Output 1

Guide package on solar energy application in 2Seas region: legislation, market, technologies and best practices

Interreg
2 Seas Mers Zeeën
SOLARISE
European Regional Development Fund

EUROPEAN UNION

Low-carbon technologies

TOTAL PROJECT BUDGET:
4.35 M €
INCLUDING AN ERDF BUDGET OF:
2.61 M €

Prof.dr.ir. Emilia Motoasca – KU Leuven; 24.01.2020

Solarise = Interreg 2Seas project aiming to:

- **boost the adoption of solar energy** in **historical and public buildings** and for **households with a focus on low-income families**, and also **shows future technologies through living labs**.
- **lower the impact of the solar renewables on the electricity grid** by, for example, **installing storage capacity**.

Objectives

Stimulate, broaden and accelerate solar energy adoption in the 2 Seas by:

- Identifying and overcoming barriers;
- Using smart grids, electricity/heat storage, internet of things and energy management systems;
- Proposing cost-effective and affordable solutions;
- Implementing innovative living-labs and a series of demonstrations in public buildings/infrastructure and in households with low income families;
- Delivering training tools and solar-energy roadmaps.

Consortium Partners

Interreg
EUROPEAN UNION
2 Seas Mers Zeeën
SOLARISE
European Regional Development Fund

Brighton & Hove City Council

UNIVERSITÉ de Picardie Jules Verne

KU LEUVEN
TECHNOLOGIECAMPUS GENT

flux50
ENERGISING THE FUTURE

ZOERSEL

Fourmies
Entreprendre et réussir

enercoop
L'énergie militante
Hauts-de-France

KAMPC

MIDDELBURG

middelkerke

UNIVERSITY OF PORTSMOUTH

Heerhugowaard
Stad van kansen

www.interregsolarise.eu

Residential buildings (social housing)

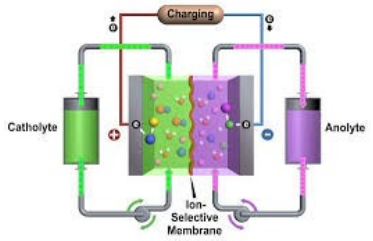
Historical buildings (monuments or not)

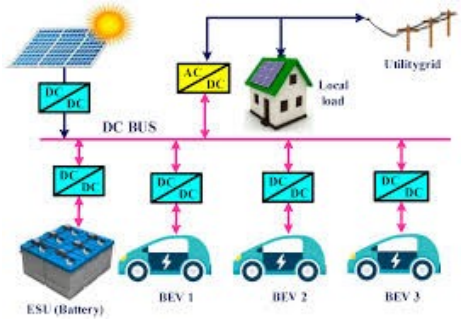
Public buildings (schools, city-halls)

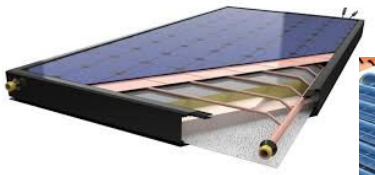
Solar farms in peri-urban environment

Smart (micro) grids, smart energy management V2G, energy storage systems

Unobtrusive integration in buildings (BIPV, transparent PV….)







Hybrid systems (electricity & heat) PV/T, Bi-facial PV, CSP, BISPV, …

PROJECT

WP1: Contextual Framework

WP2: Feasibility case studies

1. Living Labs
2. Residential, Historical & Public Buildings
3. Solar farms

WP4: SOLARISE installations

WP3: Accelerating solar uptake

WP 5: Project Management

WP 6: Communication

Start:03/18 ----------End:09/21

OUTPUT 1

Based on WP1 (Contextual framework) with activities and deliverables :

- **Guidelines** for benchmarking and pilots
- Technical report on **smart grids**
- Report on **solar energy market analysis, legal issues and future potential**
- Report on solar energy harvesting **cost and investment models**
- Technical report on **hybrid PV/T systems**
- Technical report on **innovative solar technologies**
- **Database** as inventory of existent pilots, of benchmarks and of good practices

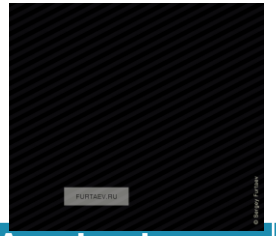
OUTPUT 1

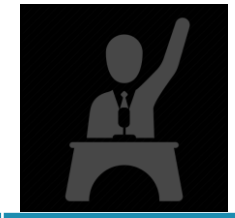
Is meant to:

- give stakeholders **a clear picture of solar energy context** in the 2 Seas region of the from different complementary issues and points of view
- create **awareness** on:
  - the latest available and promising **innovations**
  - the possible manners for **flexible and cost effective implementation** of solar energy

OUTPUT 1

Stakeholders involvement





Stakeholders	Academics (R&D instit)	Municipalities	Politicians	Installers (commercial SME)	Citizens cooperatives
Affiliation	Univ/Instit	Local authority	Policy makers	SME	None
Objective (stakeholder needs)	Knowledge	Solve problems	Societal relevant	Solve problems Commercial	Knowledge
How (what to offer)	Novelty	Usefulness	Impact	Econ. yield	Usefulness Econ. yield
Stakeholder expertise	Multi-disciplinary	Non-technical Mono-disciplinary	Non-technical Mono-disciplinary	Technical Mono-disciplinary	Non-technical



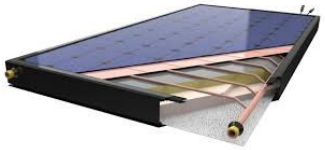


Legislation/regulations

Solar energy market

Cost/investment models

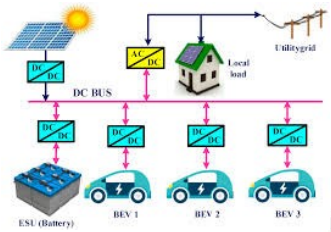
Innovations/technologies: PV/T hybrid systems

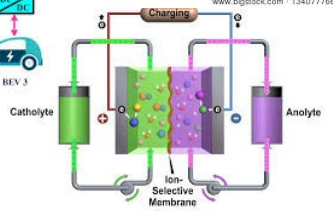



SOLARISE

Innovations/technologies: BIPV, transparent, CSP


Innovations: smart grids

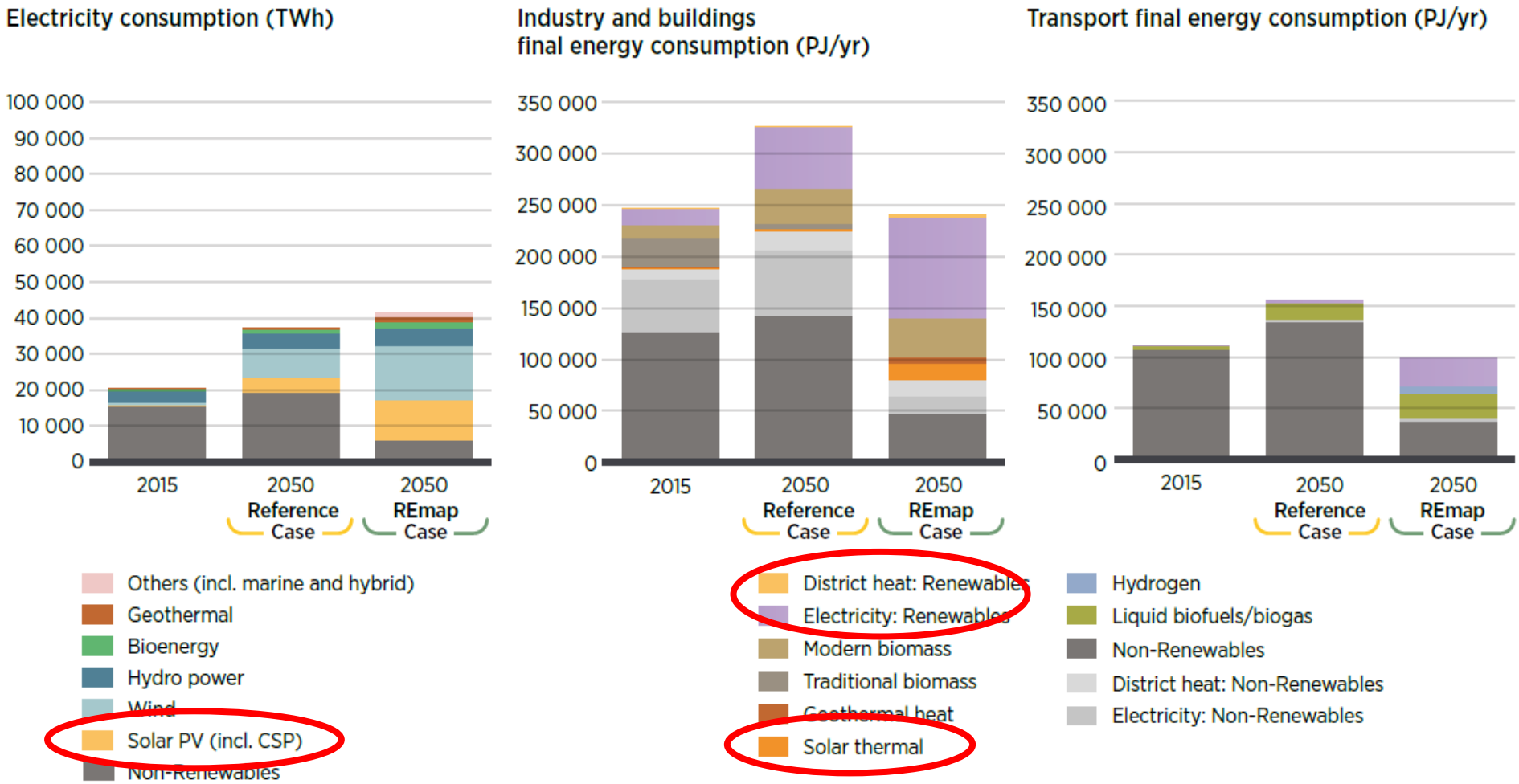




Guidelines for benchmarking and pilots

Database with pilots, good practices and benchmarks

Global energy context: RE roadmap 2050?



Source: IRENA 2018 'Global energy transformation: A roadmap to 2050'

2Seas energy context – embedded in EU context

Investment:
extra EUR 177 billion per year of investment from 2021 to meet 2030 climate & energy targets Crucial role for EFSI

Economic growth*:
1% increase in GDP
EUR 190 billion into the economy 900,000 new jobs
*Upper end of estimates

Decarbonisation:
Carbon intensity of the economy 43% lower in 2030 than in 2015
72% share of non-fossil fuels in electricity generation in 2030

2Seas energy context – embedded in EU context

Energy Union and Climate Action

Investment Plan

Attracting additional Investments

Skills Agenda

Adapting the workforce

Digital Single Market

Empowering citizens and consumers

Capital Markets Union

Triggering sustainable finance for the clean economy

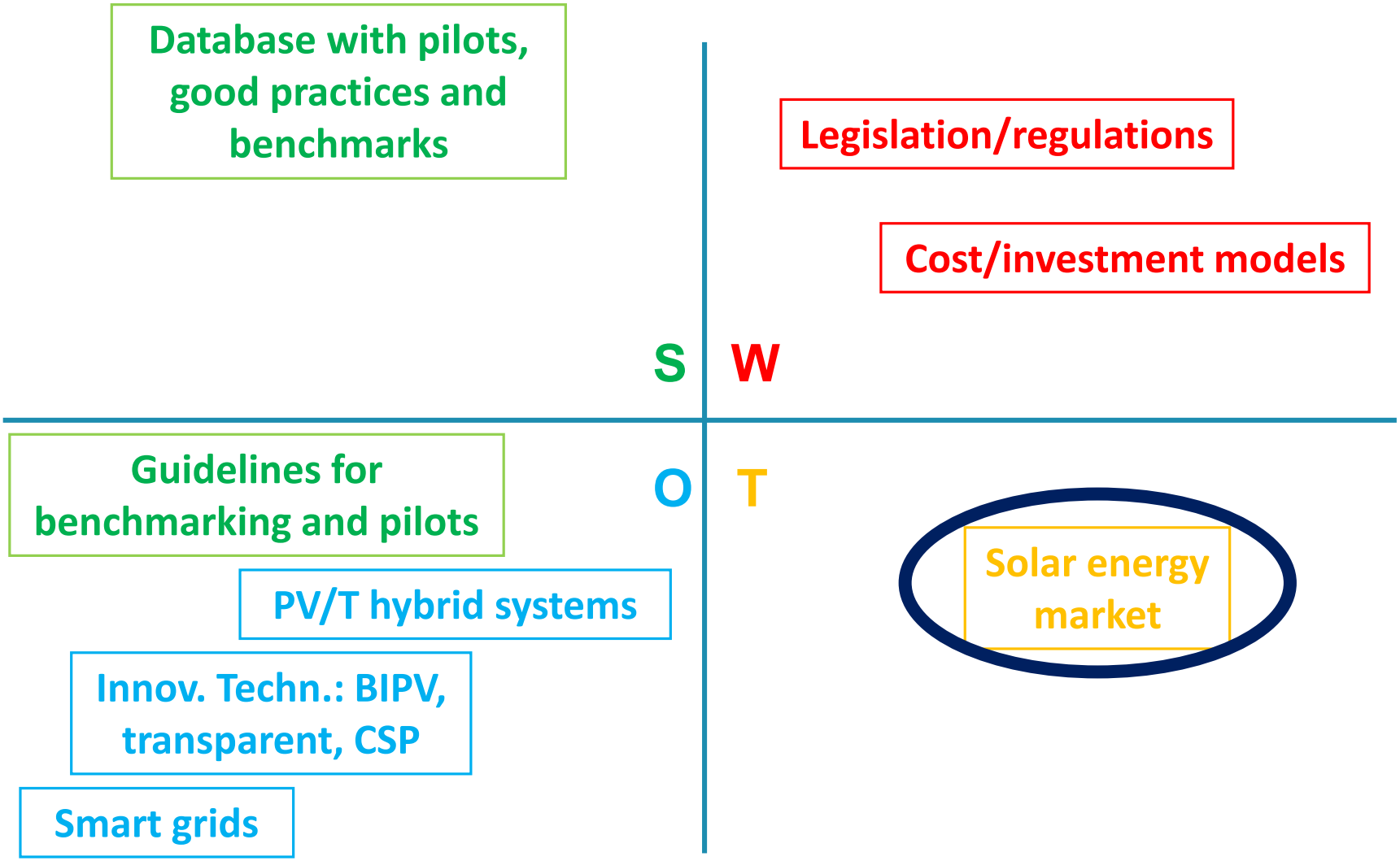
Innovation

Bringing new technologies from research to market

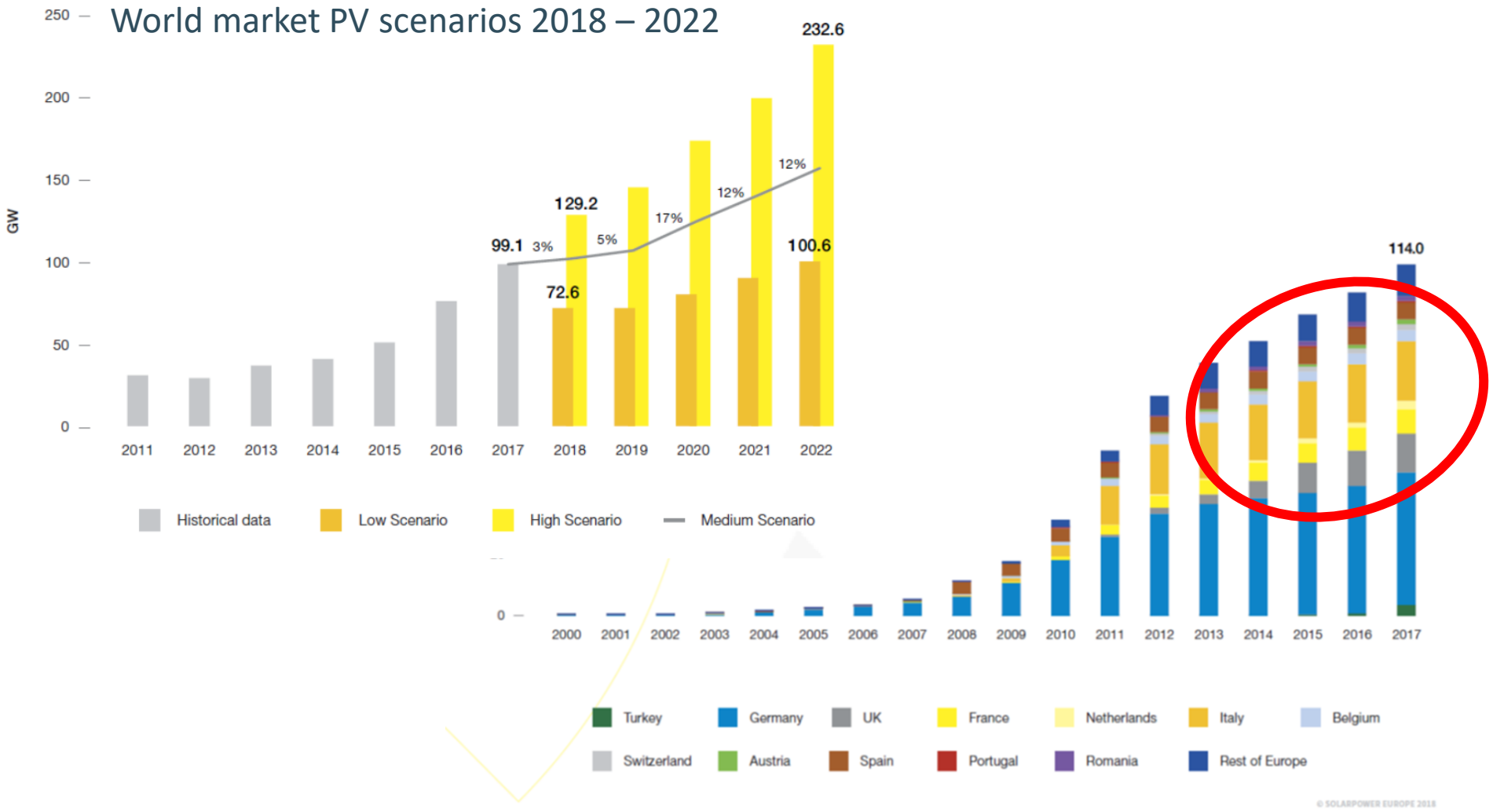
Circular Economy

Achieving a recourse-efficient low-carbon economy

Solar energy in 2Seas region



2Seas – Solar energy market



Source: Solar Power Europe

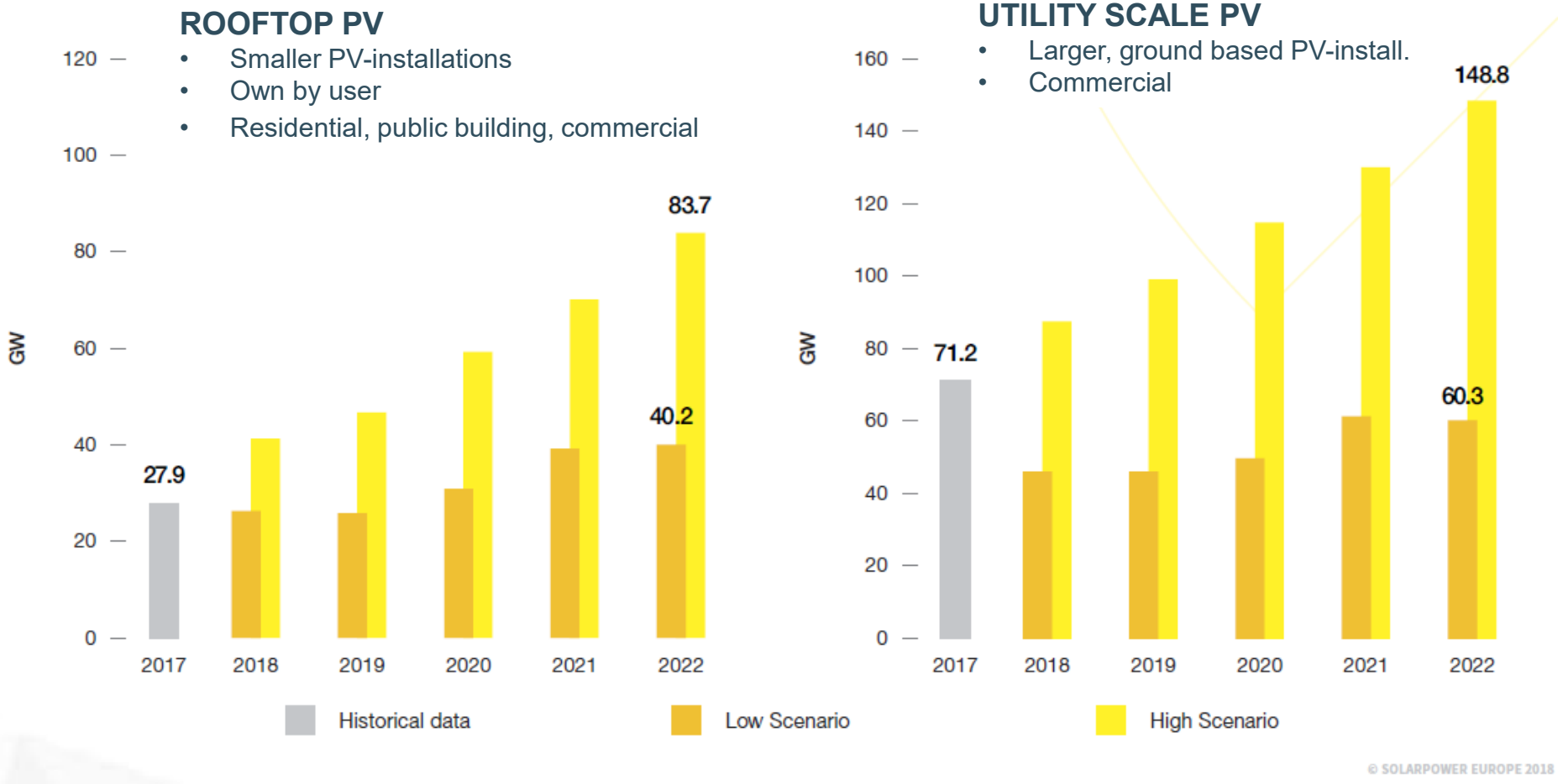
2Seas – Solar energy market

ROOFTOP PV

- Smaller PV-installations
- Own by user
- Residential, public building, commercial

UTILITY SCALE PV

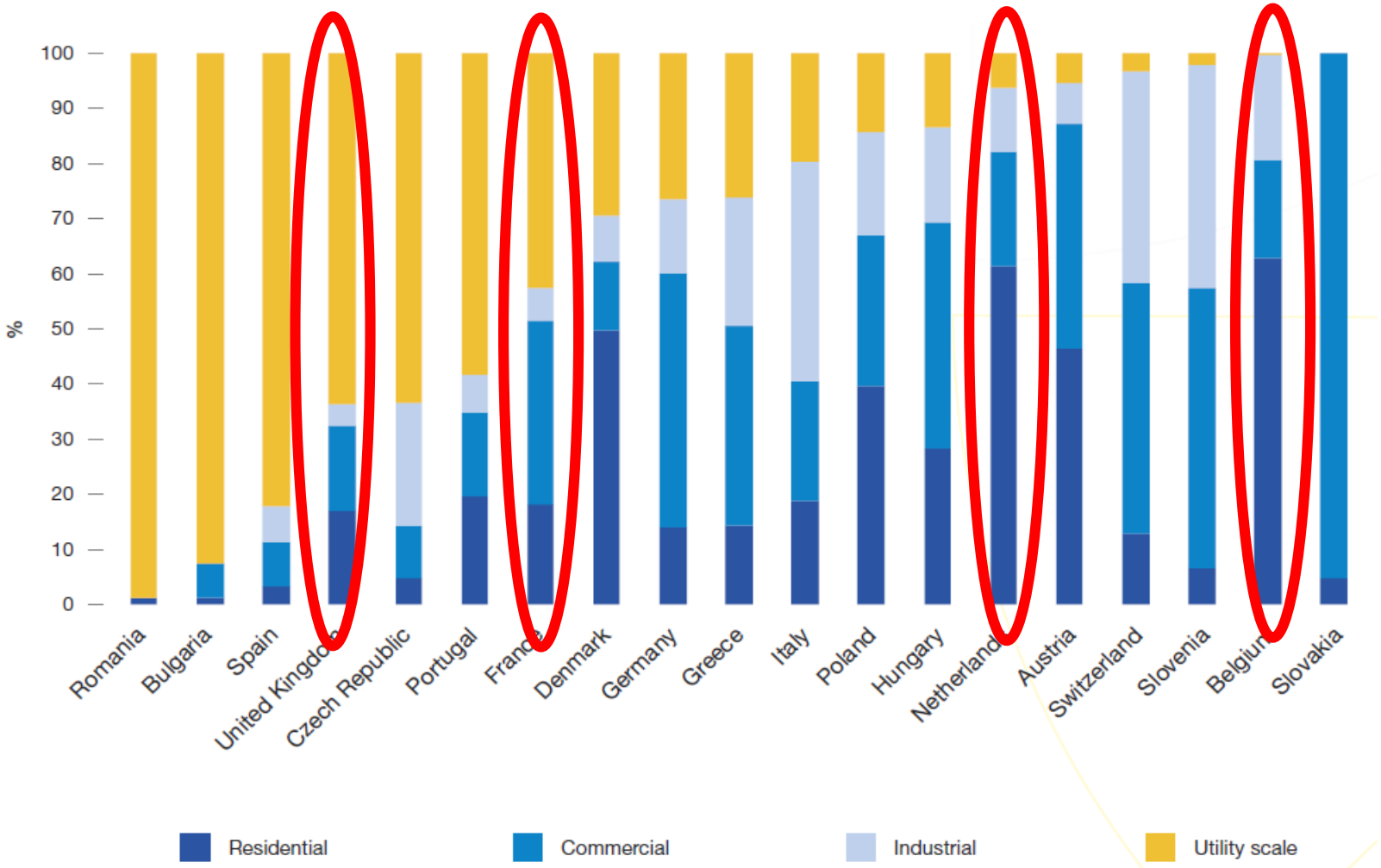
- Larger, ground based PV-install.
- Commercial



Scenarios for PV installations 2018 -2022

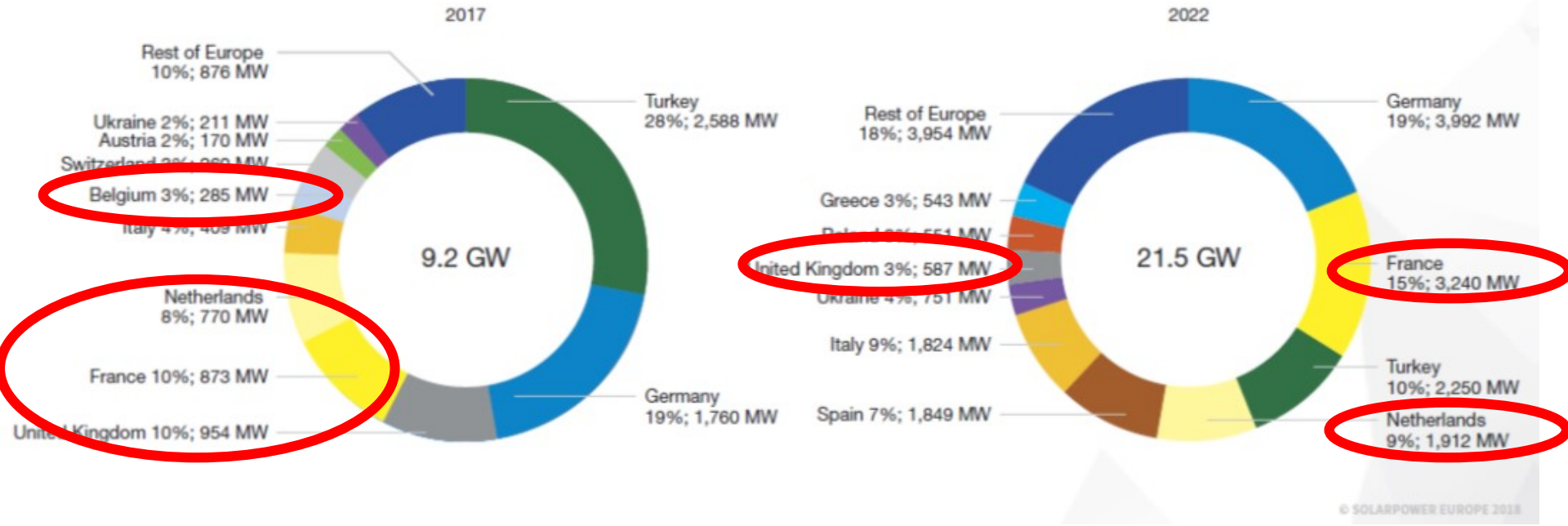
Source: Solar Power Europe

2Seas – Solar energy market



Source: Solar Power Europe

2Seas – Solar energy market

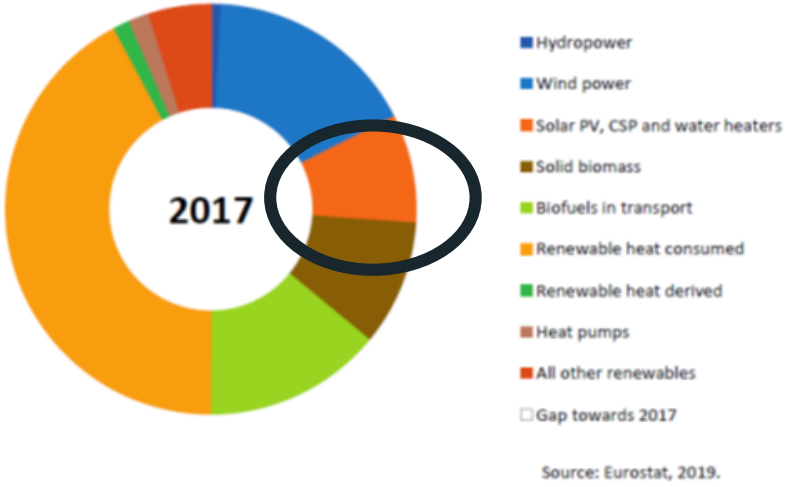


Source: Solar Power Europe

2Seas – Solar energy market

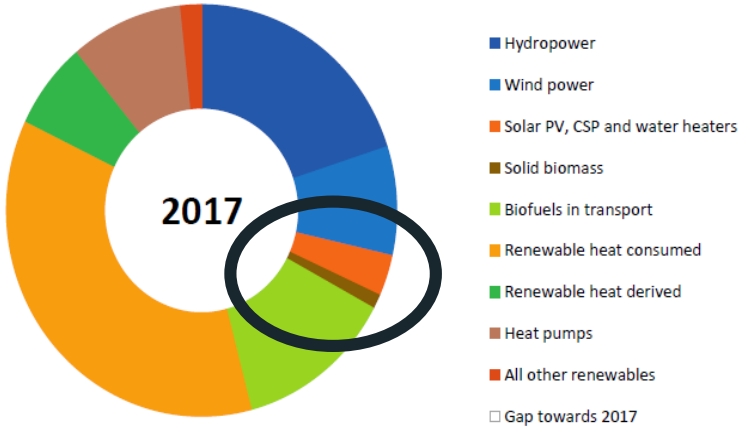
Source: EEA Eurostat 2019

Belgium



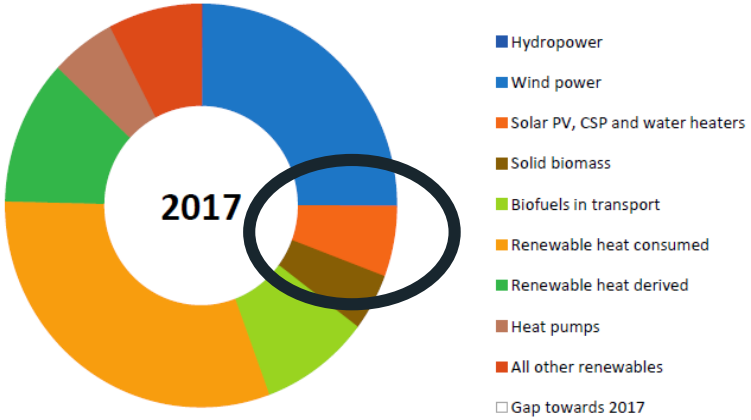
Source: Eurostat, 2019.

France



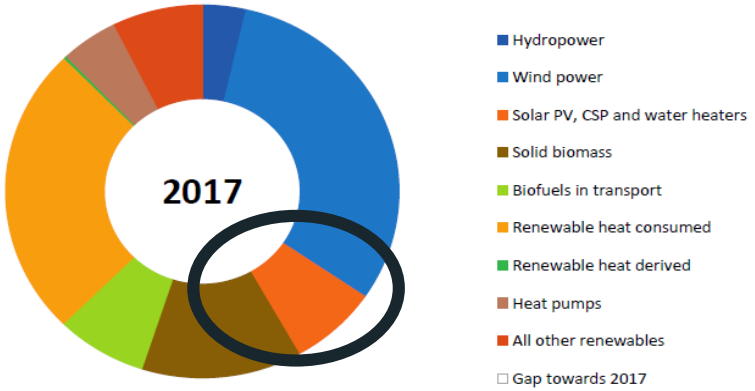
Source: Eurostat, 2019.

Netherlands



Source: Eurostat, 2019.

United Kingdom



Source: Eurostat, 2019.

2Seas - Local manufacturers

Tabl. n° 5

Main photovoltaic module manufacturers in 2018

Company	Country
Jinko Solar	China
JA Solar	China
Trina Solar	China
LONGi Solar	China
Canadian Solar	China
Hanwha Q-CELLS	Korea
Risen Energy	China
GCL-SI	China
Talesun	China
First Solar	USA

Estimates from GlobalData.* ***Sources: Annual reports, GLobalData.*

Over the past two years, most of the Chinese photovoltaic players have delisted from the American sto
tion obligations, information about them has become much scarcer. This primarily applies to their ann

Tabl. n° 6

Representative European solar thermal collector manufac

Company	Country	
GREENoneTEC	Austria / China	
Dimas	Greece	
Bosch Thermotechnik	Germany	
Solimpeks	Turkey	
Thermosolar	Slovakia	
Eraslanlar	Turkey	
Hewalex	Poland	
Viessmann	Germany	
Delpaso Solar	Spain	
Ariston	Italy	
Vaillant Group	Germany	
Arcon-Sunmark	Denmark	
Nobel	Bulgaria	
Cosmosolar	Greece	Fla
BDR Thermea	Spain	

Source: EurObserv'ER 2019.

Common **challenges:**

- No large local manufacturers of PV-modules and solar colectors
- Totally dependent on imports

2Seas - Local developers

Tabl. n° 6

Main European solar photovoltaic developers in 2018

Company	Country	Installed photovoltaic capacity (MW)
Enerparc	Germany	2 000
Lightsource BP	United-Kingdom	2 000
EDF Renouvelables	France	2 402
Juwi AG	Germany	2 500
Belectric	Germany	2 240
Voltalia	Portugal	1 800
Enel Green Power	Italy	1 553
Scatec Solar	Norway	> 1000
ENGIE Green	France	935 (France)

Source: EurObserv'ER

Commonalities:

- No shortage on developers of PV systems
- Job creation in the same rate for the 4 countries

SWOT - 2Seas Solar energy market

S

- Low(er) prices components
- Reliable products (warranties)

W

- (Almost) No local production modules
- Expensive monitoring/control solutions

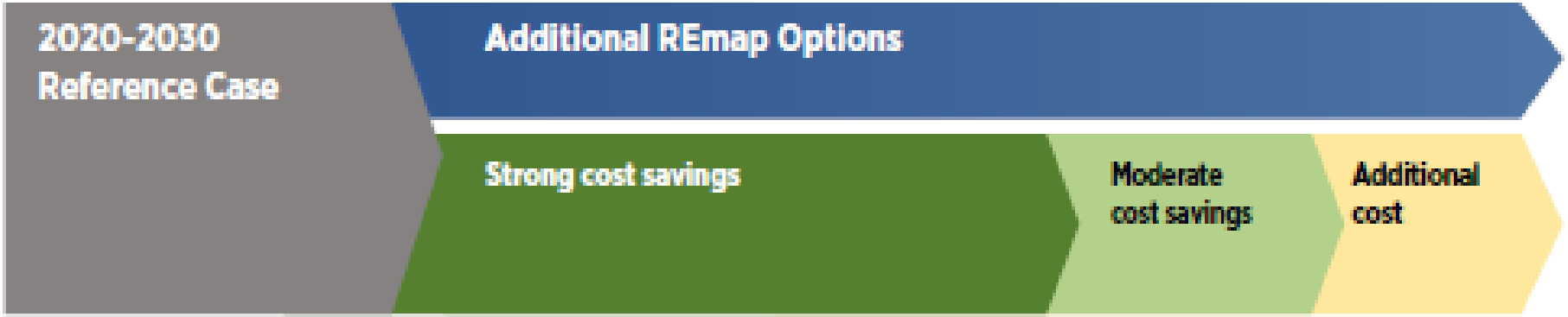
O

- Innovations to be exploited: floating PV, Agrivoltaics, PV/T, ….

T

- Dependence on (PV-panels) imports
- Missing strategy to develop market more steadily

Cost savings by RE-sources

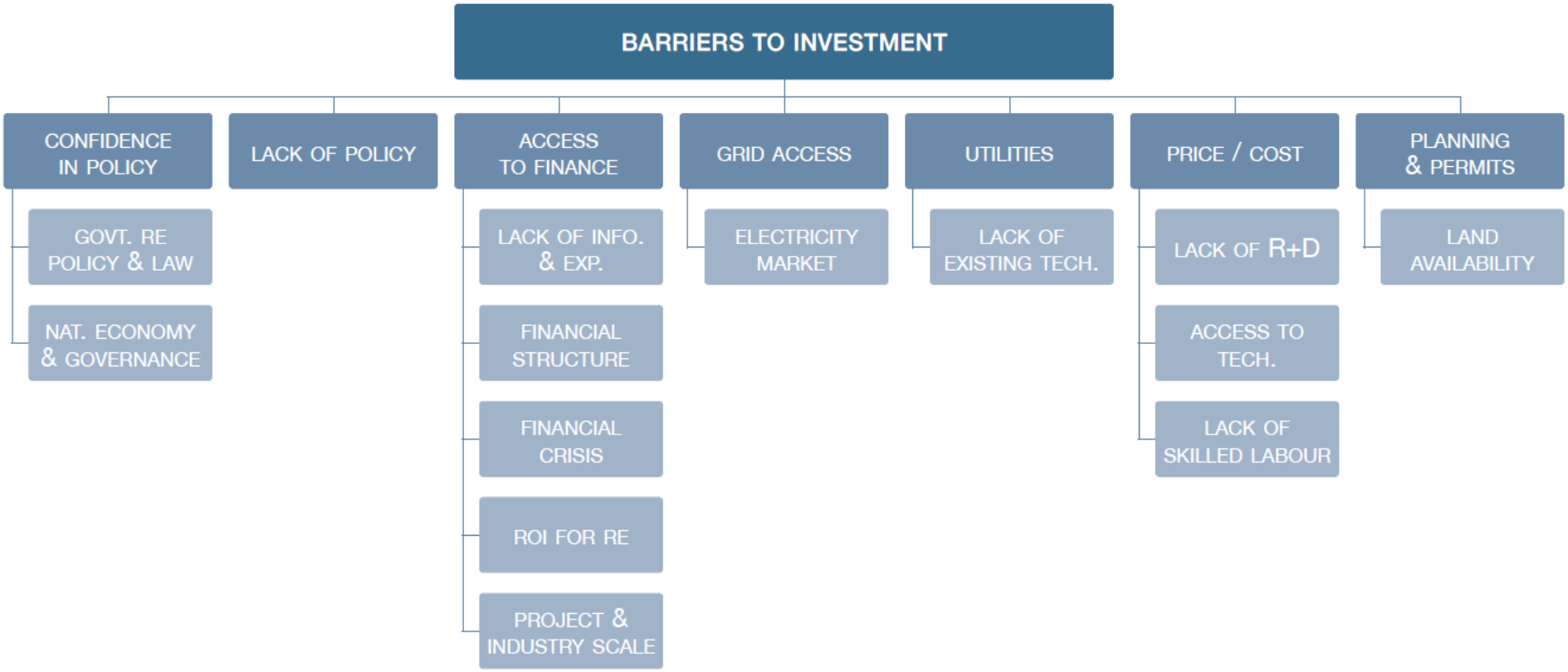


Strong cost savings
- Wind power
- Solar power
- Solar thermal in buildings
- Hydro power
- Geothermal power

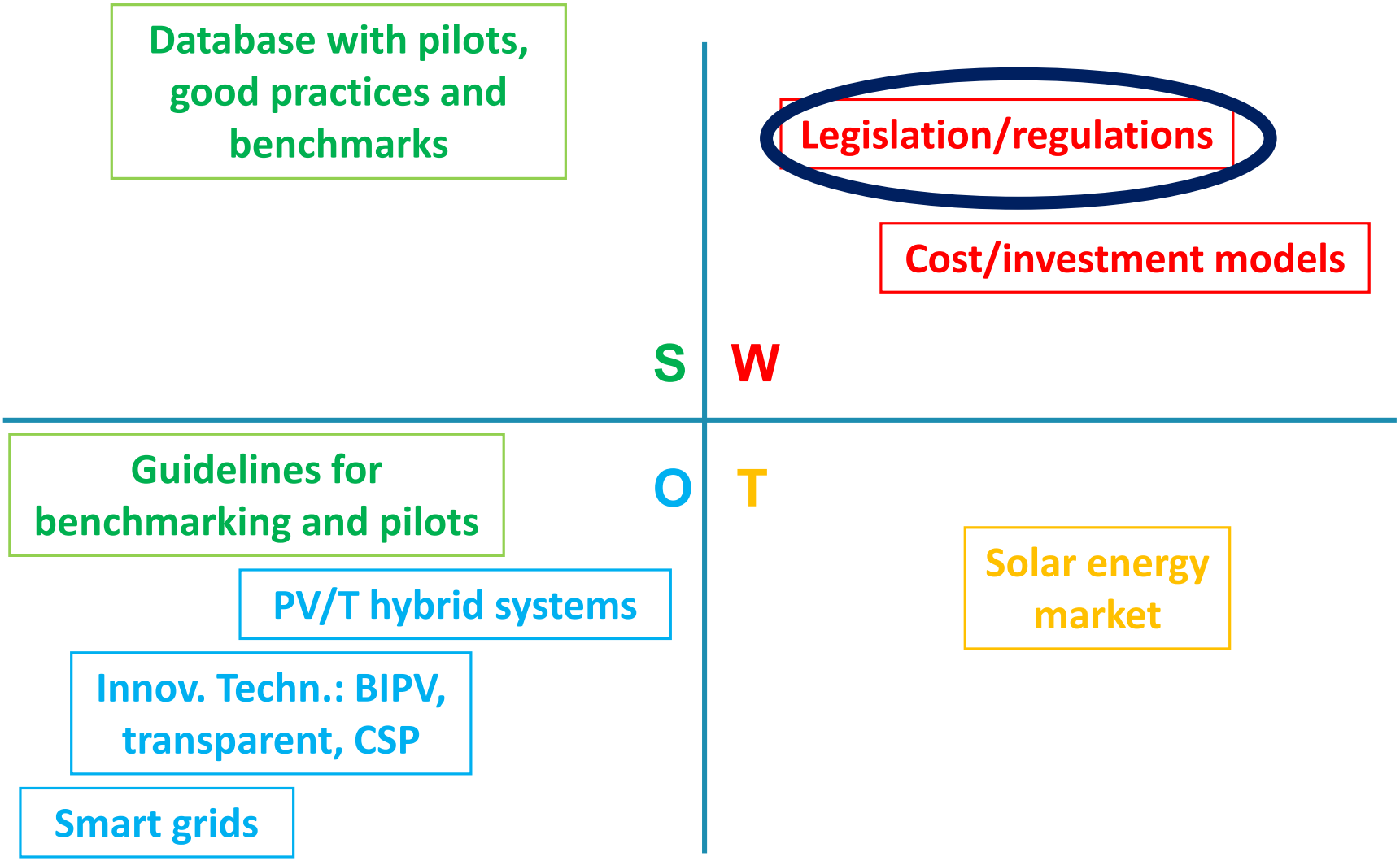
Moderate cost savings
- Heat pumps
- Electric vehicles
- Biodiesel
- Geothermal district heating
- Solar thermal in industry

Additional cost
- Biomass in industry
- Conventional bioethanol
- Biomass in power and district heat
- Advanced bioethanol
- Biokerosene

Barriers to investments in RE-sources



Solar energy in 2Seas region



Support schemes

Source: EEA Eurostat 2019

Belgium

	REGULATORY POLICIES						FISCAL AND OTHER STATE FUNDED INCENTIVES		
	Feed-in tariffs	Feed-in premiums 1)	Tenders	Quota obligation with Tradable Green certificates	Quota obligation without Tradable Green certificates	Net-metering/ net-billing	Investment subsidies	Tax credits mechanisms	Soft loans
RES-E									
- Offshore wind		x	x	X					
- Onshore wind				X			x		
- Solar PV		x		X		x	x		

France

	REGULATORY POLICIES						FISCAL INCENTIVE AND PUBLIC FINANCES		
	Premium tariff	Feed-in tariff (for < 500 kW plants)	Tendering	Quota obligation with Tradable Green certificates	Quota obligation without Tradable Green certificates	Net-metering/ net-billing	Capital subsidy, grants (Heat Fund and)	Tax regulation mechanism (Tax credit)	Loans
RES-E									
- Offshore wind	o		o						
- Onshore wind	o		o						
- Solar	o	o	o						

Netherlands

	NON-FISCAL SUPPORT SCHEMES					FISCAL AND OTHER STATE FUNDED INCENTIVES			
	Feed-in premium (SDE+)	Tendering	Quota obligation with Tradable Green certificates	Quota obligation without Tradable Green certificates	Net-metering/ virtual net metering	Capital subsidy, grants (e.g. ISDE)[4]	Tax regulation mechanism I (EIA)	Tax regulation mechanism II (MIA/VAMIL)	Soft loans
RES-E									
- Offshore wind	x	x					x	x	
- Onshore wind	x	x			x		x	x	x
- Solar	x	x			x		x	x	x

United Kingdom

	REGULATORY POLICIES					FISCAL INCENTIVE AND PUBLIC FINANCES		
	Feed-in tariff <5MW	Premium tariff	Quota obligation with certificates system >5 MW	Tendering	Net-metering/ net-billing	Capital subsidy, grants	Tax regulation mechanism	Loans
RES-E								
- Offshore wind	o	o						
- Onshore wind	o	o						
- Solar	o	o						

2 Seas – Solar legislation/regulations

Barriers for solar energy uptake

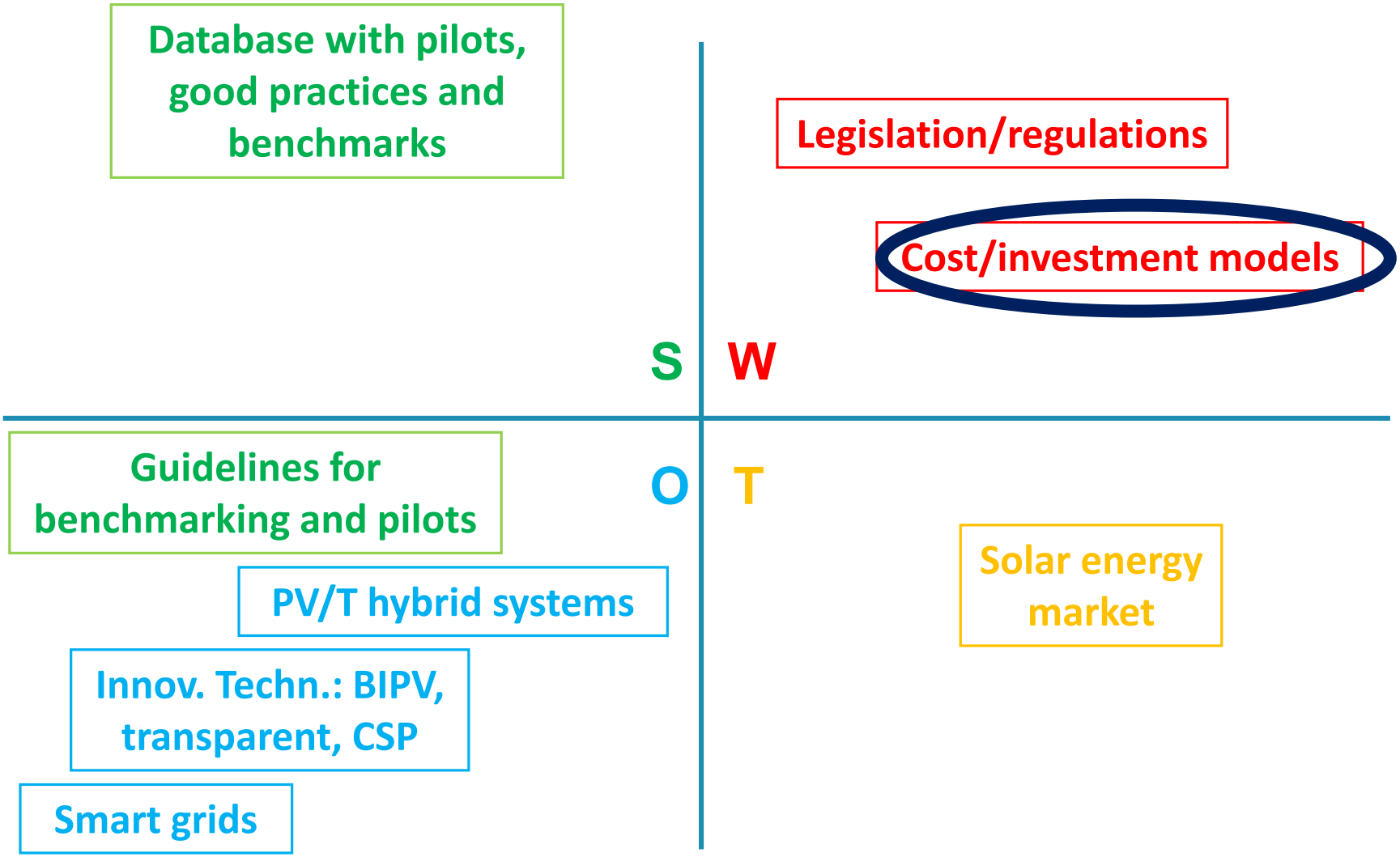
- **Uncertainty of incentive schemes**
  Investment companies, citizen not sure whether it is worth to invest in solar

- **Environmental planning**
  Specific regulations for rooftop PV systems - eg historic buildings, monuments
  Environmental issues for solar farms – preservation of biodiversity, agriculture

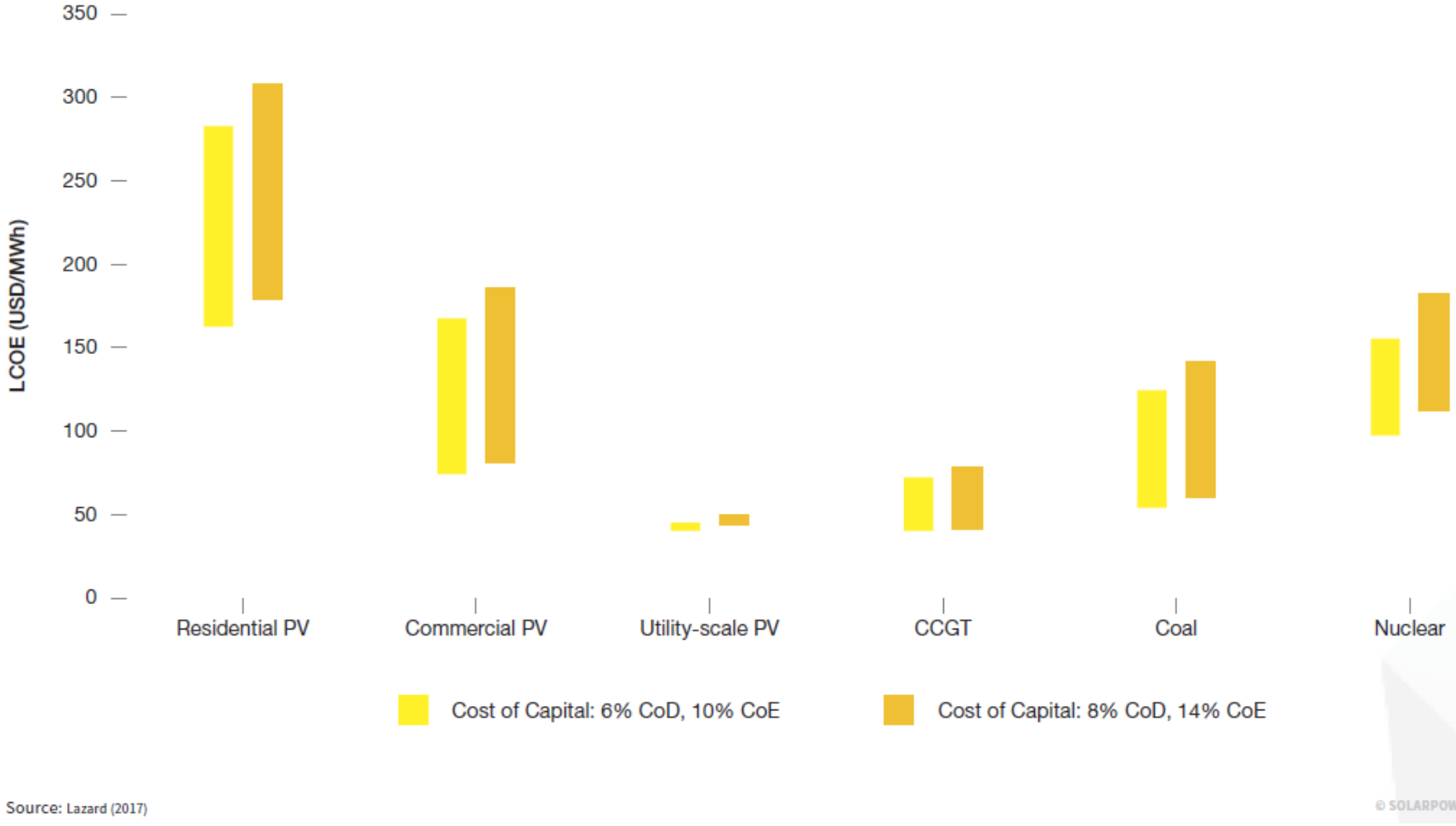
- **Lack of integrated climate policy**

  Eg responsibilities are split amongst different federal, regional and local authorities in Belgium

Solar energy in 2Seas region

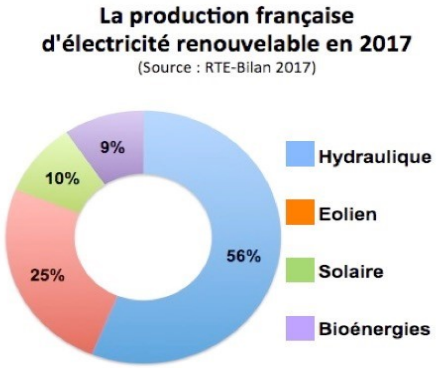


2Seas – cost/investment models

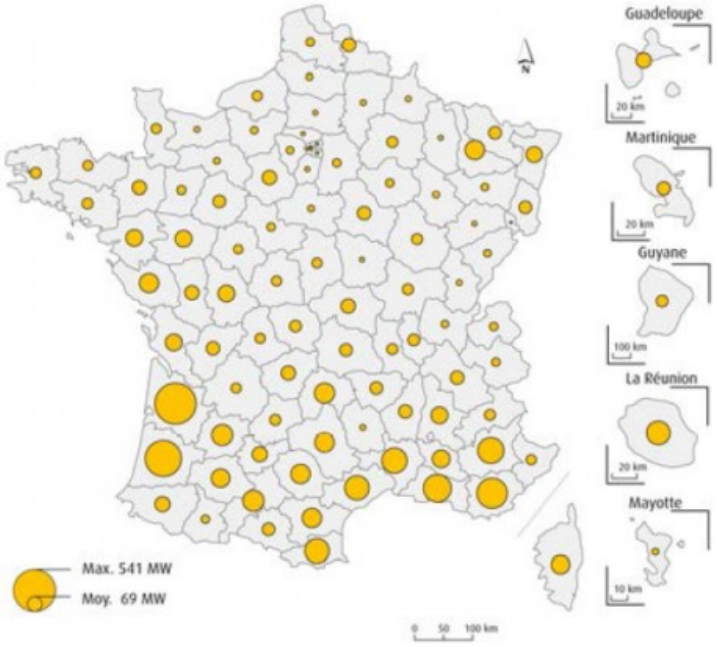


Solar electricity generation costs in comparison with other renewables

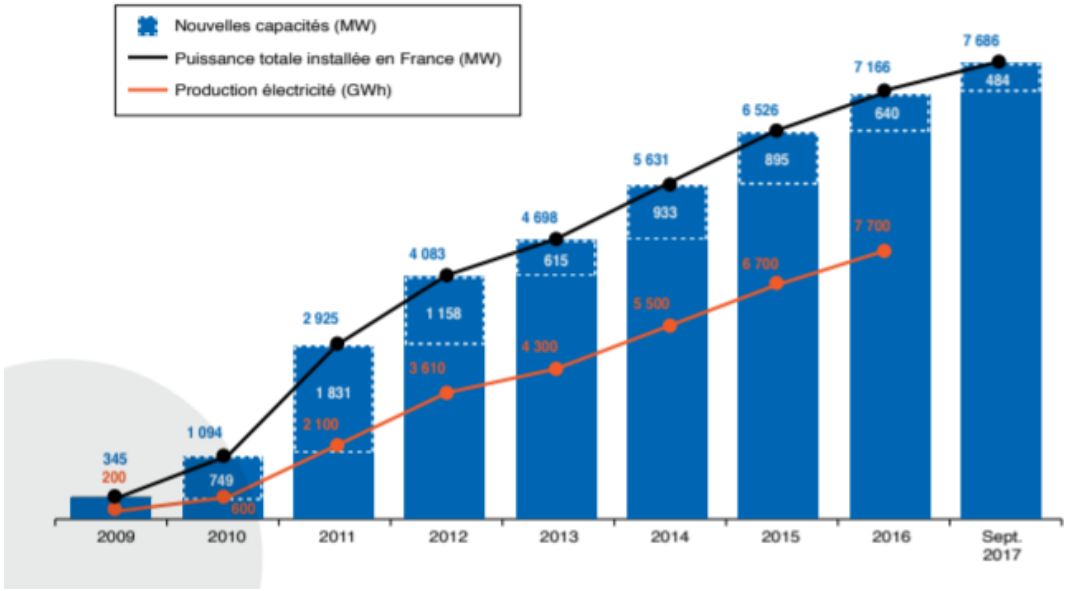
2Seas – Cost/investment models



According to RTE, mainland France PV production reached 8,3 TWh in 2016. PV electricity represented 1,6 % of the electric consumption of mainland France in 2015.



Parc total photovoltaïque et production d'électricité annuelle en France
Source : Observ'ER d'après les chiffres du SDES



2Seas – Cost/investment models

BELGIUM:

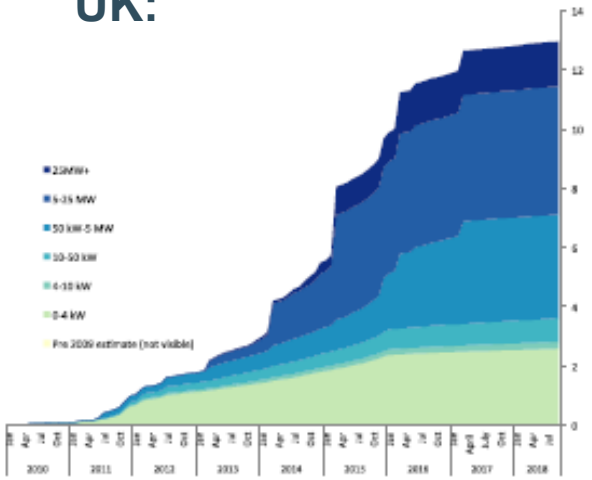
	2017 Numbers
Number of PV systems in operation in your country (a split per market segment is interesting)	**≤ 10 kVA:** 459.854 systems **> 10 kVA et ≤ 250 kVA :** 7.009 systems **> 250 kVA :** 1.004 systems **TOTAL :** 467.867

- Many small installations
- Residential/commercial
- No fancy technologies

FRANCE:

	2017		
	Peak Power range	**Installations (number)**	**Power (MW)**
Number of PV systems in operation in your country	0 – 3 kW	289 494	779
	3 kW – 9 kW	73 224	467
	9 kW – 36 kW	17 522	438
	36 kW – 100 kW	13 213	1 070
	100 kW – 250 kW	6 071	1 072
	> 250 kW	1 415	4 219
	Total	**400 939**	**8 044**
	Total Off-grid		**30**

UK:



2Seas – cost/investment models

Encouraging measures/support schemes:

- Feed-in tariffs (FITs)
- Net metering
- Smart metering
- Green/white certificates

Elements for successful renewable energy support schemes/measures:

- a clear, bankable pricing system
- priority access to grid: clear identification of responsible for connection and incentivized
- clear, simple administrative and planning permission procedures.
- public acceptance/support.

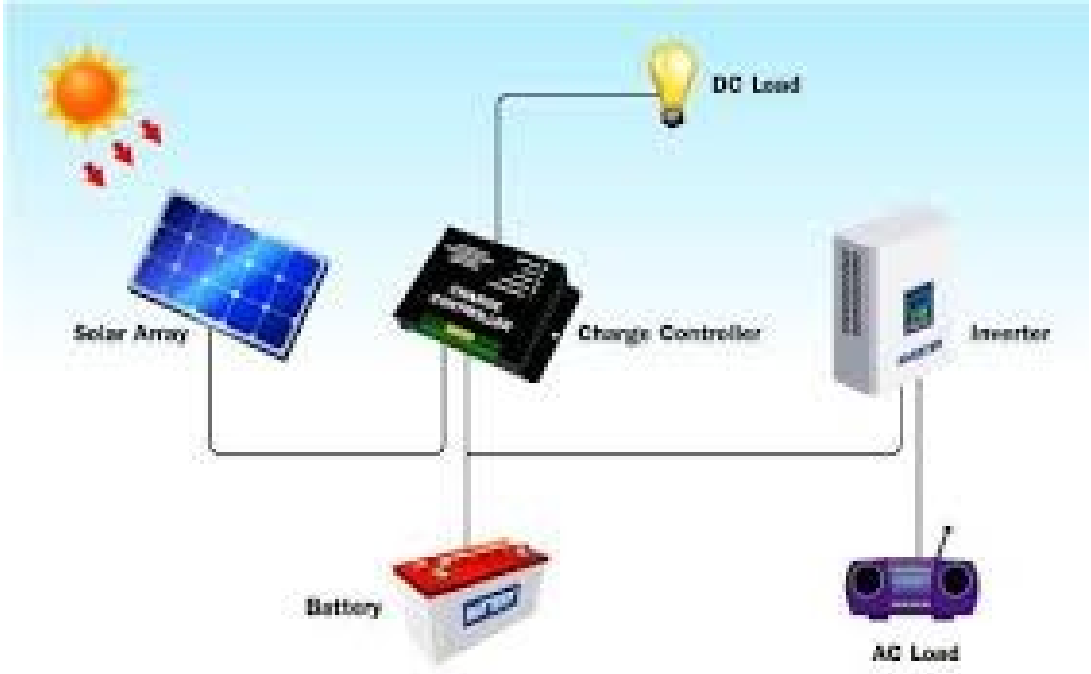
2Seas – Cost/investment models

Risks factors to consider when investing in renewable energy assets:

- **Regulatory risks:** adverse changes in laws and regulations, unfavorable tariff setting and changes or breaches of contracts.
- **Construction risks:** delayed or costly delivery of an asset, default of a contracting party, or an engineering/design failure.
- **Financing risks:** inadequate use of debt in the financial structure of the asset. (abusive use of leverage, exposure to interest rate volatility, and need to refinance at less favorable terms, etc.)
- **Operational risks:** equipment failure, counterparty default, reduced availability of the solar energy source.

2Seas – cost/investment models

Costs(expenditures) and income PV-installations

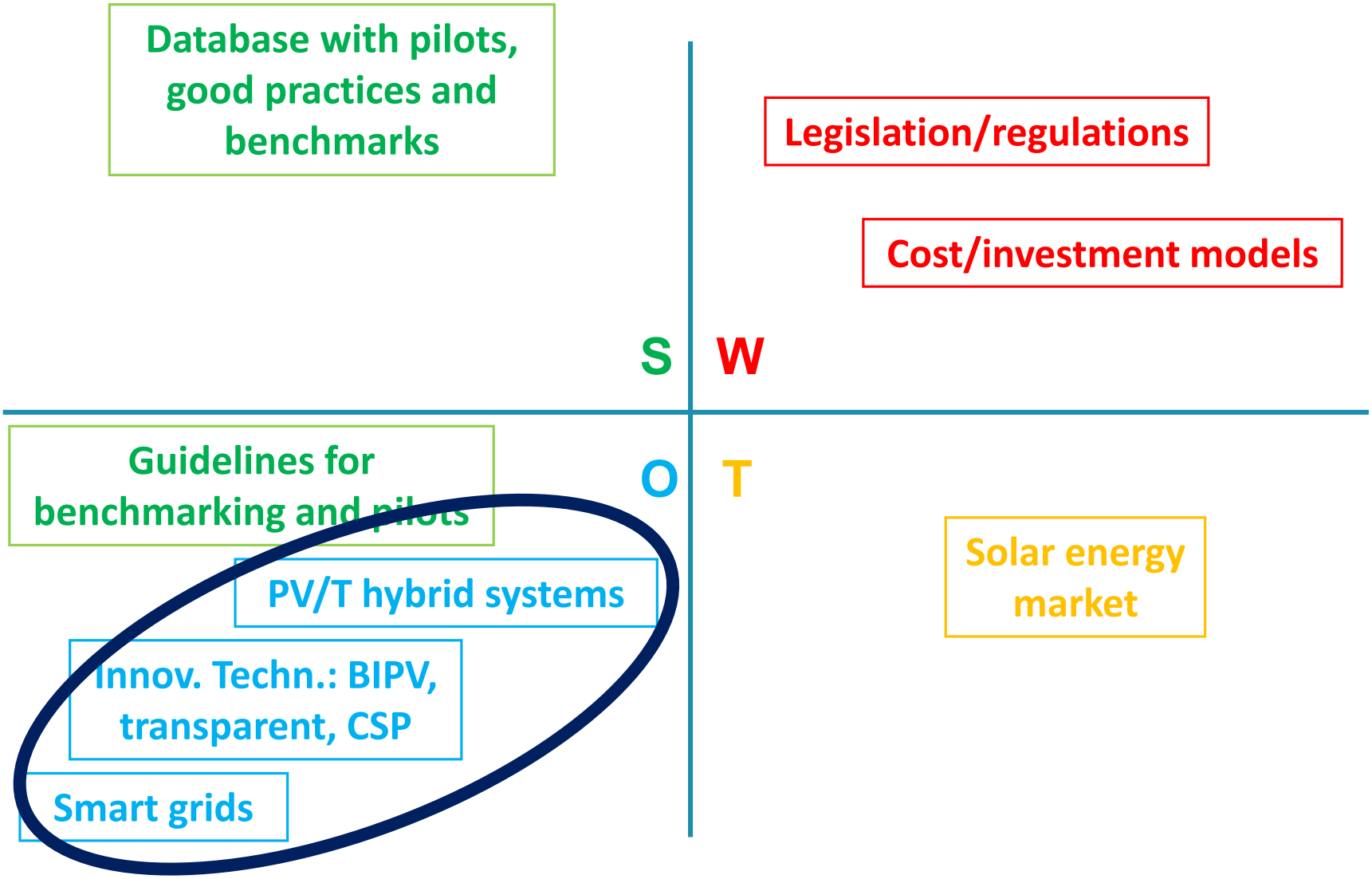


Initial costs + O&M + recycling +

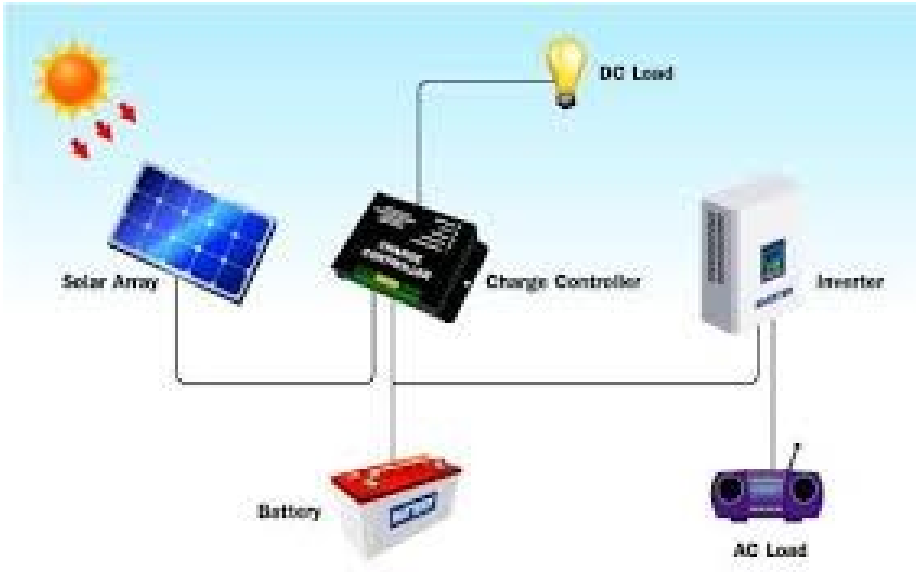
+ land purchase (Solar farms)

+ roof reinforcement/renovation

Solar energy in 2Seas region



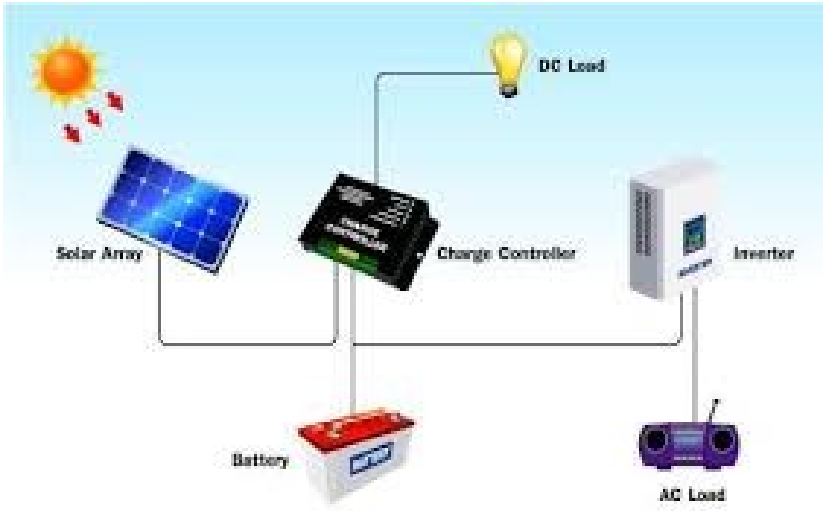
2Seas – Solar technology innovations



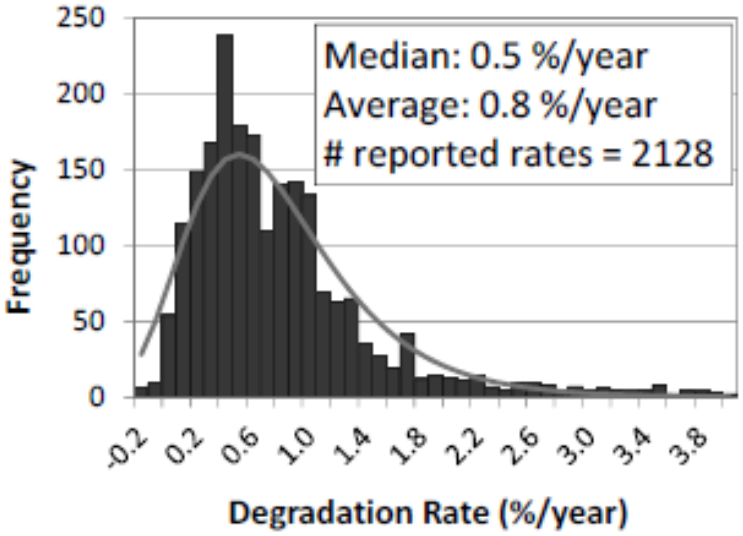
PV-modules(panels) 50 % of total system costs

Technology	**Drawbacks to future use**
Crystalline-silicon	Efficiency, materials
Thin-film	Efficiency, stability, toxicity, lifetime
Concentrating PV	Stability, complexity, high cost
Organic PV	Efficiency, stability, lifetime
Third Generation PV	Efficiency, proof of concept only

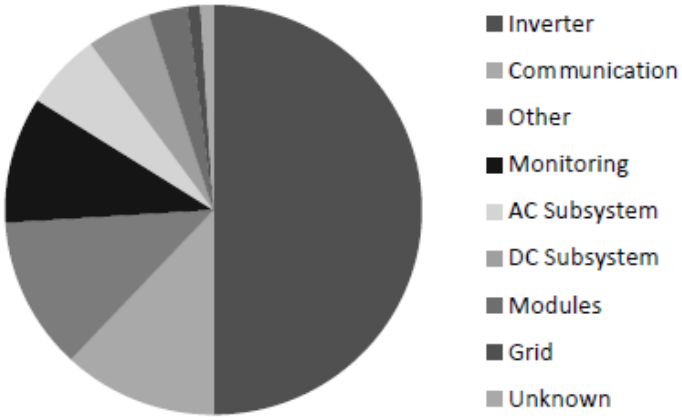
2Seas – Solar technology innovations



Degradation of PV-panels



Replacement costs (failure % in PV-installations)

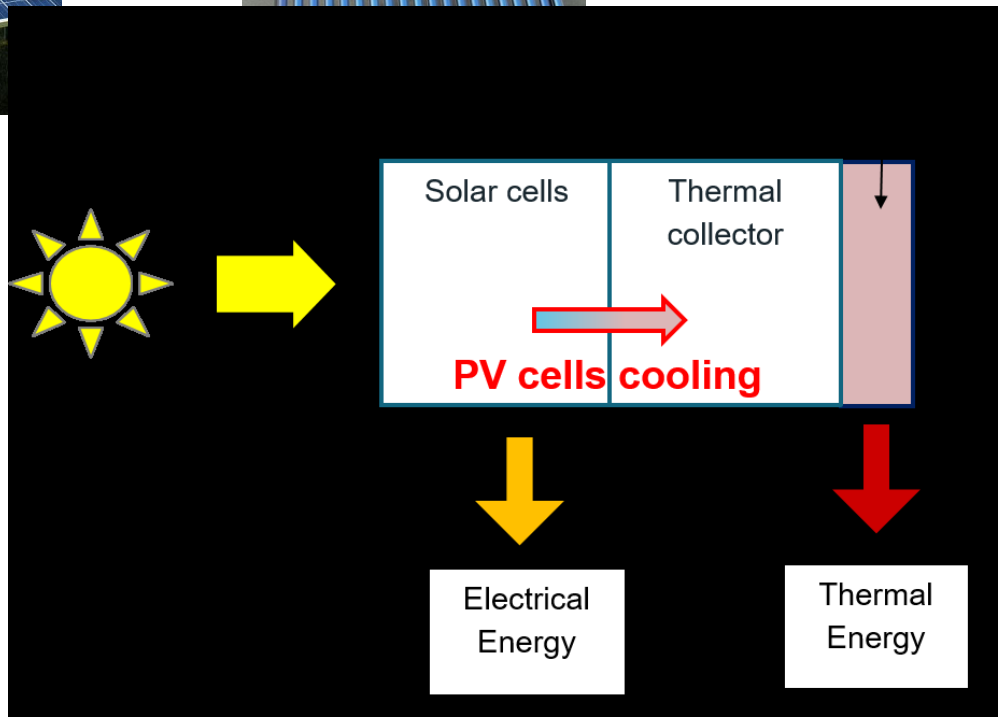


2Seas – Solar technology innovations

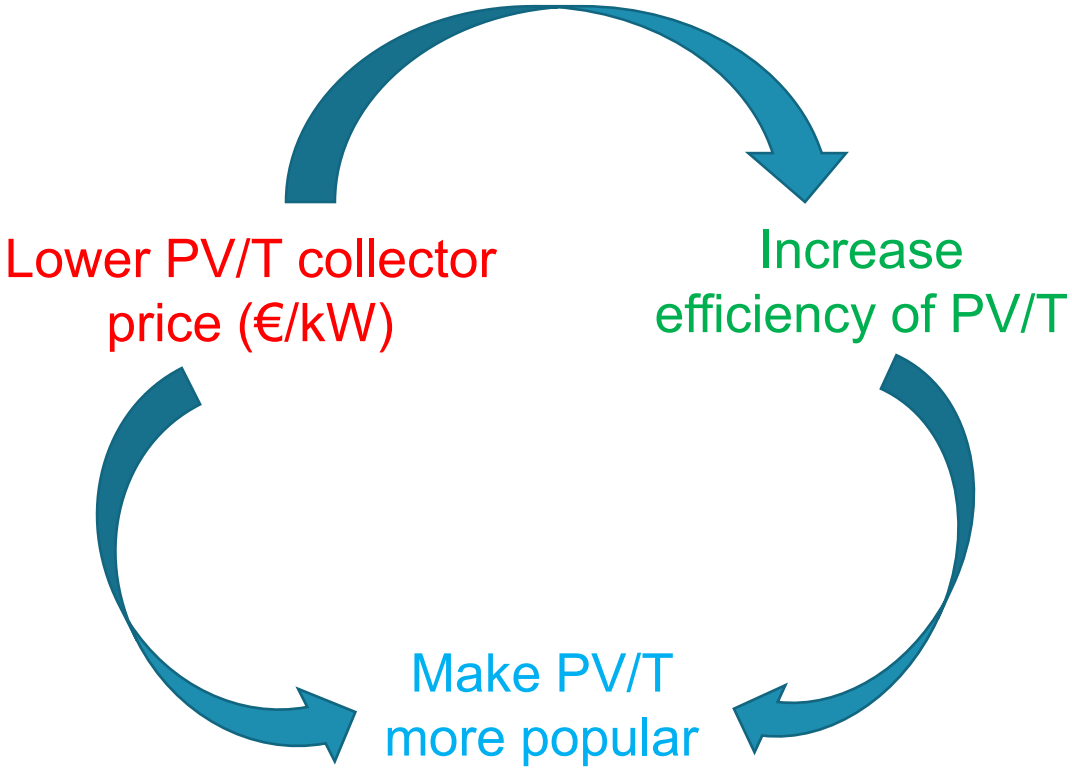
PV/T: working principle

PV-array

Solar thermal collectors



PV/T uptake: challenges



DUALSUN

SOLIMPEKS Solar Energy Corp.

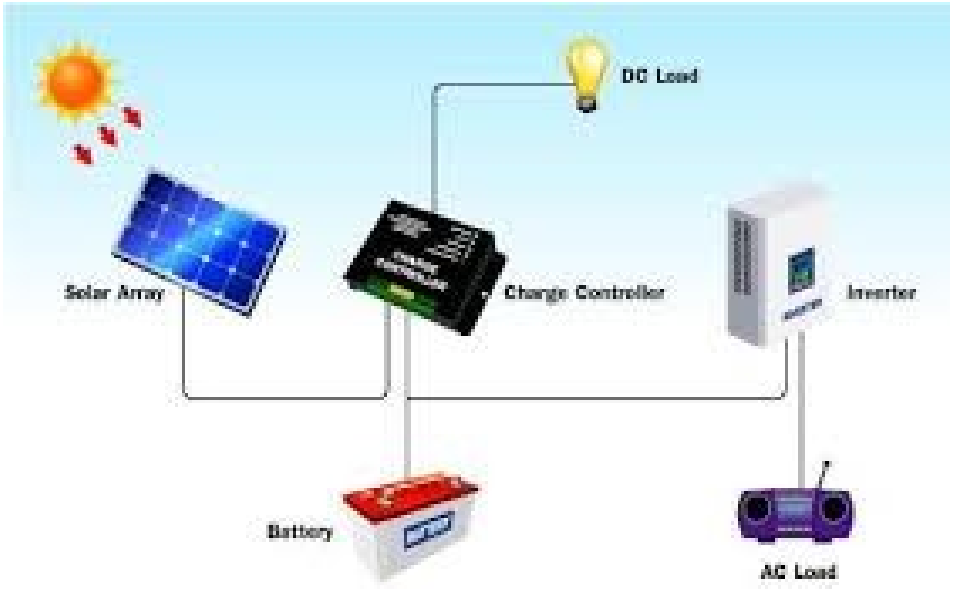
naked energy™

SOLARUS

FOTOTHERM

Are these actually **opportunities** not challenges?

2Seas – solar technology innovations

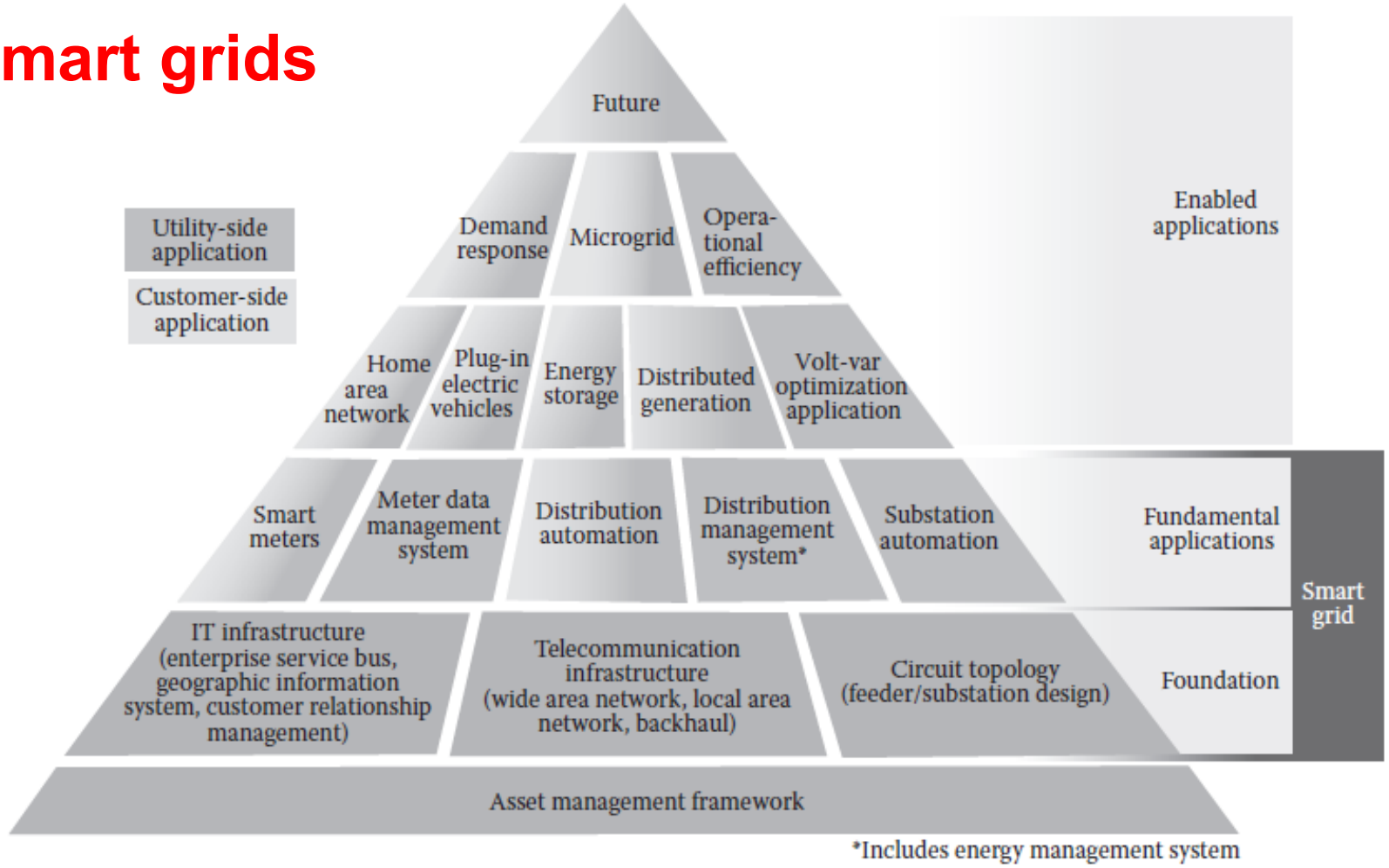


Reducing costs (EUR/kWh) means:

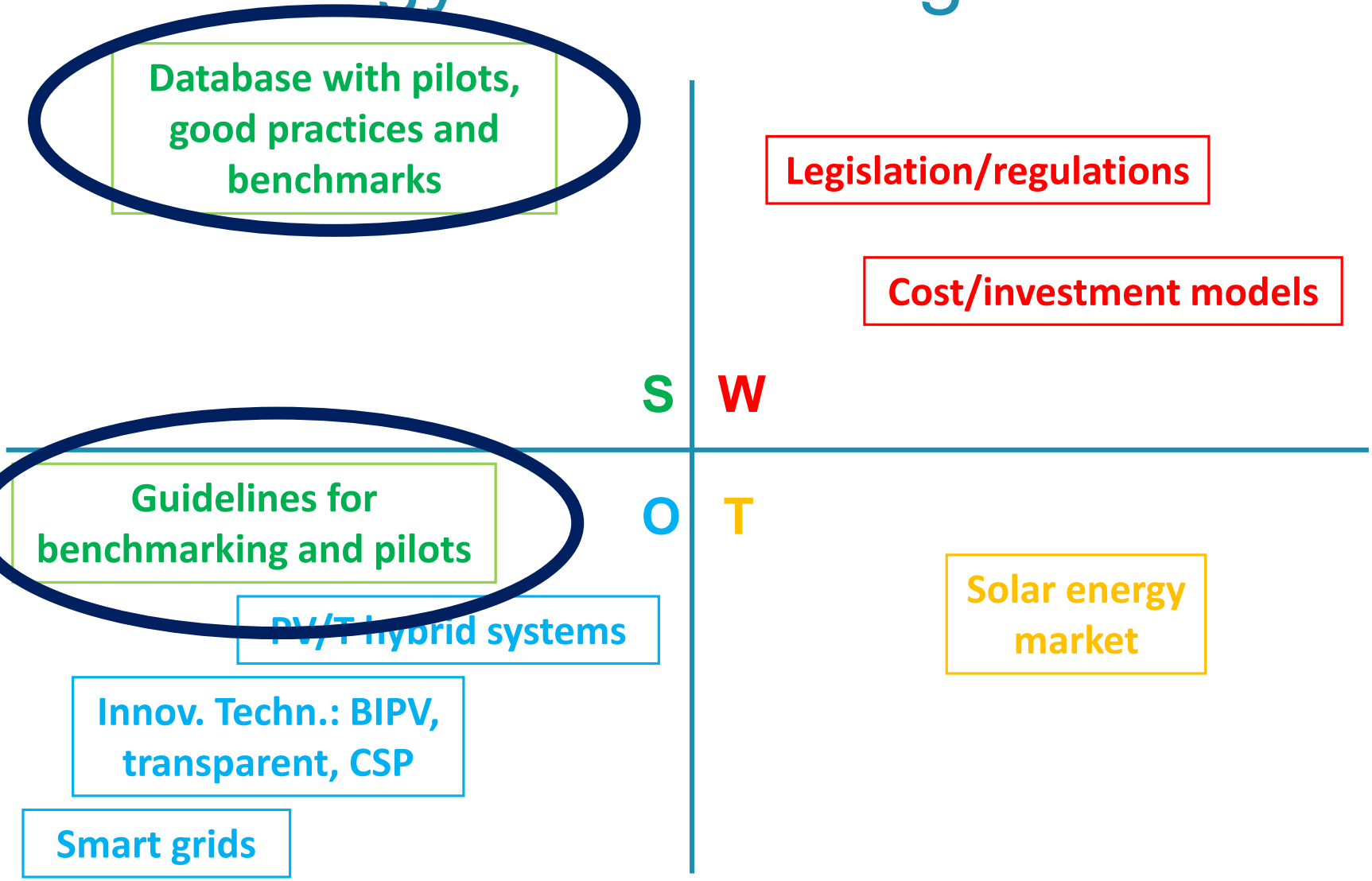
- reduce the balance of system costs (system components and installation costs);
- increase the energy **yields, stability and lifetime of the system**;
- increase the **inverter lifetime and reliability of system components**;
- not combine modules of different specifications in the same system;
- match the inverters to the modules and load profiles.

2Seas – solar technology innovations

Smart grids



Solar energy in 2Seas region



Guidelines for benchmarking and pilots

Database with pilots, good practices and benchmarks

Do we (still) need these in 2Seas region?

YES because

- Stakeholders are still not aware of existent knowledge/knowhow/innovations
- Various stakeholders with various backgrounds still co-exist
- Not enough (best practices) examples close to 'your door'

2Seas – existent solar projects, best practices, …

Obstacles to consumers – households, businesses and industry:

- **Lack of appropriate information** on costs/consumption, or **limited transparency** in offers
- Increasing proportion of **network charges/taxes/levies** in average final electricity bill.
- **Insufficient competition** in many retail markets, a lack of reward for active participation, and difficulties in switching act as disincentives.
- **Insufficiently developed markets for residential energy services and demand response**
- **Preventing self-generation and self-consumption** reduces potential gains.
- **Unequal access to information** and **high entry barriers for new competitors** slow down the adoption of available advanced technologies and practices such as **smart metering, smart appliances, distributed energy sources and energy efficiency improvements**.

Solarise database

SOLARISE benchmarking and pilots. The main information below has to be obtained **from trustable sources, be anonymized and still able to preserve some characteristics that make it country/region specific**.

1. Name of the project
2. Start year of operation
3. Address of the project
4. Type (Houses / Commercial / Industrial building / Residential Building / Public building / Solar farm)
5. Installation Type (Rooftop flat / Rooftop inclined / Wall / Ground)
6. …

20. How is the produced energy measured /accounted in the energy bills (Net metering or Smart metering)
21. Type of solar inverters (Central Inverter, 1 for all the panels / String Inverters, 1 per string of panels with or without DC optimizers / Micro – Inverters, 1 micro-inverter per panel)

Initial Costs of the installation (EUR)

1. Solar PV installation
2. Renovation of building roofing/wall ……

Operation and management (O&M) and annual costs during first year and base year (EUR)

1. Annual Grid-related costs (transport & other)
2. Annual Maintenance and planned replacements…..

Subsidies and revenues (EUR)

1. Subsidies at installation
2. Other incentives and subsidies (cumulative since operation date)
3. Revenues (cumulative since operation date)

Solarise database

Link	Functions	Access Option
https://navigator.irena.org/index.html	Provide a quantitative overview of solar PV installations without any qualitative way. But it gives the link to several interesting tools.	Free access
http://www.polis-solar.eu/	Provide a strategic approach by the municipality can enhance the expanding integration of small-scale, decentralized energy applications into the built environment.	Free access
https://solargis.com/	Provide reliable and accurate solar, weather and solar electricity data that are used in the whole lifecycle of solar power plants, from prospection to development and operation	Free trial version; software should be purchased.
https://www.energysage.com/solar/solar-operations-and-maintenance/solar-monitoring-systems/	An interesting tool that gives an deep economic analysis of a future solar installation. However, it is only valid for USA.	Free access
https://www.renewables.ninja/#/country	Provide the potential of solar energy of a location in a global way	Free access
https://open-power-system-data.org/background/	Provides an open platform for data required by energy system	Free access
https://www.data.gouv.fr	Provides global data of the installed PV and wind power in France	Free access
http://re.jrc.ec.europa.eu/pvg_tools/en/tools.html	This tool allows evaluating performance of grid-connected PV plant.	Free access

Table Useful tools for solar installations post-evaluation

Solarise – collected best practices

Governance and participation of stakeholders (citizens, end-users)

- General information about the project
- Participative governance
- (Participative) development

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Interreg 2 Seas Mers Zeeën SOLARISE

PV Best practices

Criterion : Governance, participation

Title : Local Energy Strategy (LES)

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General information about the solar installation :

Country : the Netherlands

City : Heerhugowaard

Owner : -

Date (works, putting in service, investiture...) :in progress

Price : -

Type of solar energy : -

Governance and participation at developing the LES

While Heerhugowaard, with the Suncities «Stad van de Zon» solar-energy project is already performing well, the new local energy strategy (LES) also is focusing on solar energy as one of the main components. Governing the increase of solar-energy capacity, a so-called solar-ladder is applied, which basically names approx. 140 MWp of roof-top solar-PV capacity as base that needs to be harvested first and may be at a later point followed by solar-PV projects around infrastructural facilities or even a new solar-PV farm. Hybrid solar-PV-warmth project are named possibilities for individual houses. This solar-ladder aims to prevent using valuable and limited farm-lands for solar-installations. Further, different scenarios for meeting the future energy-demand are developed within the LES, which are scored along a scoring matrix that aids in governing the energy-transition in Heerhugowaard and making good and informed choices. However, aiming at fully meeting local demand from wind and solar-energy, large scale installations are named as being inevitable in the city since this provides the biggest potential capacity. Given the high importance of citizens in the energy transition is the LES painting the general picture while the concrete realization that also includes participation of citizens is following the LES in a roadmap that is to be developed once the LES is finalized. Finally, the important step of storage will be also picked up in this roadmap.

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Solarise – collected best practices

Architectural integration of rooftop PV-installations at building or neighboorhood scale

- General information about the project
- Innovative elements

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PV Best practices

Criterion : Architectural Integration solar PV

Title : Kuijpers Helmond

General information about the solar installation :

Country : The Netherlands

City : Helmond

Owner : Kuijpers Installatie BV

Date : 2018

Price : undisclosed

Type of solar energy : Esthetical façade with integrated photovoltaics and programmable LED

Description of the installation :

In this project an attempt was made to fully design a façade that combines multiple functionalities. Number one functionality is the façade design itself. Besides meeting all building regulations and standards and protecting the building from the weather and environment, a façade gives a building a certain identity. Design freedom for architects is of crucial importance. By embedding programmable LEDs in the façade the building can be illuminated in a color matching the seasons. Finally, PV is embedded to generate electricity. By primarily focusing on the other functionalities of the façade, the PV itself is a last 'add-on' to the façade that can be integrated with little additional costs.

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Solarise – collected best practices

Self-consumption and smart systems to reduce peaks and overproduction

- General information about the project
- Technical details smart systems

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PV Best practices

Criterion : Self-consumption

Title : PV installation on a private company combined with charging of electric vehicles

Map : location of the installation in the 2 seas region (location in West-Flanders, Belgium)

General information about the solar installation :

Country : Belgium

City : Roeselare

Owner : Private company

Date (works, putting in service, investiture...) : to be installed

Price : 145.340 Euro TVA excluded

Type of solar energy : PV panels

Description of the installation :

Technical details :
A PV installation of 134 kWp can be installed on the roof. The auto self consumption is estimated to be 59%. The electricity produced by the solar panels is only 36% of the total electricity use of the company.

Financial details :
- Investment cost : 145.340 Euro TVA excluded
- Project-IRR : 9,8%
- Benefit after 20 years : 165.277 Euro TVA excluded

Smart system to reduce peaks and overproduction :
The company has 2 charging stations for electric cars. In total 3 employees use them to charge their electric car. The charging stations can also be used by 1 one visitor. Eventual overproduction can be used to charge the electric cars.

General placement of installation

Electric charging stations

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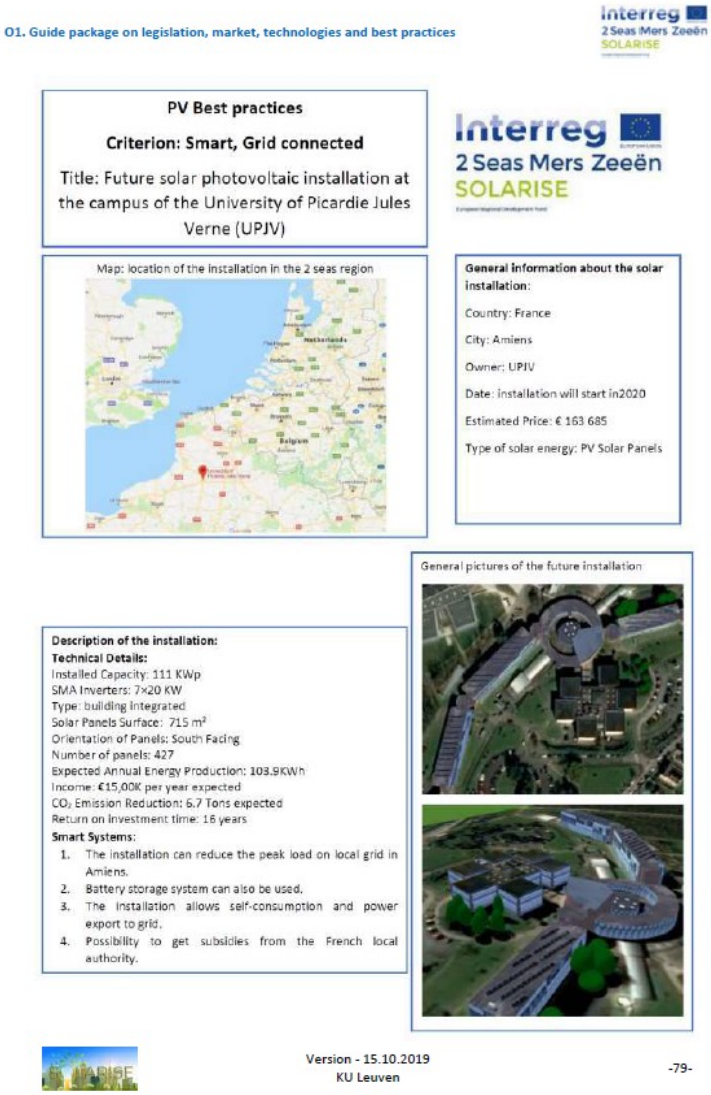
Solarise – collected best practices

Economic, not speculative, profitability of solar energy

- General information about the project
- Economic/financial and technical details systems



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PV Best practices

Criterion: Smart, Grid connected

Title: Future solar photovoltaic installation at the campus of the University of Picardie Jules Verne (UPJV)

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Map: location of the installation in the 2 seas region

General information about the solar installation:

Country: France

City: Amiens

Owner: UPJV

Date: installation will start in2020

Estimated Price: € 163 685

Type of solar energy: PV Solar Panels

General pictures of the future installation

Description of the installation:

Technical Details:

Installed Capacity: 111 KWp

SMA Inverters: 7×20 KW

Type: building integrated

Solar Panels Surface: 715 m²

Orientation of Panels: South Facing

Number of panels: 427

Expected Annual Energy Production: 103.9KWh

Income: €15,00K per year expected

CO_2 Emission Reduction: 6.7 Tons expected

Return on investment time: 16 years

Smart Systems:

1. The installation can reduce the peak load on local grid in Amiens.
2. Battery storage system can also be used.
3. The installation allows self-consumption and power export to grid.
4. Possibility to get subsidies from the French local authority.

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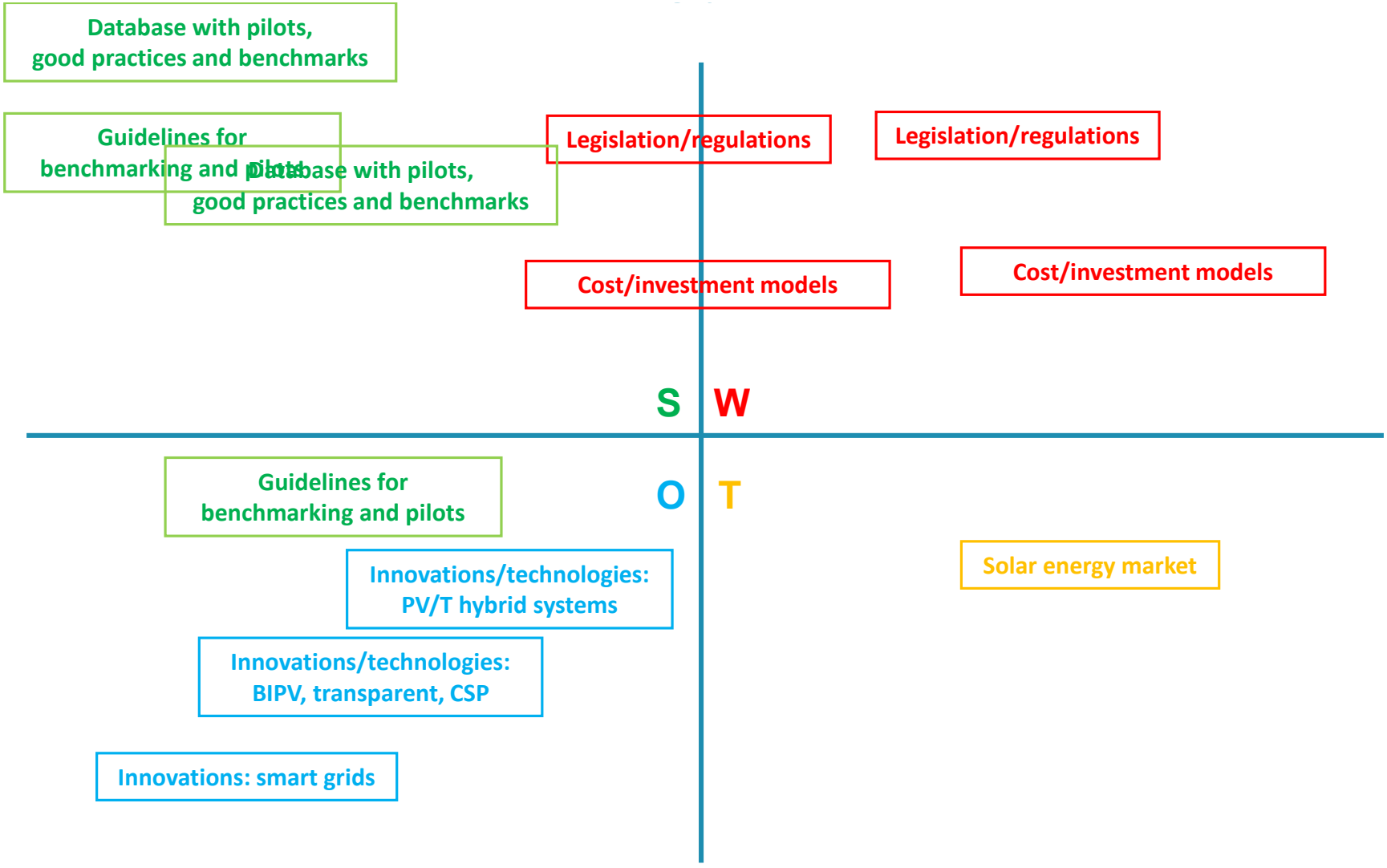
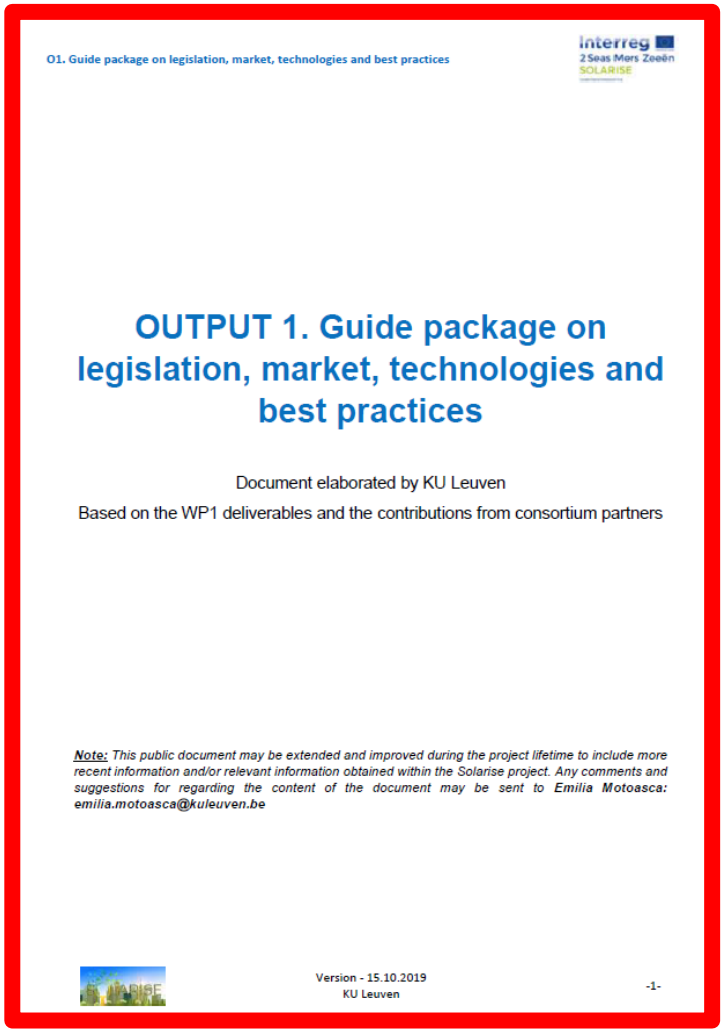
Solarise – collected best practices

Visibility of PV-systems in public spaces and in education

- General information about the project
- Technical details systems
- Use for education purposes

SWOT – Solar energy **after** Solarise

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OUTPUT 1. Guide package on legislation, market, technologies and best practices

Document elaborated by KU Leuven

Based on the WP1 deliverables and the contributions from consortium partners

Note: *This public document may be extended and improved during the project lifetime to include more recent information and/or relevant information obtained within the Solarise project. Any comments and suggestions for regarding the content of the document may be sent to* ***Emilia Motoasca: emilia.motoasca@kuleuven.be***

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Consult/download Output 1 and fill in the evaluation form on the Solarise website:

https://www.interregsolarise.eu/

Thank you for your attention!