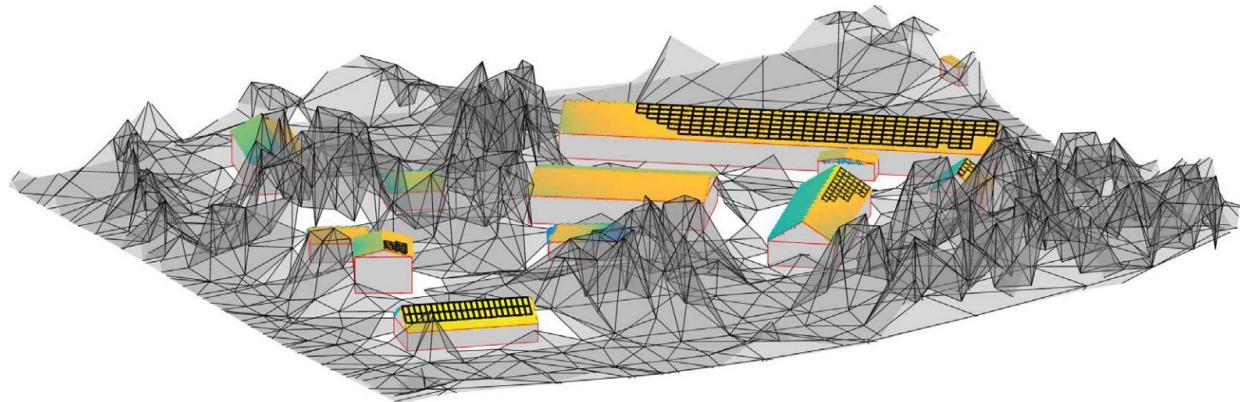
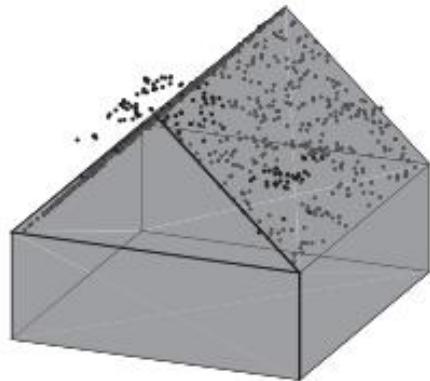


Alfrödull — Modelldesign



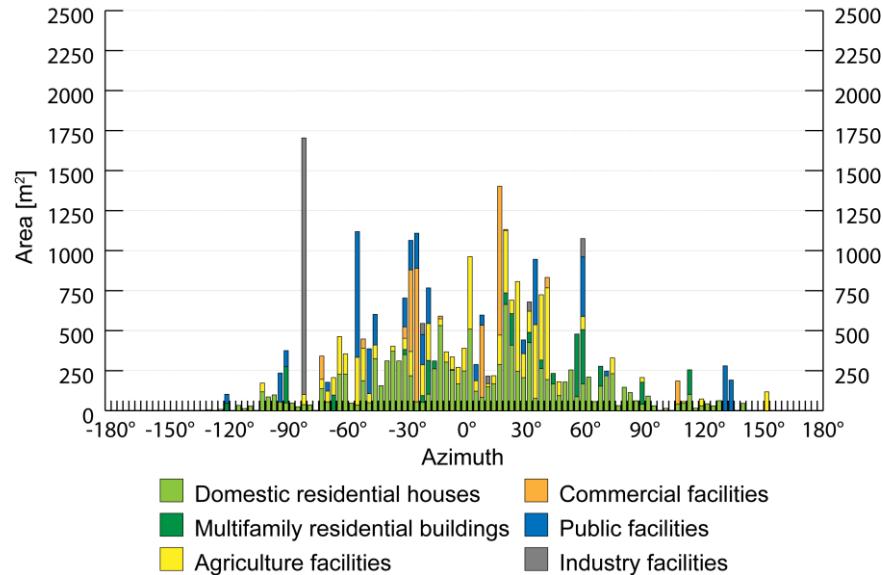
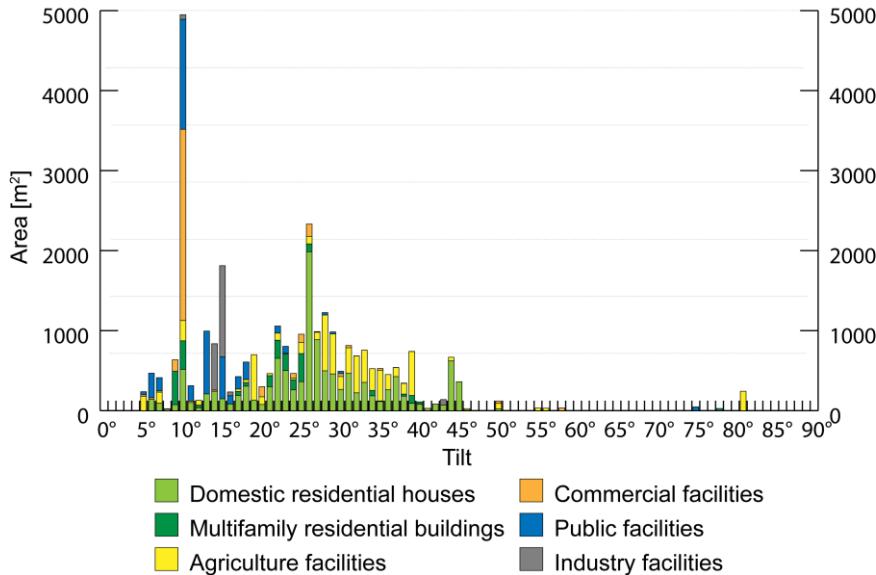
Alfrödull

Beräkning av orientering (lutning och azimut) med hjälp av LiDAR-data

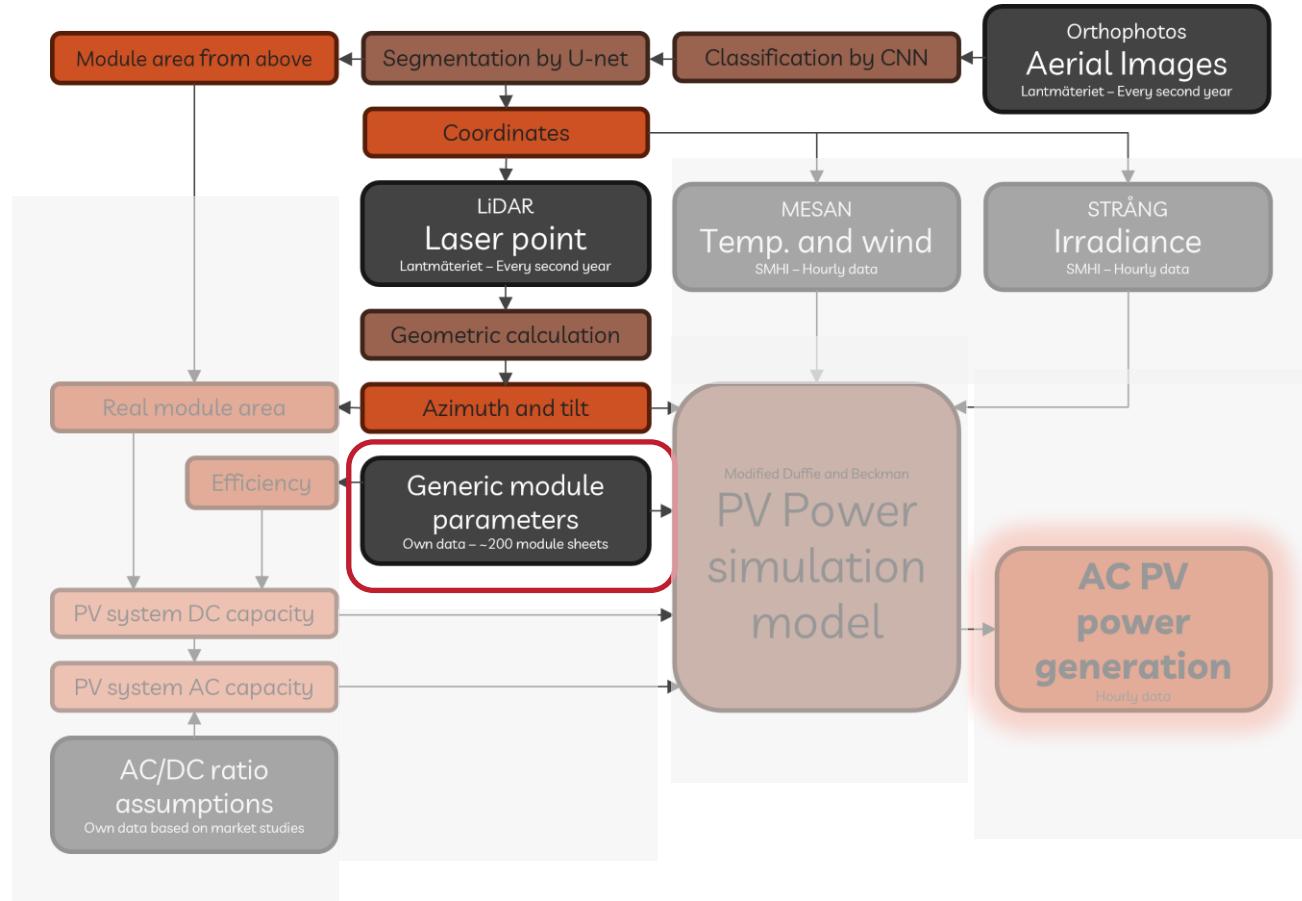


Alfrödull

Resultat: spridningen i lutning och azimut



Alfrödull — Modelldesign



Mundilfare

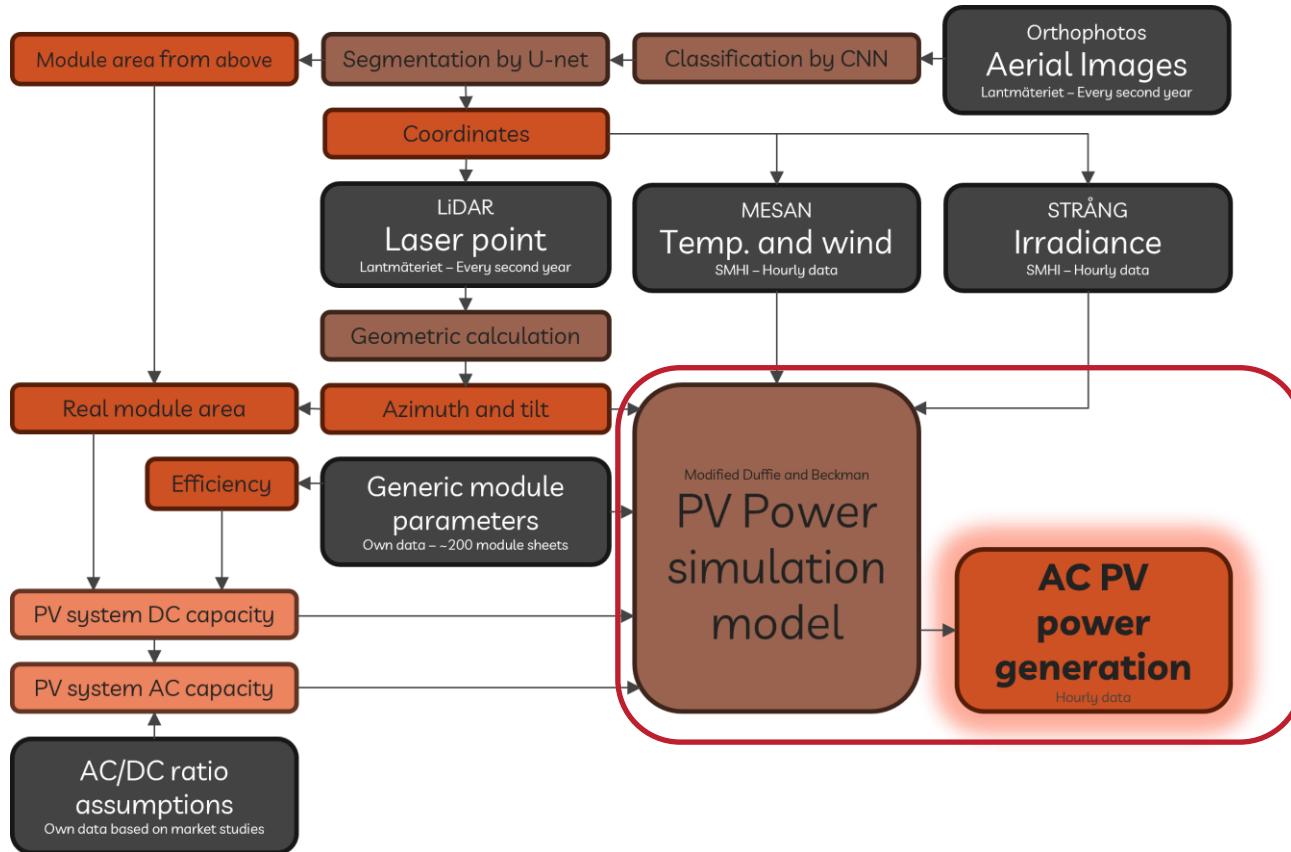
Modulparametrar för att omvandla area till produktionskapacitet

Becquerel Sweden skapat en databas baserad på <200 olika datablad för typiska monokristallina och polykristallina kiselmoduler för den svenska marknaden vid olika tillfällen mellan 2015 och 2020

Year	2015	2016	2017	2018	2019	2020
η [%]	16.3	17.0	17.8	18.3	18.9	20.5
V_{mp} [V]	32.2	31.8	32.7	33.3	35.5	38.2
V_{oc} [V]	39.5	38.9	40.3	40.4	43.0	45.5
μ_{Voc} [mV/°C]	-123	-122	-124	-117	-127	-124
Nominal power [W]	265	281	298	309	329	416
Modules	39	24	24	44	30	39
Manufacturers	14	15	17	12	9	10



Alfrödull — Modelldesign



Mundilfare

Simuleringsmodell

$$P_{DC/kW_{DC}} = G_{g,t} \left[1 + \frac{\mu}{\eta} (T_a - T_{STC}) + \frac{\mu}{\eta} \frac{9.5}{5.7 + 3.8\nu} \frac{(NOCT - 20)}{800} (1 - \eta) G_{g,t} \right]$$

where η is the efficiency of the PV module at standard test conditions (STC) (%), μ is the temperature coefficient of the maximum power efficiency (%/°C), T_a is the ambient temperature (°C), T_{STC} is the temperature during STC (25°C), ν is the wind speed (m/s), NOCT is the nominal operating cell temperature (°C) and $G_{g,t}$ is the global tilted irradiance (W/m²).

$$P_{AC/kW_{DC}} = \min \left(P_{DC/kW_{DC}}, \frac{1000}{P_{max,DC}/P_{max,AC}} \right)$$

where $P_{max,DC}$ is the installed DC capacity and $P_{max,AC}$ is the installed AC capacity.

Mundilfare

Validering av simuleringsmodell

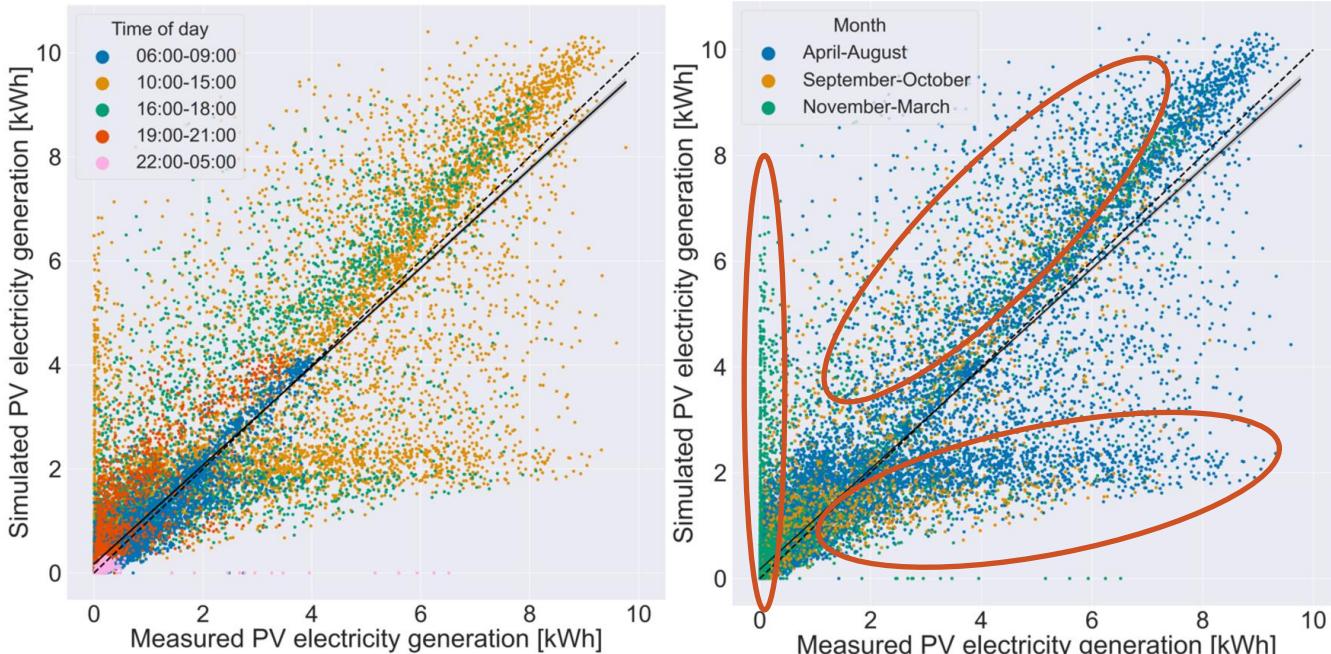
System	Simulated PV power [MWh]	Measured PV power [MWh]	Difference [%]
PVS1-U	40.9	39.0	4.7%
PVS2-U	42.8	40.1	6.7%
PVS3-F	53.5	46.6	15.0%
PVS4-F	70.3	65.5	7.4%
PVS5-K	41.3	31.3	31.8%
PVS6-K	86.7	64.8	33.9%
Total	335.6	287.3	16.8%

Table V: Statistical measurements for validation step 2, employing LiDAR-derived orientations. For R^2 , red is the lowest value, green is the highest value and yellow is the 50th percentile (median). For the other metrics, green is the highest value, and red is the lowest value. N denotes the number of hours simulated.

PVS	N	R^2	RMSE	MSE	SSR	MAE	MBE
			[kWh]	[kWh]	[kWh]	[kWh]	[kWh]
1-U	33 912	0.79	0.92	4.39	31306	0.45	0.05
2-U	33 720	0.79	0.99	4.75	33278	0.47	0.08
3-F	30 806	0.69	3.30	10.59	101670	0.80	0.23
4-F	42 280	0.74	2.7	9.06	100308	0.71	0.11
5-K	43 796	0.77	0.52	2.24	22761	0.34	0.23
6-K	40 188	0.83	1.67	9.59	67166	0.77	0.55

Mundilfare

Validering av simuleringsmodell



Snöförlustmodell—
Under utveckling

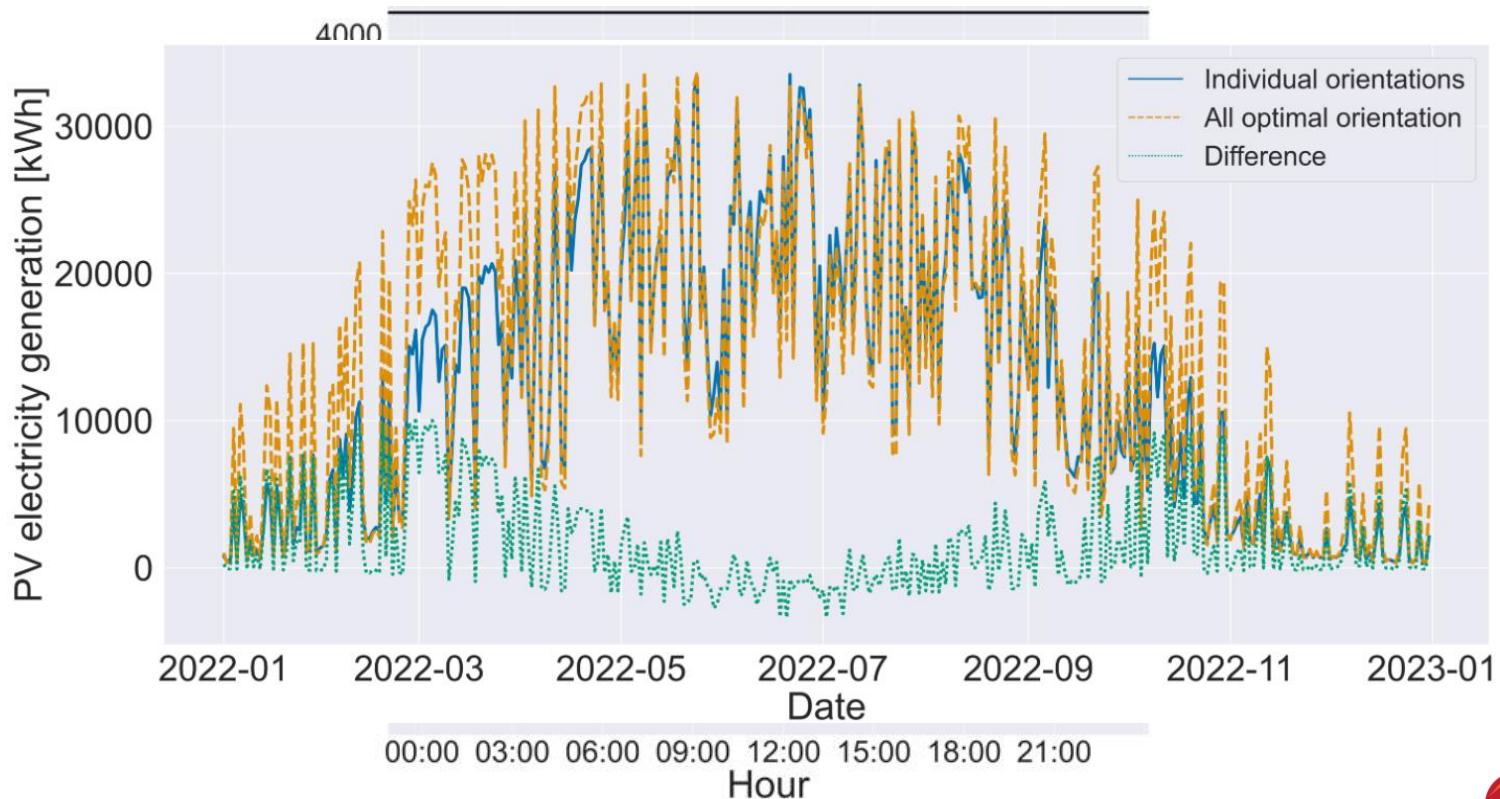
Skuggförlustmodell
— Under utveckling
UU

Testa en annan
solinstrålnings-
modell

Figure 3a. Scatter plot for validation step 1 for PVS2-U, using orientations provided by the reference system owners. The data points are divided by colour, showcasing different time-intervals of the day on the left and for monthly time intervals on the right. The fitted regression is represented by a continuous line and the dotted line indicates a perfect model.

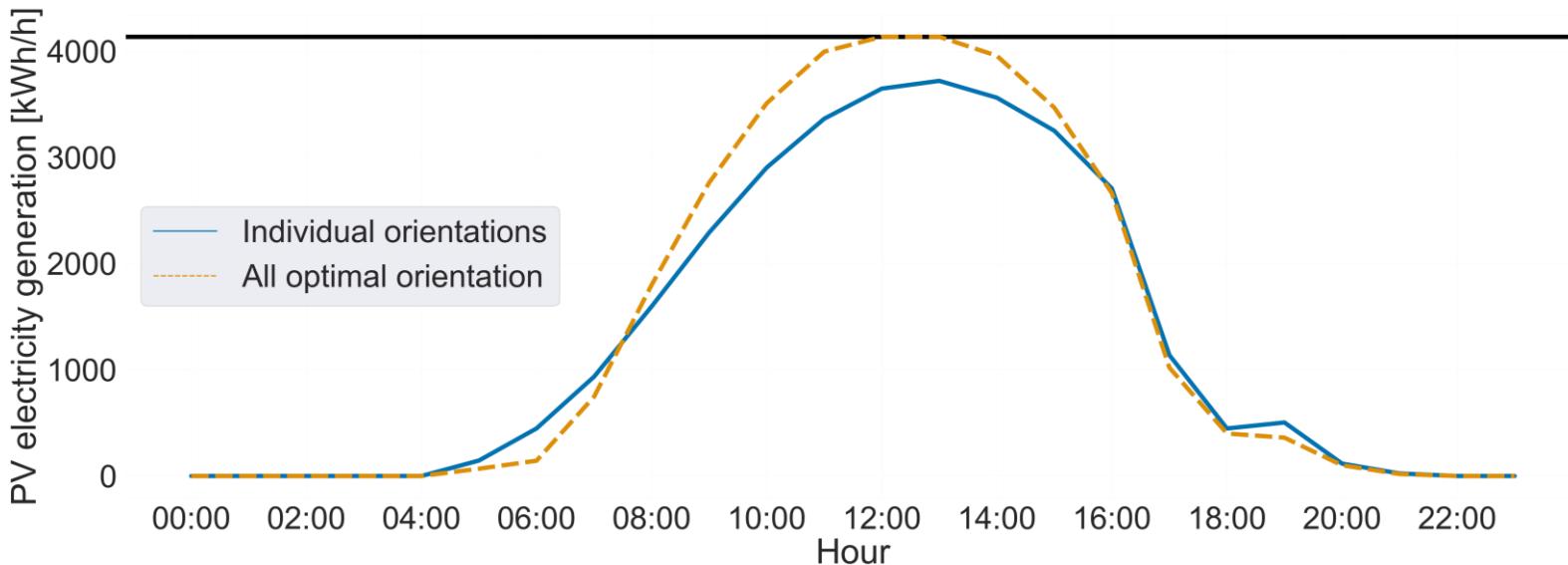
Mundilfare

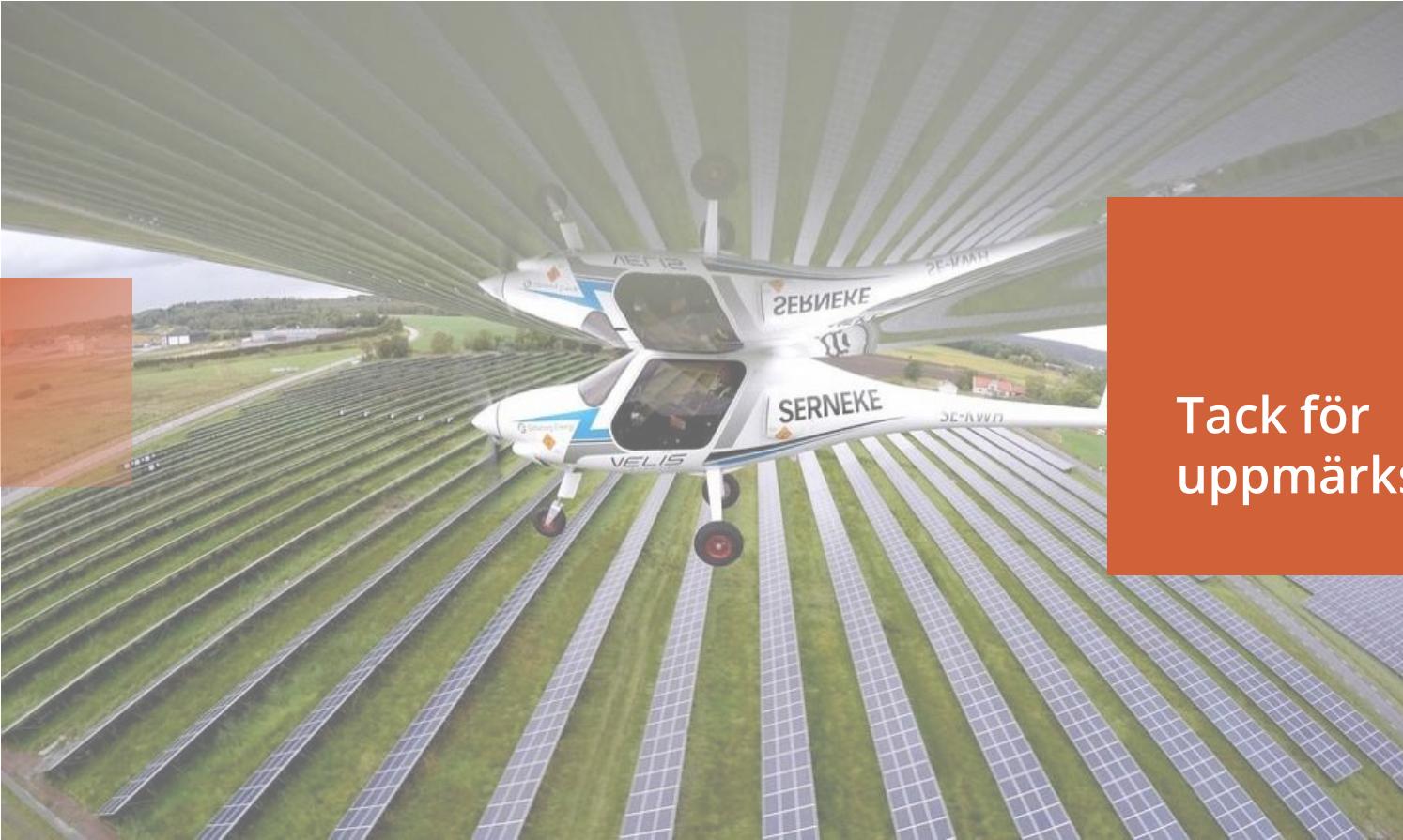
Utjämningseffekter



Mundilfare

Frigörande av nätkapacitet i planeringsstadiet





Tack för
uppmärksamheten!