Design of a Photovoltaic Charging Station (PVCS) by implementing the VDI 2206

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http://otto-sohn.com/product/pv-off-grid-solar-system-victron-energy-multiplus-5000va-complete-kit-2/

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Introduction

In other countries the massive implementation of electric vehicles is causing adverse effects in the Power grid.

https://www.teslarati.com/tesla-model-3-inventory-fremont-factory-drone-video/

Colombian citizens are taking the initiative to use cheaper EV, such as electric bicycles.

http://saladeprensa.argos.co/Public/Resource/Tags?idTag=27 &tagName=Ambiental

Charging stations that integrate renewable energy sources (RES), such as Solar energy, (PVCS) are facing these power-grid challenges and EV growth.

http://aavea.org/giulio-barbieri-estaciones-de-carga-solar-y-eolica-para-ve/

Introduction

- PVCS are becoming important for the power grid and so does its design and development process.
- The design and development process of a PVCS require a close integration of technical domains: Electrical, Mechanical and Information technology. Assessed by mechatronic design.
- Although there are various methodologies for mechatronic design, our intention is to aid the design and development process of a PVCS using the mechatronic design methodology VDI 2206.

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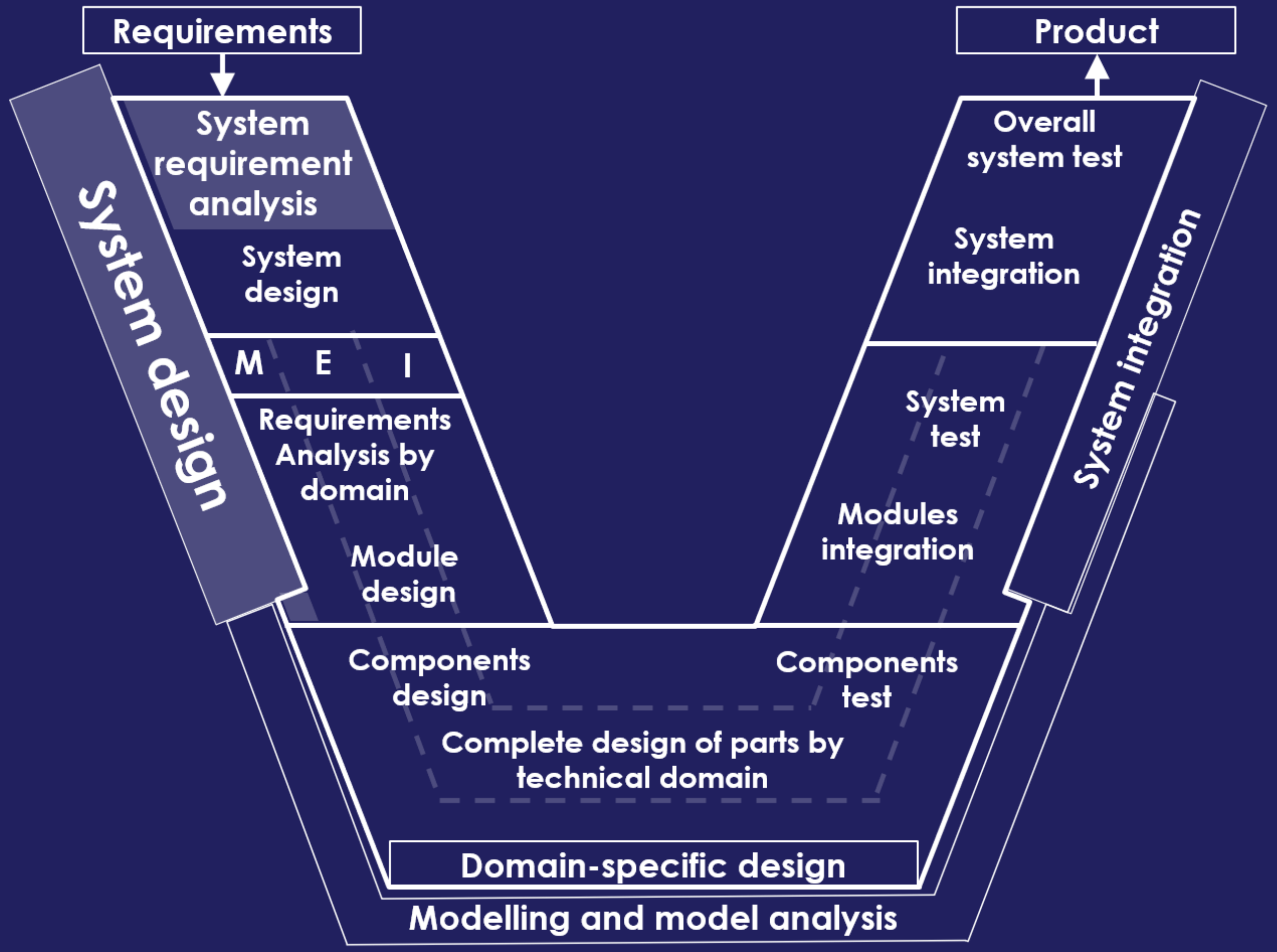
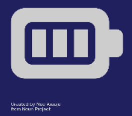
V model of the PVCS



Be able to:

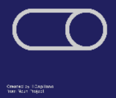

Transform solar energy into photovoltaic energy.


Exploit the maximum power from solar energy.

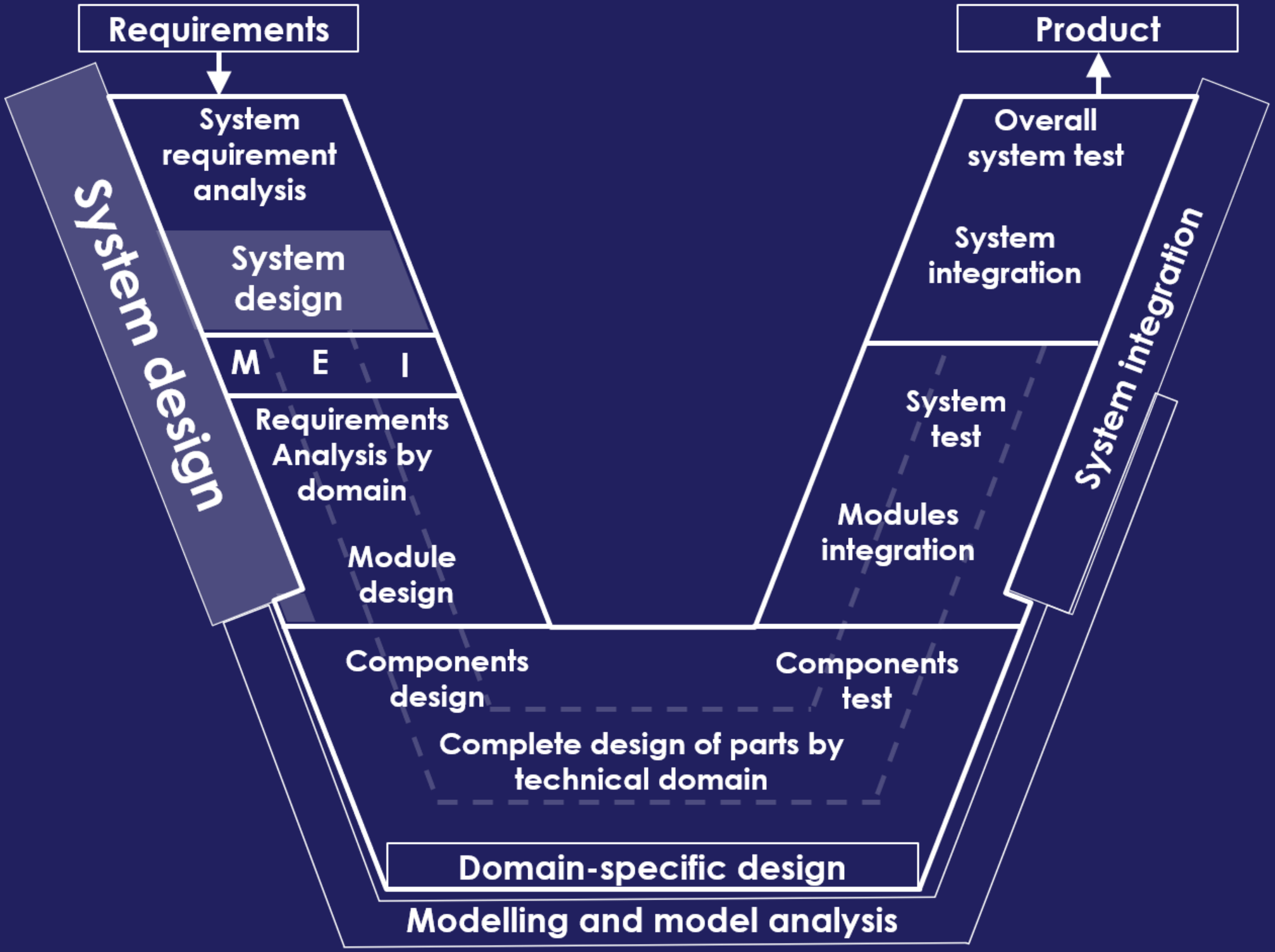

Store energy.

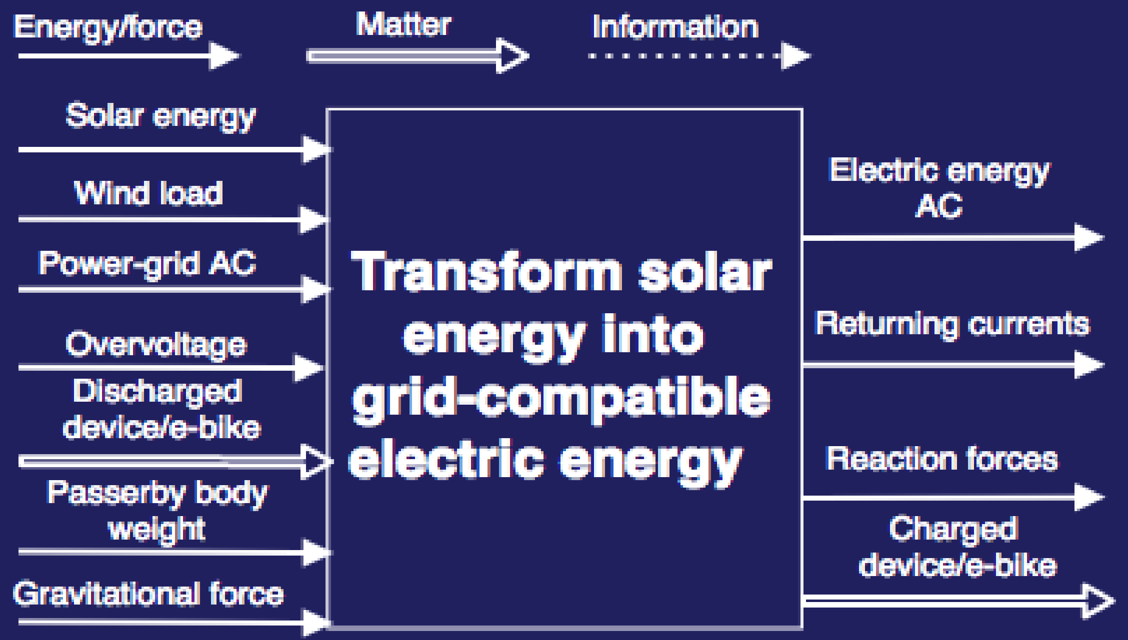

Deliver AC energy.


Align with the sun optical path.


Manage the energy that has to be delivered.

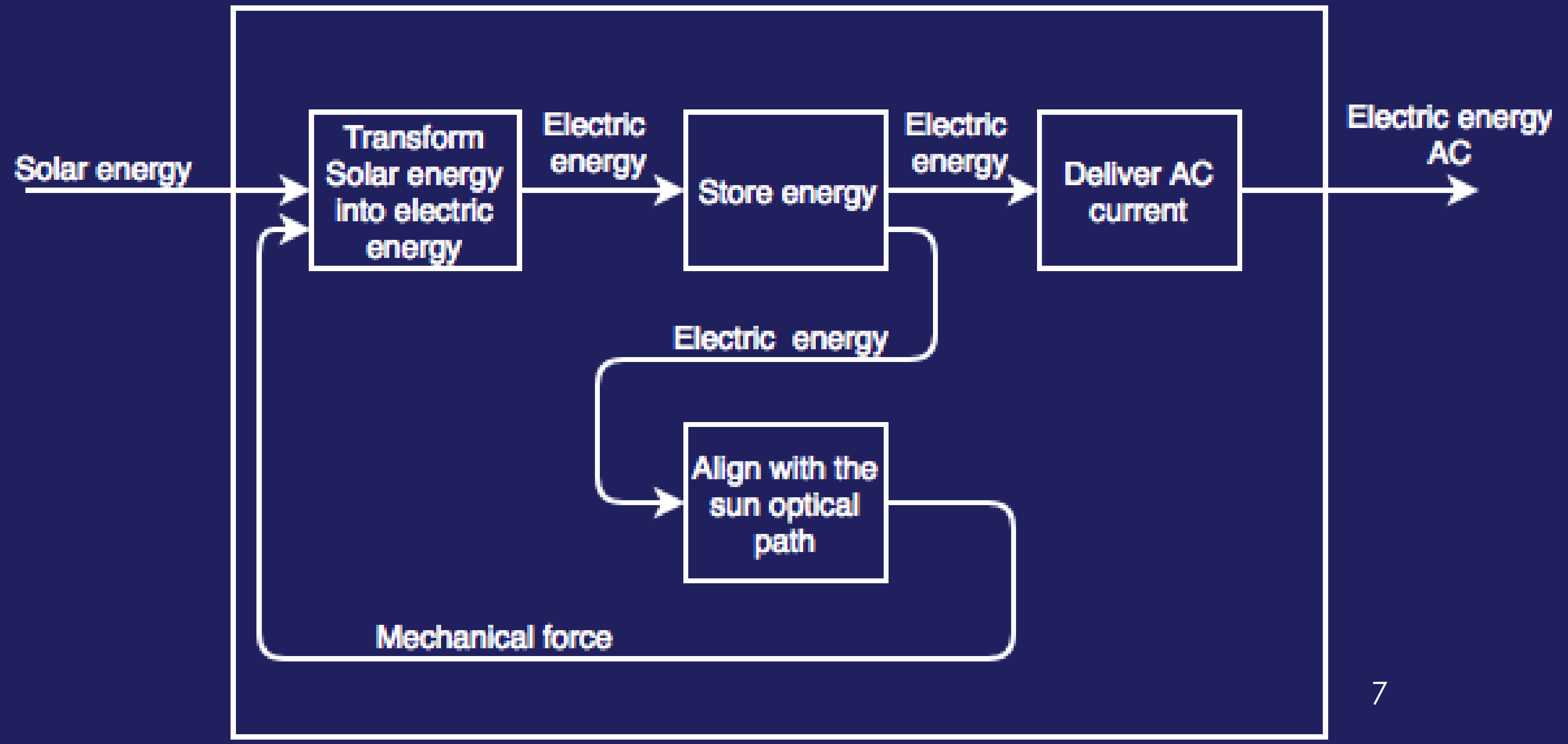
V model of the PVCS



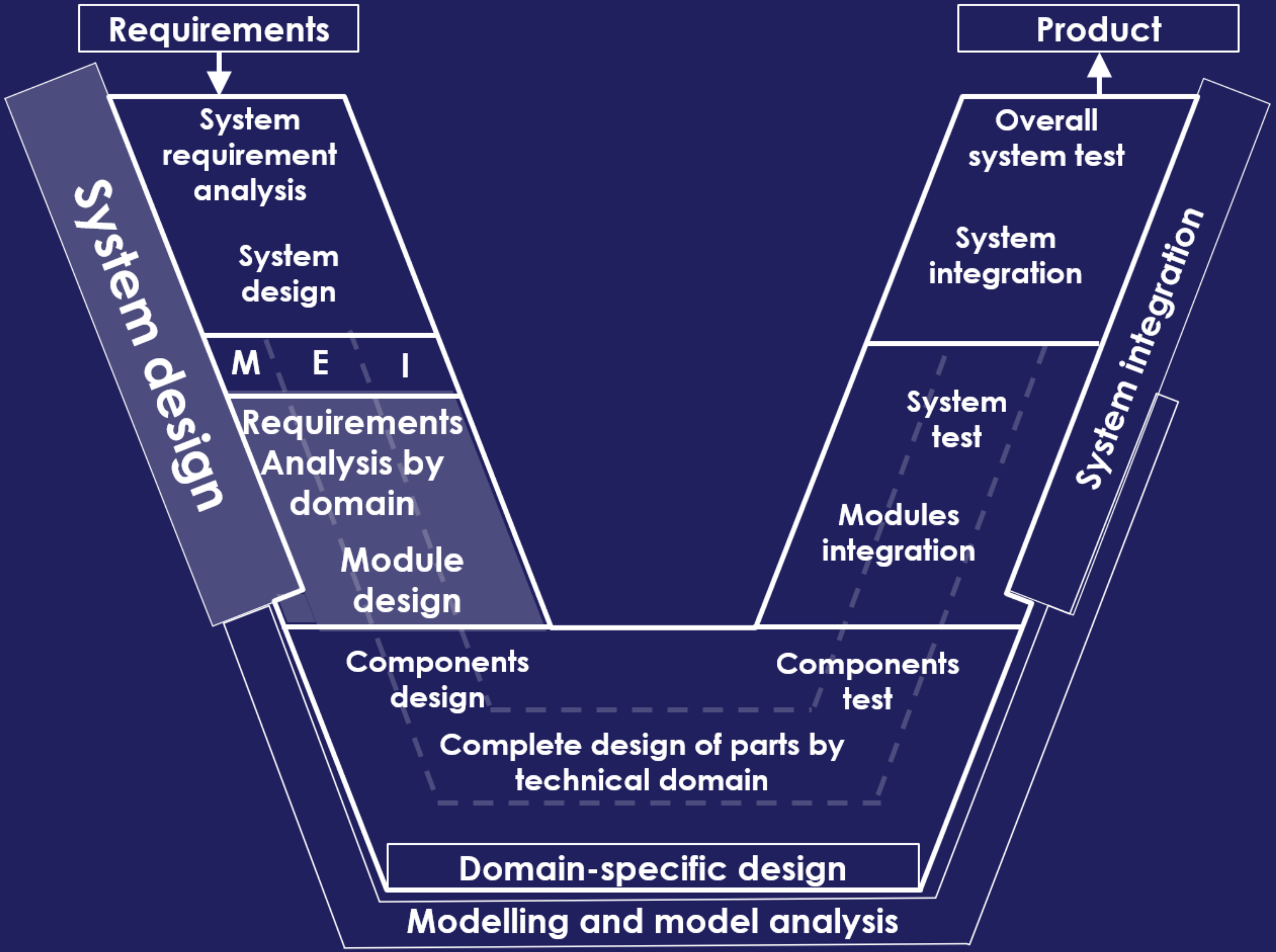


PVCS main function

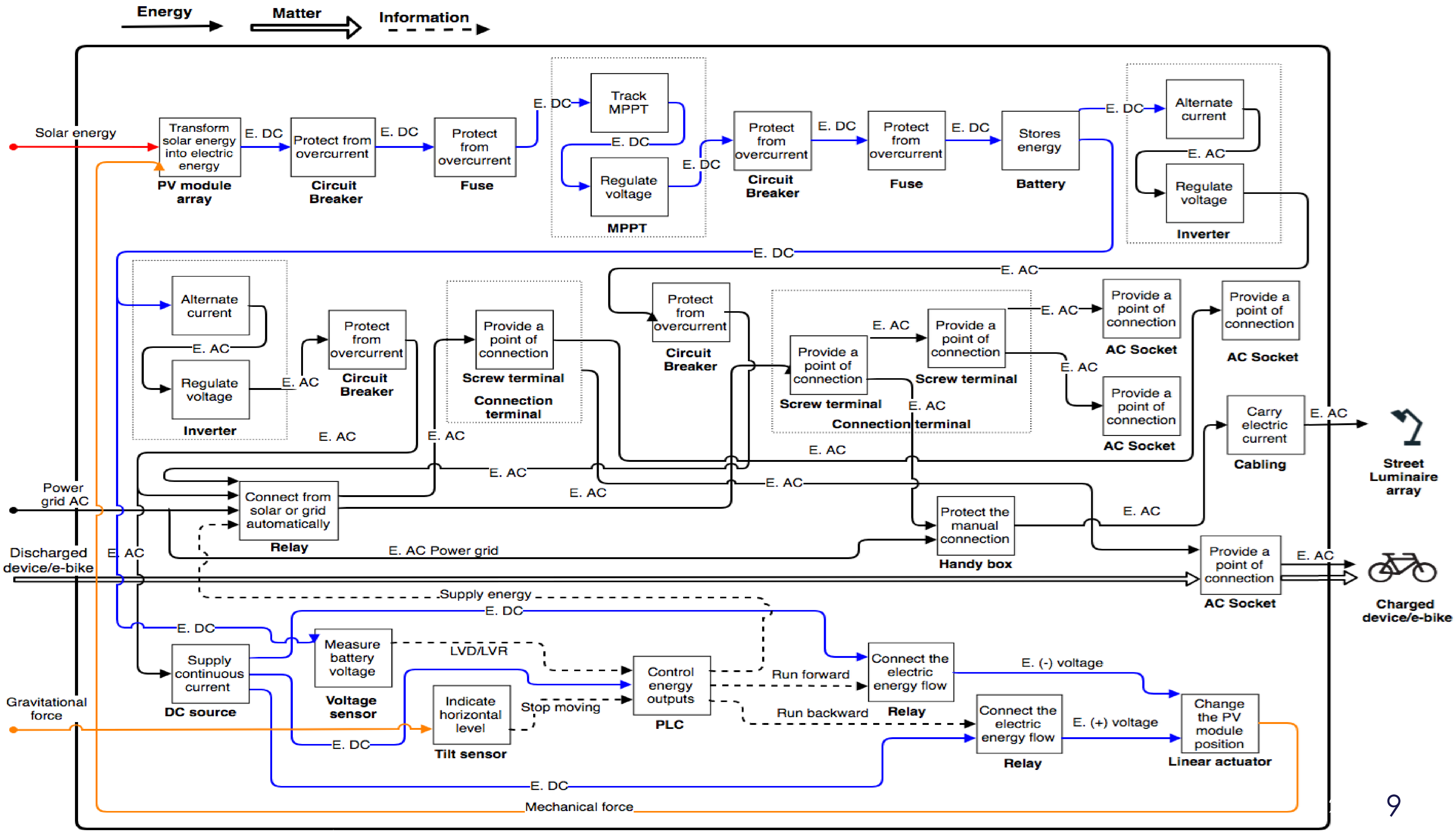
PVCS main functionality



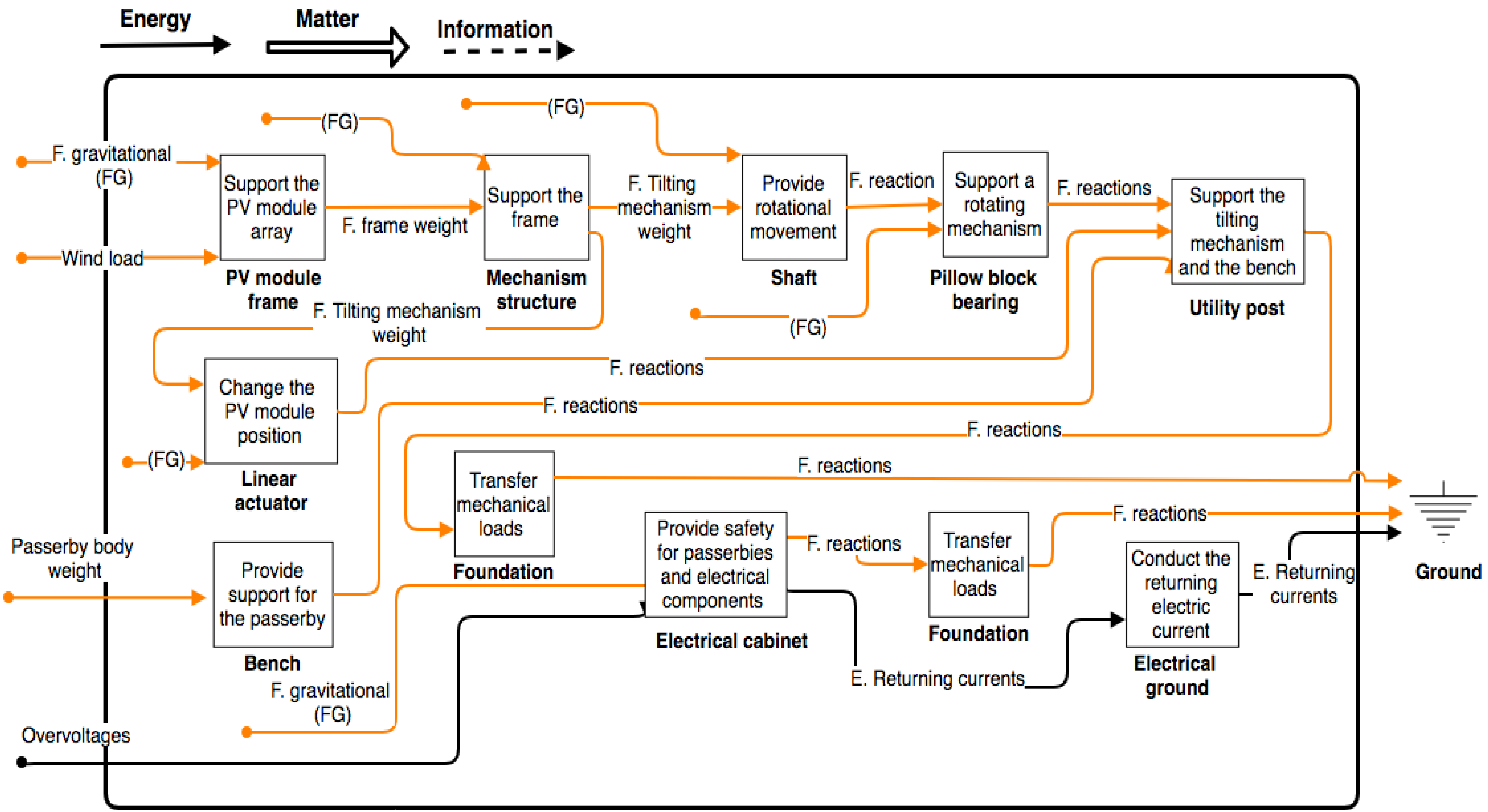
V model of the PVCS



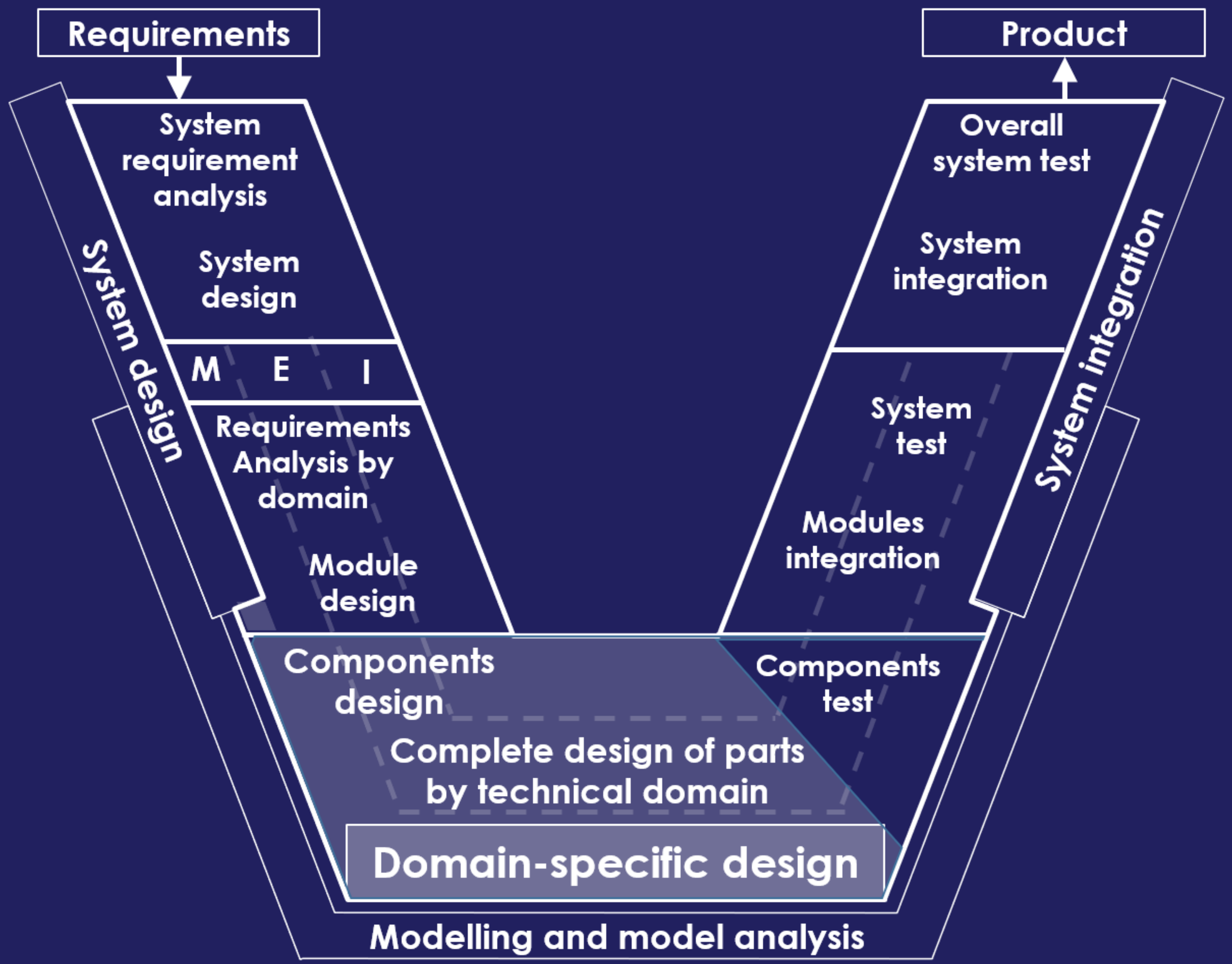
Main energy flow



Secondary energy flow

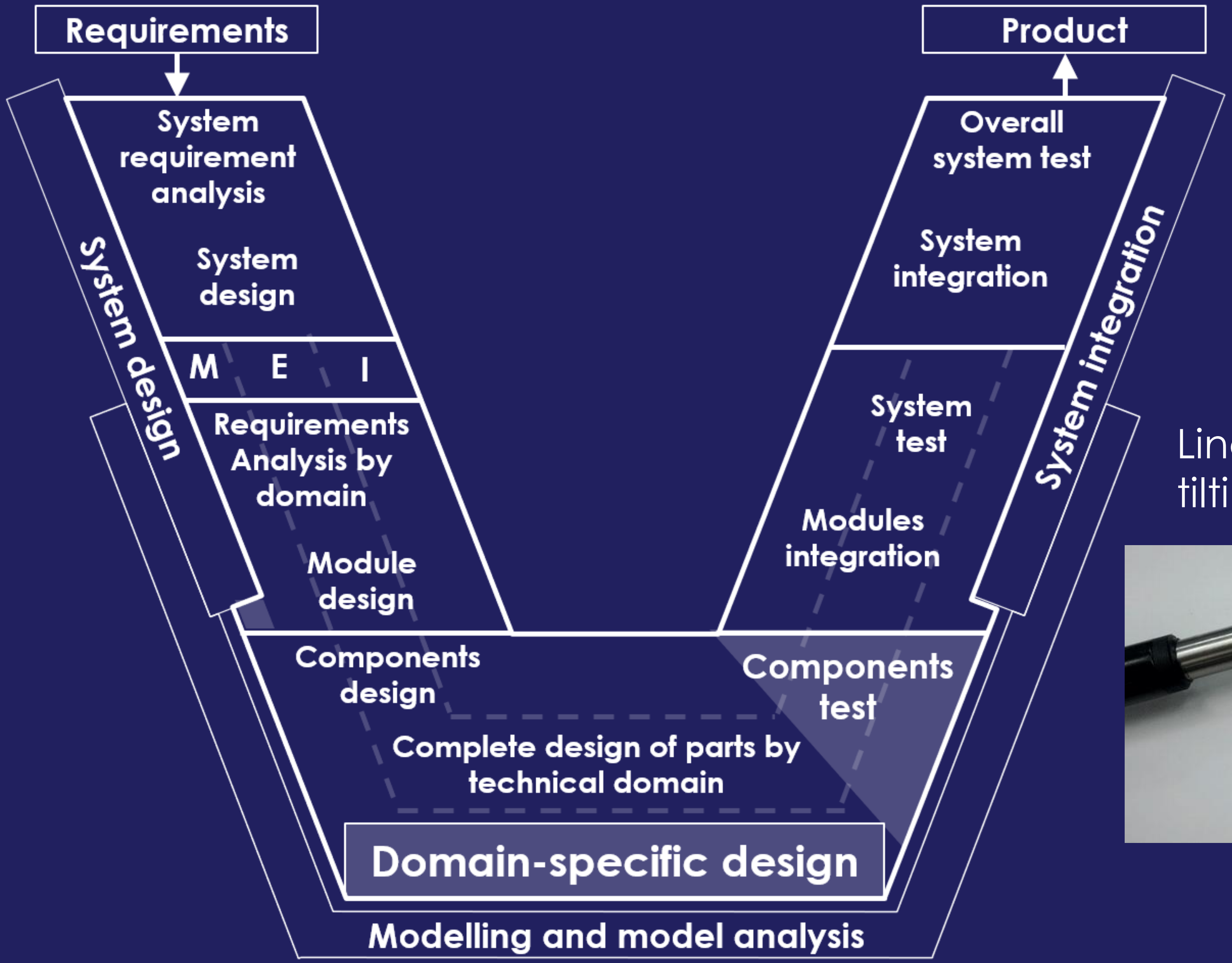


V model of the PVCS



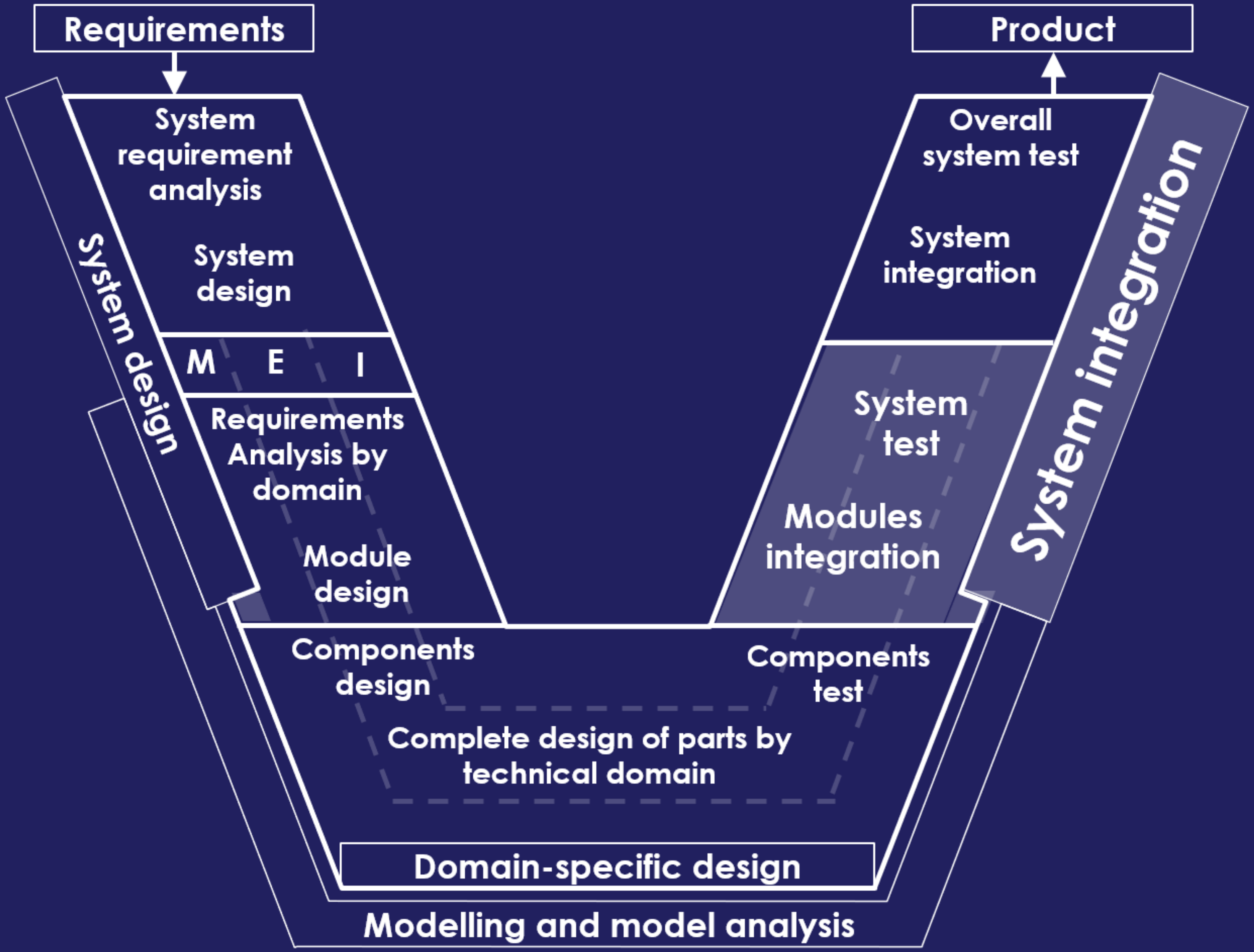
Technical system	Mechanics	Electronics	Informatics
Working subsystem		Pv module	
Prime mover subsystem	Linear actuator	Battery DC Source	
Transmission subsystem	Shaft Pillow block Mechanism	AC Socket Cabling	
Control subsystem		Inverter MPPT Relay Tilt sensor	PLC
Frame subsystem	Mechanism PV frame Utility post Foundation	Electric cabinet	
Helping subsystem	Bench	Breaker Fuse Terminal Handy box Electric ground	Voltage sensor

V model of the PVCS



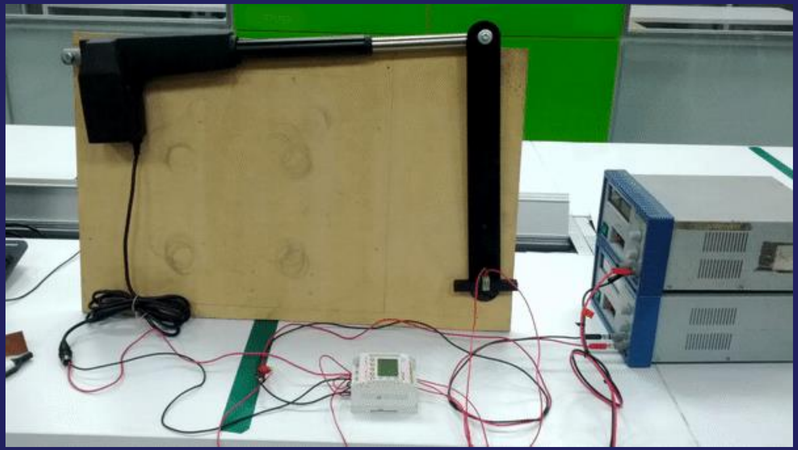
Linear actuator and tilting algorithm test

V model of the PVCS

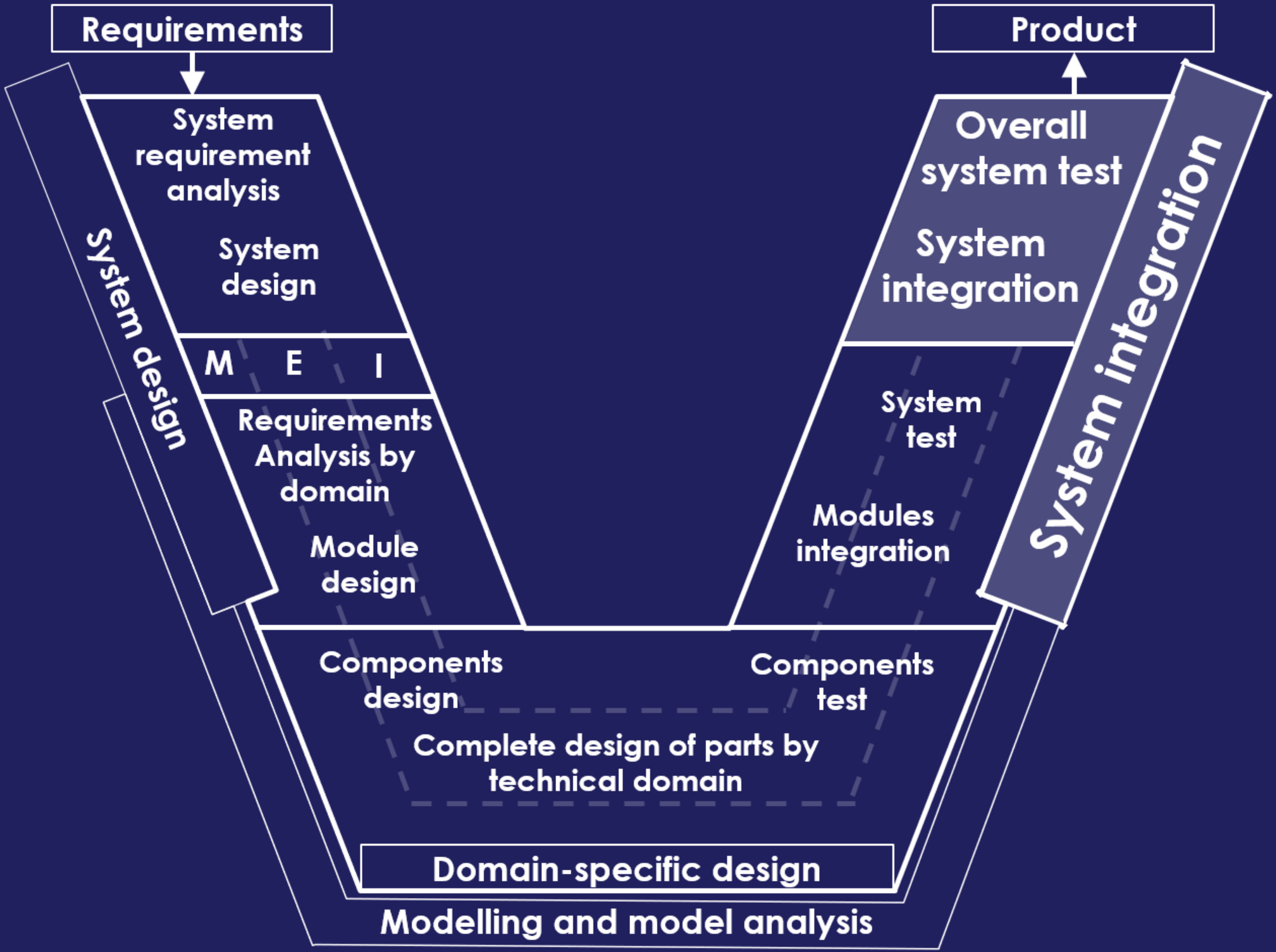


Modules integration and system test

Subsystem	Components
Foundation	(Concrete and electric ground)
Chassis	(Utility Post and bench)
Electric panel	(Electric cabinet, inverters, DC source, Battery, MPPT, relays, breaker, fuse, terminal)
Tracking Mechanism	(Mechanism and linear actuator)
PV Frame	(Pv modules and frame)
Controll subsystem	(tilt sensor, PLC, linear actuator, voltage sensor)



V model of the PVCS



Overall system test and integration

- User validation: Although not monitored, hundreds of visitors have charged their electronic devices. Other uses were reported.

Date	Use	Power demand
Jun 2015	Electric grinder	~1000 W
Sep 2015	Laptop – Academic organization	~60 W
Sep 2015	Stereo – Academic organizations	~80 W
Jan 2017	Electric car (Renault twizy)	~6000 W

- Weather validation: The mechanical design had to withstand wind speeds of 120 km/h

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Discussion

- **System and domain-specific design methodology framework:** The guide proposes the methodology of Pahl and Beitz for the conceptualization of the mechatronic product, but is this recommendation enough to conceptualize the informatics or define the product architecture?

- **Design requirements traceability:** PVCS are mechatronic systems that are increasing in complexity, leading to the question if it is needed to add to the analysis a System Engineering (SE) or Model Based Systems Engineering (MBSE) approach.

Discussion

- **Subsystem definition:** How the subsystems should be defined in order to improve the DDP of a PVCS? Technical domain-based, Function-based or location-based?

- **Domain-design phase sequence definition:** A parallel design should be considered for this case. Since informatics are software based and require less hardware than mechanics, its development can be started as soon as possible.

- Charges that were not expected, such as the electric car, have been connected to the charging station, perhaps due to the paradigm of unlimited power and energy that represents an AC socket for the user.

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Thank you!

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