

# Model-Based Optimization of a Solar-Powered Car



L I G H T Y E A R

**Clean mobility for everyone**

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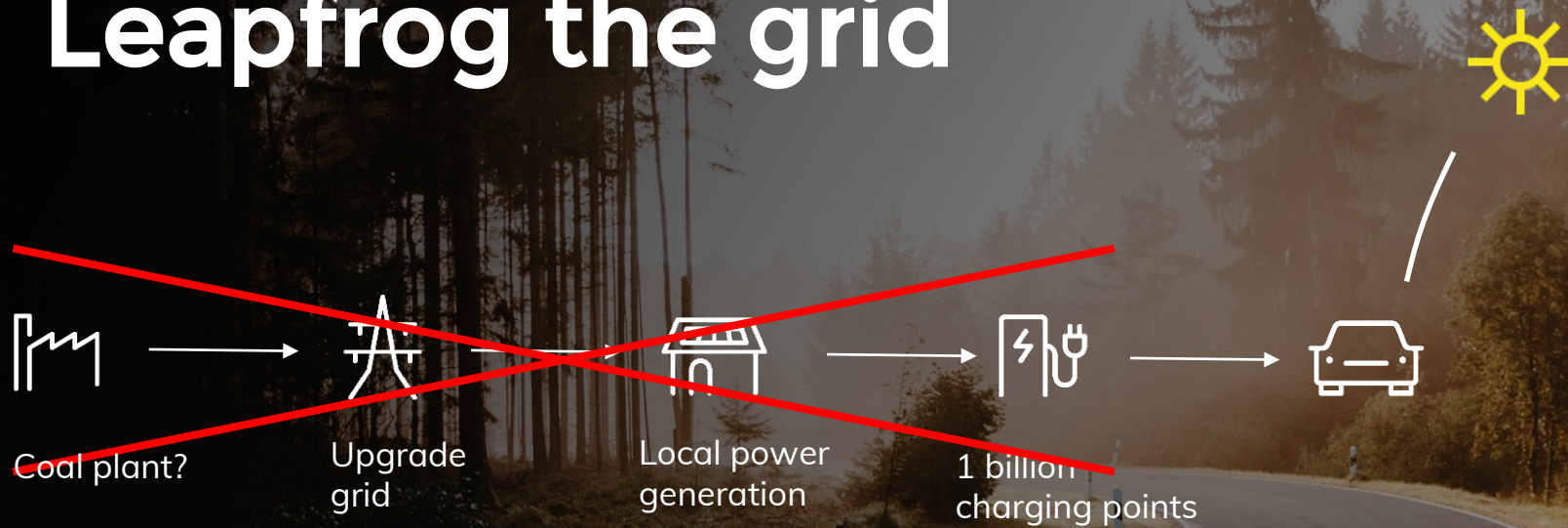


**Clean mobility for everyone**

A world map composed of a grid of small blue dots, centered on the Atlantic Ocean. The text is overlaid on the map.

**Only 3% live  
near charging points**

# Leapfrog the grid



# Lightyear One

Solar panels on roof  
and hood

10.000km

Solar range per year, in NL

12km/kWh

Efficiency

Solar-electric  
family car

725km

WLTP range

60kWh

Battery



# A two week surf trip in Portugal

1.154 km

Total distance

0

Grams of CO<sub>2</sub>

0

Charging stops

6

Surfspots





# 100+ engineers on a mission

## 200+ years of automotive experience



Ferrari



PALV

ALPINE



JAGUAR



LAND-ROVER

# The first pioneers

€119,000

Excluding taxes

65

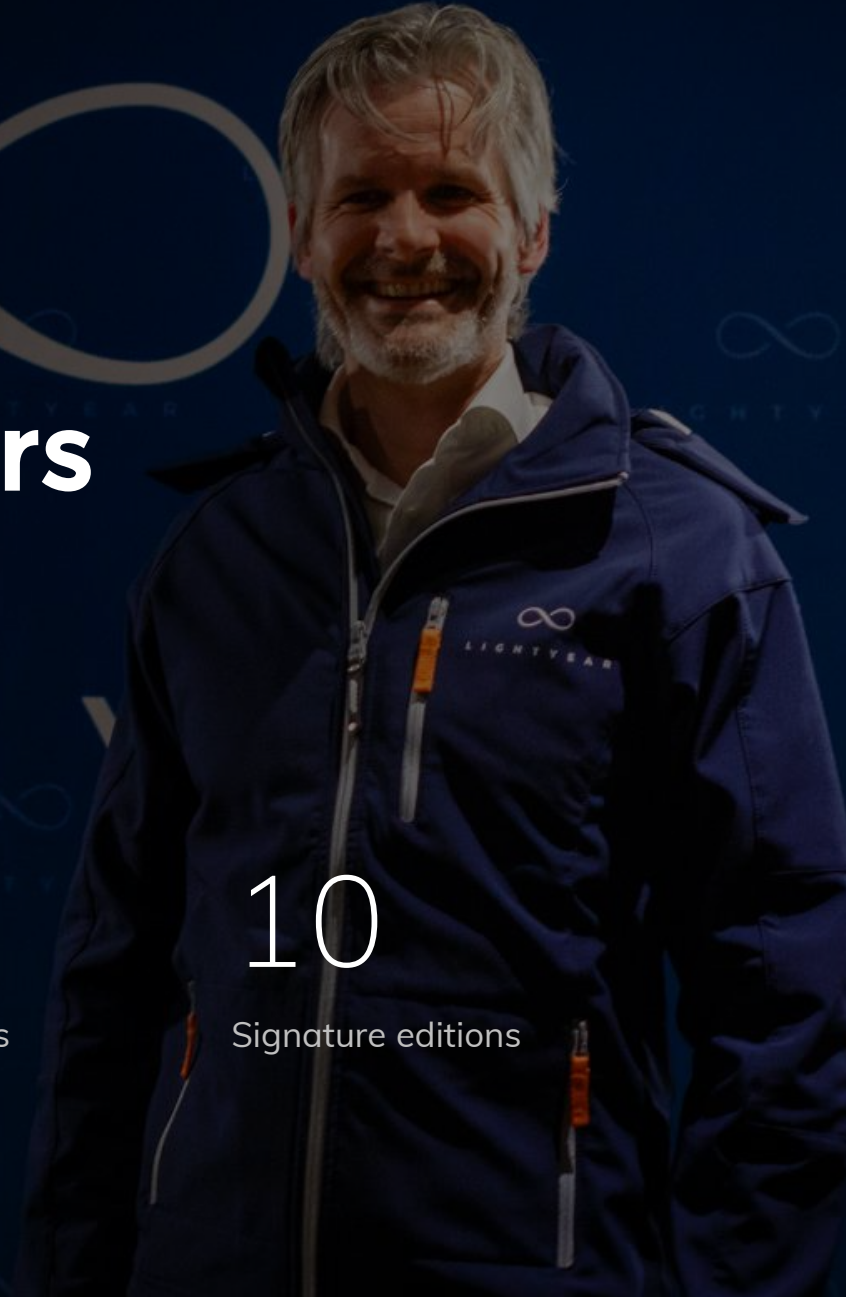
Early investors

80+

Signed reservations

10

Signature editions





# Re-imagine the car

Solar cells are just the start

Lightweight  
materials

Lightweight  
cycle

In-wheel  
motors

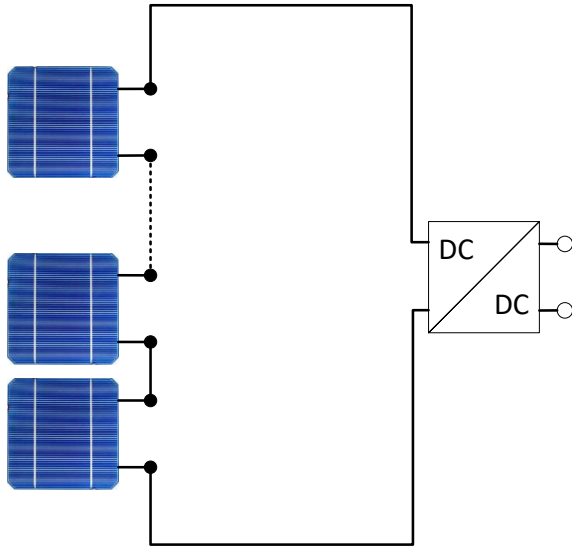
Improved  
aerodynamics

Solar panel  
size

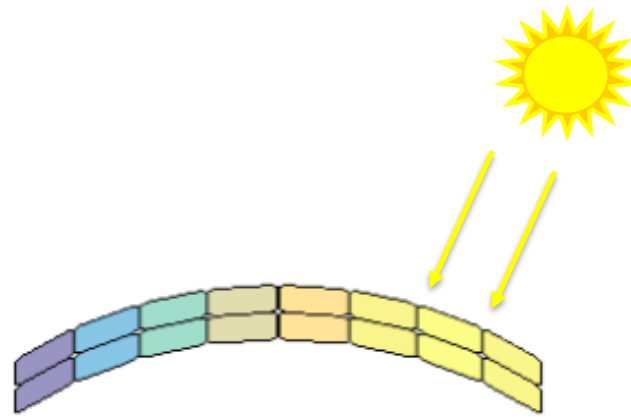
Solar panel  
efficiency



Energy use vs  
solar yield



- State-of-the-art for SEV:
- 3 strings of 125 cells
  - The **weakest** cell determines the string current



**Curved Surfaces** and **Shadows** cause mismatches between cells



Therefore, Solar Electric Vehicles have flat solar roofs

This limits **design freedom** and **aerodynamic performance**

**Grouping Efficiency:** *ratio between the individual cell MPPs and the suboptimal group MPPs*

$$\eta_{group} = \frac{\sum P_{mpp,group}}{\sum P_{mpp,cell}}$$



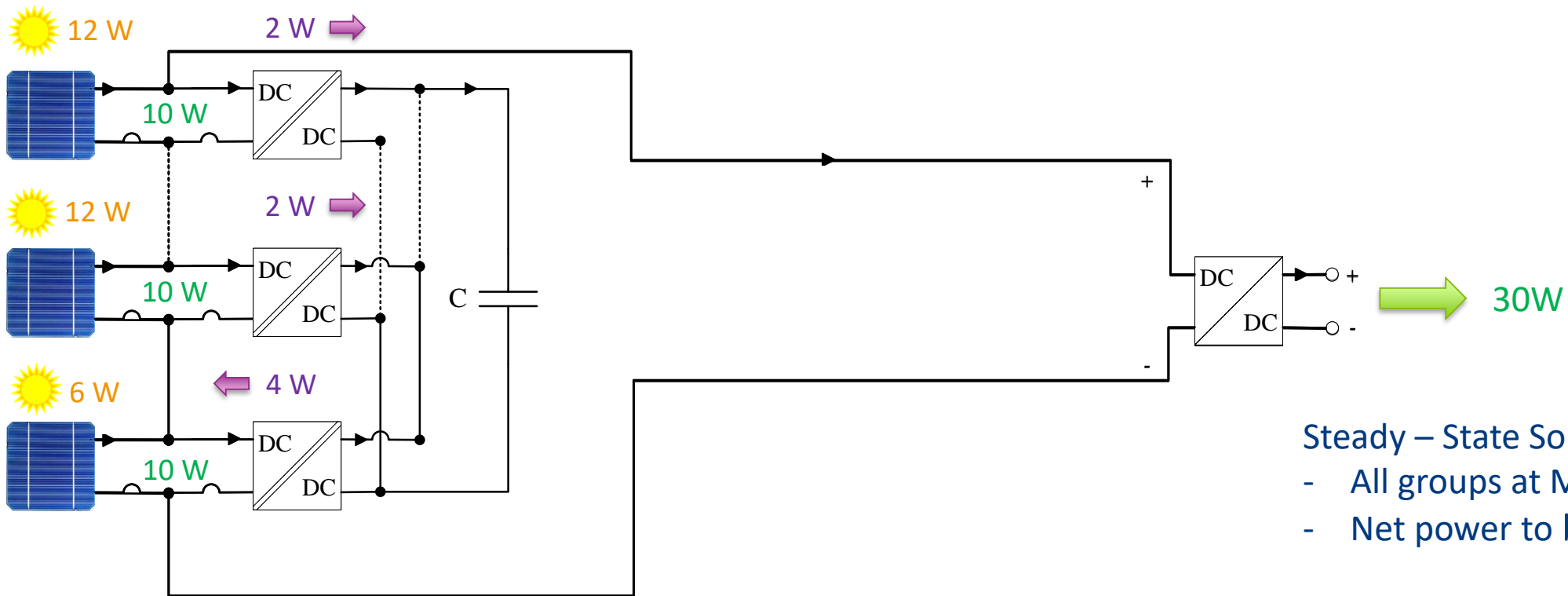
$$\eta_{group} = 98.6 \%$$



$$\eta_{group} = 75 \%$$

**Solution:** Smaller groups, AKA Distributed Maximum Power Point Tracking

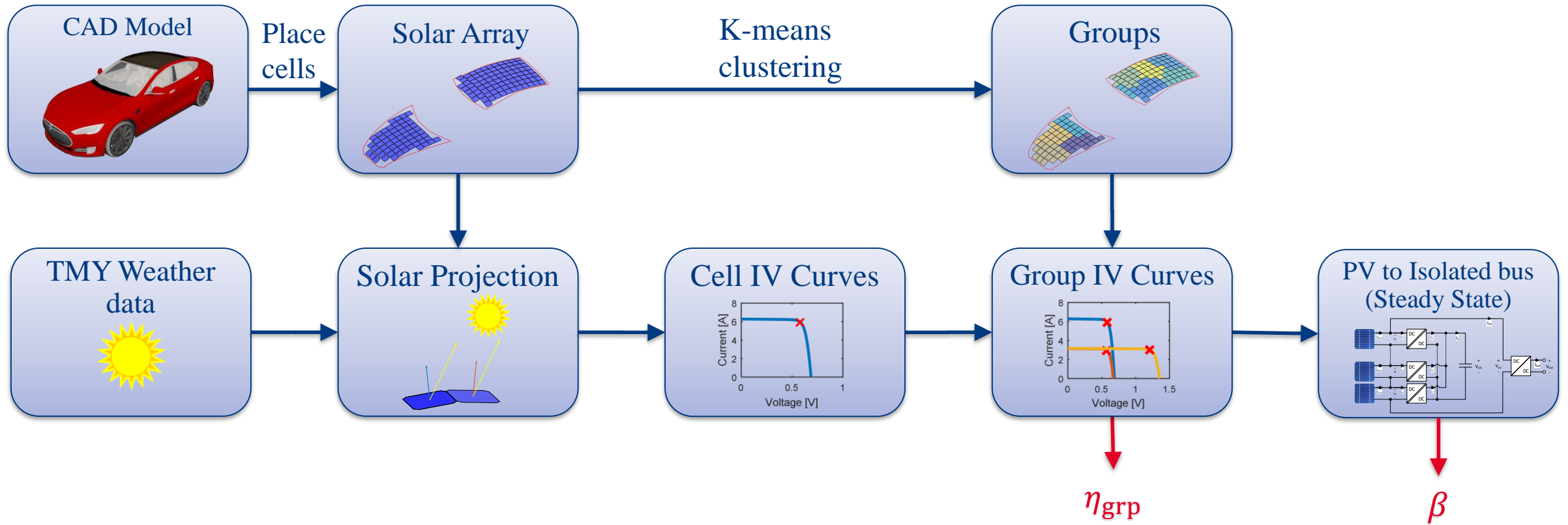
## PV to Isolated Bus Architecture (Olalla, 2013)

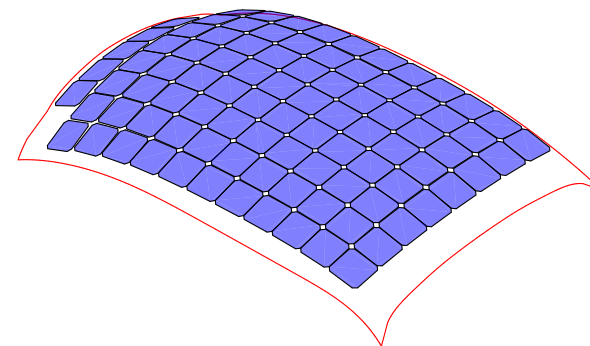
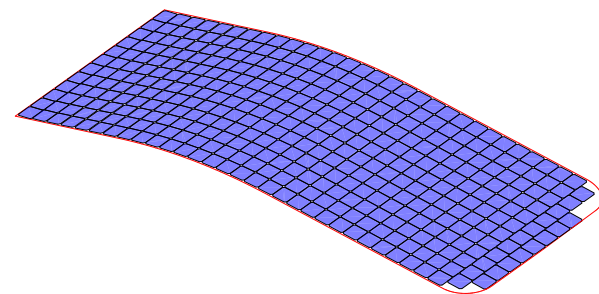
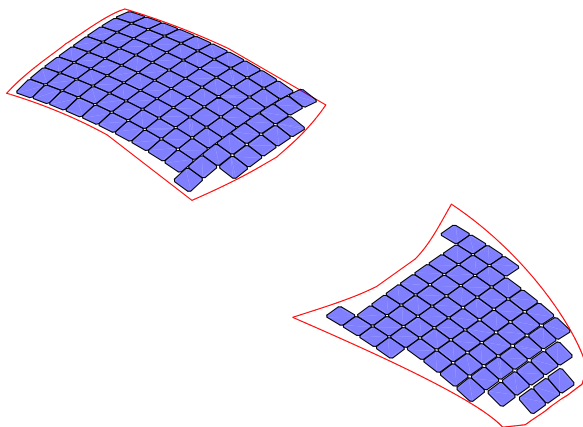
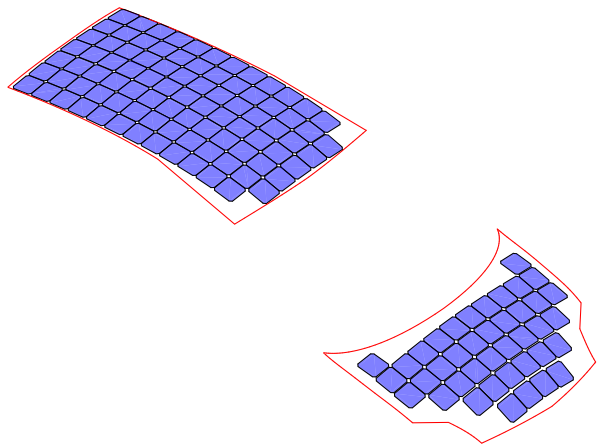


Steady – State Solution:

- All groups at MPP
- Net power to bus is zero

# MATLAB Solar Simulator Model





**Fiat Grande Punto**

**Tesla Model S**

**Stella**

**VW Beetle**

#cells	129
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#cells	159
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#cells	380
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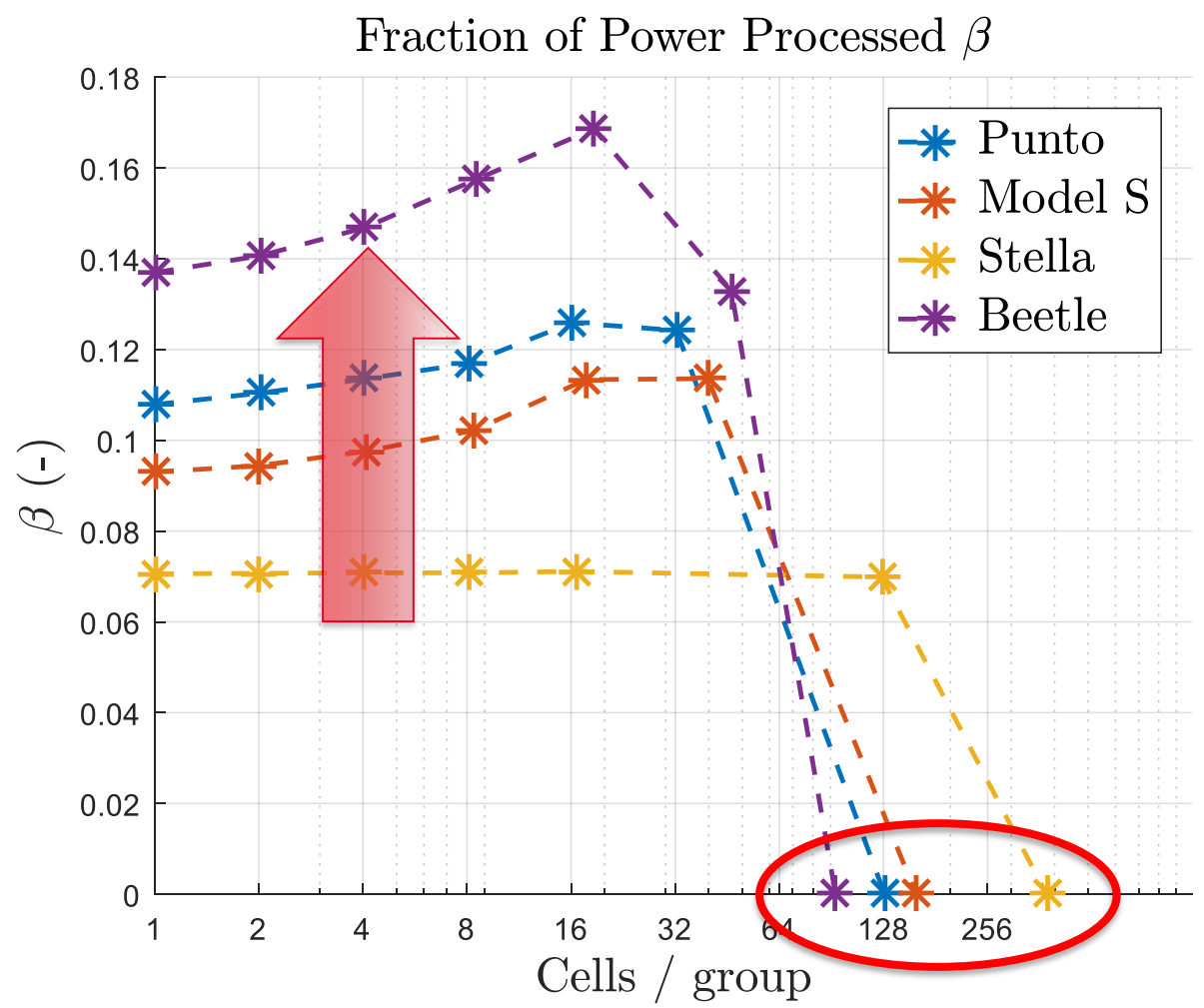
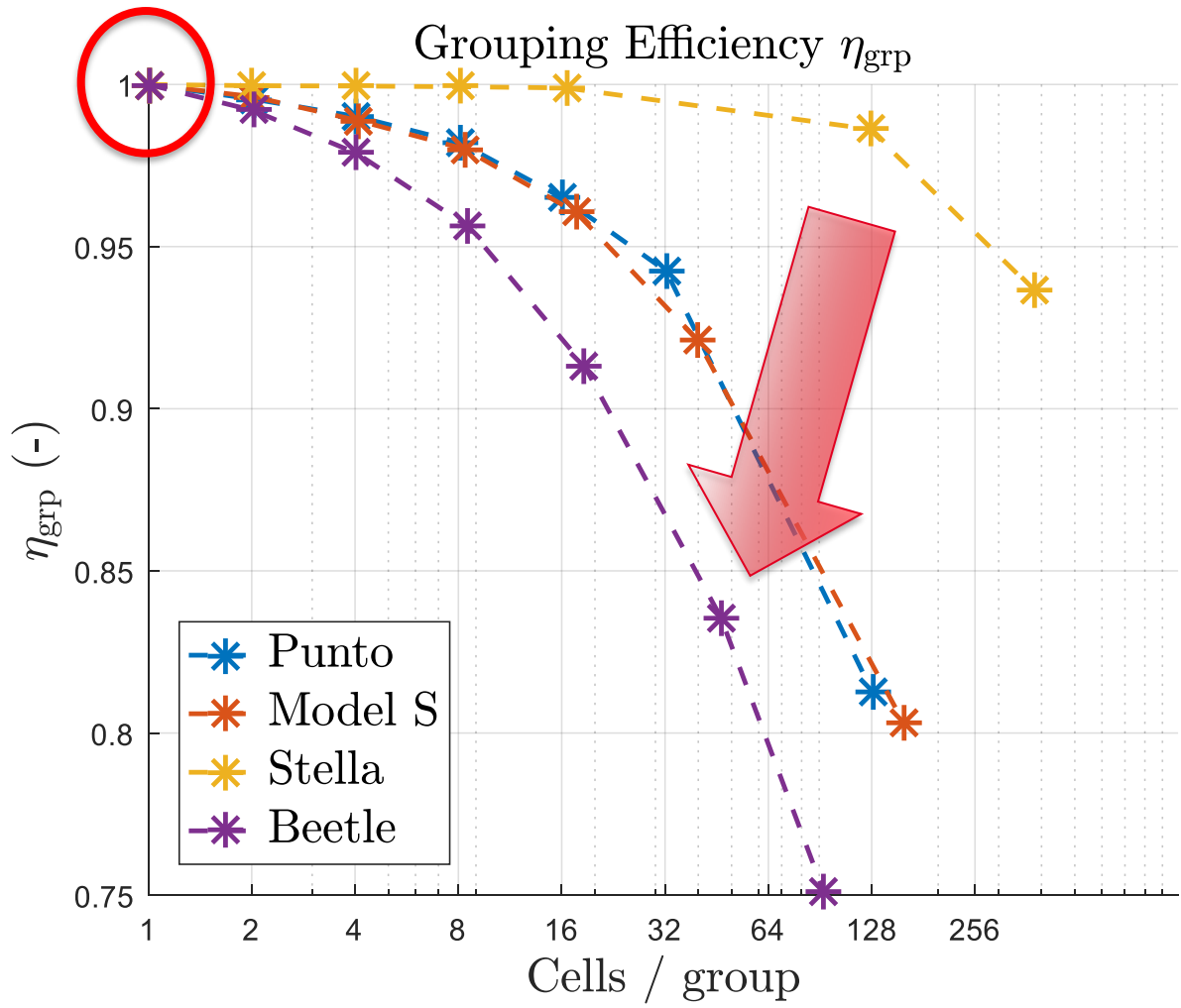
#cells	93
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$A_{solar}$  1.98 m<sup>2</sup>

$A_{solar}$  2.44 m<sup>2</sup>

$A_{solar}$  5.84 m<sup>2</sup>

$A_{solar}$  1.43 m<sup>2</sup>



More Curvature



Old System

Grouping Efficiency		99%	80%	75%
Conversion Efficiency		98%	98%	98%
<b>System Efficiency</b>		<b>97%</b>	<b>79%</b>	<b>74%</b>

New System

Grouping Efficiency		100%	-1	+15	98%
Conversion Efficiency		96%	95%	94%	
<b>System Efficiency</b>		<b>96%</b>	<b>94%</b>	<b>92%</b>	

+18



# A look into the future

A car is shown in a dark environment, covered in a highly reflective, metallic-looking material that catches the light, creating bright highlights and deep shadows. The car is positioned in the center of the frame. To the right of the car, a person is standing, their silhouette dark against the background. The overall scene is dramatic and mysterious, suggesting a high-tech or futuristic theme.

2019

Lightyear One  
prototypes

2020

First deliveries of  
Lightyear One

2021

1000 deliveries of  
Lightyear One  
Start Lightyear Two

# Key Takeaways



*Detailed modelling is key to understanding the design space and creating optimized solutions*

*For typically curved cars, the DMPPT system can improve performance by up to 18%-points*

*The diversity of MATLAB / Simulink allows it to be used as a 'swiss army knife' for engineers*

# Thank you



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