Guadua Angustifolia Kunth as an alternative to metals and synthetic fibers

In order to build comfortable urban furniture including Hi-Tech wind turbine for powering ultimate technology L.E.D. street lamp.

Iker Gómez Iborra, BAMBHAUS COMPOSITES, S.L.

Iván Villalva, ALBAERO, S.L.

Mónica Rios Arroyo, BAMBHAUS COMPOSITES, S.L.

Jaime Espinosa, Polytechnic University of Madrid (UPM)

- IX W.B.C. 2.012 G.A.K. as an alternative to metal and synthetic fibers

BAMBHAUS MAIN LINES

ENGINEERED BAMBOO FOR SUSTAINABLE DEVELOPMENT

- Importing and distribution
- Housing + Urban development
  - Flexible, evolving BIOhousing
- RD+i
  - Industrialized Building systems
  - Joints and conexions of poles
  - Biohousing

Iker gómez iborra; ivan villalba; monica rios arroyo; jaime espinosa;

ALBAERO Albatross Aeronautics.S.L

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- IX W.B.C. 2.012 G.A.K. as an alternative to metal and synthetic fibers

DIFFICULTIES FOR INTRODUCING BAMBOO IN BUILDING SECTOR

- Unknown material
- Variable properties.
- Non isotropic properties
- Quality acceptance
- Fatigue and wear resistance
- Fire behaviour
- Price
- Profitability

- IX W.B.C. 2.012 G.A.K. as an alternative to metal and synthetic fibers

DIFFICULTIES FOR INTRODUCING BAMBOO IN BUILDING SECTOR

• Variable properties	**security factors**
• Non isotropic properties	**take advantage of them**
• Quality acceptance	**proper selection**
• Fatigue and wear resistance	**treatments**
• Fire behaviour	**treatments**
• Price	
• Profitability	
• Unknown material	

- IX W.B.C. 2.012 G.A.K. as an alternative to metal and synthetic fibers

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• Fire behaviour	**treatments**
• Price	
• Profitability	
• Unknown material	**show the material in extrem conditions**

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EXTREM CONDITIONS

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EXTREM CONDITIONS:

URBAN FURNITURE

+

WIND TURBINE

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EXTREM CONDITIONS:

URBAN FURNITURE

+

WIND TURBINE

- *Wear resistance*
- *Atmospheric conditions*
- *Safety standards*
- *Citizen behaviour*
- *Mechanical fatigue*
- *Vandalism*

Iker gómez iborra; ivan villalba; monica rios arroyo; jaime espinosa;

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- IX W.B.C. 2.012 G.A.K. as an alternative t[illegible]nthetic fibers

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- IX W.B.C. 2.012 G.A.K. as an alternative to metal and synthetic fibers

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URBAN FURNITURE

+

WIND TURBINE

- *Wear resistance*
- *Atmospheric conditions*
- *Safety standards*
- *Citizen behaviour*
- *Mechanical fatigue*
- *Vandalism*

So we have designed:

LED-Lamp, wind turbine, bench, trashbin, and parking for 6 bikes

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REQUIREMENTS FOR URBAN FURNITURE DESIGN

- Built and repaired "priceless" (In behalf of tax payers)
- Citizens need a place to
  - REST — bench
  - RELAX — playground
  - SOCIALIZE — communication
  - CONNECT THE CITY — bike park
  - FEEL PROTECTED — light

LED-Lamp, wind turbine, bench, trashbin, and parking for 6 bikes

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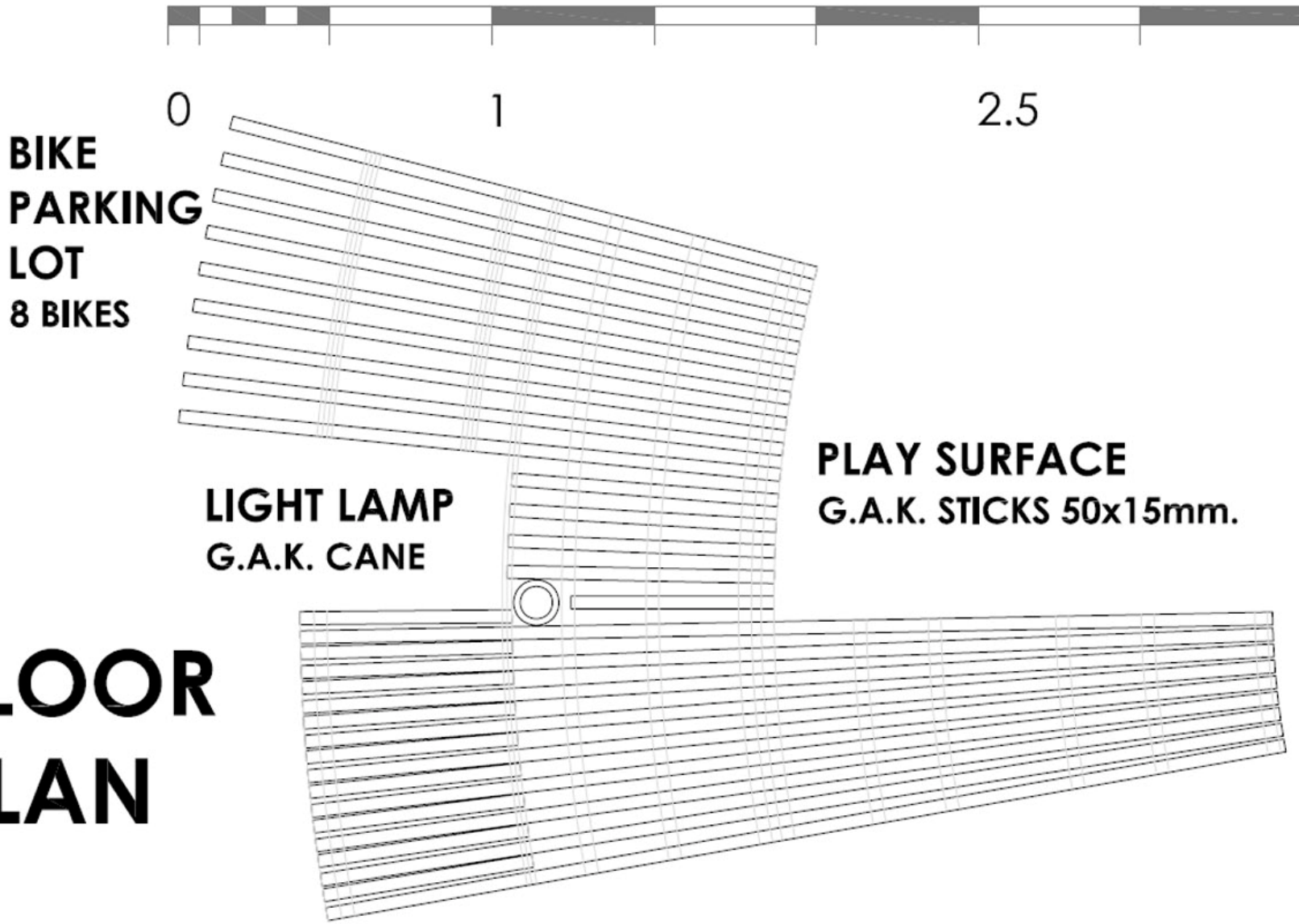
- IX W.B.C. 2.012 G.A.K. as an alternative



FLOOR PLAN

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- IX W.B.C. 2.012 G.A.K. as an alternative

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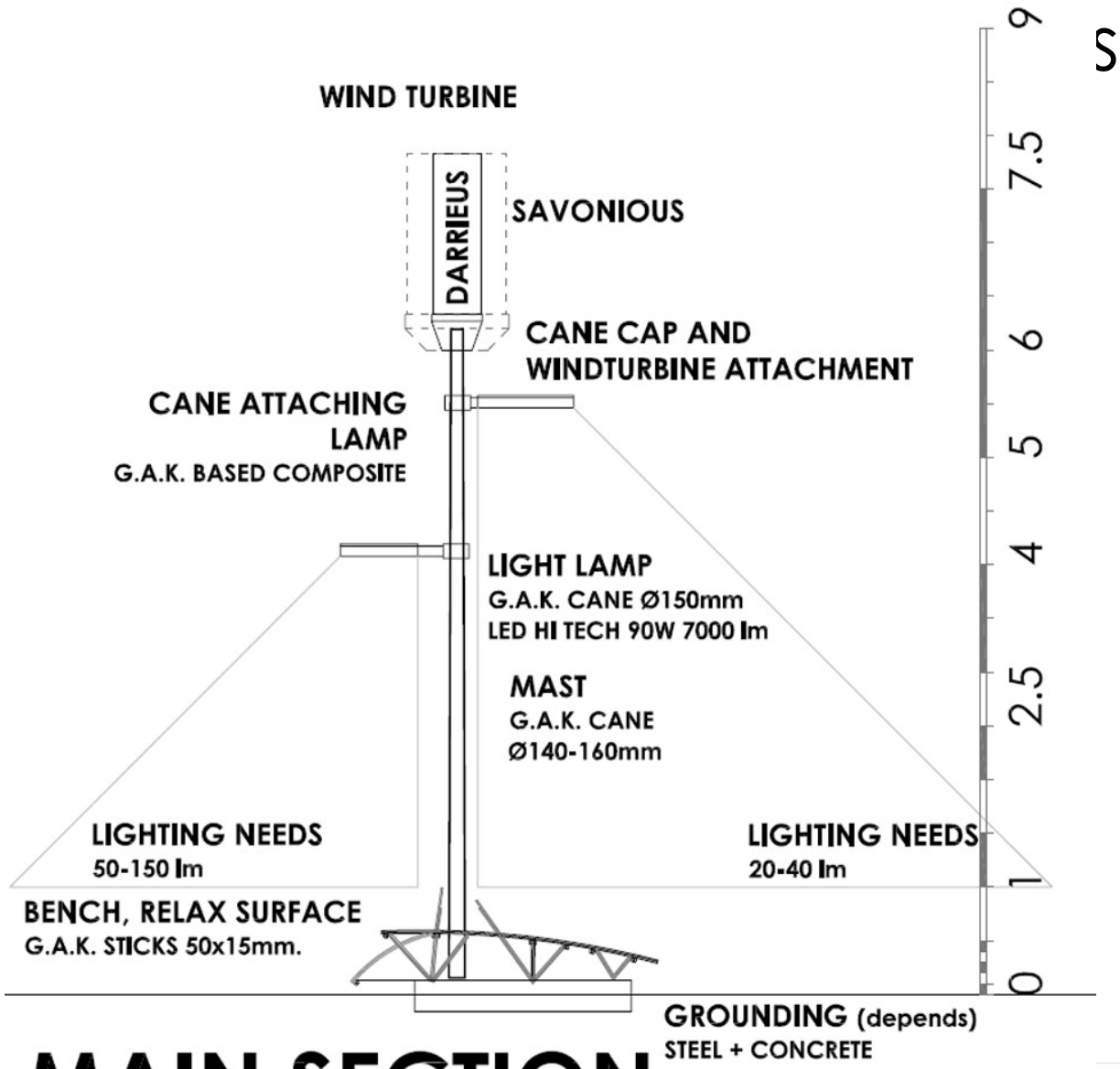

MAIN SECTION

Many other designs

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- IX W.B.C. 2.012 G.A.K. as an alternative

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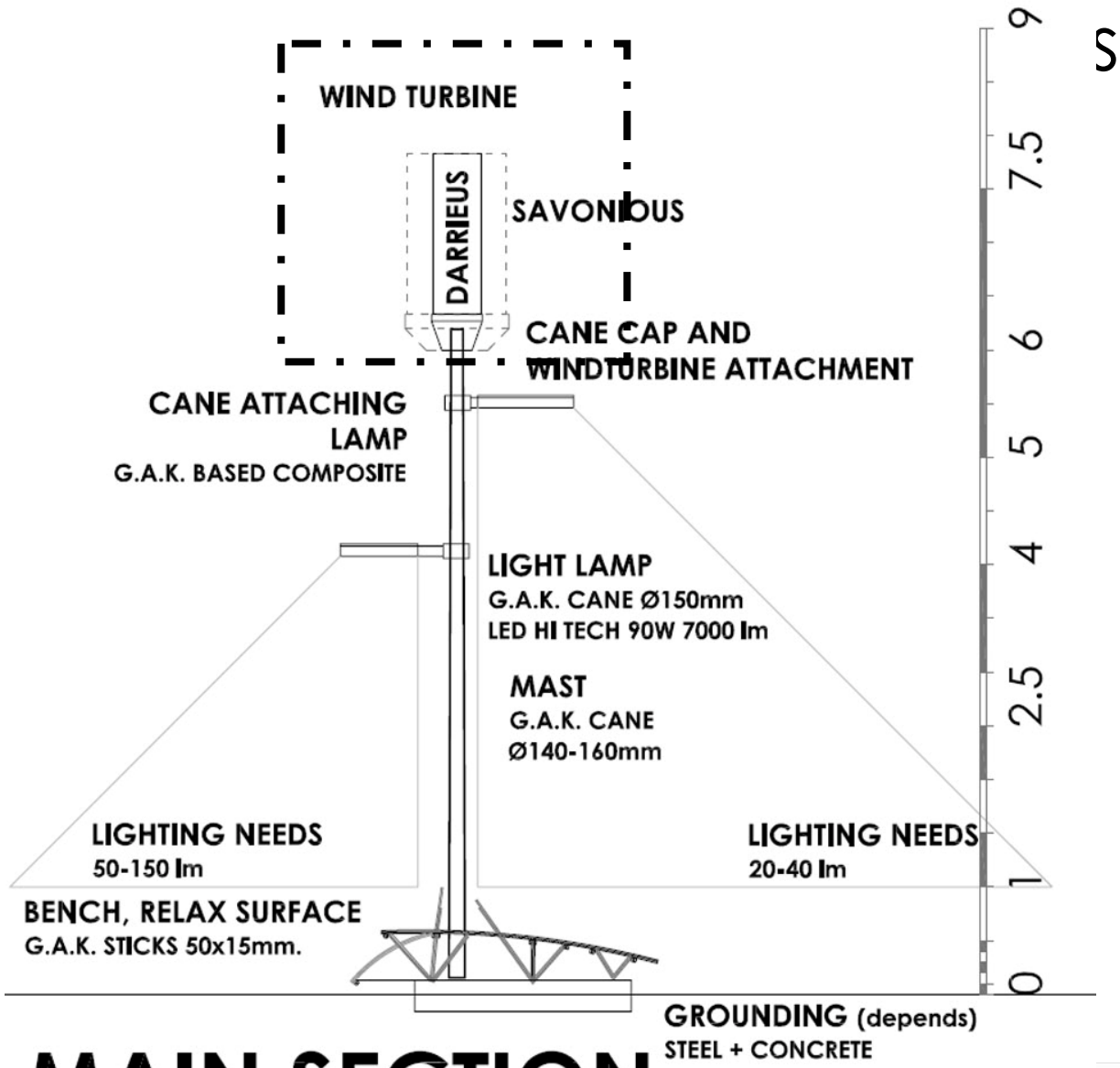

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WIND RESOURCE IN THE CITIES AND ELECTRICITY PRODUCTION

Classical models are not appropiate:

Solari, Von Karman

2 Main types of wind:

- Turbulent wind (non directional)
- Street canyon (directional)

CFD Modelling is needed in order to avoid unnecessary spent of resources.

- Wind characteristics
- Trees grownth

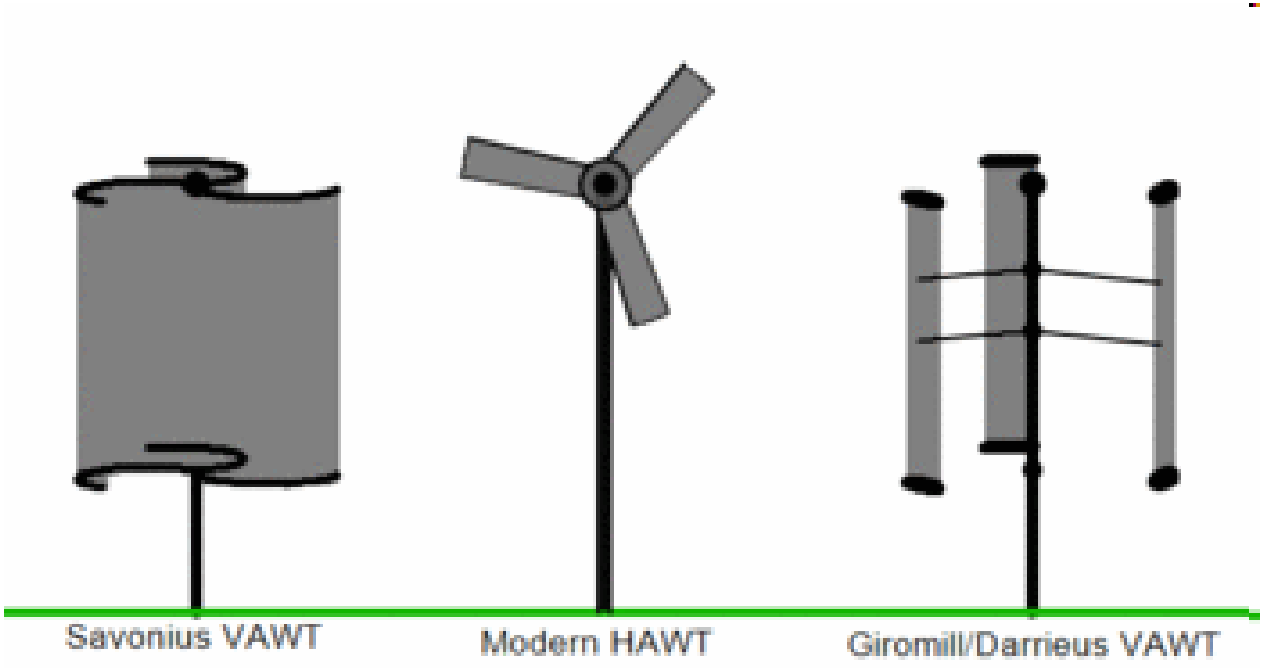
- IX W.B.C. 2.012 G.A.K. as an alternative to metal and synthetic fibers

WIND TURBINE CHOICE AND ENERGY PRODUCTION

3 different types of wind turbine:

vertical axis — TURBULENT WIND

Horizontal axis — DIRECTIONAL WIND



Cp≈ 0.20 **0.35-0.59*** **0.31-0.52**

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vertical axis **TURBULENT WIND**

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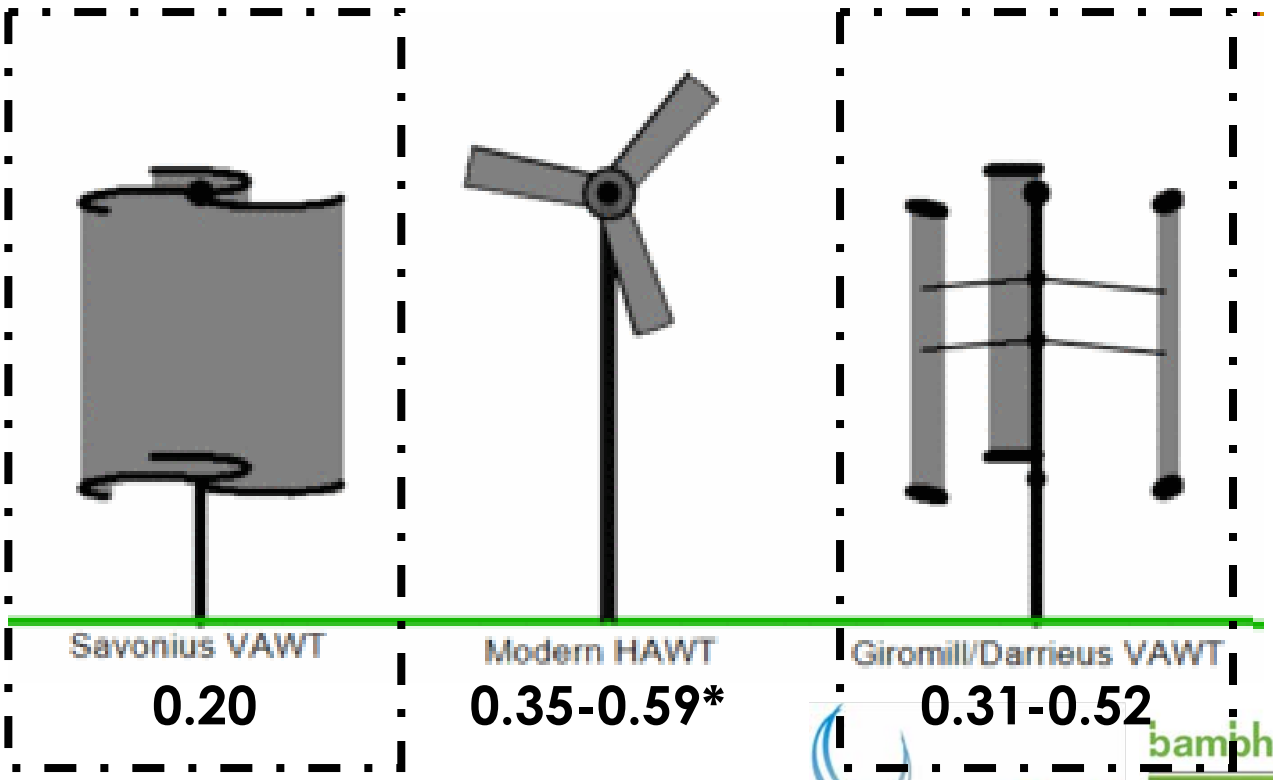

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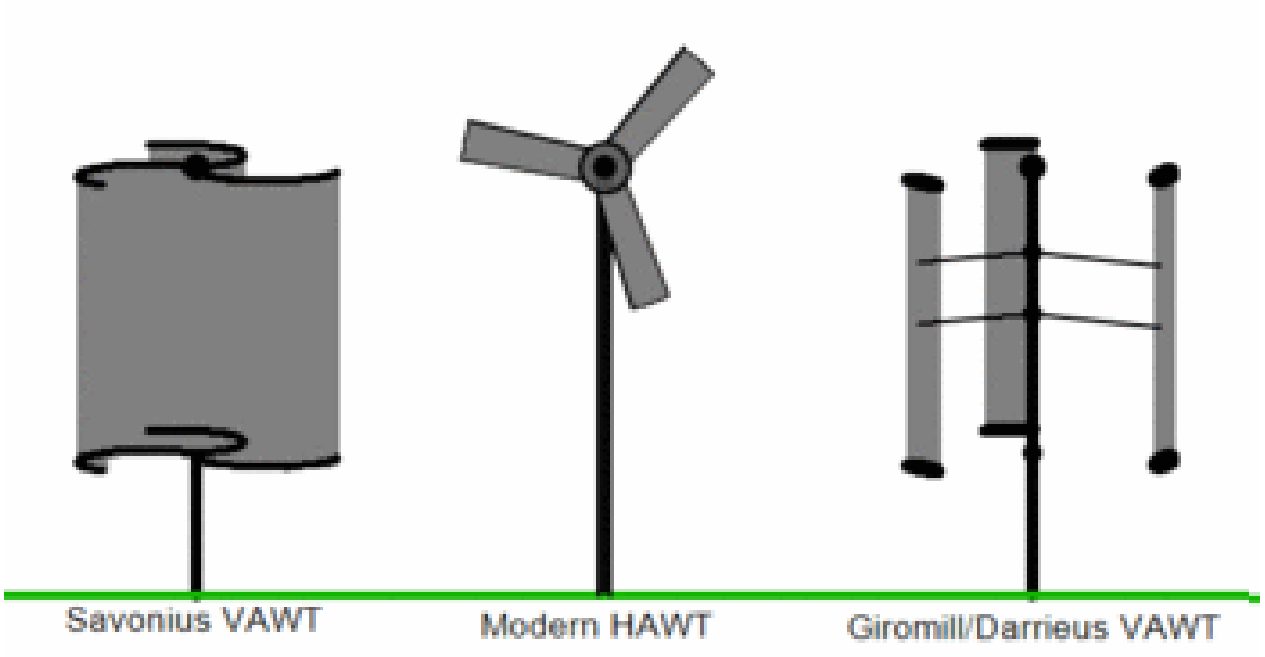
POWER NEEDED AND SURFACE

HI TECH LED LAMP: 2x150W (2x90W)

365 days x 8 hours a day = 876 KW·h (525 KW·h)

$P = \frac{1}{2} \times \rho \times \mathbf{S} \times v^3 \times Cp$

Savonius: **S=4.3 m²** Darrieus optimized: **S=1.9 m²**



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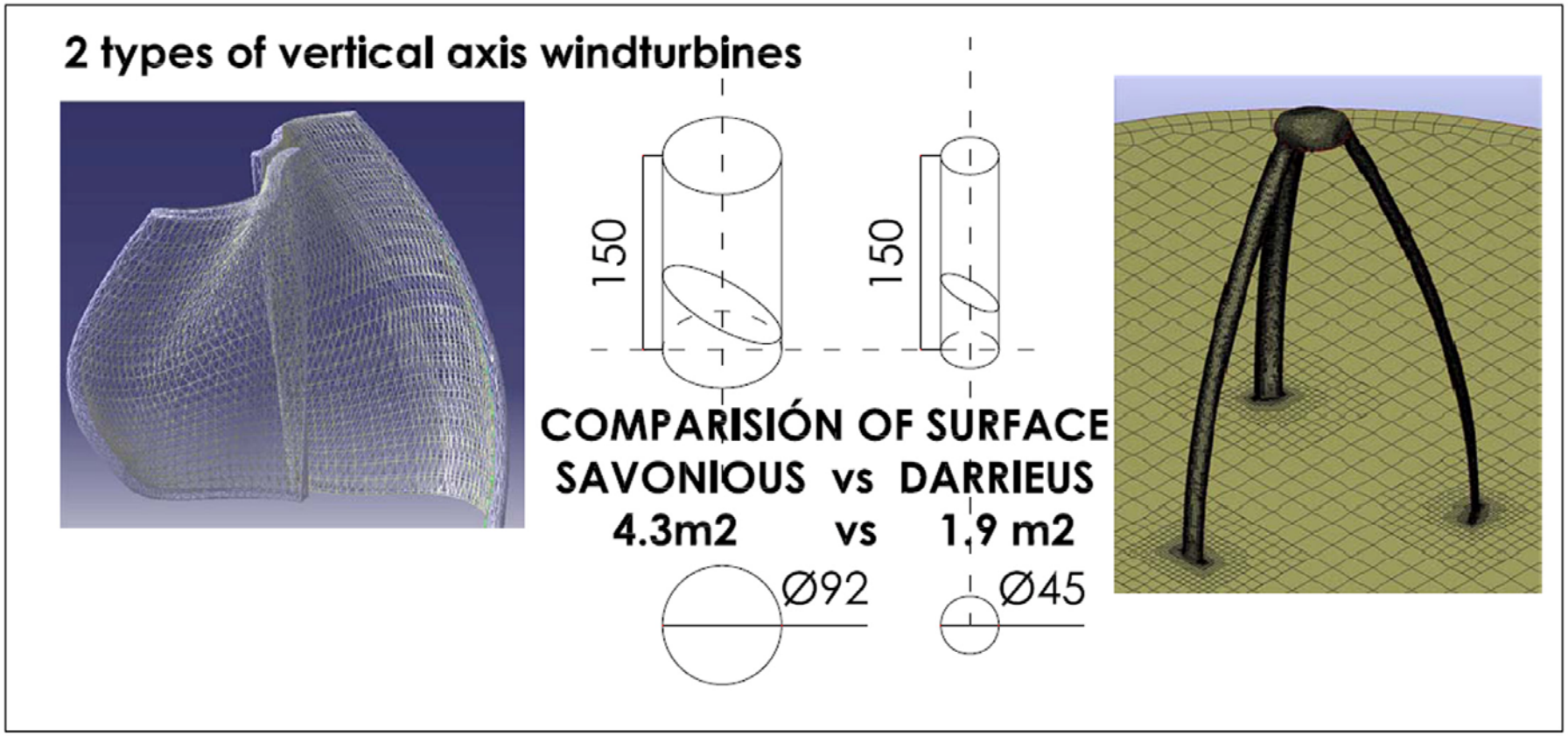

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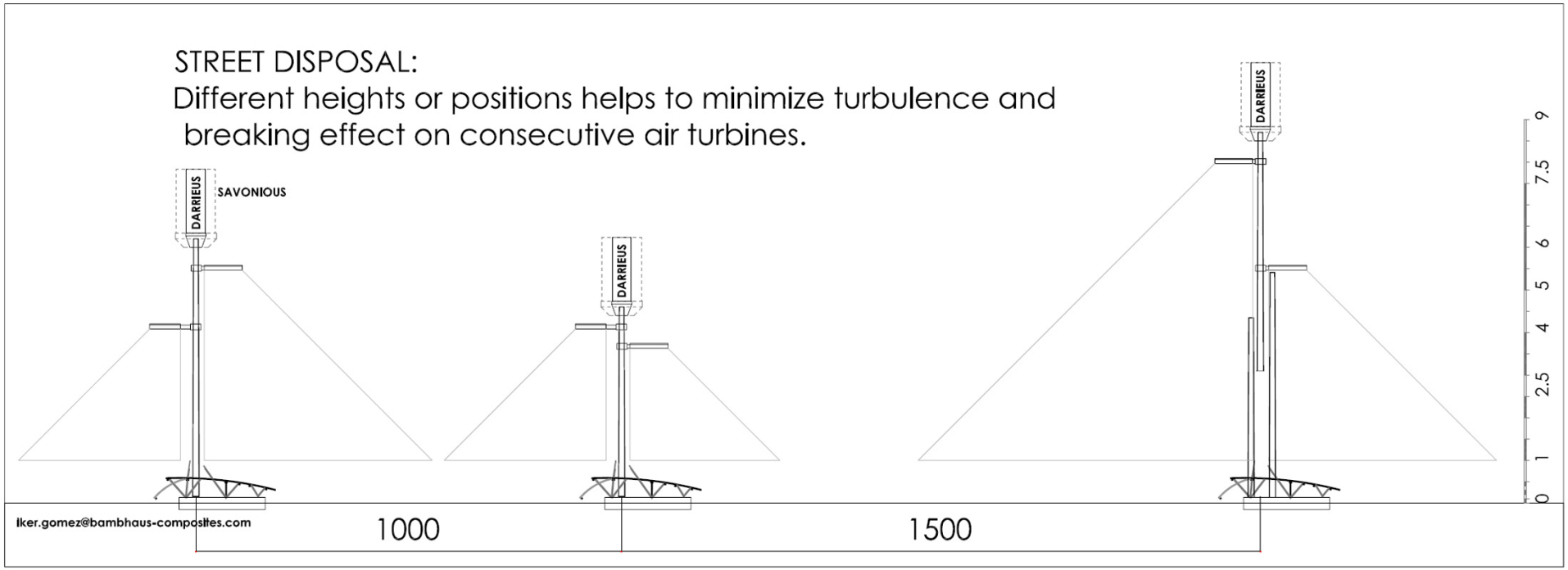
STREET DISPOSAL FOR AVOIDING SELF DISTURBANCE



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Engineered Bamboo for Sustainable Development

- IX W.B.C. 2.012 G.A.K. as an alternative to metal and synthetic fibers

GUADUA ANGUSTIPHOLIA KUNTH AS MAIN MATERIAL

- LOW DENSITY
- HIGHT DIRECTIONAL STRENGTH (TRACTION)
- ELASTIC PROPIERTIES
- NATURAL BEHAVIOUR AGAINST STRONG WINDS

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- IX W.B.C. 2.012 G.A.K. as an alternative to metal and synthetic fibers

GUADUA ANGUSTIPHOLIA KUNTH AS MAIN MATERIAL

TYPICAL VALUES		Flexural Bending*		Parallel compression	
Material	Density	Strength	Specific yield	Strength	Specific yield
	Kg/m3	*MPA*	*MPA/KG*	*MPA*	*MPA/KG*
GAK AXIAL TRACTION	**800**	**100**	**0,125**		
GAK CANE	800	45	0,056	44	0,055
2024 ALUMINUM	2780	290	0,104		
4130 STEEL	7850	841	0,107		
GAK STICK	800	45	0,056	50	0.055
GAK STICK+CORTEX	800	80	0,100	60	0.187
GAK FIBERS*	1200	800	0,650		
GAK COMPOSITES*	1200	150	0,125		
GLASS FIBER AXIAL	2600	3445	1,325	1080	0.415

- IX W.B.C. 2.012 G.A.K. as an alternative to metal and synthetic fibers
  GUADUA ANGUSTIPHOLIA KUNTH AS MAIN MATERIAL

  - LOW DENSITY
    HIGHER INERTIA MODULUS

  - DIRECTIONAL STRENGTH (TRACTION)
    FIBRE REINFORCEMENT

  - ELASTIC PROPIERTIES
    CHANGING WIND AND ACCELERATION STRESS ABSORBTION

  - NATURAL BEHAVIOUR AGAINST STRONG WINDS
    IDEAL FOR MAST BUILDING

- IX W.B.C. 2.012 G.A.K. as an alternative to metal and synthetic fibers

EMBODIED CO_2 APPROACH

	Weight	Embodied CO2		Embodied Energy	
	kg	kg CO2/kg	total	MJ/kg	total
GAK. Cane	150	-0,55	-82,5	9	1350
GAK. Stick	500	-0,4	-200	10	5000
Concrete base:	500	0,13	65	1,3	650
Corrugated Steel	20	2	40	47,4	948
Steel and metals:	15	2	30	48,4	726
Electrics and Optics:	15	4	60	90	1350
windturbine G.A.K. based:	50	2	100	20	1000
			12,5 kg CO2		**11.024 MJ**

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EMBODIED CO_2 APPROACH

	Weight	Embodied CO2		Embodied Energy	
	kg	kg CO2/kg	total	MJ/kg	total
Steel Cane	300	2	600	50	15000
GAK. Stick	500	-0,4	-200	10	5000
Concrete base:	1500	0,13	195	1,3	1950
Corrugated Steel	80	2	160	47,4	3792
Steel and metals:	0	2	30	48,4	726
Electrics and Optics:	15	4	60	90	1350
windturbine polymer composite:	40	8	320	50	2000
			1.160 kg CO2		**47.818 MJ**

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EMBODIED CO_2 APPROACH

- G.A.K. BASED URBAN FURNITURE + G.A.K. BASED WIND TURBINE

  $CO_2 \approx 12$

- G.A.K. BASED URBAN FURNITURE + TRADITIONAL COMPOSITE & STEEL WIND TURBINE

  $CO_2 \approx 1.160kg$

- EMBODIED ENERGY RELATION

  1 TO 4

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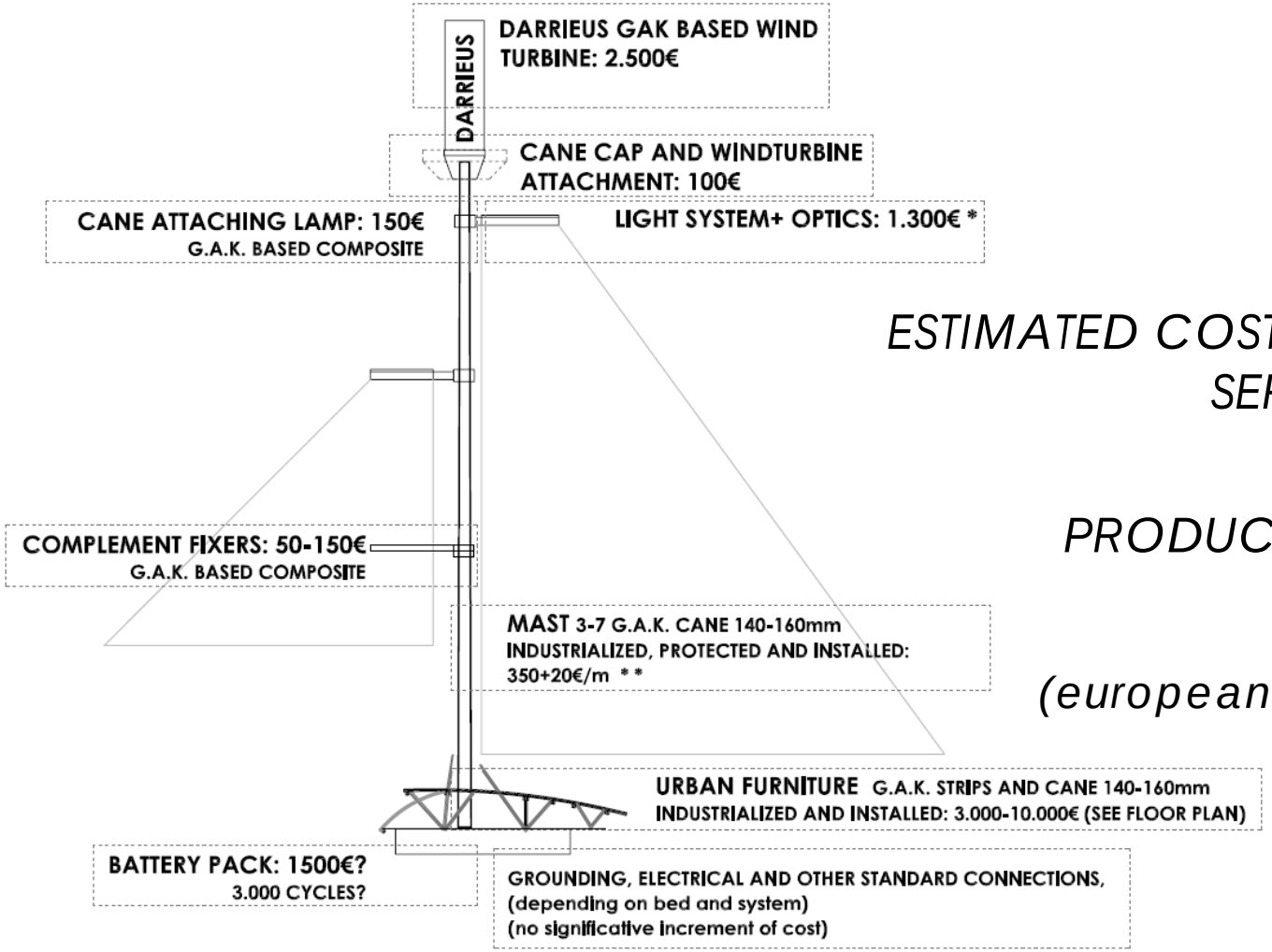
CONCLUSIONS

- G.A.K. CAN BE COMBINED WITH HI TECH EQUIPMENT
- DUE TO MECHANICAL PROPIERTIES G.A.K. IS A GREAT ALTERNATIVE TO STEEL, ALUMINUM AND OTHER SYNTHETIC MATERIALS;
  BUT SHOULD STUDIED IN ADVANCE.
- CO2 EMISSIONS AND ENERGY EMBODIED MUST TAKE AS AN APPROACH
- ALTHOUGHY USE OF G.A.K. OR OTHER BAMBOO OR WOODS BALANCING CO2 EMISSIONS IS A DIFFICULT TASK.

- IX W.B.C. 2.012 G.A.K. as an alternative to metal and synthetic fibers

APPENDIX: COST OF PROJECT



ESTIMATED COST FOR INDUSTRIAL / SERIES PRODUCTION;

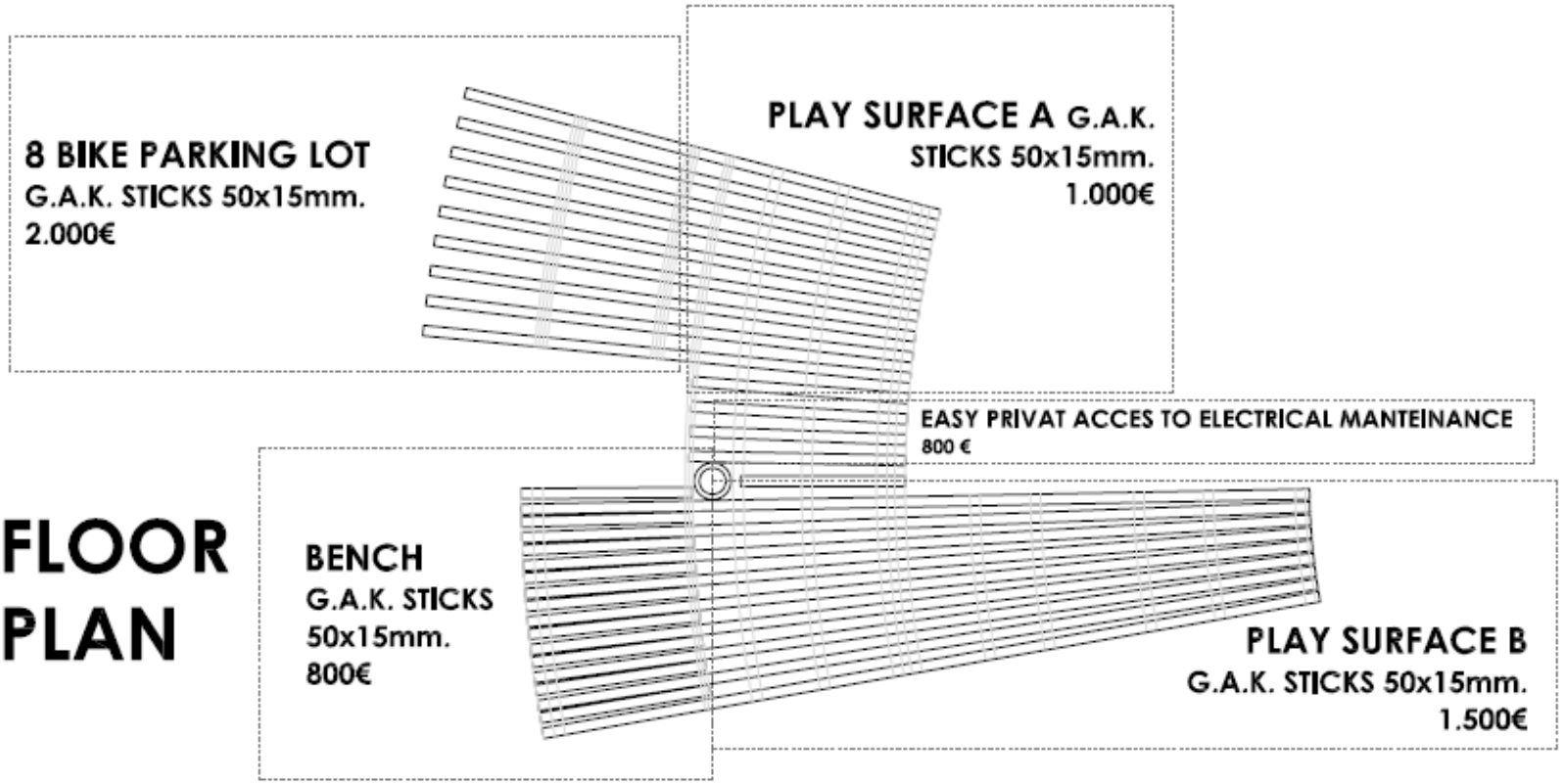
PRODUCED & INSTALLED IN VITORIA-GASTEIZ

(european green capital 2012)

- IX W.B.C. 2.012 G.A.K. as an alternative to metal and synthetic fibers

APPENDIX: COST OF PROJECT

INDUSTRIAL PRODUCTION, (VITORIA-GASTEIZ AS SITE)



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APPENDIX: COST OF PROJECT; SEEKING INVESTORS

R.D.I. PROJECT FOR VITORIA-GASTEIZ EUROPEAN GREEN CAPITAL 2012:

RESEARCH DEVELOPED, PRODUCED, INSTALLED & MANTEINED

300-600W WINDTURBINE	**R.D.I. COST**	**S. PROD. COST**
5 UNITS:	60.000€	≈ 2.500 €/u
2 YEAR MANTEINANCE:	10.000€	
3.000-5.000W WINDTURBINE		
5 UNITS:	125.000€	≈ 10.000 €/u
2 YEAR MANTEINANCE:	24.000€	
G.A.K. COMPOSITES WIND BLADES R.D.I.		
1.5-2 YEARS	150.000€	
WIND MAP		
EACH SECTOR	20.000€	
MEDIUM CITY	60.000-100.000€	

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THANK YOU VERY MUCH FOR YOUR INTEREST AND DISPLAYED KNOWLEDGE

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