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MOST DEMANDING STANDARD COMBINATION TO SUPPORT BIPV DEVELOPMENT AND SUSTAINABILITY – FIRE SAFETY

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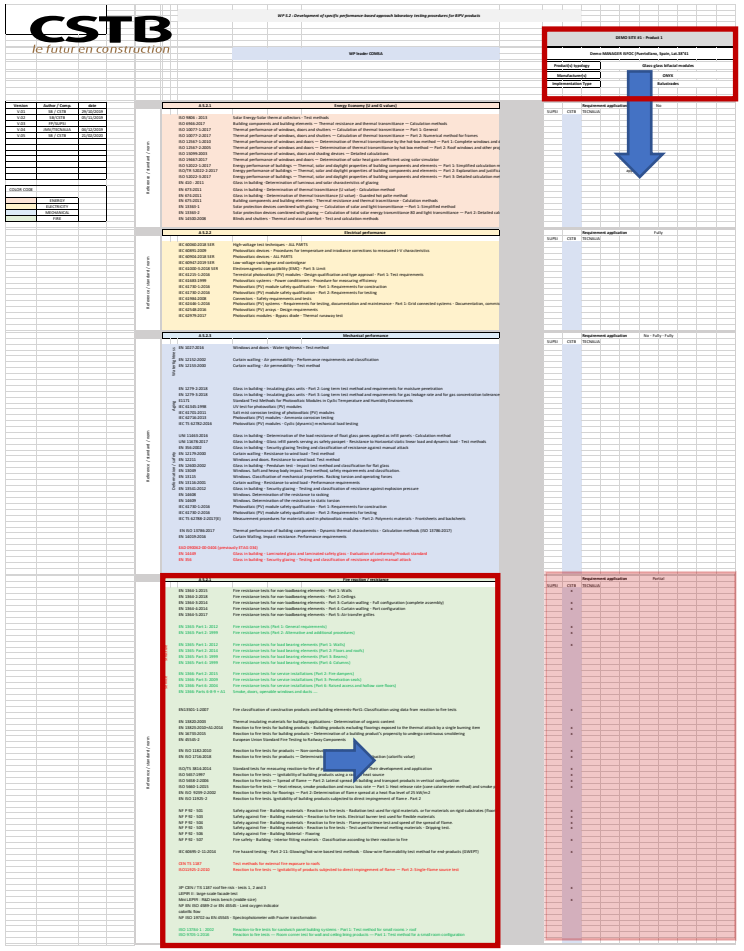
BIPV boost

TABLE OF CONTENTS

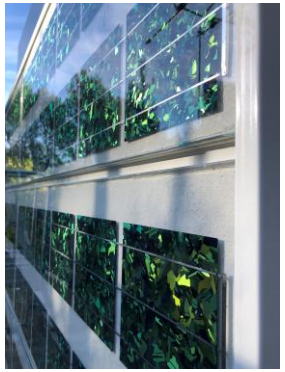
HOW TO TACKLE BIPV SYSTEM IN THE CURRENT STANDARD ENVIRONMENT

- CPR and building code

Reference / standard / norm		A 5.2.1 Fire reaction / resistance
Structure	EN 1364-1:2015	Fire resistance tests for non-loadbearing elements - Part 1: Walls
	EN 1364-2:2018	Fire resistance tests for non-loadbearing elements - Part 2: Ceilings
	EN 1364-3:2014	Fire resistance tests for non-loadbearing elements - Part 3: Curtain walling - Full configuration (complete assembly)
	EN 1364-4:2014	Fire resistance tests for non-loadbearing elements - Part 4: Curtain walling - Part configuration
	EN 1364-5:2017	Fire resistance tests for non-loadbearing elements - Part 5: Air transfer grilles
	EN 1363: Part 1: 2012	Fire resistance tests (Part 1: General requirements)
	EN 1363: Part 2: 1999	Fire resistance tests (Part 2: Alternative and additional procedures)
	EN 1365: Part 1: 2012	Fire resistance tests for load bearing elements (Part 1: Walls)
	EN 1365: Part 2: 2014	Fire resistance tests for load bearing elements (Part 2: Floors and roofs)
	EN 1365: Part 3: 1999	Fire resistance tests for load bearing elements (Part 3: Beams)
	EN 1365: Part 4: 1999	Fire resistance tests for load bearing elements (Part 4: Columns)
Service	EN 1366: Part 2: 2015	Fire resistance tests for service installations (Part 2: Fire dampers)
	EN 1366: Part 3: 2009	Fire resistance tests for service installations (Part 3: Penetration seals)
	EN 1366: Part 6: 2004	Fire resistance tests for service installations (Part 6: Raised access and hollow core floors)
	EN 1366: Parts 6-8-9 + A1	Smoke, doors, openable windows and ducts ....
	EN13501-1:2007	Fire classification of construction products and building elements-Part1: Classification using data from reaction to fire tests
	EN 13820:2003	Thermal insulating materials for building applications - Determination of organic content
	EN 13823:2010+A1:2014	Reaction to fire tests for building products - Building products excluding floorings exposed to the thermal attack by a single burning item
	EN 16733:2015	Reaction to fire tests for building products – Determination of a building product's propensity to undergo continuous smoldering
	EN 45545-2	European Union Standard Fire Testing to Railway Components
	EN ISO 1182:2010	Reaction to fire tests for products — Non-combustibility test
	EN ISO 1716:2018	Reaction to fire tests for products — Determination of the gross heat of combustion (calorific value)
	ISO/TS 3814:2014	Standard tests for measuring reaction-to-fire of products and materials — Their development and application
	ISO 5657:1997	Reaction to fire tests — Ignitability of building products using a radiant heat source
	ISO 5658-2:2006	Reaction to fire tests — Spread of flame — Part 2: Lateral spread on building and transport products in vertical configuration
	ISO 5660-1:2015	Reaction-to-fire tests — Heat release, smoke production and mass loss rate — Part 1: Heat release rate (cone calorimeter method) and smoke pro
	EN ISO 9239-2:2002	Reaction to fire tests for floorings — Part 2: Determination of flame spread at a heat flux level of 25 kW/m2
	EN ISO 11925-2	Reaction to fire tests. Ignitability of building products subjected to direct impingement of flame . Part 2
	NF P 92 - 501	Safety against fire - Building materials - Reaction to fire tests - Radiation test used for rigid materials. or for materials on rigid substrates (flooring
	NF P 92 - 503	Safety against fire - Building materials – Reaction to fire tests. Electrical burner test used for flexible materials
	NF P 92 - 504	Safety against fire - Building materials - Reaction to fire tests - Flame persistence test and speed of the spread of flame.
	NF P 92 - 505	Safety against fire - Building materials - Reaction to fire tests - Test used for thermal melting materials - Dripping test.
	NF P 92 - 506	Safety against fire - Building Material - Flooring
	NF P 92 - 507	Fire safety - Building - Interior fitting materials - Classification according to their reaction to fire
	IEC 60695-2-11:2014	Fire hazard testing - Part 2-11: Glowing/hot-wire based test methods - Glow-wire flammability test method for end-products (GWEPT)
	CEN TS 1187	Test methods for external fire exposure to roofs
	ISO11925-2:2010	Reaction to fire tests — Ignitability of products subjected to direct impingement of flame — Part 2: Single-flame source test
	XP CEN / TS 1187 roof fire risk - tests 1, 2 and 3	
	LEPIR II : large scale facade test	
	Mini LEPIR : R&D tests bench (middle size)	
	NF EN ISO 4589-2 or EN 45545 - Limit oxygen indicator	
	calorific flow	
	NF ISO 19702 ou EN 45545 - Spectrophotometer with Fourier transformation	
	ISO 13784-1 : 2002	Reaction-to-fire tests for sandwich panel building systems - Part 1: Test method for small rooms > roof
	ISO 9705-1:2016	Reaction to fire tests — Room corner test for wall and ceiling lining products — Part 1: Test method for a small room configuration



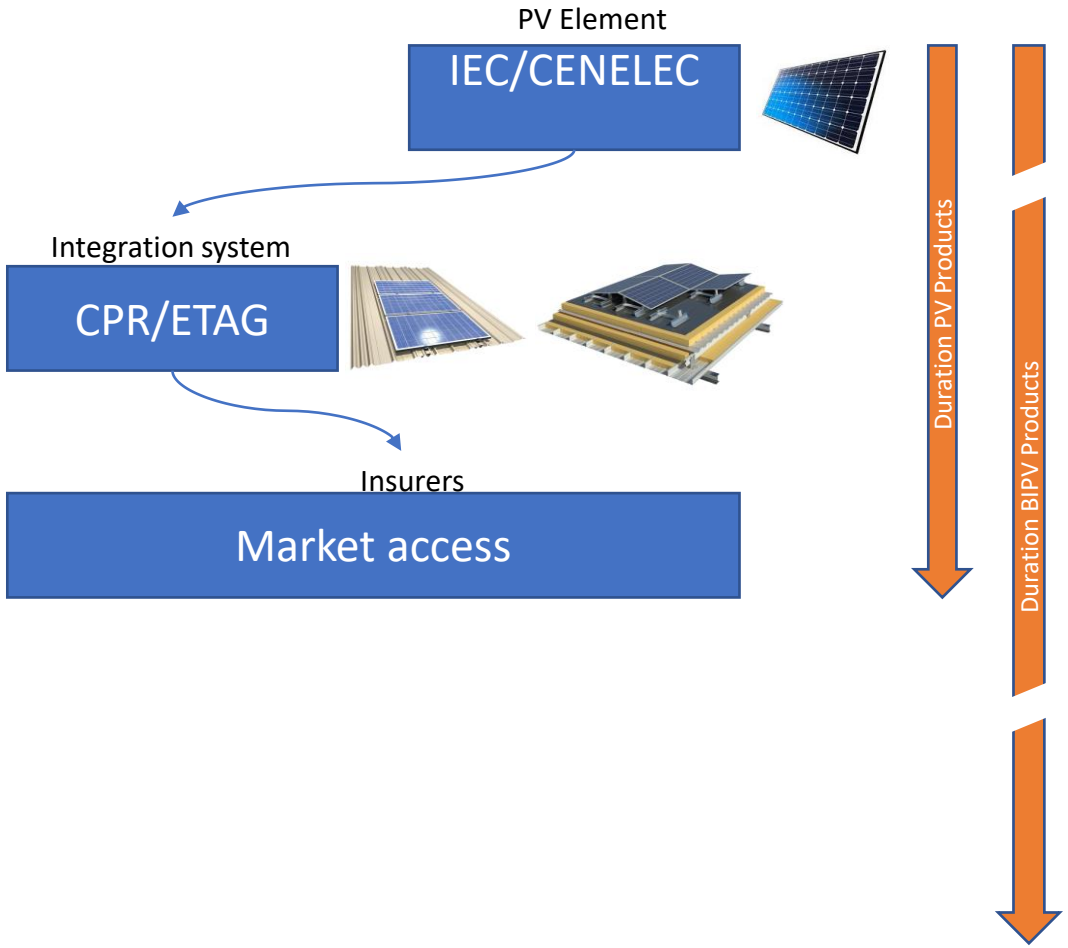
DEMO SITE #1 - Product 1	
Demo MANAGER ISFOC (Puertollano, Spain, Lat.38°41	
Product(s) typology	Glass-glass bifacial modules
Manufacturer(s)	ONYX
Implementation Type	Balustrades



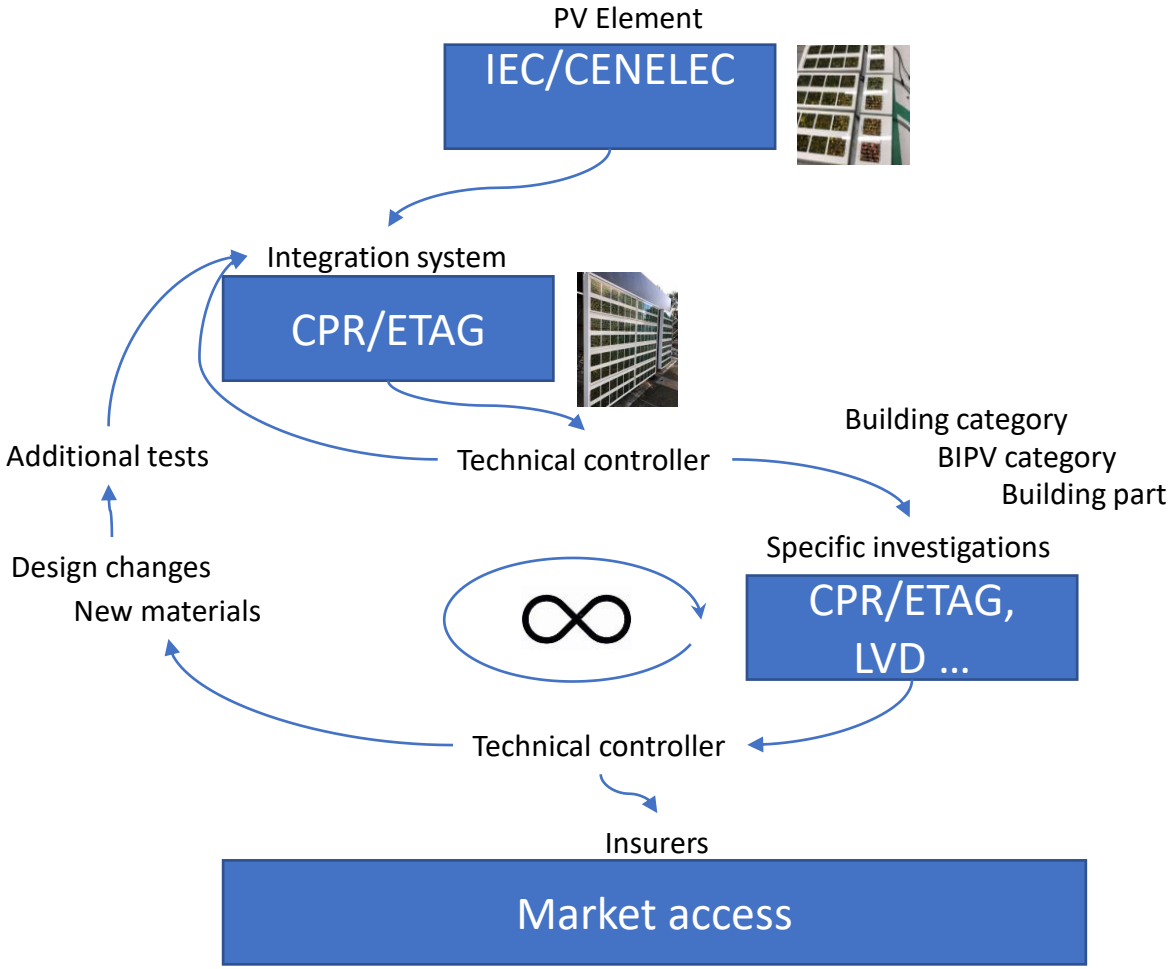
Standards to consider
To assess BIPV system

NORMATIVE PROCEDURES PV / BIPV

- PV as building part

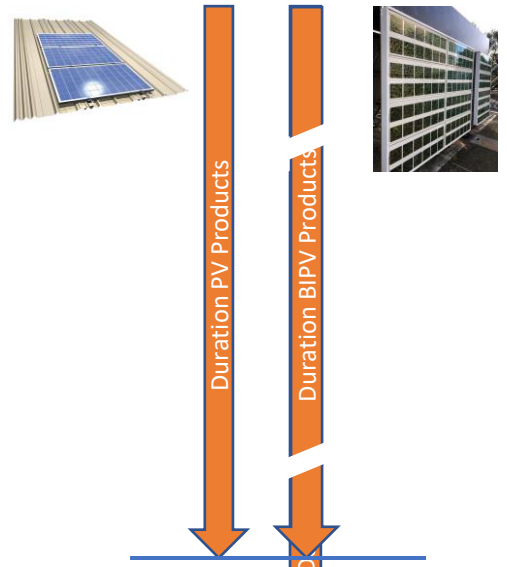


- PV in building as BIPV part



WHY DEAL WITH THIS ISSUE

- To support growth of BIPV market
- To reduce time and cost for BIPV
- To bring more competitiveness
- To ensure a similar access market time as PV



- To improve confidence in BIPV solution
- BIPV as a building elements
- Support innovation in BIPV Field
- Reach the market

- To reach a same base time
  - Similar cost and tests duration
  - Combination tests
  - Specific guarantees

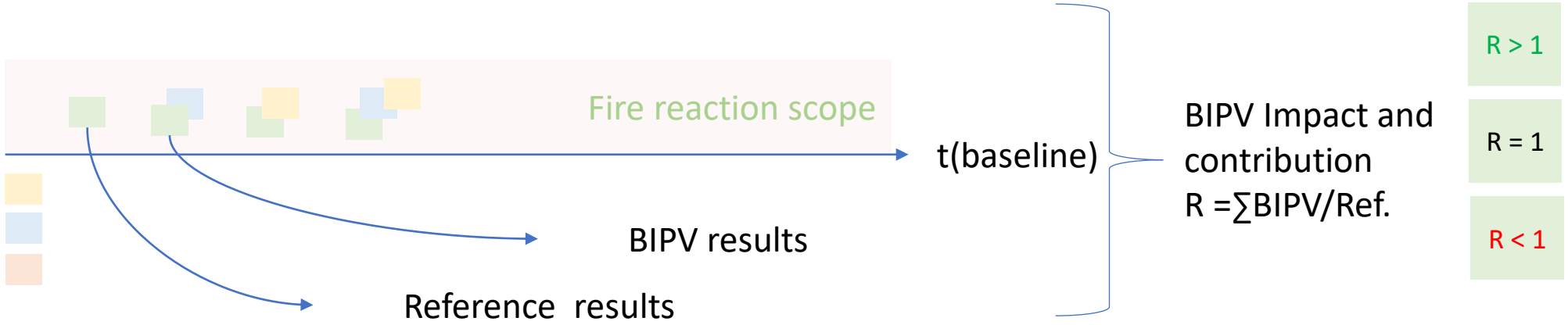
HOW TO ANSWER THIS ISSUE

- Three approaches have been studied
  - Evolution 1
    - Definition of new standards
    - Merge of actuals standards with extension/modification and addition of other topics
    - New standard numbering by components / by family / .. Duration of this process / peer reviewing ?
  - Evolution 2
    - Adaptation of current standards
    - Capitalize on actual standards and extend/modify some topics
    - > retesting guidelines with specific applications (by components / by family /)
  - Evolution 3
    - Take significant/relevant part of standards
    - Identify possible combination, addition of several relevant standard
    - Process adapted to each demo case – methodology validation by partners experts in BIPV
- Time baseline is used to identify the most supporting answer

METHODOLOGY MAIN FRAME

- To apply combination approach on Fire tests
  - New working pathway to develop specific BIPV assessment solution
  - Validate this NTP by experimentation
  - Realistic test conditions / system wide
  - Most demanding requirements

COLOR CODE		
	ENERGY	
	ELECTRICITY	
	MECHANICAL	
	FIRE	



METHODOLOGY MAIN FRAME

- Start from Fire requirements
- Increase demanding test condition by combination approach

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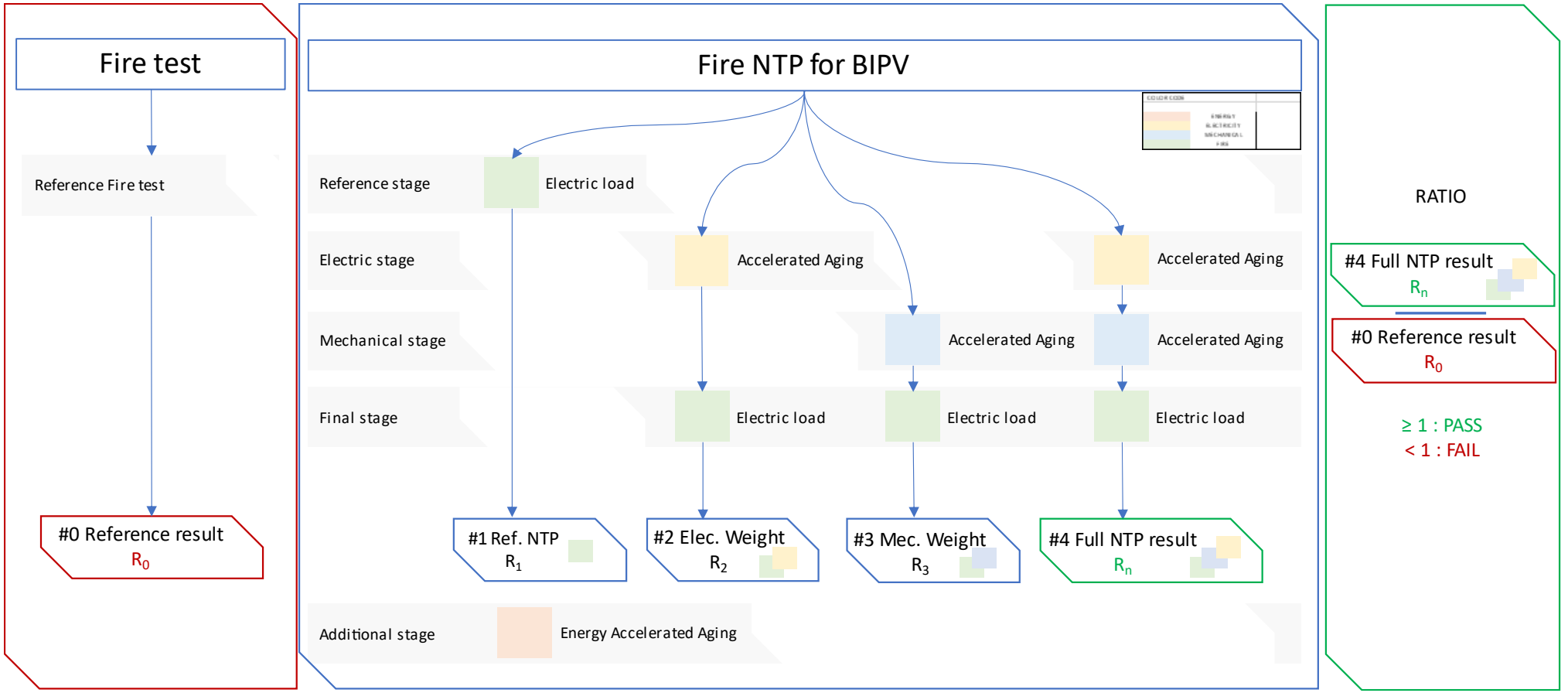
	ELECTRICITY
	MECHANICAL
	FIRE



METHODOLOGY MAIN FRAME

- Start from Fire requirement + fist step forward
- Definition of a specific assessment solution

COLOR CODE		
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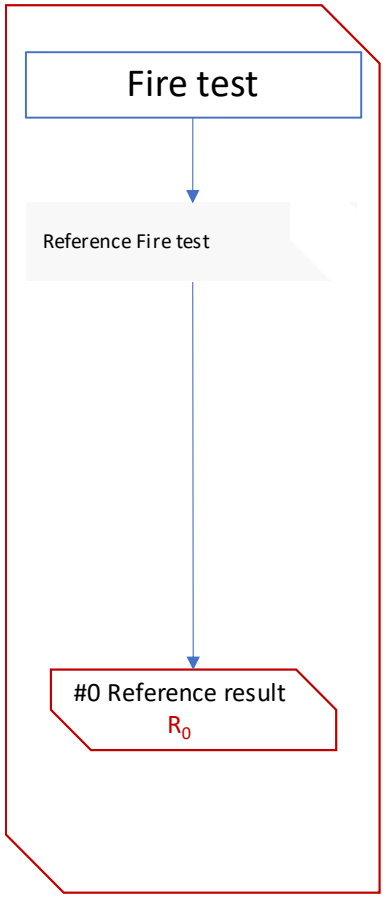
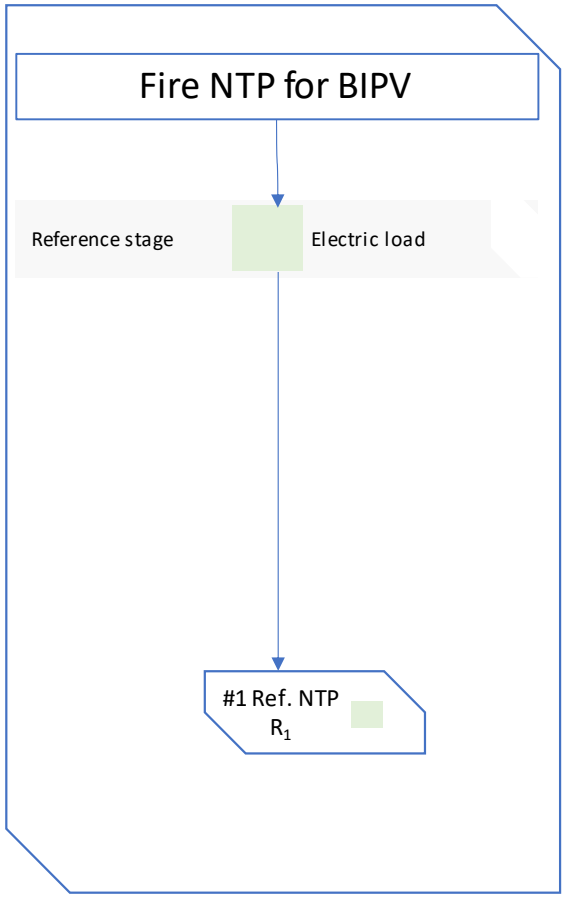
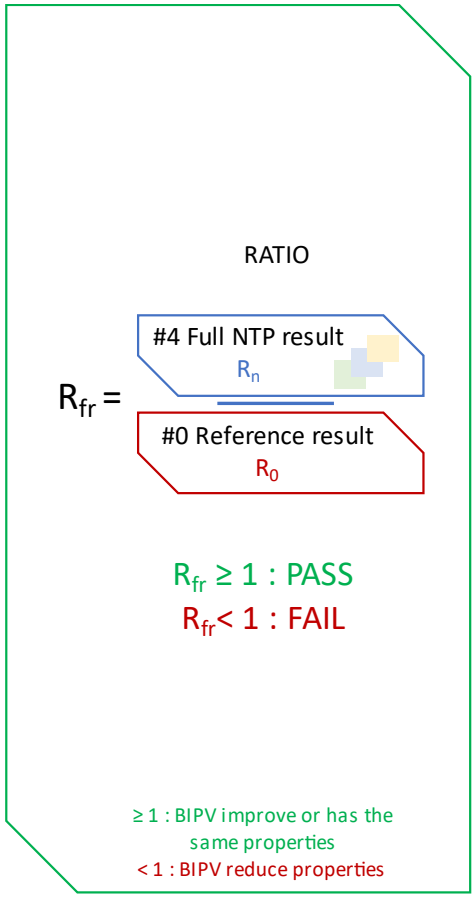
	ELECTRICITY	
	MECHANICAL	
	FIRE	







METHODOLOGY ON BIPV SOLUTION

COLOR CODE		
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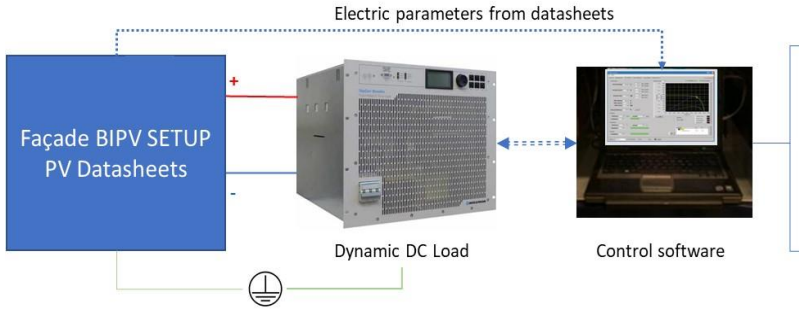
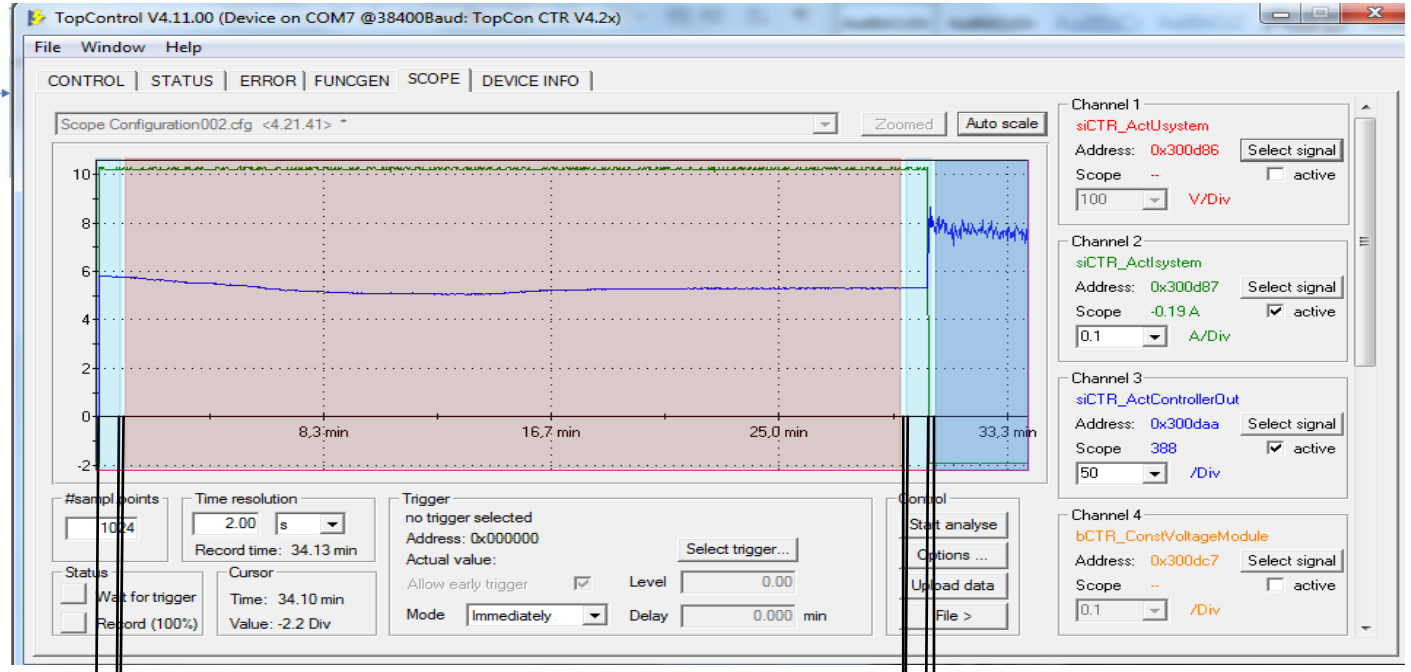
	ELECTRICITY	
	MECHANICAL	
	FIRE	

Fire NTP with electric load - procedure



Control interface



- DC PV generator
- Reverse mode connection
- Electric compatibility
- Most demanding STC conditions
- Adaptable to any cell categories
- Up to 10 KWp

Forced breakdown

1 mn
stabilization

30 mn
Test duration

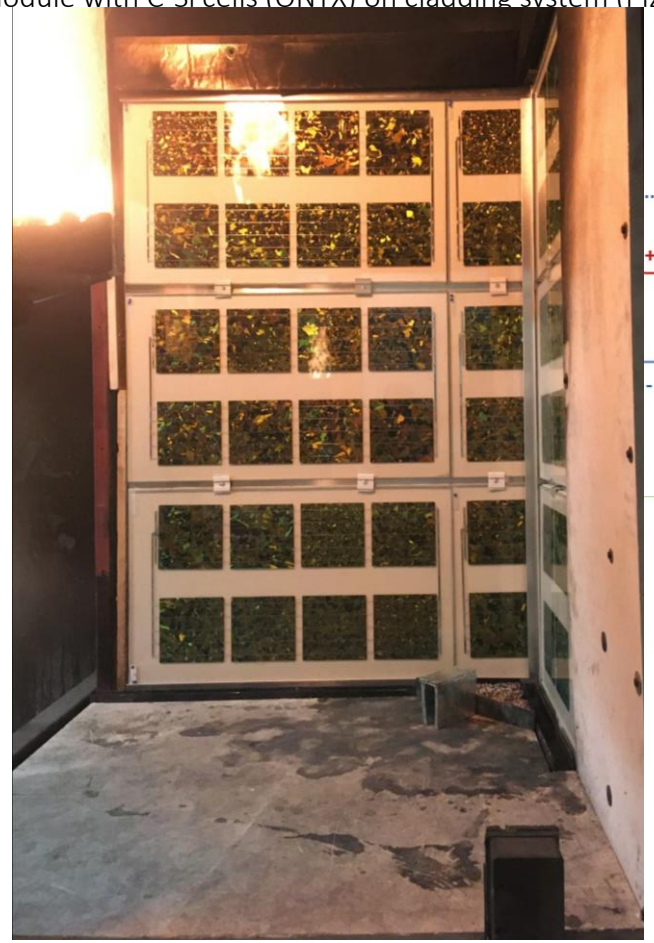
1 mn
stabilization

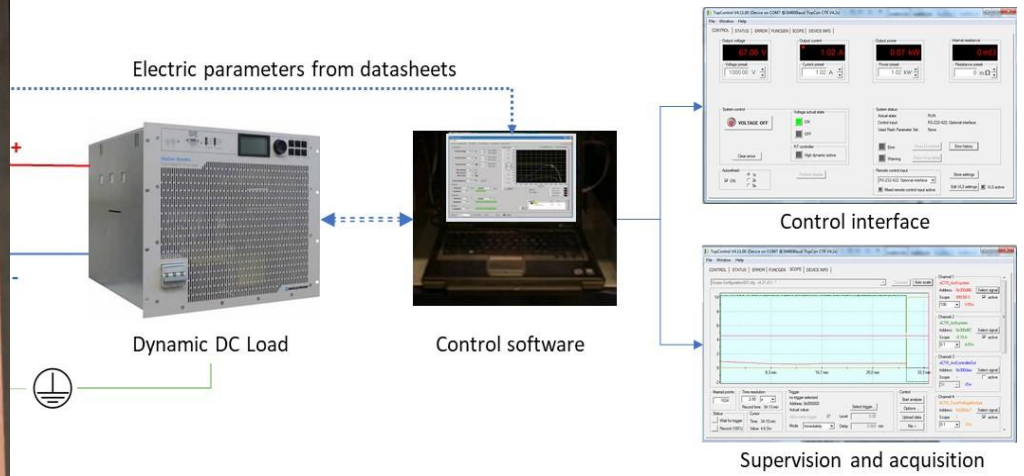
METHODOLOGY ON BIPV SOLUTION

COLOR CODE		
	ENERGY	
	ELECTRICITY	
	MECHANICAL	
	FIRE	

Façade requirement and NTP

Glass/Glass module with C-Si cells (ONYX) on cladding system (PIZ)





METHODOLOGY ON BIPV SOLUTION

Façade requirement and NTP

Glass/Glass module with C-Si cells (ONYX) on cladding system (PIZ)

COLOR CODE		
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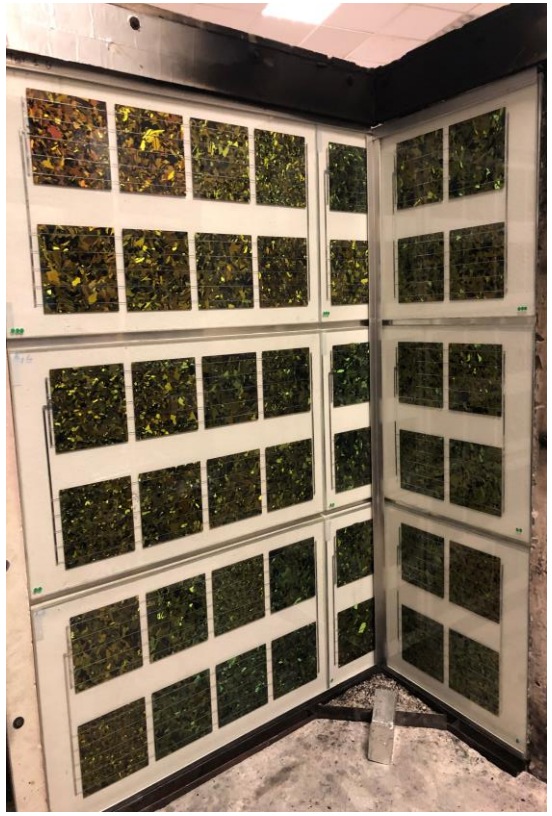
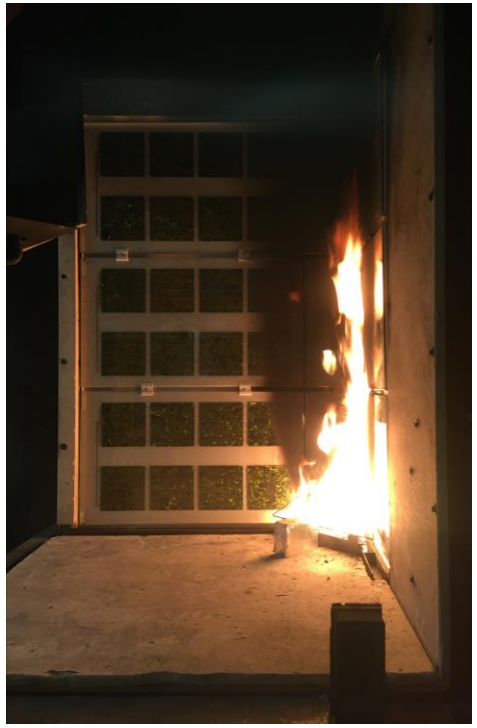
	MECHANICAL	
	FIRE	





No Busbar failures

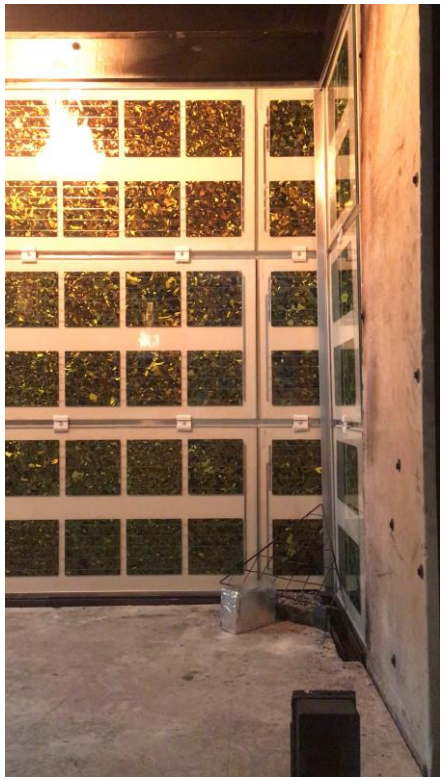
No JB failures

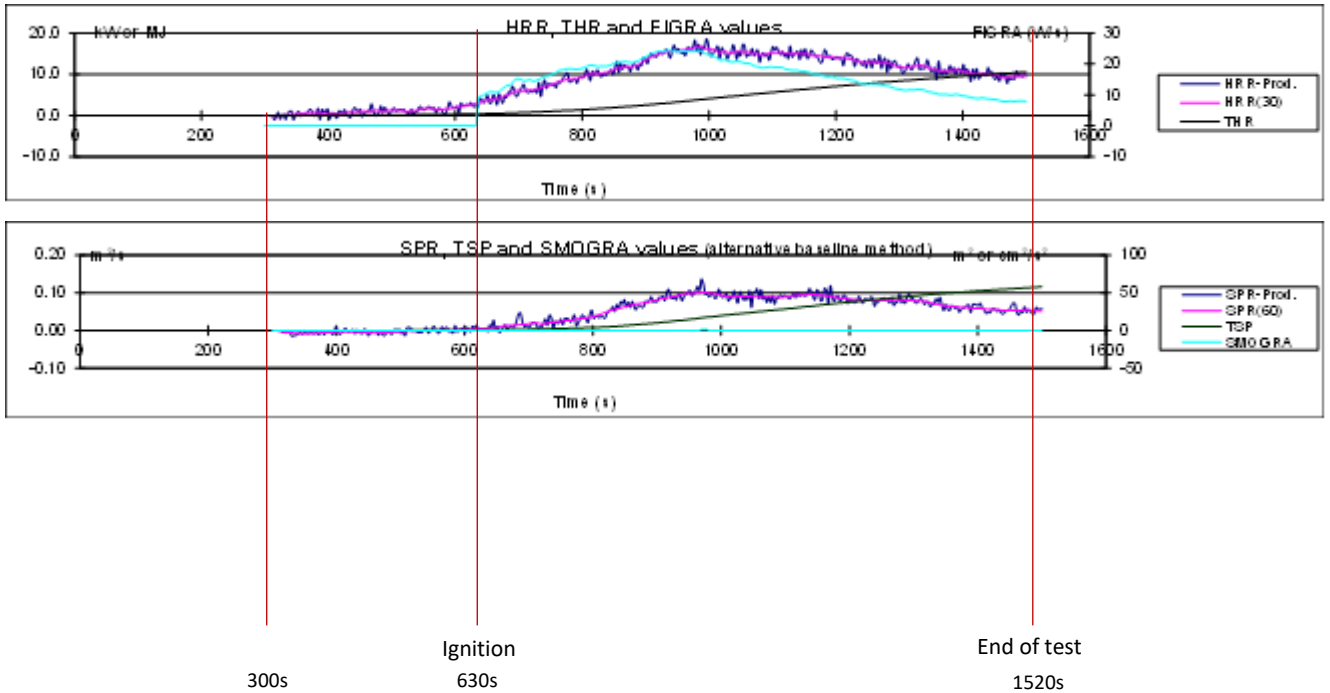
No fire penetration

METHODOLOGY ON BIPV SOLUTION

Façade requirement and NTP

Glass/Glass module with C-Si cells (ONYX) on cladding system (PIZ)





DEMO REQUIREMENT	INDOOR TEST
Targets : B-s3, d0 Results EPIZ-ONYX : B-s1,d0 EPIZ-FLISOM : E-s2, d2	EPIZ - ONYX D5.3 // SBI test n°1 / **7 December** / Mounting on 06/12/2021
	EPIZ - ONYX D5.3/ SBI test n°2 (483 mm) Dates planed from **6-8 December**
	EPIZ - ONYX D5.3 // Ignitability test n°1 **8 December**

DEMO REQUIREMENT	NTP TEST
Targets : B-s3, d0 Results EPIZ-ONYX : B-s1,d0 EPIZ-FLISOM : E-s2, d2	EPIZ - ONYX D5.2 // SBI test n°2 **7 December /** Mounting on 06/12/2021 **With Voc max according to IEC 61215 = 1000V**
	EPIZ - ONYX D5.2 // SBI test n°3 **7 December / Mounting on 7/12/2021 With Voc max according to IEC 61215 = 1000V**
	x

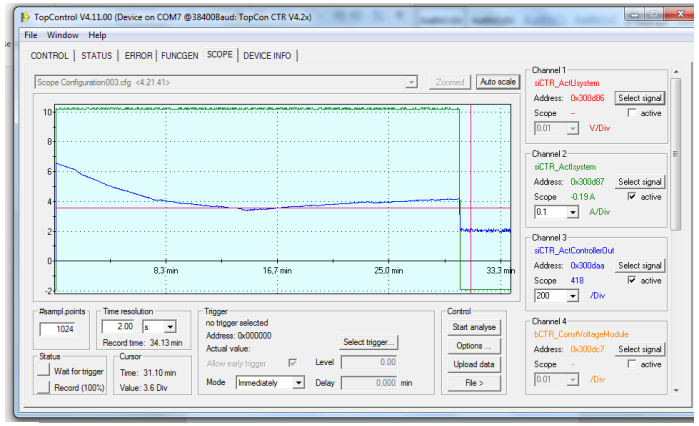
METHODOLOGY ON BIPV SOLUTION

- Result and observation
  - From Fire point of view

	Av.(R_0)	Av.$_{load}$.(R_1)	Std.dev.
FIGRA(0.2) W/s	37.7	38.3	0.4
THR(600) M	5.1	4.95	0.1
SMOGRA cm2/s2	2.2	2.2	0
TSP(600) m2	32	28.3	-2,1

Potential classification	Av.	Av.$_{load}$	Trend
Class	A2/B	A2/B	=
Smoke production	s1	s1	=
Flaming droplet/particules	d0	d0	=

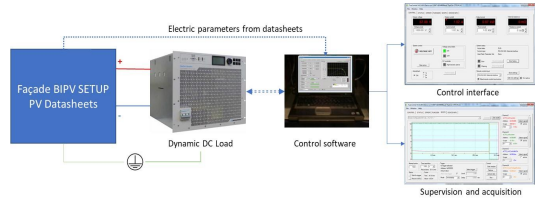
  - From electric point of view



$$R_{fr} = \frac{R_1}{R_0} = 1$$

No discontinuity
No electric arc

COLOR CODE		
	ENERGY	
	ELECTRICITY	
	MECHANICAL	
	FIRE	



Passed test

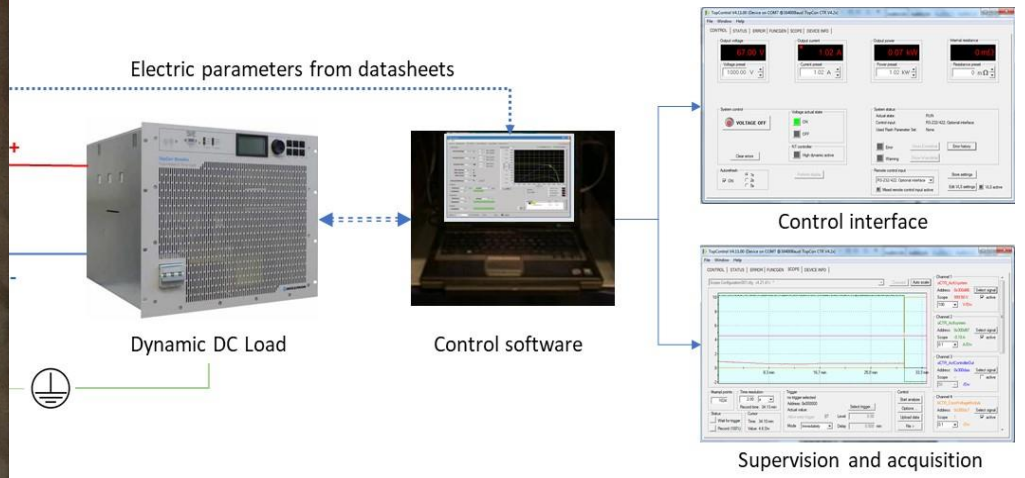
Validated methodology

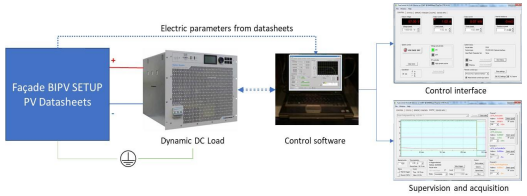
METHODOLOGY ON BIPV SOLUTION

Validation NTP on different PV solution

COLOR CODE		
	ENERGY	
	ELECTRICITY	
	MECHANICAL	
	FIRE	

Flexible module with CIGS cells (FLISOM) on cladding system (PIZ)

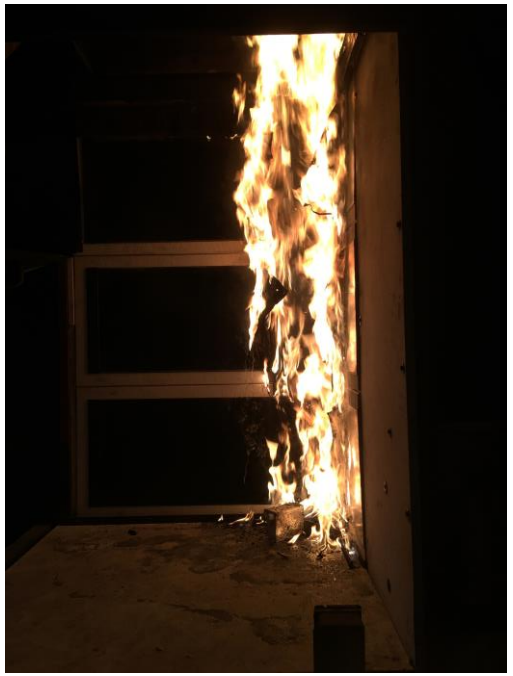




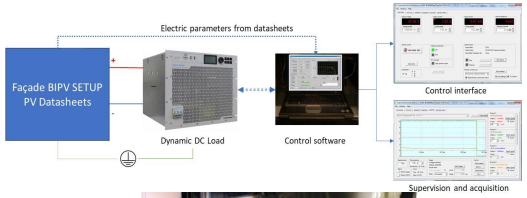
METHODOLOGY ON BIPV SOLUTION

Validation NTP on different PV solution

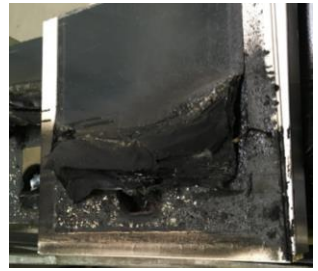
Flexible module with CIGS cells (FLISOM) on cladding system (PIZ)



COLOR CODE		
	ENERGY	
	ELECTRICITY	
	MECHANICAL	
	FIRE	



No fire penetration

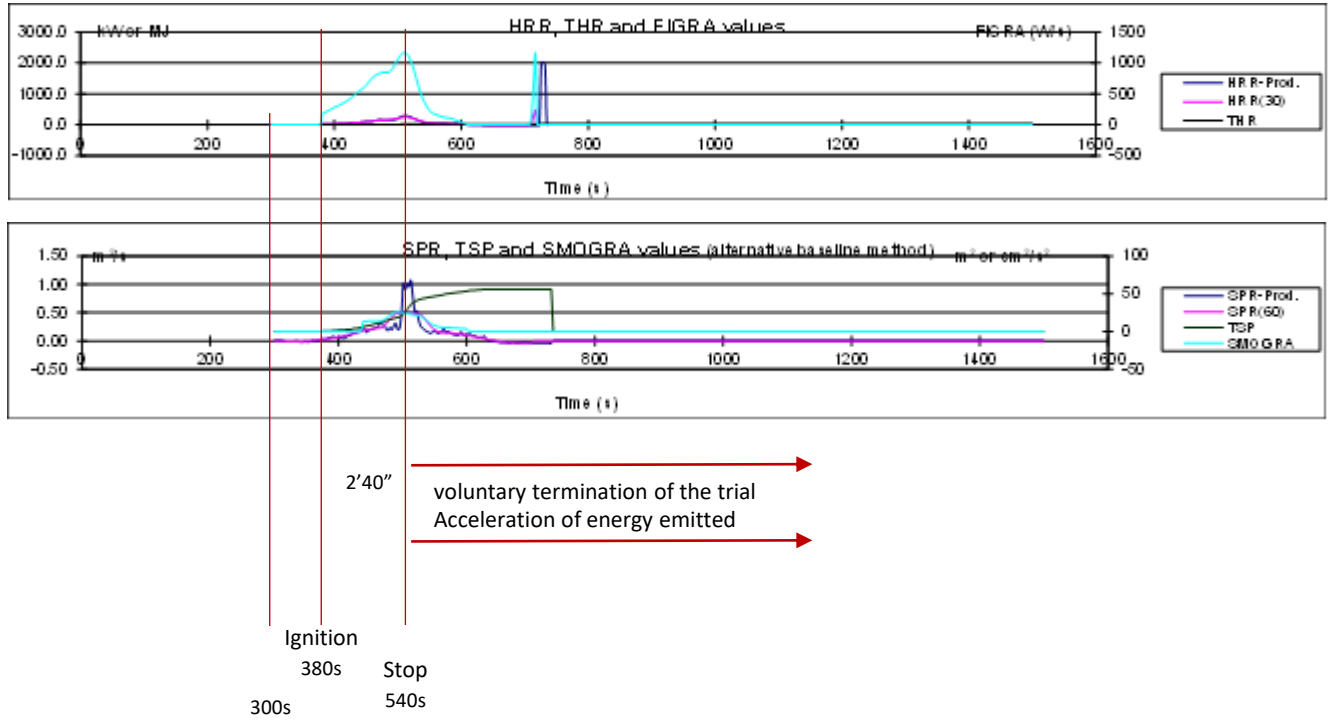


Bonding effects

METHODOLOGY ON BIPV SOLUTION

Validation NTP on different PV solution

Flexible module with CIGS cells (FLISOM) on cladding system (PIZ)



DEMO REQUIREMENT	INDOOR TEST
Targets : B-s3, d0 Results EPIZ-ONYX : B-s1,d0 EPIZ-FLISOM : E-s2, d2	EPIZ - ONYX D5.3 // SBI test n°1 / **7 December** / Mounting on 06/12/2021
	~~EPIZ - ONYX D5.3/ SBI test n°2 (483 mm) Dates planed from **6-8 December**~~
	EPIZ - ONYX D5.3 // Ignitability test n°1 **8 December**

DEMO REQUIREMENT	NTP TEST
Targets : B-s3, d0 Results EPIZ-ONYX : B-s1,d0 EPIZ-FLISOM : E-s2, d2	EPIZ - ONYX D5.2 // SBI test n°2 **7 December /** Mounting on 06/12/2021 **With Voc max according to IEC 61215 = 1000V**
	EPIZ - ONYX D5.2 // SBI test n°3 7 December **/ Mounting on 7/12/2021 With Voc max according to IEC 61215 = 1000V**
	X

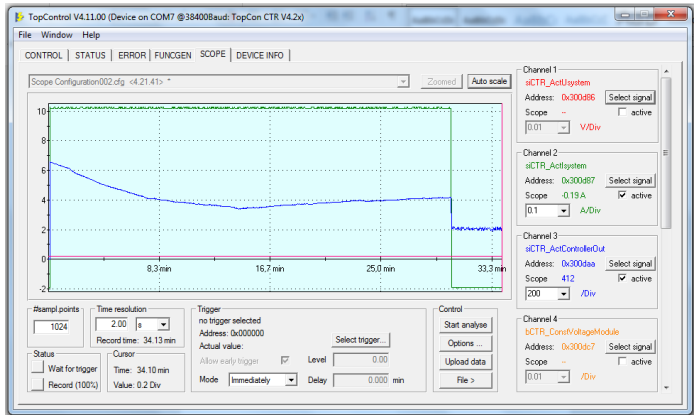
METHODOLOGY ON BIPV SOLUTION

- Result and observation
  - From Fire point of view

	Av.(R_0)	Av.$_{load}$.(R_1)	Std.dev.
FIGRA(0.2) W/s	1161.3	1017.3	-101
THR(600) M	21.3	14.7	-4.6
SMOGRA cm2/s2	27.1	18.4	-6.2
TSP(600) m2	61.5	35.8	-20,7

Potential classification	Av.	Av.$_{load}$	Trend
Class	E	E	=
Smoke production	s2	s1	^
Flaming droplet/particules	d2	d2	=

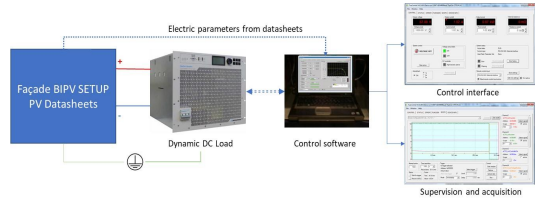
  - From electric point of view



$$R_{fr} = \frac{R_1}{R_0} > 1$$

No discontinuity
No electric arc

COLOR CODE		
	ENERGY	
	ELECTRICITY	
	MECHANICAL	
	FIRE	



Passed test

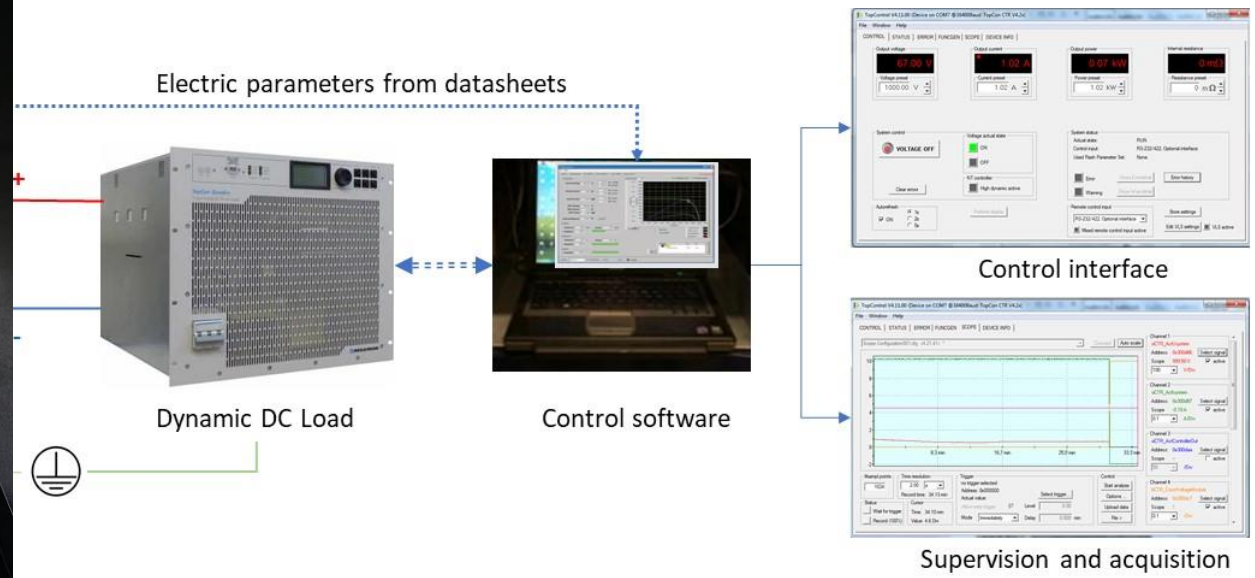
Validated methodology

METHODOLOGY ON BIPV SOLUTION

- Roof requirements and NTP validation (CEN/TS 1183) and classification according to NF EN 13501-5

COLOR CODE	
	ENERGY
	ELECTRICITY
	MECHANICAL
	FIRE

Flexib…gration system (SCHWEIZER)

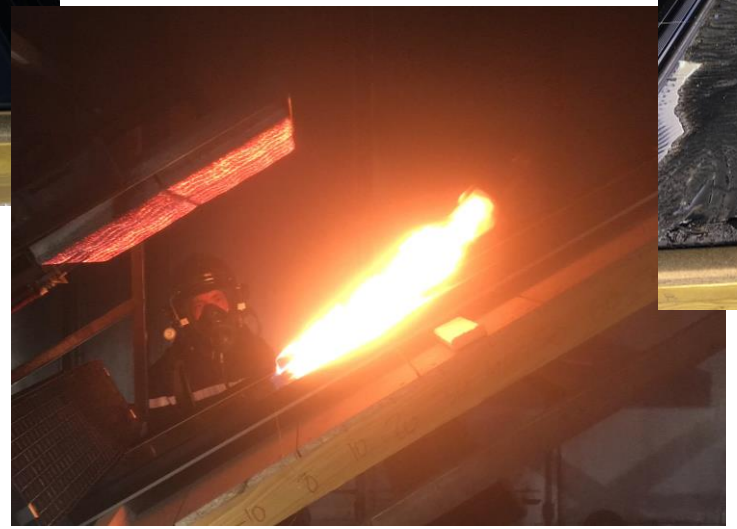


METHODOLOGY ON BIPV SOLUTION

- Roof requirements and NTP validation (CEN/TS 1183) and classification according to NF EN 13501-5

COLOR CODE	
	ENERGY
	ELECTRICITY
	MECHANICAL
	FIRE

Flexible module with CIGS cells (FLISOM) on solrif® integration system (SCHWEIZER)



No Busbar failures

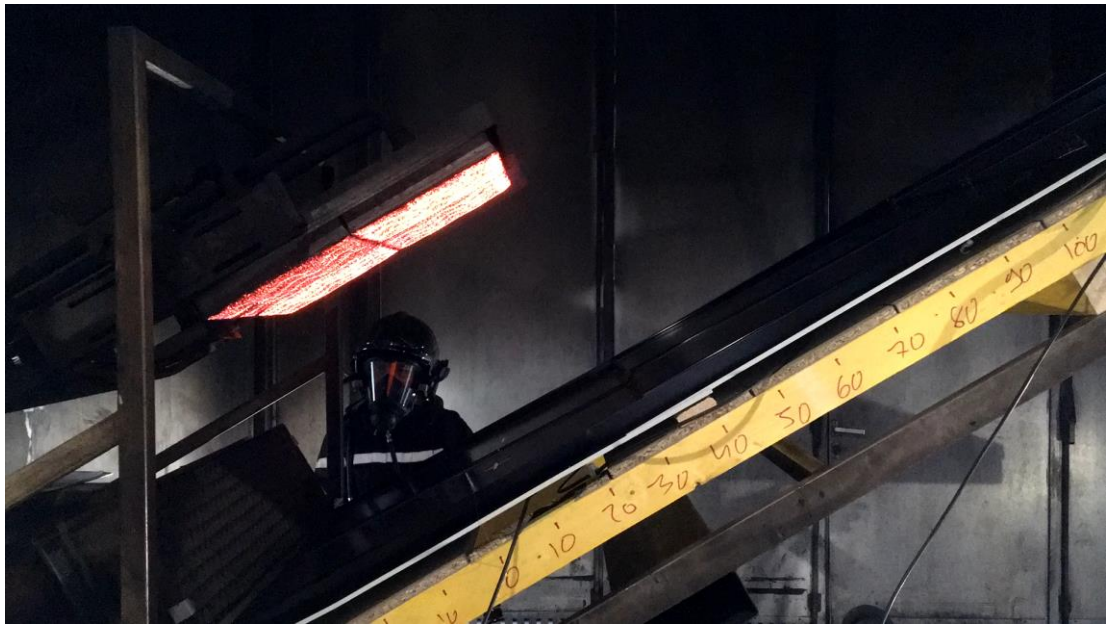
No JB failures

No fire penetration

METHODOLOGY ON BIPV SOLUTION

- Roof requirements and NTP validation (CEN/TS 1183) and classification according to NF EN 13501-5

Flexible module with CIGS cells (FLISOM) on solrif® integration system (SCHWEIZER)



DEMO REQUIREMENT	INDOOR TEST
Target : Broof(t3) Results **SCHWEIZER/FLISOM : Broof(t3)**	SCHWEIZER/FLISOM // BROOF test n°1 Case A - 10° - Dates to be planned > **March**
	SCHWEIZER/FLISOM // BROOF test n°1 Case A - 30°
	SCHWEIZER/FLISOM // BROOF test n°5 Case B - 10° - Dates to be planned > **March**
	SCHWEIZER/FLISOM // BROOF test n°3 Case B - 30°

DEMO REQUIREMENT	NTP TEST
Target : Broof(t3) Results **SCHWEIZER/FLISOM : Broof(t3)**	SCHWEIZER/FLISOM // BROOF test n°2 Case A - 10° - Dates to be planned > **March**
	SCHWEIZER/FLISOM // BROOF test n°2 Case A - 30°
	SCHWEIZER/FLISOM // BROOF test n°6 Case B - 10° - Dates to be planned > **March**
	SCHWEIZER/FLISOM // BROOF test n°4 Case B - 30°

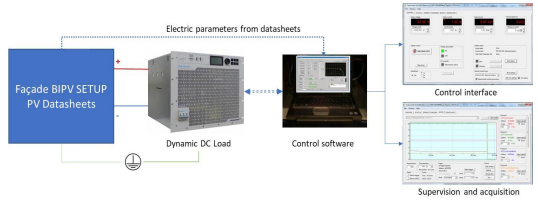
METHODOLOGY ON BIPV SOLUTION

- Result and observation
  - From Fire point of view

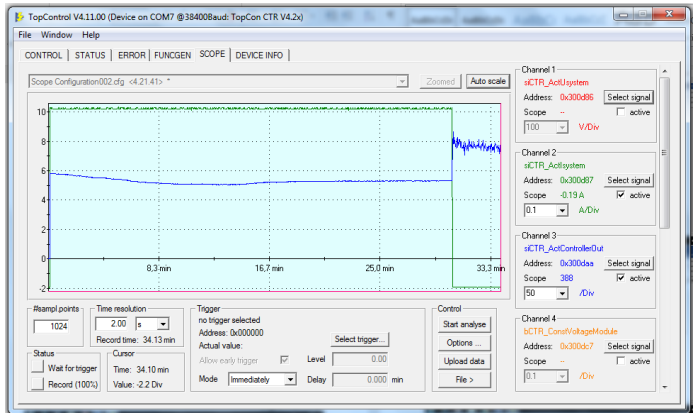
Potential classification	Av.	Av.load	Trend
Propagation time	Tp > 30 min	Tp > 30 min	=
External prop. time	TE = 30 min	TE = 30 min	=
Classification	B ROOF (t3)	B ROOF (t3)	=

$$R_{fr} = \frac{R_1}{R_0} = 1$$

COLOR CODE		
	ENERGY	
	ELECTRICITY	
	MECHANICAL	
	FIRE	



  - From electric point of view



No discontinuity
No electric arc

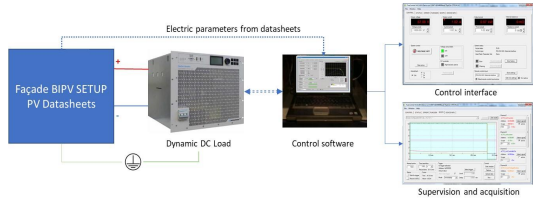
Passed test

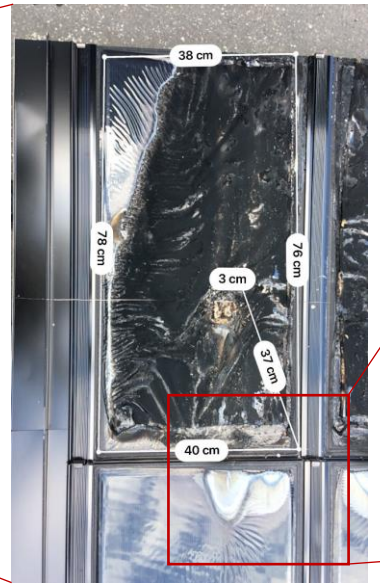
Validated methodology

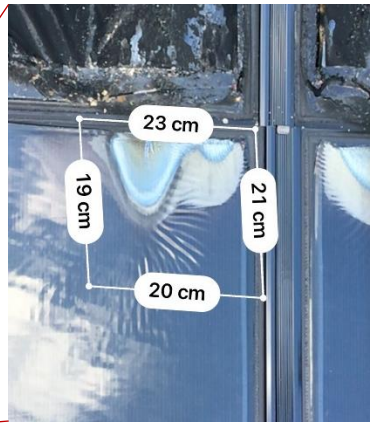
METHODOLOGY ON BIPV SOLUTION

- Result and observation

COLOR CODE		
	ENERGY	
	ELECTRICITY	
	MECHANICAL	
	FIRE	





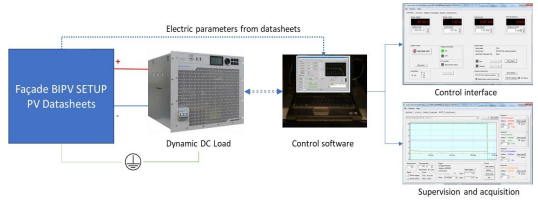


Firebrand locations

CONCLUSION

- NTP validation on combination tests Building/electric load
- NTP could be applied on any BIPV categories
- NTP takes into account any cells components

COLOR CODE		
	ENERGY	
	ELECTRICITY	
	MECHANICAL	
	FIRE	



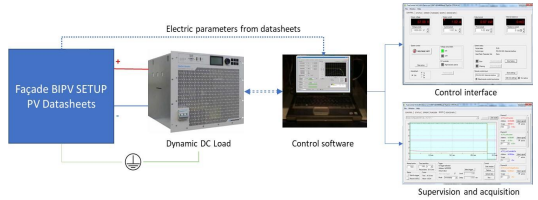
- A way to save time and cost
- Support manufacturers in components definition
- Accelerate market access for several BIPV solution and cell technologies
- Insurers proof of confidence to adopt BIPV in building projects

  > no additional risks observed even in most demanding conditions

PERSPECTIVES

- Specific electric load definition
- Arc detection by module
- Identification with high accuracy of weak points
- Insights to support improvement and BIPV optimization

COLOR CODE	
	ENERGY
	ELECTRICITY
	MECHANICAL
	FIRE



- to integer other NTP in the process and accelerated aging effects
- Reduce as short as standard procedure to save more time
- Support the definition of specific BIPV standards to boost BIPV market

www.bipvboost.eu

Thank you for your attention

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