



Soleva



Lightyear0



SolarStratos, in Payerne



Conference & Exhibition on
Vehicle Integrated PV
March 6-8 | Neuchâtel, Switzerland

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25.03.2024

LA MOBILITÉ SOLAIRE : UN RÊVE OU UNE RÉALITÉ ?

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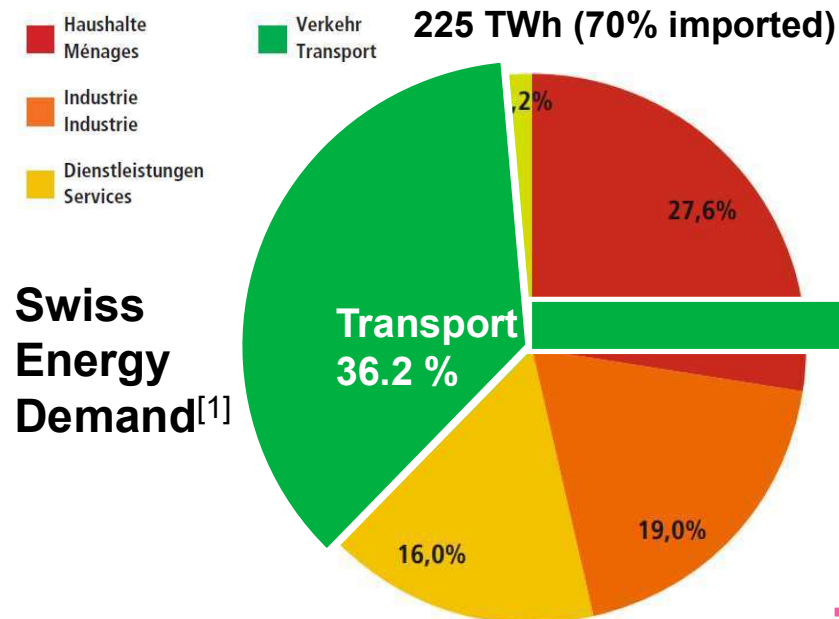
EPFL

PV-lab
IEM NEUCHÂTEL

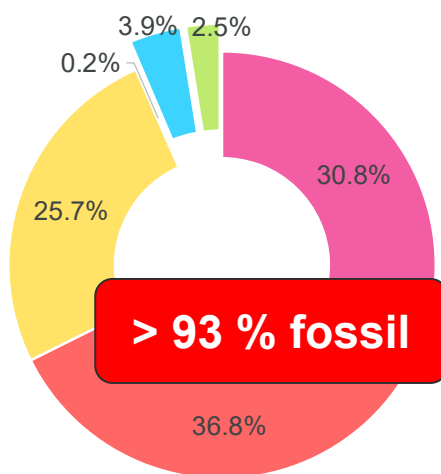
Schweizerische Eidgenossenschaft
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SWISS ENERGY DEMAND



Energy carriers for transport



> 93 % fossil

■ gasoline ■ diesel ■ kerosene ■ gas ■ electricity ■ other renewables

Source: Luca Castiglioni, SFOE

2 La mobilité solaire : un rêve ou une réalité ?

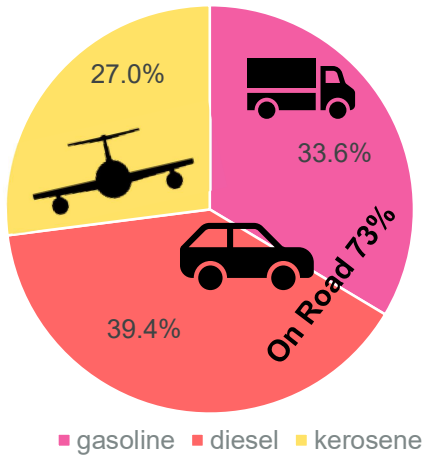
[2] L. Castiglioni, V2G - The convergence of PV and electric mobility, PVinMotion2024, SFOE energy statistics 2019/2022.

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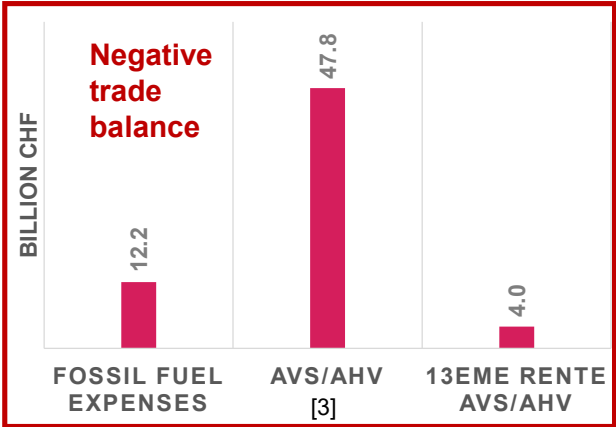
CO2 EMISSION AND EXPENSES FOR TRANSPORTATIONS

- 2023 has the sad record for CO2 emission from human origin with 36.8 Gt (previous record in 2022) [1]

CO₂ emissions (estimated)^[2]



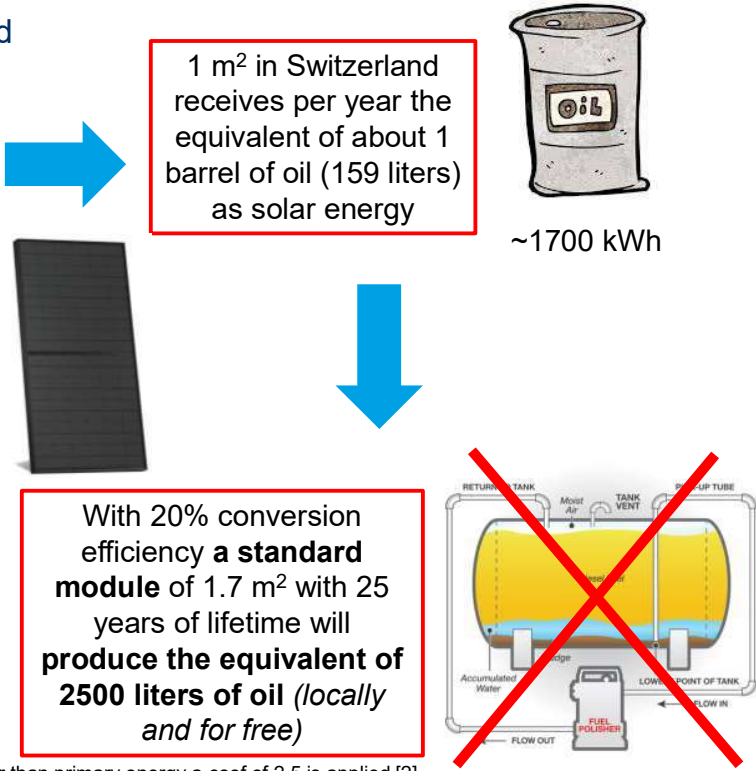
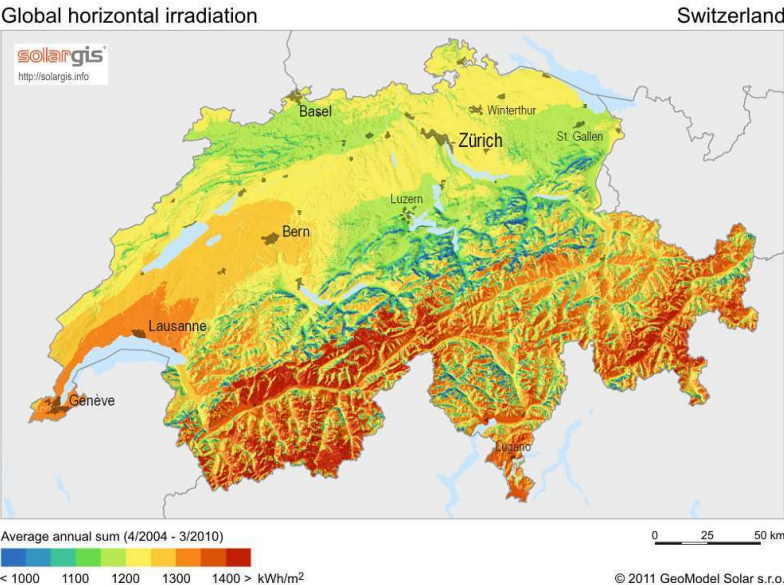
- Road transport alone:**
7 Mio. tons of gasoline & diesel (60 TWh prim. energy)
- 12.2 bn expenses** for fossile energy. Completely dependent on imports.



Source: Luca Castiglioni, SFOE
 [1] <https://usys.ethz.ch/en/news-events/news/archive/2023/12/fossile-co2-emissionen-erreichen-neues-rekordhoch.html>
 [2] L. Castiglioni, V2G - The convergence of PV and electric mobility, PVinMotion2024, SFOE energy statistics 2019/2022.
 [3] Statistiques de l'AVS 2022, mai 2023, DFI, Office fédéral des assurances sociales

SOLAR IRRADIATION VS FOSSIL FUELS

- The solar energy production versus oil in Switzerland

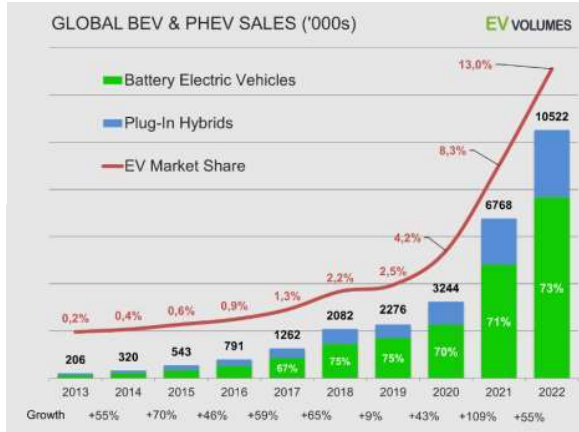


[1] <https://www.uvek-gis.admin.ch/BFE/sonnendach/?lang=en>
 [2] Ch. Ballif, The Future of Solar is Bright, PVinMotion2024

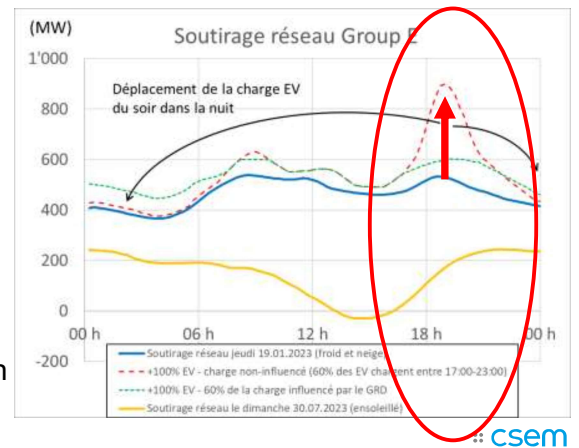
As electricity is nobler than primary energy a coef of 2.5 is applied [2]

GROWTH OF ELECTRIC VEHICLES (EV)

- The decarbonization of transportation will have to pass via electric vehicles (EV)



- EV are way more efficient (77%) compared to thermal engines (between 12% and 30%) [2].
- 60 TWh/y (thermal car) = 20 TWh/y (electric car)



- But electric vehicles induce pressure on the electric grid [3]
- Solar on EV can reduce this pressure on the grid

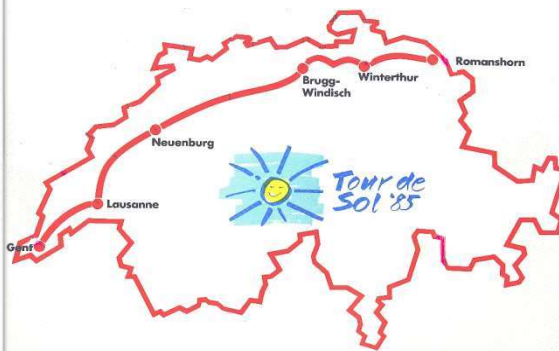
[1] <https://www.weforum.org/>

[2] <https://www.fueleconomy.gov/feg/evtech.shtml>

[3] P. Cuony, Grid-friendly charging of e-cars and the dynamic VARIO tariff at Groupe E, PVinMotion2024

SOLAR CAR HISTORY

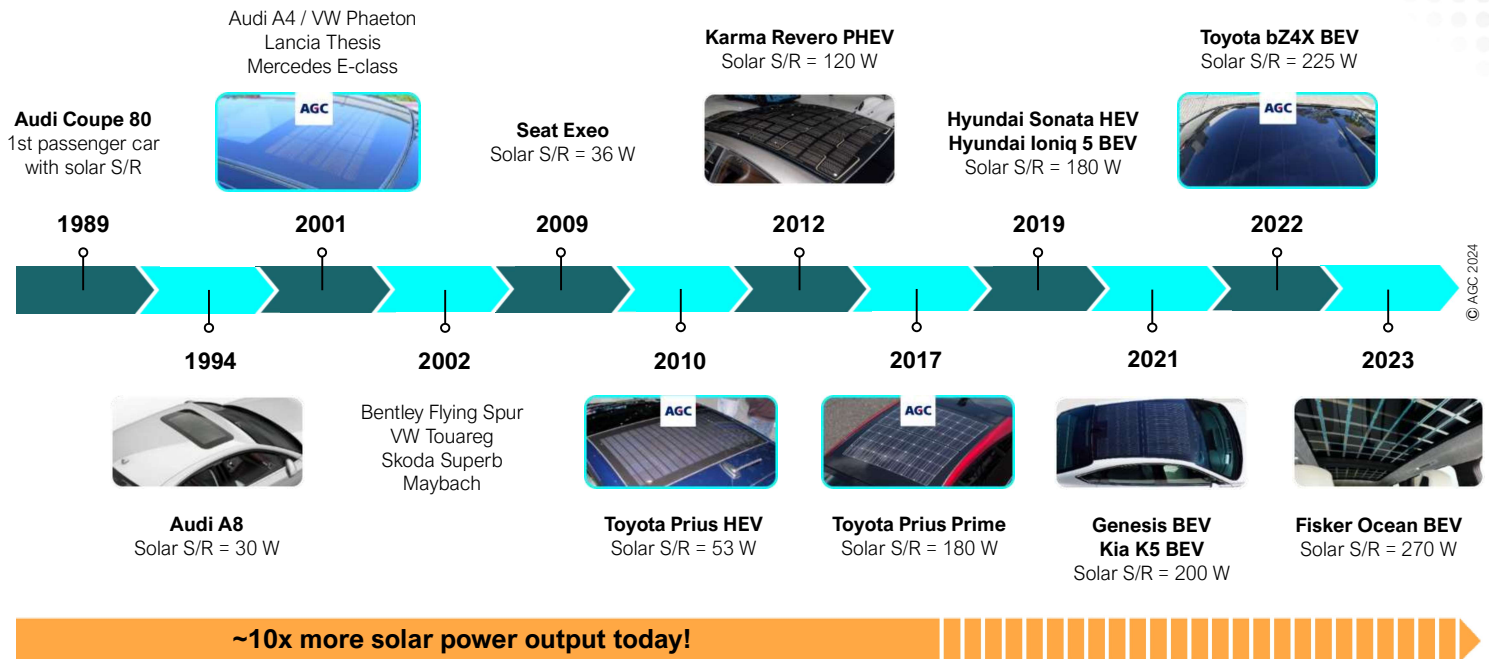
- First solar car: Baker EV (model 1912) with solar cells from International Rectifier IR in 1960 [1]



- First solar car race: Tour de Sol 1985 - Alpha real/Mercedes Benz as winning solar car [2]

Source: Urs Muntwyler

30 YEARS OF PROGRESS WITH SOLAR ROOFS



7 La mobilité solaire : un rêve ou une réalité ?

[1] L. Tous, AGC's panoramic solar roof : ready for the masses, PVinMotion2024

Source: Loic Tous, AGC

© AGC 2024
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FAILURE OF SOLAR MOBILITY?

- Difficult year 2023 for new solar car companies!
- **Wrong business model:**

In existing car company,

**a new car model
cost \$6 billion**

if all-new car on all-new platform with an all-new engine and an all-new transmission and nothing carrying over from the old model [4].

Automobile

Sono Motors faces insolvency



By Chris Randall

22.03.2023 - 13:02

BEV PaC Sion

Lightyear attempts to rescue solar EV future following bankruptcy

By Tom Seymour | 24 March 2023

electric and hybrid vehicles



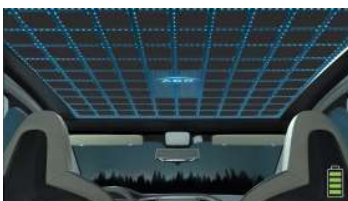
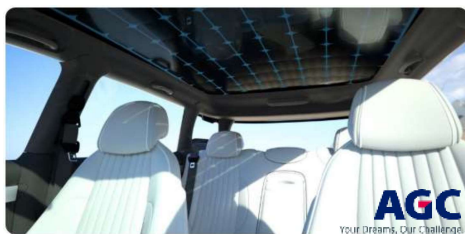
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[1] <https://www.electrive.com/2023/03/22/sono-motors-faces-insolvency/>
 [2] <https://www.fleetnews.co.uk/news/latest-fleet-news/electric-fleet-news/2023/03/23/lightyear-attempts-to-rescue-solar-ev-future-following-bankruptcy>
 [3] <https://www.sses.ch/fr/les-vehicules-solaires-ne-simposent-pas-encore/>
 [4] <https://www.autoblog.com/2010/07/27/why-does-it-cost-so-much-for-automakers-to-develop-new-models/>

8 La mobilité solaire : un rêve ou une réalité ?

SOLAR MOBILITY: OTHER BUSINESS MODELS

➔ Solar modules produced by automotive suppliers (Tier 1 suppliers)

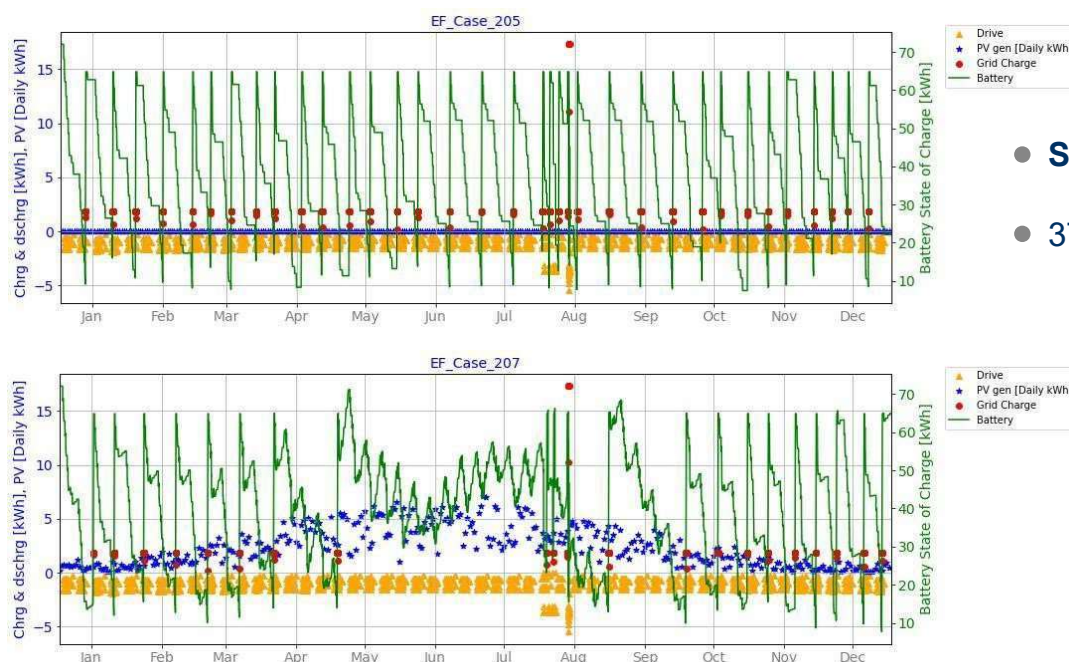


- [1] <https://www.pv-magazine.com/2023/05/03/toyota-uses-kanekas-26-63-efficient-solar-cells-for-electric-vehicle/>
 [2] <https://a2-solar.com/>
 [3] L. Tous, AGC's panoramic solar roof : ready for the masses, PVinMotion2024.
 [4] <https://www.pv-magazine.com/2023/09/21/vehicle-integrated-pv-system-for-retractable-car-roofs/>
 [5] <https://www.imec-int.com/en/research-portfolio/snroof>
 [6] <https://www.simoldes.com/en/innovation-plastics/pvab-photovoltaic-automotive-body/>

9 La mobilité solaire : un rêve ou une réalité ?

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ADVANTAGES OF SOLAR ELECTRIC VEHICLE (MODELLING)



SUV car with 11'300 km/y

- Standard Electric Vehicle (EV)
- 37 charging per year

- **Solar EV**
- 23 charging per year (-37%)
- No charging in summer (end April to mid Sept.)

Source: Anna Carr, TNO


[1] A. Carr, Modeling the impact of VIPV, PVinMotion2024

➔ In EU, the PV on EV can reduced the need from the electric grid by 17 TWh/y
 In Switzerland, it will correspond to **435 GWh/y**

10 La mobilité solaire : un rêve ou une réalité ?

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PVAB & SOLARBODY PROJECTS



PVAB
PhotoVoltaic Automotive Body

Innovative polymeric photovoltaic modules for VIPV

Lower costs at usage

Consumption
Lower consumption of oil or kWh

Emissions
Lower emission of CO₂

Weight
Lightweight solution

Range autonomy
Extra 20 km gained daily with PV modules*

Independency
Less dependency on charging stations

Competitiveness
Market-ready polymeric PV modules with lower cost than conventional glass panels

Higher resistance
Very high impact resistant polymer

Automated processes
Industrial solutions for mass production

Design freedom
Plastic materials molded to any body shape

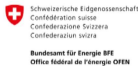
Higher versatility
Modules compatible with any car



Simoldes CEIIA CSEM STELLANTIS

COMPETE 2020

Source: Julien Robin, Simoldes



11 La mobilité solaire : un rêve ou une réalité ?

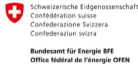
[1] J. Robin, PhotoVoltaic Automotive Body (PVAB): The outcome of 3 years of VIPV R&D industrial project, PVinMotion2024

PVAB & SOLARBODY PROJECTS

Installation of the PV panel



Source: Julien Robin, Simoldes



12 La mobilité solaire : un rêve ou une réalité ?

[1] J. Robin, PhotoVoltaic Automotive Body (PVAB): The outcome of 3 years of VIPV R&D industrial project, PVinMotion2024

PVAB & SOLARBODY PROJECTS

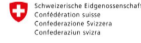


LIGHTER

13% lighter than glass module

PVAB
PhotoVoltaic Automotive Body

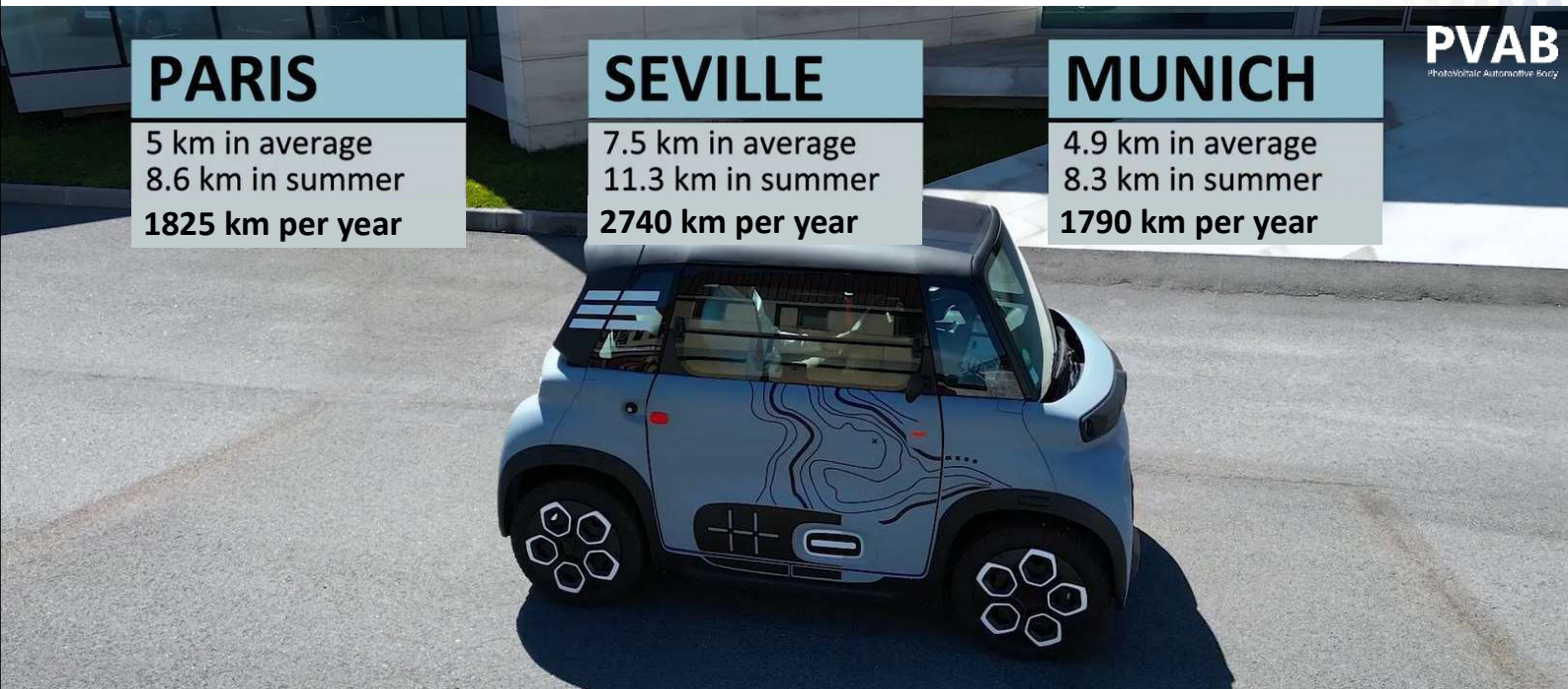
Source: Julien Robin, Simoldes



13 La mobilité solaire : un rêve ou une réalité ?

[1] J. Robin, PhotoVoltaic Automotive Body (PVAB): The outcome of 3 years of VIPV R&D industrial project, PVinMotion2024

PVAB & SOLARBODY PROJECTS



PARIS

5 km in average
8.6 km in summer
1825 km per year

SEVILLE

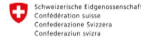
7.5 km in average
11.3 km in summer
2740 km per year

MUNICH

4.9 km in average
8.3 km in summer
1790 km per year

PVAB
PhotoVoltaic Automotive Body

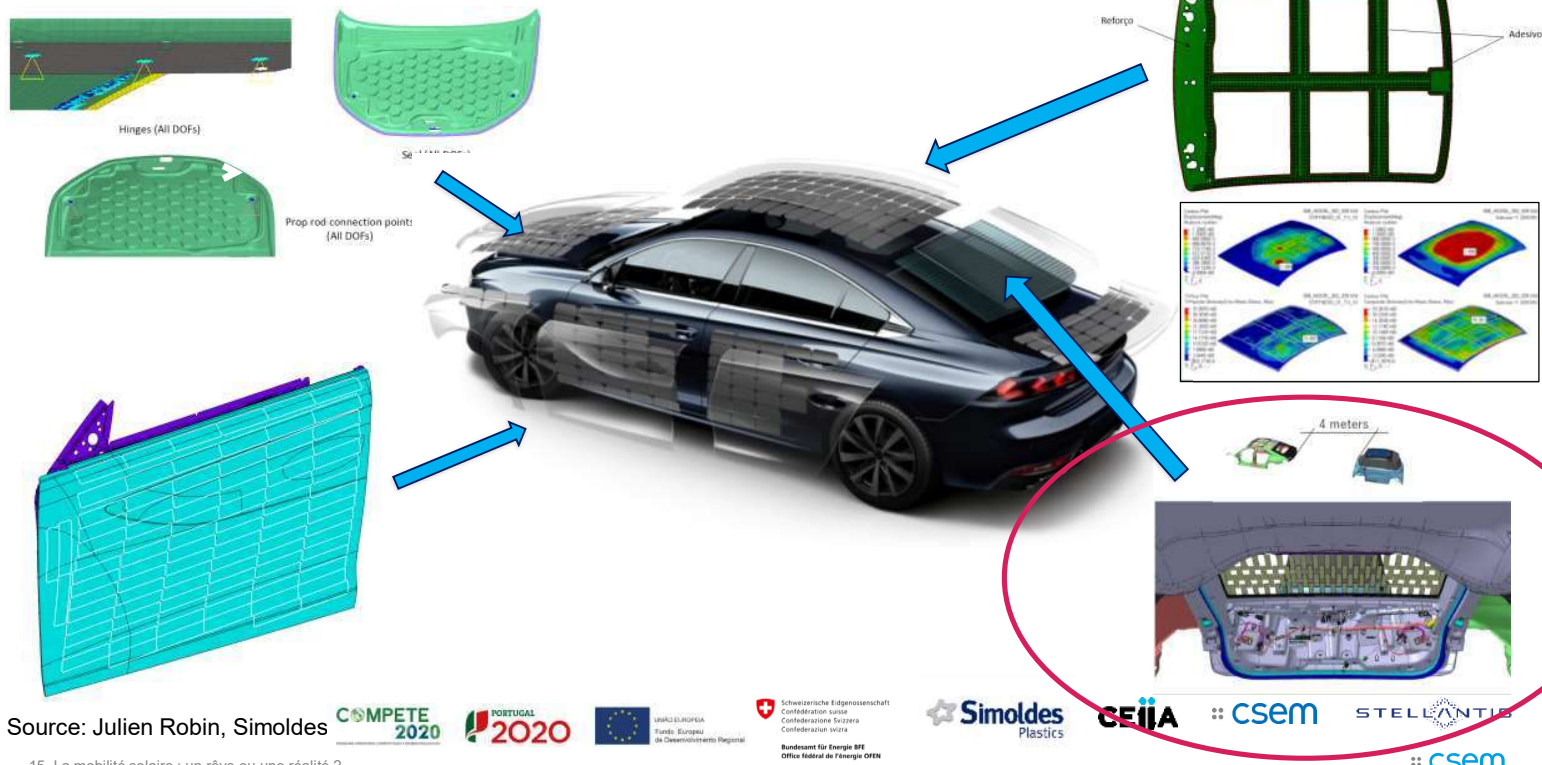
Source: Julien Robin, Simoldes



14 La mobilité solaire : un rêve ou une réalité ?

[1] J. Robin, PhotoVoltaic Automotive Body (PVAB): The outcome of 3 years of VIPV R&D industrial project, PVinMotion2024

PVAB & SOLARBODY PROJECTS



[1] J. Robin, PhotoVoltaic Automotive Body (PVAB): The outcome of 3 years of VIPV R&D industrial project, PVinMotion2024

PVAB & SOLARBODY PROJECTS



[1] J. Robin, PhotoVoltaic Automotive Body (PVAB): The outcome of 3 years of VIPV R&D industrial project, PVinMotion2024

PVAB & SOLARBODY PROJECTS

CELLS

161 cells (1/8 G1 size)

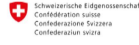
POWER

100 Wp

TECHNOLOGY

IBC 22-23% efficiency

Source: Julien Robin, Simoldes

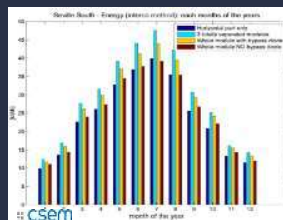


17 La mobilité solaire : un rêve ou une réalité ?

[1] J. Robin, PhotoVoltaic Automotive Body (PVAB): The outcome of 3 years of VIPV R&D industrial project, PVinMotion2024

Photovoltaic for Automotive Application

1. Selection of the optimal PV technology
2. Selection of vehicles and implementation surface
3. Energy yield calculation
4. Yearly range extension



CSEM software HETSIM

Yearly extension in Paris = 4'800 km/year

→ up to 22 km/day in summer



Yearly extension in Sevilla = 7'300 km/year

→ up to 30 km/day in summer



- What is the potential?



©Simoldes

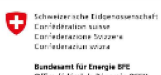
Berline:
20 kWh/100km

PV on all
surfaces: about
1260 Wp total



©CEIIA

18

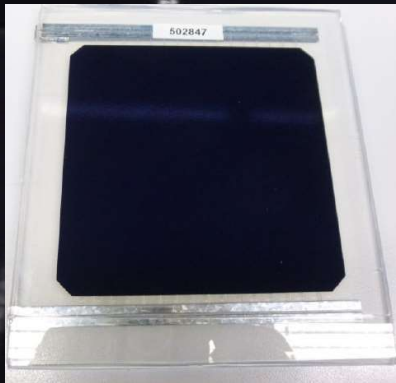


Next Cell and module Generation for VIPV

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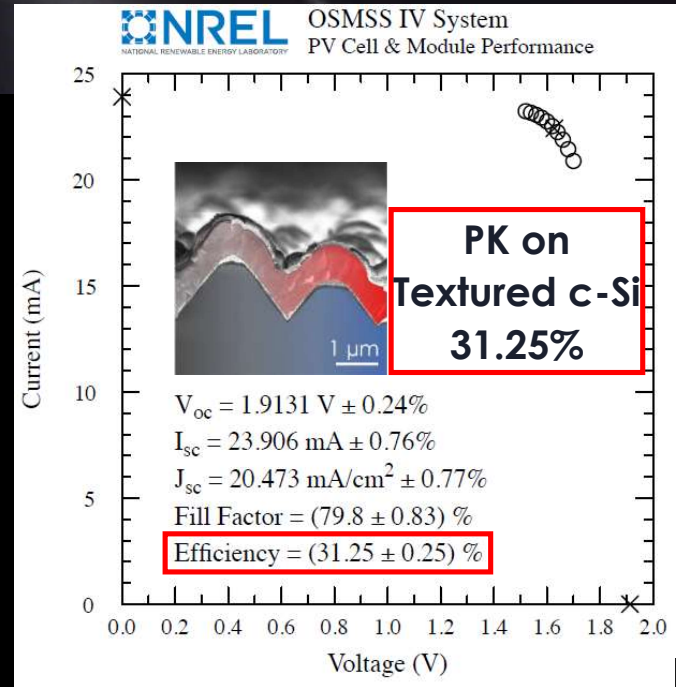
IBC-HJT solar cells

- Certified laminate efficiency of 24.7% on 201.2 cm²
- Tunnel-IBC solar cell (IBC-HJT)
- Smart Wire Connection Technology (SWCT)TM



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Bundesamt für Energie BFE
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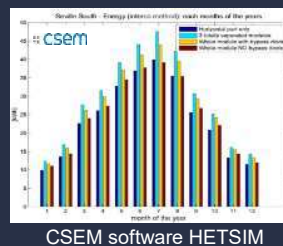
Perovskite/c-Si tandem



*Courtesy of Quentin Jeangros

Photovoltaic for Automotive Application

1. PV technology: IBC-HJT or Perovskite/Si tandem
2. Selection of vehicles and implementation surface
3. Energy yield calculation
4. Yearly range extension



- What is the future potential?



New Berline:
10 kWh/100km^[1,2]



[1] Mercedes-Benz EQXX



[2] www.lightyear.one/

	IBC-HJT	PK-Si tandem
VIPV total Power W	1'470	1'860
km per year in Paris	11'200	14'200
km per year in Sevilla	17'000	21'600

Potential of having between 10'000 and 20'000 km per year powered only by the sun

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OTHER SECTORS



• Light and heavy-duty trucks

- Diesel engine: Can cover 40% of the need when stopped [1] (save 3 to 9 tons of CO₂ emission per year [2])
- Electric truck: Can cover between 5 and 10 % of the electricity needs in Freiburg [3]
- Potential in EU → 2.2 mio new vehicles each year → 30 mio m² of PV available → 5 GW of PV installed [4]
- **Potential in CH → 28'000 new vehicles each year → 65 MW**

• Refrigerated Containers

- Refrigerated and fully connected unit load device (ULD) [5]
- Solar Powered → -48% CO₂ footprint emission



Swiss Airtainer
Cryo Container for Pharma
:: csem

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[1] <https://www.euronews.com/green/2023/12/15/could-the-worlds-first-solar-power-truck-be-the-answer-to-decarbonising-haulage>
[2] <https://inefficiency.com/solarontop>
[3] <https://www.ise.fraunhofer.de/en/press-media/press-releases/2021/electric-truck-with-fully-integrated-photovoltaics-picks-up-speed.html>
[4] R. Händel, OPES Group, Competitive VIPV Manufacturing in Europe. PVinMotion 2024
[5] <https://www.swissairtainer.com/>

21 La mobilité solaire : un rêve ou une réalité ?

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VIPV is already moving in Switzerland



Credit: David Lambelet

- Observed by chance last Monday in Neuchatel area
- 30 light-duty trucks from MAN: each equipped by 1.5 kWp PV on the roof and will save 1000 liters of diesel per year [1]

[1] <https://mantruckandbus-blog.ch/fr/30-utilitaires-man-pour-coop-ch/>

• Solar Electric Vehicles produced in Switzerland by Kyburz

- The solar vehicle test is in full swing at the Swiss Post in Embrach
- From last June, the Solar trolley had already covered 2'914 km, 33% of which was driven using solar energy [2]



[2] https://kyburz-switzerland.ch/de/hauszeitung?article_id=629696






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25.03.2024

THANK YOU FOR YOUR
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