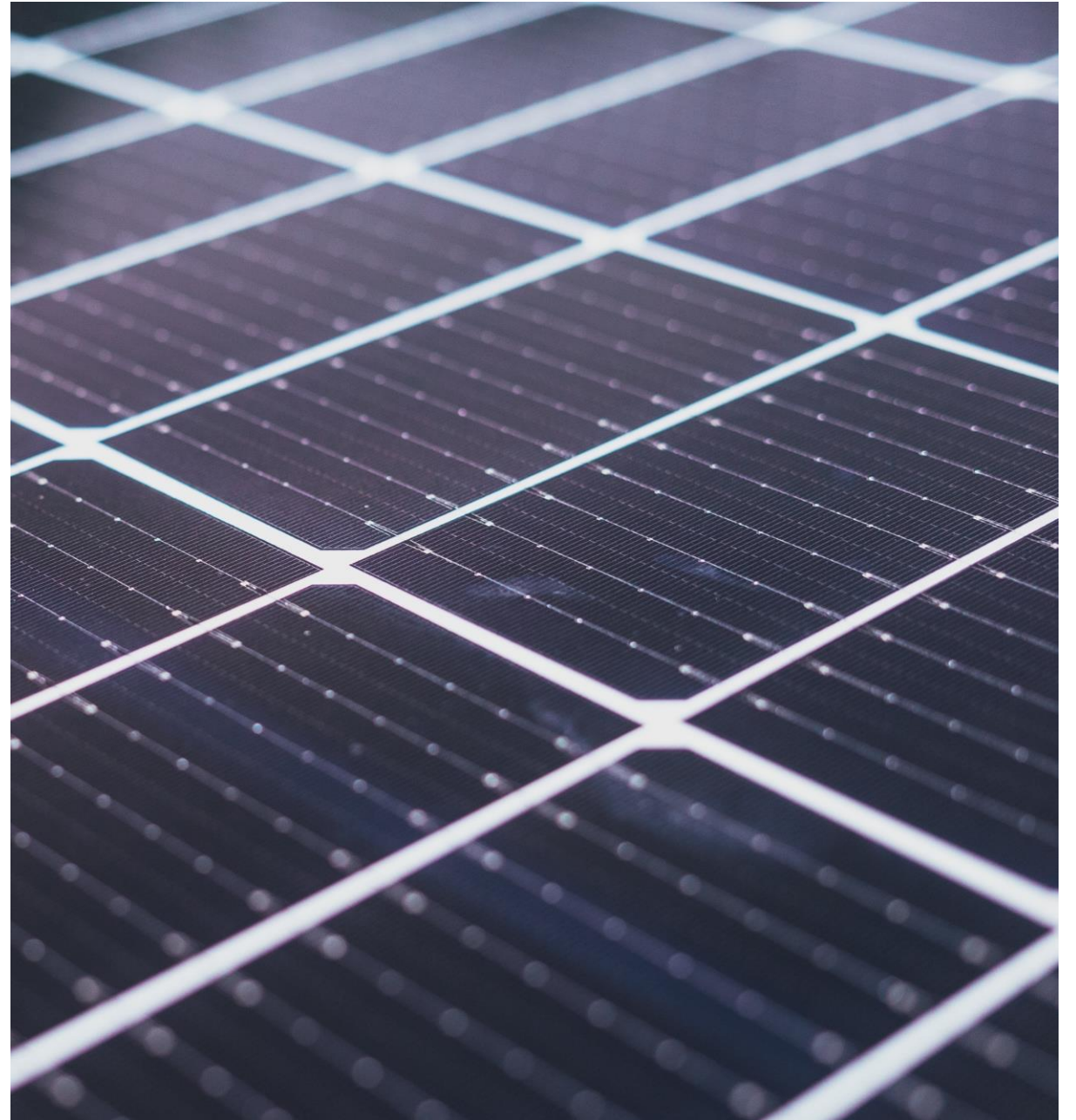




SOLELFORSKNINGS CENTRUM SVERIGE

Malin Unger (RISE), Chris Bales (Högskolan Dalarna)

Aktuellt inom solel, Bebo webinarium, 2023-11-14



SOLVE WELCOME

Solar Electricity Research Centre,
Sweden

One of 11 new Competence Centres
approved by the Swedish Energy Agency
for 2022-2026

The purpose of the competence centers
To strengthen collaboration between business, the
public sector and academia

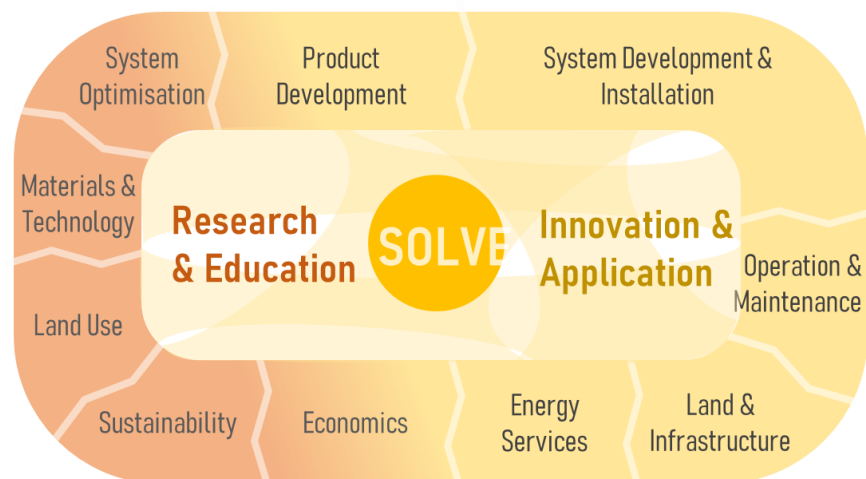
To build up and make available **knowledge** of the
highest quality and **competence** for society's
transition to a sustainable energy system.



SOLVE PARTNERS

Who is involved?

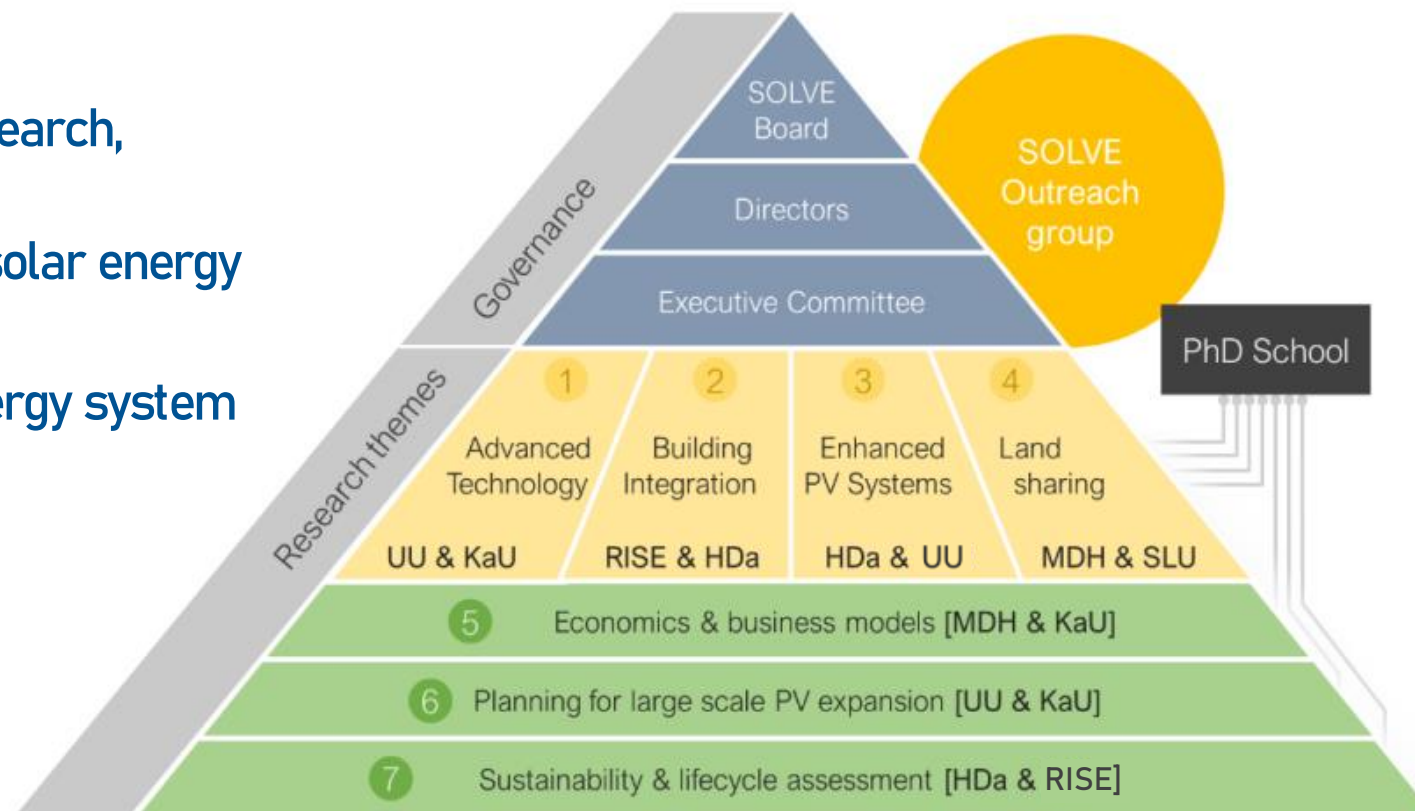
6 Universities/Institutes
50 Companies/Organisations



From 2023 also **EQUA**.

SOLVE OBJECTIVES

Needs-driven, collaborative research,
enhancing the role and contribution of solar energy
as part of a sustainable energy system



SOI VE RESEARCH THEMES



1. ADVANCED TECHNOLOGY

Technology development for improved performance and sustainability

Marika Edoff, Uppsala University
Markus Rinio, Karlstad University



2. BUILDING INTEGRATION

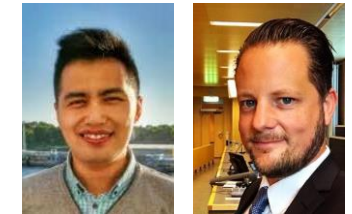
Improved function and uptake of BIPV, for energy-efficient, functional and attractive buildings

Malin Unger, RISE
Chris Bales, Dalarna University

3. ENHANCED PV SYSTEMS

Optimising PV in complex new energy systems over different scales

Xingxing Zhang, Dalarna University
Joakim Munkhammar, Uppsala University



4. LAND SHARING

Effective sharing of PV and other land uses in urban and agricultural environments

Marcos Lana, SLU
Pietro Campana, Mälardalen University



5. ECONOMICS & BUSINESS MODELS

Improving economic performance of PV in new energy markets

Bengt Stridh, Mälardalen University

Markus Rinio, Karlstad University



6. PLANNING FOR LARGE SCALE EXPANSION

Enabling smart, sustainable and rapid expansion of PV in Sweden

Andreas Theocharis, Karlstad University

Joakim Widén, Uppsala University

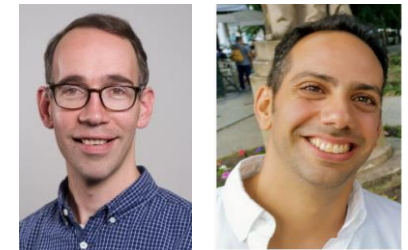


7. SUSTAINABILITY AND LCA


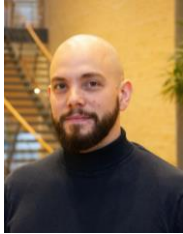
















Quantifying the contributions of PV to our sustainability goals

Michiel van Noord, RISE

André Augusto, Dalarna University



SOLVE SOLVE PhD STUDENTS

| | | | | |
|---|---|---|---|---|
| | <p>Phil</p>  | <p>Nicklas</p>  | <p>Marieke</p>  | |
| <p>Majid</p>  | | | <p>Santiago</p>  | <p>Elin</p>  |
| |  |  |  | |
| <p>Mohamad</p>  |  |  | <p>Silvia</p>  | |
| |  |  | | |
| | <p>Bhavya</p>  | <p>Sebastian</p>  | <p>Klara</p>  | |

Started November 1!

10 PhDs started/recruited
1 graduated
1 under recruitment: RISE/HDa
1-2 positions planned/under discussion

SOLVE THEME 2 - BUILDING INTEGRATION

Theme 2 Leaders



Malin Unger
RISE

malin.unger@ri.se

<https://www.ri.se/sv/vad-vi-gor/solenergi>



Chris Bales
Dalarna University

cba@du.se

Phd Students



Marieke Ryneson
Dalarna University



Elin Daun
RISE/ Halmstad University

SOLVE Marieke Rynoson (HDa)

Ongoing research 2023-2024

- Validation of advanced PV modelling in IDA ICE (v5.0 beta)
 - EU PVSec paper for three types of modules with annual data (no shading)
 - (half-cut, Mono-Si; full cell Mono-Si with optimizers; CIGS)
 - Ongoing analysis of shading experiments for same modules
 - Supervision of relevant master thesis projects

- Qualitative Interview Study: BIPV & Churches/Heritage



Svenska kyrkan



DALARNA UNIVERSITY SOLVE

PV MODELING IN IDA ICE (5.0 BETA)
PERFORMANCE ANALYSIS OF BASED ON MEASURED DATA IN HIGH LATITUDES

University of Dalarna, School of Information and Engineering, Falun, SE-79188
 rikarda@dalarna.se, marieke@dalarna.se, Tel. +46 2377 85 47

ABSTRACT
 In recent years, the widespread adoption of photovoltaic (PV) installations across various sectors has created a growing demand for accurate PV design tools. To this extent, the state-of-the-art of IDA Indoor Climate and Energy (IDA ICE) beta version is an excellent offering advanced PV modeling capabilities. This study evaluates the accuracy of PV modeling within IDA ICE by comparing simulated power outputs to real-world data from existing PV systems located at the Research Institute of Sweden (RISE) in Borås. To achieve this, weather files are created using

horizontal weather and radiation data. As the measured radiation data is only available as total irradiation on a tilted plane, it was decomposed into direct and diffuse components on the horizontal plane using a modified version of the model by Fritzsche et al. Additional losses parameters for the PV array, and the characteristics of PV panels and inverters, based on their product data sheets. The accuracy of the PV design tool in IDA ICE is evaluated by comparing the power output of simulated arrays against the measured data from RISE.

The calculated power output is compared to the measured power output and analyzed through ASHRAE 14-2014 guidelines for performance evaluation. It was found that the simulation gives an accurate prediction of both panel temperature and PV power production. A study on shading effects is an open project to improve the accuracy of the results in the future.

Keywords: PV Array, PV Modeling, Renewable Energy Planning, IDA ICE, Building Energy Simulation

INTRODUCTION
 • The building energy and indoor climate simulation tool IDA ICE will integrate a new PV design tool to complement the existing functions.
 • How high is the accuracy and precision of the PV modelling tool in IDA ICE 5.0 (beta) regarding panel temperature and predicted power output?
 • Data of existing PV systems provided by the Research Institute of Sweden (RISE) for comparison to simulation

METHOD
Decompositions and transposition:
 historic irradiance data only given as GTI
 • Procurement of DHI and DNI from GTI with newly developed decomposition method based on "tilted clearness index" K_t
IDA ICE implementation:
 • Prepare historic weather file based on provided data
 • Decomposed irradiance
 • Measured air temperature
 • Wind speed, cloud cover, relative humidity from SMHI
 • Modelling of three systems in IDA ICE
 • Input parameters from product data sheets

Data analysis: (see example plots and tables)
 • Panel temperature: hourly
 • PV power: total annual & hourly
 • Statistical analysis of results
 • Hourly data: MBE and CV RMSE (ASHRAE 14-2014)
 • Determination of outliers: Median Method

| Panel Temperature | MBE [%] | CV RMSE [%] | System | Measured [kWh] | IDA ICE [kWh] | % | PV Power | MBE [%] | CV RMSE [%] |
|-------------------|---------|-------------|--------|----------------|---------------|-------|----------|---------|-------------|
| A | 0.8 | 16.8 | A | 3132.5 | 3078.5 | 98.3 | A | -0.8 | 15.6 |
| B | -0.9 | 20.3 | B | 3515.6 | 3587.4 | 102.0 | B | 8.2 | 16.6 |
| C | -0.9 | 25.5 | C | 2346.9 | 2393.8 | 102.0 | C | 2.0 | 16.6 |

CONCLUSIONS
 • Decomposition: **meets expectations** and data can be used to generate an accurate weather file
 • Investigation ongoing for validation
 • IDA ICE simulation: **meets expectations**
 • Investigation ongoing for simulation with partial shading

ACKNOWLEDGEMENT
 This work was conducted within Solar Electricity Research Center Sweden (SOLVE). The authors would like to thank EQUA Simulation AB for providing the software to the researchers and RISE for supplying the data which was the foundation of this study.

duse



Potential future papers (2024...)



Modeling of Non-Standard PV Panel Formats

Modeling of Colored BIPV

Aesthetics & Human Perception of BIPV in the Urban Landscape

S-LCA Benchmarking with Living Wage

Newly recruited PhD

- Architect with practical (Kanozi) and academic (LTH lecturer) experience.
- Started at RISE on November 1, 2023
- PhD School - Solve and Halmstad University, Innovation Sciences
- Process with defining research focus and topics starting Nov/Dec 2023
- Reading published and final draft versions of BIPV TIS-analyzes from IEA PVPS Task 15



<https://iea-pvps.org/research-tasks/enabling-framework-for-the-development-of-bipv/>

Solve Webinars

- October 3, 2023
#1 "Avancerad solcellsteknik"
- December 12, 2023
#2 "Agrivoltaics - en konfliktlösare"
- Q1 2024
#3 Byggnadsintegrerad solet

Webbinarium: Agrivoltaics - en konfliktlösare?

Solelforskningscentrum, SOLVE, bjuder in till ett webinarium om agrivoltaics. Genom att kombinera jordbruk med solesproduktion, agrivoltaics, kan jordbruksmark få en optimerad användning till nytta för både energisystemet och markägaren. Under det här webinariet berättar landets främsta forskare på området om...

Datum
2023-12-12

Läs mer



<https://svensksolenergi.se/kalendarium/>

Energiforsk

Forskning | Rapportsök | Konferenser | Utlysningar | sök

DEN HÄR KONFERENSEN ÄR AVSLUTAD

3 OKTOBER, DIGITALT

Avancerad solcellsteknik

Ladda ner

- Introduction To SOLVE And Partnership
Marika Edoff
PDF 2,6 MB
- Advancements In Perovskite Based Solar
Technology Gerrit Boschloo
PDF 1,7 MB
- Current Trends In Silicon Based Solar Cell
Technology Barbara Terheiden
PDF 1 008,3 KB
- What Measures Can Be Taken To Enhance
The Efficiency Of Future Solar Cells
Marika Edoff
PDF 2,0 MB

Solforskningscentrum Sverige, SOLVE, inleder en ny webinariesatsning. Forskningen inom SOLVE är uppdelad i sju forskningsteman. Tanken är nu att varje temagrupp ska berätta om sin forskning under korta webinarier under det kommande året. Syftet är att sprida forskningsresultat och kunskap framförallt till aktörer inom solemrådet, men även till övriga intresserade i energibranschen.

f t in

<https://energiforsk.se/konferenser/genomforda/avancerad-solcellsteknik/>

SOLVE OUTREACH

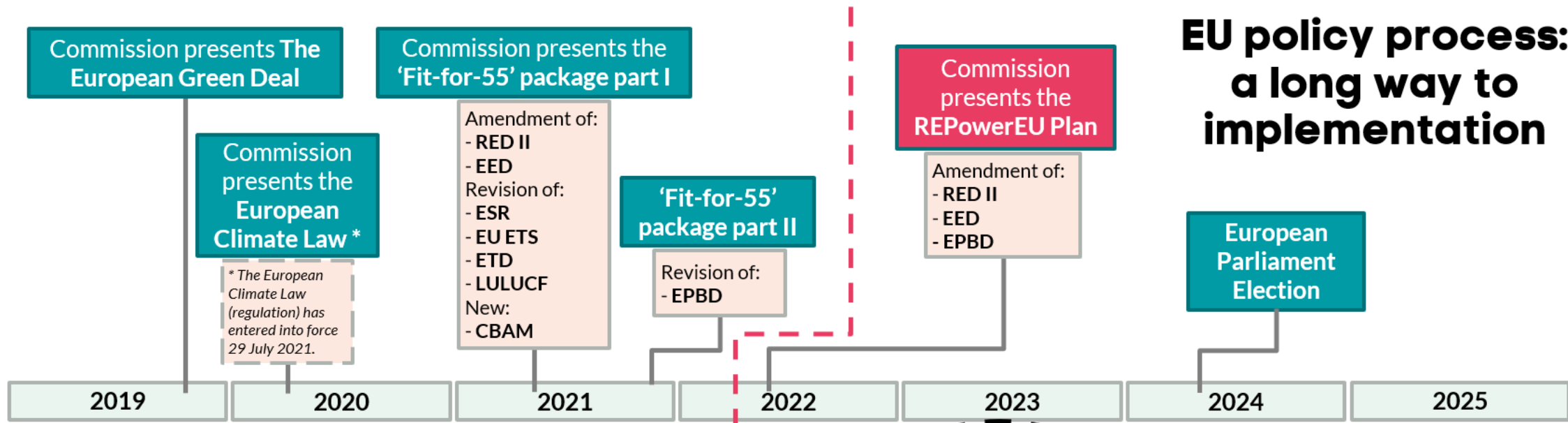
- The SOLVE website:
<https://www.uu.se/forskning/solve/>
- LinkedIn account
- Poddavsnitt i “Om vetenskap”

The screenshot shows the Uppsala University SOLVE website. The header includes the Uppsala University logo and navigation links for ADMISSIONS, RESEARCH, and COLLABORATION. The main content area features a 'Nyheter' (News) section with a headline: 'Première of the new season of SSF podcast Om Vetenskap!'. Below this, there is a text snippet: 'The first episode of the new season of the Swedish Foundation for Research (SSF) podcast Om vetenskap, episode #11 Solar Cell... technology of today and the future works was carried out by... Edoff and Erik Johansson from SOLVE.' A second news item reads: 'Big congratulations to SOLVE's place on IVA's 100 list in 2023!'. A third item is titled 'Att bygga solcellsparker' (Building solar cell parks). A podcast player for 'Om Vetenskap' is overlaid on the page, showing the title 'Solceller – så funkade dagens och framtidens teknik' and a description: 'Klimatkris och stigande elpriser gör att allt fler funderar på att installera solceller. Men hur bra är dagens solceller och hur ser morgondagens ut? Finns det nya och bättre material på gång som är både billigare och effektivare? Medverkande: Marika Edoff, professor i fasta tillståndets elekt...'.

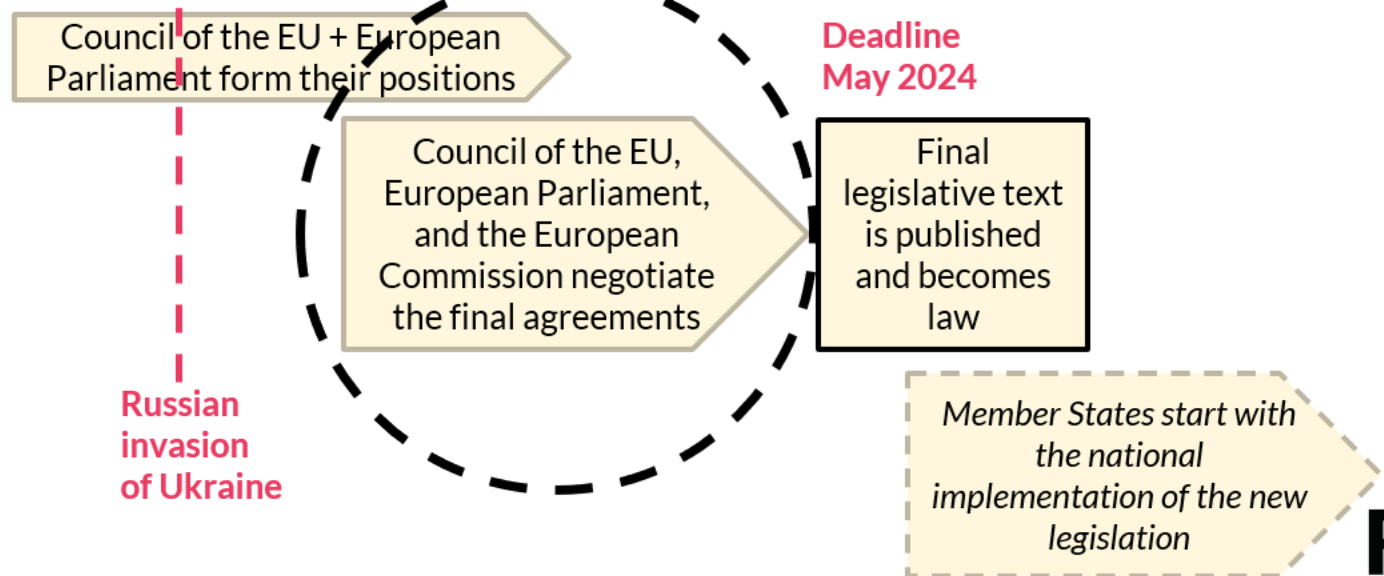
This screenshot shows the top part of the SOLVE website. The header includes 'Uppsala University / Research / SOLVE' and a language selector for 'Den här sidan på svenska'. A navigation menu lists: SOLVE, Projects in SOLVE, SOLVE outreach, SOLVE partners, Contact SOLVE, and news. Below the menu is a banner for the 'SOLAR ELECTRICITY RESEARCH CENTRE, SWEDEN'. The banner text states: 'SOLVE is a consortium of universities and public/private sector partners performing collaborative, needs-driven research projects aiming at rapid expansion of solar energy in the Swedish electric grid.'



The screenshot shows the LinkedIn profile page for SOLVE Solelforskningscentrum Sverige. The profile name is 'SOLVE Solelforskningscentrum Sverige' and it is identified as a 'Competence Center at Uppsala University'. The location is 'Uppsala, Uppsala County, Sweden'. It shows '79 connections' and buttons for 'Open to', 'Add profile section', and 'More'. At the bottom, there are two prompts: 'Show recruiters you're open to work — you control who sees this. Get started' and 'Share that you're hiring and attract qualified candidates. Get started'.



EU policy process: a long way to implementation



EU Green Deal

1. EU Climate Law
2. Policy instruments – Fit-for-55
3. Financing
4. Taxonomy – direct investments

Russian invasion of Ukraine

EPBD - Article 9a

Solar Energy in Buildings

EU kommissionen 18/5 2022

Make the installation of rooftop solar energy compulsory for:

- *all new public and commercial buildings with useful floor area larger than 250 m² by 2026*
- *all existing public and commercial buildings with useful floor area larger than 250 m² by 2027*
- *all new residential buildings by 2029*

Från obligatoriskt krav på solcellsinstallation..

EU Rådet 25/10 2022

Member States shall ensure the deployment of suitable solar energy installations:

- *(a) by 31 December 2026, on all new public and non-residential buildings with useful floor area over 250 m²*
- *(b) by 31 December 2027, on all existing public and non-residential buildings undergoing a major or a deep renovation with useful floor area over 400 m²; and*
- *(c) by 31 December 2029, on all new residential buildings.*

..till lämplig installation..

EU Parlamentet 14/3 2023

Member States shall ensure the deployment of suitable solar energy installations, if technically suitable and economically and functionally feasible, as follows:

- (a) *by ... [24 months after the date of entry into force of this Directive], on all new public and new non-residential buildings;*
- (b) *(b) by 31 December 2026, on all existing public and non-residential buildings;*
- (c) *(c) by 31 December 2028, on all new residential buildings and roofed carparks;*
- (d) *(d) by 31 December 2032, on all buildings undergoing major renovation*

..till lämplig installation där det är ekonomiskt och funktionellt möjligt.



SOLELFORSKNINGS
CENTRUM SVERIGE

