

FEASIBILITY STUDY : SEMICONDUCTOR FACTORY
JEWAR DISTRICT, UTTAR PRADESH, INDIA

European Collaborators

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Semiconductor & Electronics Ecosystem

इलेक्ट्रॉनिकी एवं सूचना प्रौद्योगिकी मंत्रालय
MINISTRY OF ELECTRONICS AND INFORMATION TECHNOLOGY

इंडिया सेमीकंडक्टर मिशन
India Semiconductor Mission

Digital India
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ANNEX

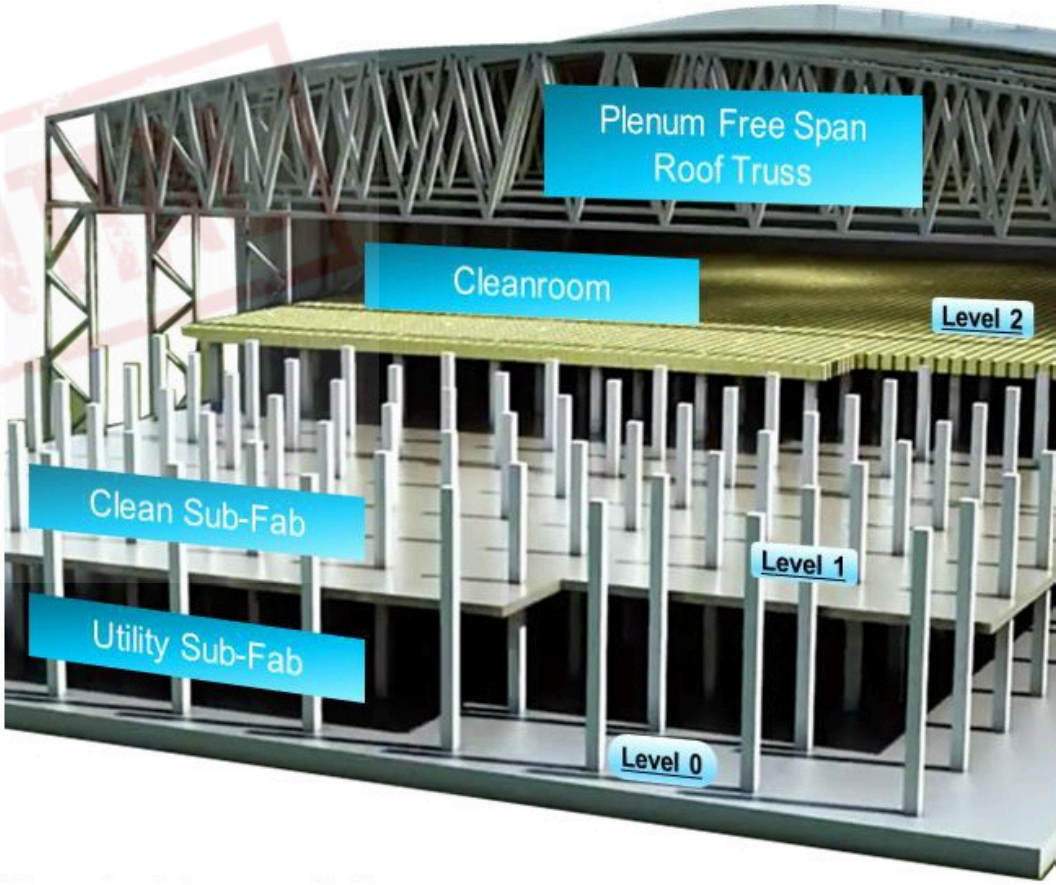
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Fab Key Criteria

Imec key FAB requirements*

Main cleanroom area Phase 1	2,000 m²
Main cleanroom area Phase 2 (Fab expansion)	2,000 m²
Baseline process technology	~ 45 nm
Manufacturing environment	21° C ± 1 K/45% r.H. ±3%
Cleanroom class ball room	ISO 6
Cleanroom class wafer start (FOUP cleaning)	ISO 3
Cleanroom class support areas	ISO 6
FAB concept	2+1 level
Waffle table load	25 kN/m²
Vibration class waffle table:	VC-D
Raised floor height	0.8 m
Clear height manufacturing area	5.5 m

Material Handling 300 mm wafer AMHS (200 mm manual)



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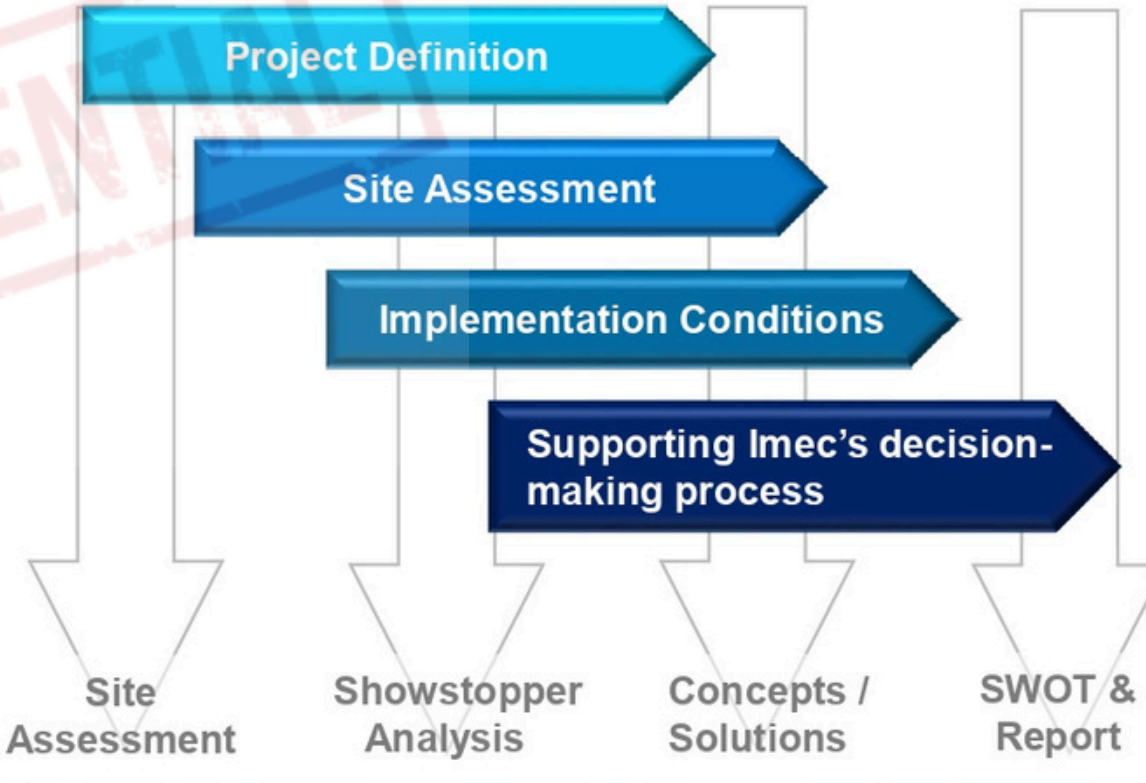
Feasibility Study's Objectives & Key Activities

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Study Approach

- Execution of feasibility study from Aug 25th to Dec 19th, 2023
  - Final Presentation Jan 11th , 2024
- Major activities:
  - Project definition
  - Development of a Fab Concept and Site Master Plan
  - Fit check of the proposed site concerning
    - City plan and regulations
    - Potential limitations
    - Available Space
    - Site Utilities (existing and upgrades)
    - Impact of neighbors, incl. vibration measurements
  - Initial site assessment of local building requirements and environmental impact
  - Discussions with PTA and local authorities
  - Cost planning estimate and tentative project schedule

Targets & Objectives



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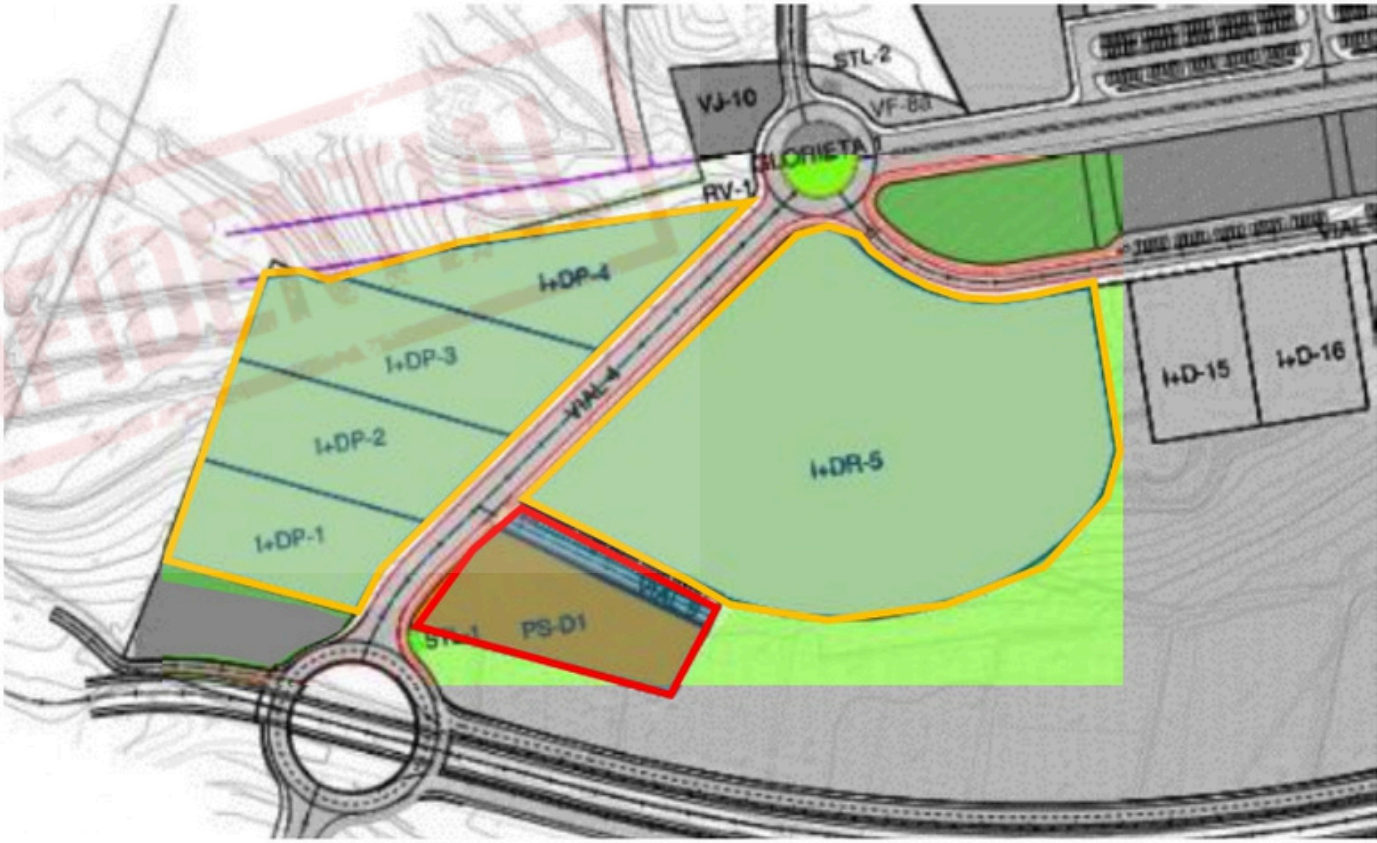
Current Site Zoning (1)

Overview of available plots – ownership and categorization

In total 6 plots to realize the Imec Fab 5 project

- I+DR-5 and I+DP-1 to I+DP-4
  - Owned by PTA*, S.A.
  - Research & development

- PS-D1
  - Public
  - Services of public and social interest



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Current Site Zoning (2)

Boundary conditions as per Plan Parcial* - Usable surface and area definitions



		Buildable Footprint (Maximum Specified)	Buildable Area (Maximum Specified)	Parking and Service (Maximum Specified)	Green Area (Minimum Specified)
Area Ratio vs Plot Size	I+DR-5	50%	69%	20%	25%
	I+DP-1	35%	67.1%	30%	35%
	I+DP-2	35%	67.1%	30%	35%
	I+DP-3	35%	67.1%	30%	35%
	I+DP-4	35%	67.1%	30%	35%
	PS-D1	100%	80%	n/a	n/a

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Current Site Zoning (3)

Site considerations & codes according to Plan Parcial*

- **Constraint**
  - Green areas cannot be consolidated from the main plot to the others
- **Assumption**
  - Plot aggregation will be processed administratively
- **Heights**
  - Maximum height to be built is 12 m
- **Parking requirements**
  - 1 parking space per 50 m2 of constructed building area
- **Topography**
  - Height difference of approx. 5 m up to 14 m

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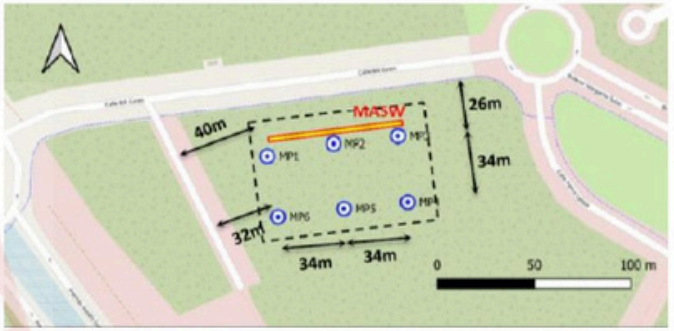
Vibration Site Measurements

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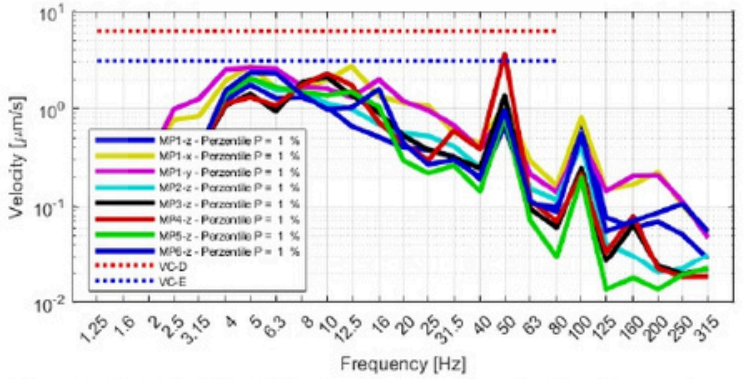
Vibrations and dynamic soil properties

- Two different kinds of measurements performed:
  - Long-term soil vibration measurements, duration of > 7,5 h.
  - Measurements of the wave propagation properties of the subsoil.

- **Results**
  - No identified critical external vibration sources.
  - Wafer FAB achievable with VC-D on the waffle table and VC-E on the ground slab.
  - Dynamic soil properties are sufficient for a stiff waffle table construction.
  - Plot is suitable for the construction of a semiconductor wafer FAB.



Defined measuring points on main plot (I+DR-5)

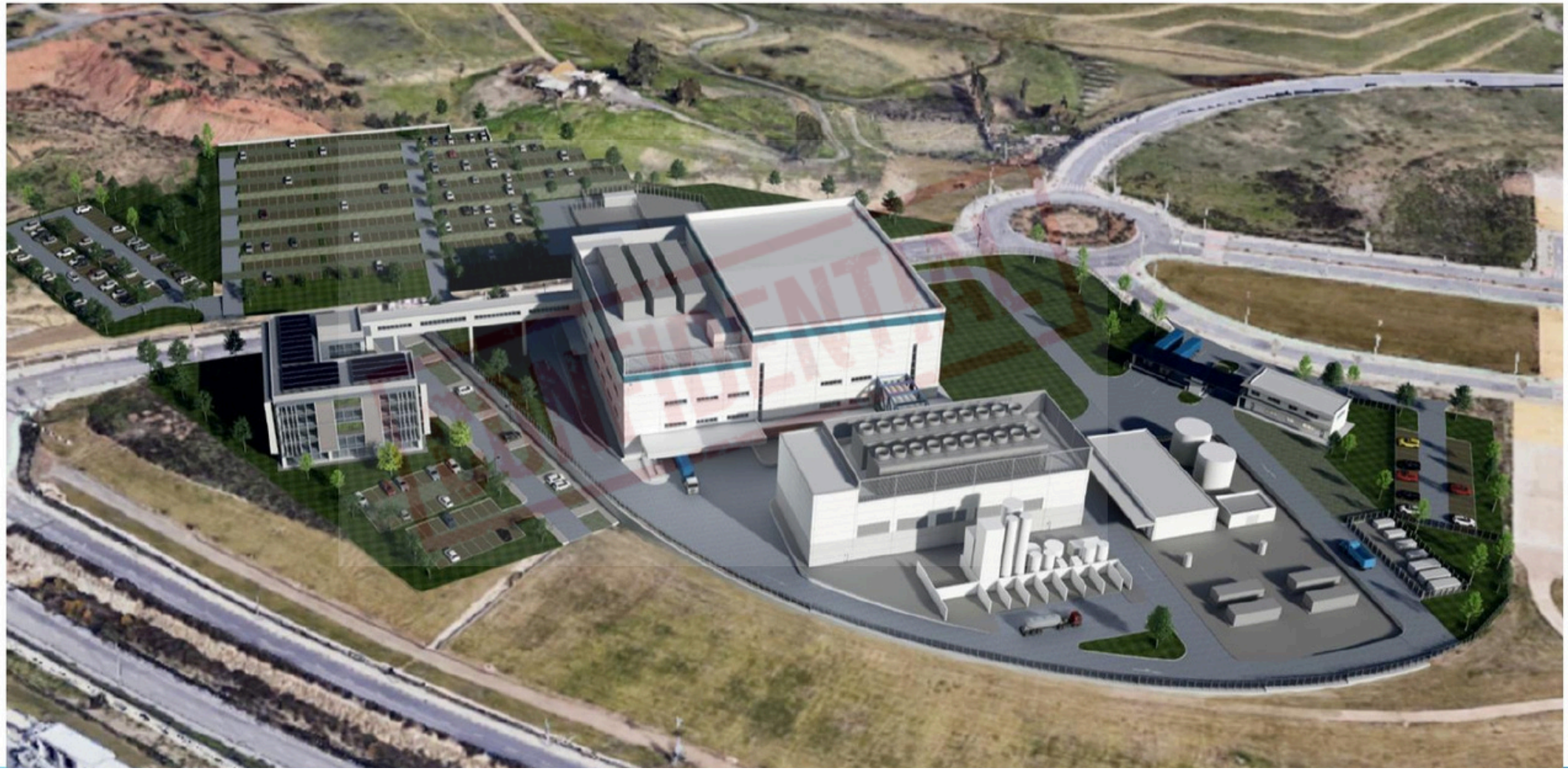


Statistical curves (P = 1% of 30s RMS vibration velocity spectra) for all measuring

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Aerial Overview – Phase 1



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Entrance of R&D Building Phase 1



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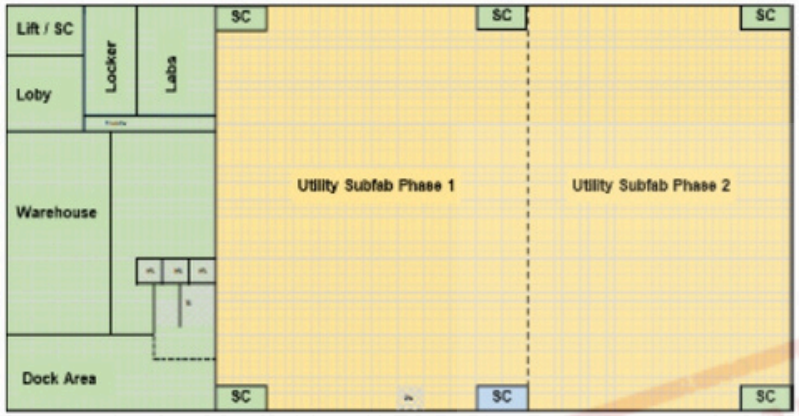
Site Master Plan



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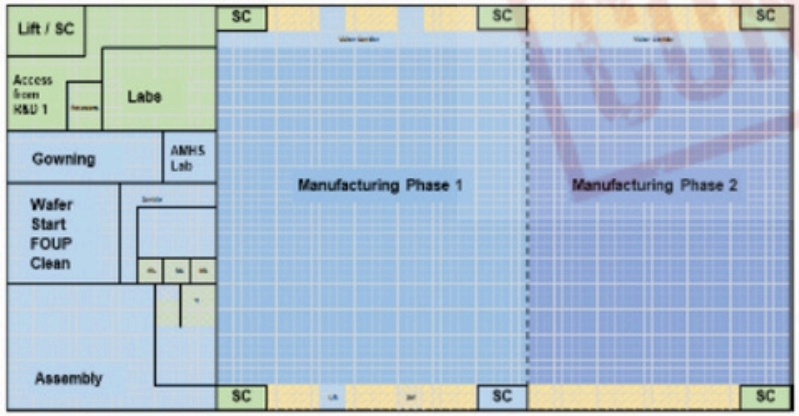
FAB Building Functions by Level & GFA*



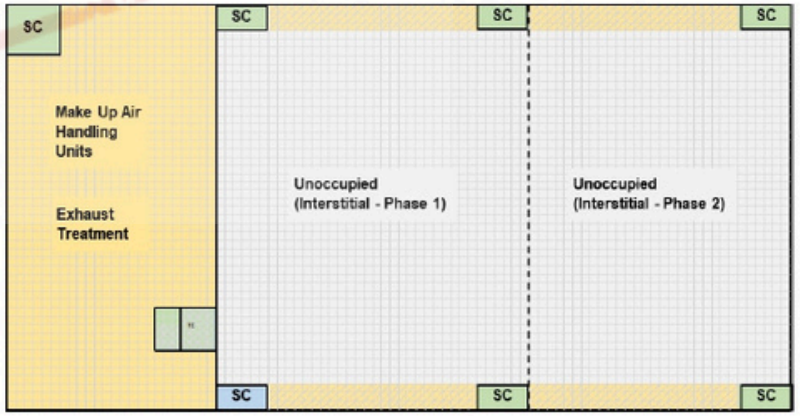
Level 0
Phase 1: 4,200 m²
Phase 2: 6,200 m²



Level 1
Phase 1: 3,700 m²
Phase 2: 5,700 m²



Level 2
Phase 1: 4,200 m²
Phase 2: 6,200 m²



Level 3
Phase 1: 1,700 m²
Phase 2: 1,700 m²

Gross Floor Area
Ph.1: 13,800 m²
Ph.2: 19,800 m²

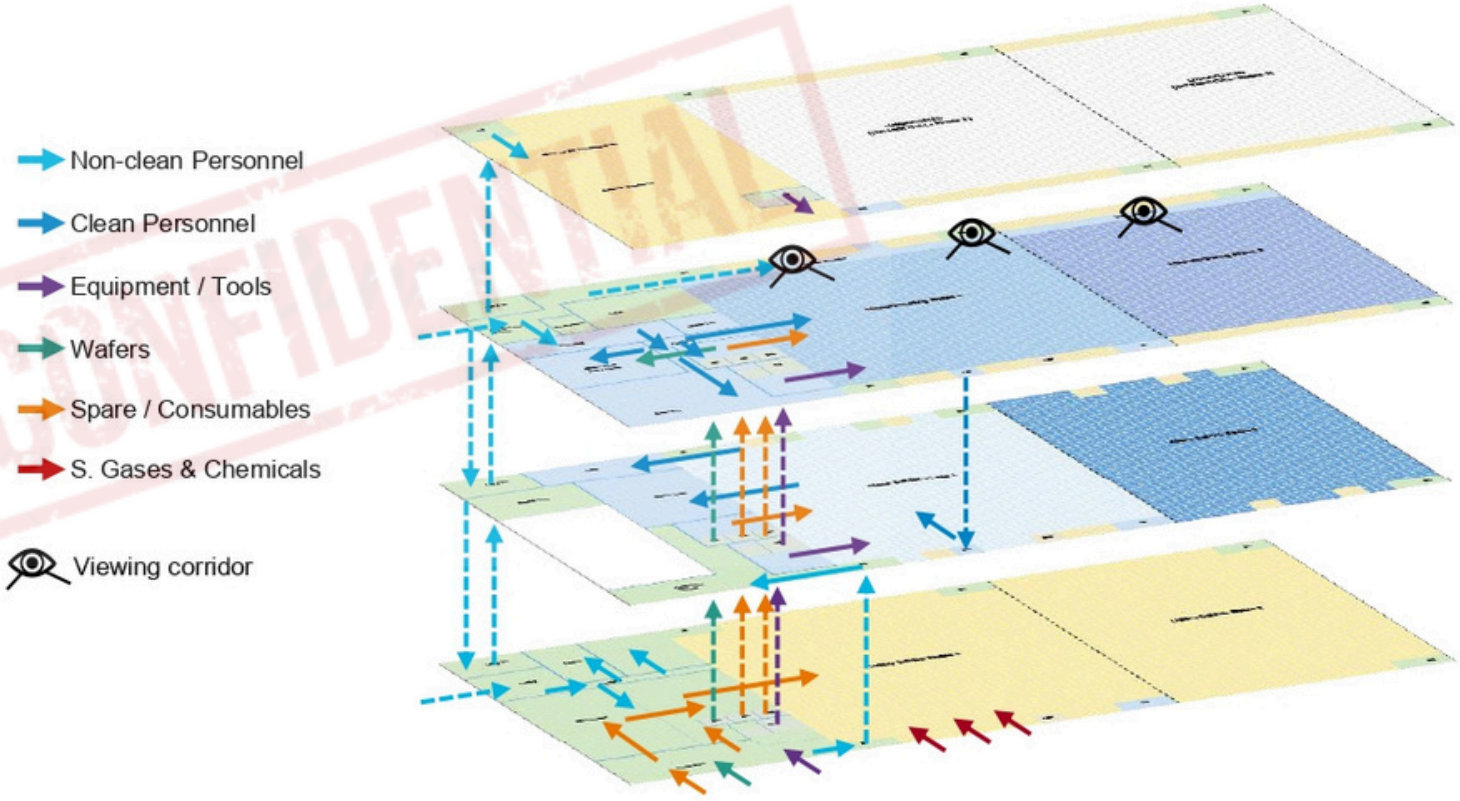
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FAB Building Concept – Logistics Overview

Sample Personnel and Material Flows

- Personnel

- Tool move-in
- Wafers
- Spare parts and consumables
- Gases and Chemicals



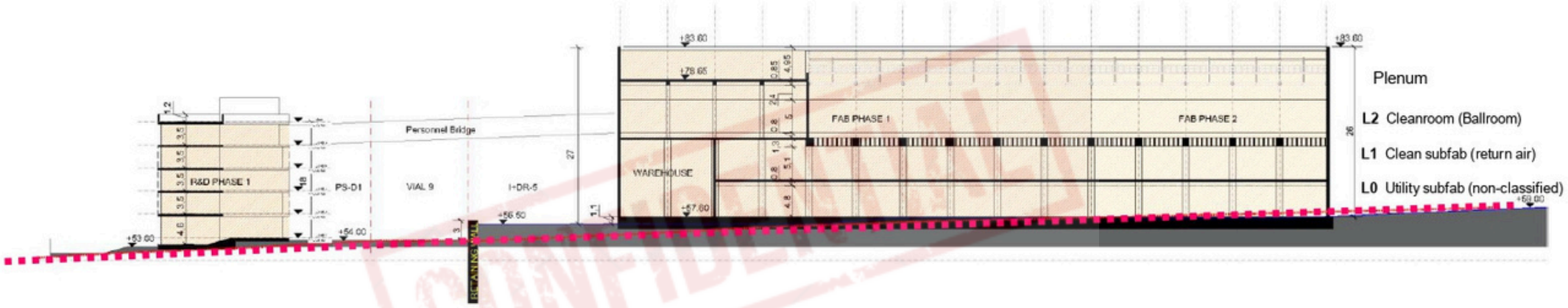
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Building Concepts – Sections & Topography

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= Existing level
= Anticipated level / fill

FAB + R&D Phase 1



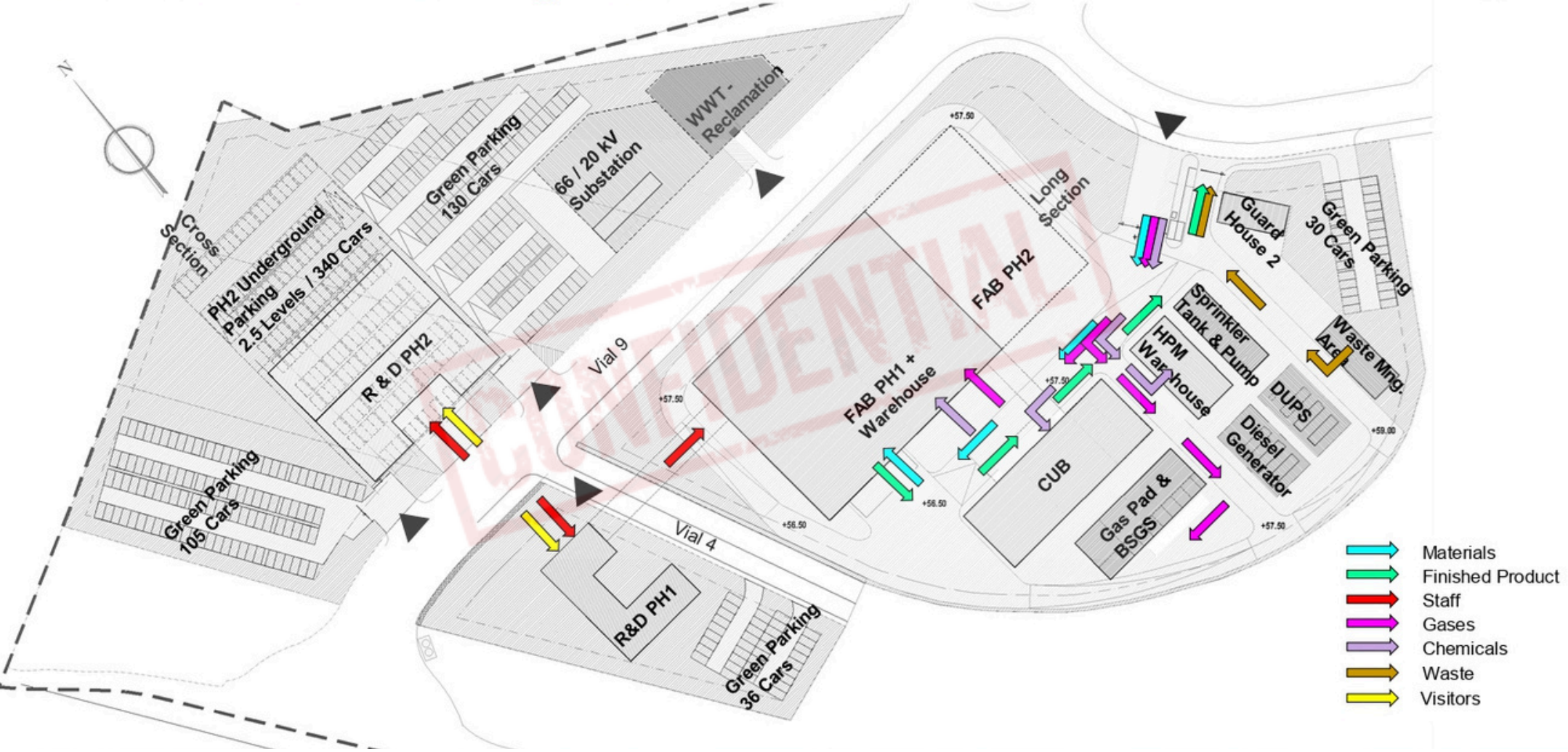
R&D Phase 1 + R&D Phase 2 & Parking Garage



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Site Master Plan Logistics – Phases 1 & 2

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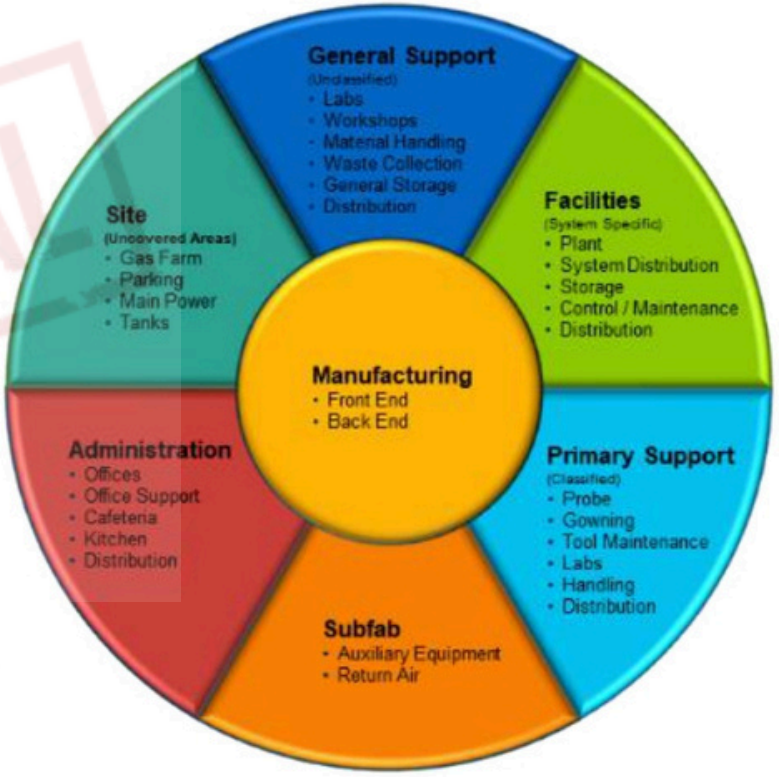
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Fab Building Areas

By Function and Phasing

FUNCTION	Subtotal Ph 1 [m²]	SPLIT %	TOTAL [m²]	SPLIT %
Manufacturing	2,125	10.1%	3,897	12.6%
Subfab	2,268	10.8%	4,238	13.7%
Primary Support	1,865	8.9%	1,908	6.2%
General Support	3,361	16.0%	3,499	11.3%
Facilities	3,973	36.7%	6,884	34.3%
Research & Development centers (separated)	*3,650*	17.4%	*6,750*	21.8%
Central Utility Building (separated)	*3,732*		*3,732*	
TOTAL GROSS FLOOR AREAS (TA)	**20,974**	**100.0%**	**30,908**	**100.0%**
Area Ratio (TA / GMA)	**9.87**		**7.93**	



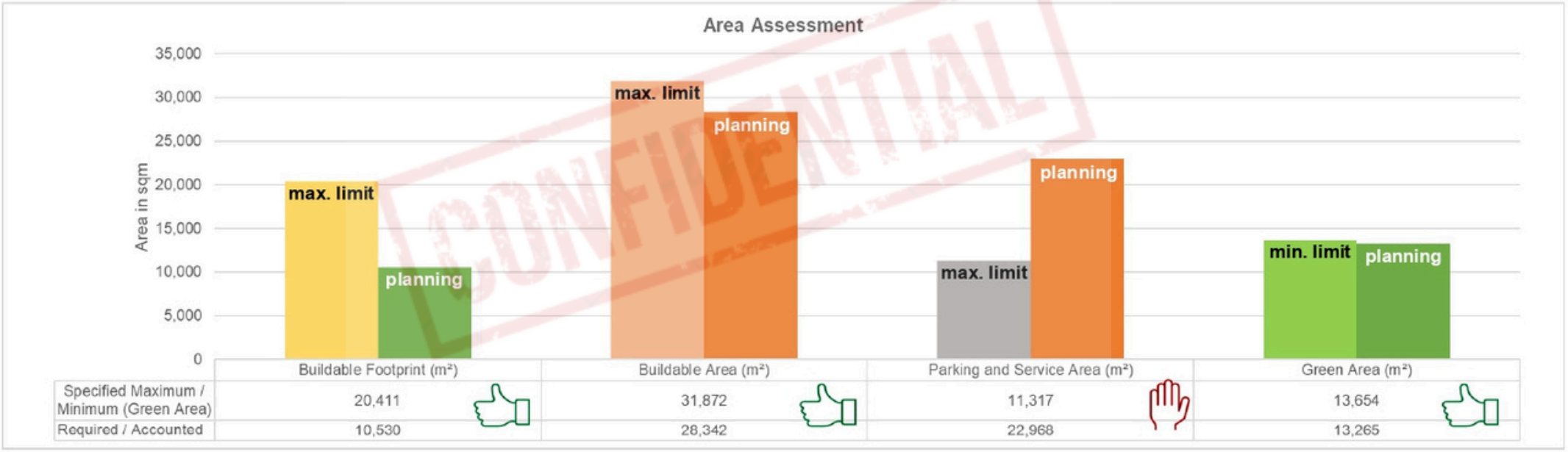
- Total GFA to manufacturing area ratio is within range of industry benchmarks for smaller wafer fabs.
- Noticeable contribution of R&D centers´ floor areas to results.
- Benchmarks exclude parking garage areas as well as open site functions.

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Areas Overview

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Area assessment vs. requirements according to Plan Parcial - Graphic



	Buildable Footprint (m²)	Buildable Area (m²)	Parking and Service Area (m²)	Green Area (m²)
Specified Maximum / Minimum (Green Area)	20,411	31,872	11,317	13,654
Required / Accounted	10,530	28,342	22,968	13,265

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Estimated Utility Requirements

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Based on HVM benchmarking and current Imec KPIs – Final status

Facility System	Benchmark								Remark
	Specific Consumptions (Average)				Average Consumptions				
	Unit	low. limit	upp. limit	recom.	Phase 1 24/7	Phase 2 24/7	Phase 1+2 24/7	Unit	
Benchmarking Consumptions & Capacities Process Equipment, Local Abatement and Facilities									
Electrical Fab Complex	kW/m²	2.3	3.5	3.1	5,580	5,580	11,160	kW	11.4 MVA @ 0.98 PF
Chilled water flow rate	m³/h/m²				1,230	1,030	2,260	m³/h	delta T = 8K (MT chilled water: 13/21)
Cooling capacity (chilled water)	kW/m²				11,400	9,600	21,000	kW	cooling only + heat recovery chillers + HR chillers / heatpumps
Heating capacity	kW/m²				4,860	3,960	8,820	kW	100% heating from boiler
Natural Gas (total)	Nm³/h/m²				230	230	460	Nm³/h	Process tools (local abatement) and hot water generation
Exhaust - general	Nm³/h/m²	18	39	35	63,000	63,000	126,000	Nm³/h	
Exhaust - acid	Nm³/h/m²	14	39	40	72,000	72,000	144,000	Nm³/h	
Exhaust - caustic	Nm³/h/m²	2	12	14	25,200	25,200	50,400	Nm³/h	
Exhaust - solvent	Nm³/h/m²	4	12	14	25,200	25,200	50,400	Nm³/h	
Exhaust - total	Nm³/h/m²	54	94	103	185,400	185,400	370,800	Nm³/h	
Fab Make-up Air	Nm³/h/m²			88	158,400	158,400	316,800	Nm³/h	
Make-up Air (total)	Nm³/h/m²			115	210,000	210,000	420,000	Nm³/h	
City water (total)	m³/h/m²						613	m³/day	
Waster water (total)	m³/h/m²						499	m³/day	

Criteria / Scenario	Reclaim Baseline	Reclaim Advanced	Reclaim MLD*
Water supply demand	613 m^3/day	405 m^3/day	352 m^3/day
→ City water + city reclaim water	484 m^3/day + 129 m^3/day	387 m^3/day + 18 m^3/day	352 m^3/day + 0 m^3/day
Sewer discharge	499 m^3/day	290 m^3/day	152 m^3/day
Other Non-process use	--	--	85 m^3/day
Reclaim rate	50%	70%	75%



* MLD = Minimized Liquid Discharge

Estimated Utility Requirements

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Based on HVM benchmarking and current Imec KPIs – Final status

Facility System	Specific Consumptions (Average)				Benchmark Average Consumptions				Remark
	Unit	low. limit	upp. limit	recom.	Phase 1 24/7	Phase 2 24/7	Phase 1+2 24/7	Unit	
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Exhaust - acid	Nm³/h/m²	14	39	40	72,000	72,000	144,000	Nm³/h	
Exhaust - caustic	Nm³/h/m²	2	12	14	25,200	25,200	50,400	Nm³/h	
Exhaust - solvent	Nm³/h/m²	4	12	14	25,200	25,200	50,400	Nm³/h	
Exhaust - total	Nm³/h/m²	54	94	103	185,400	185,400	370,800	Nm³/h	
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Make-up Air (total)	Nm³/h/m²			115	210,000	210,000	420,000	Nm³/h	
City water (total)	m³/h/m²						613	m³/day	
Waster water (total)	m³/h/m²						499	m³/day	
Benchmarking Consumptions Process Equipment and Local Abatement									
Electrical Tool	kW/m²	0.9	1.4	1.2	2,200	2,200	4,400	kW	plasma abatement systems considered, excluding UPW-Heater
UPW	m³/h/m²	0.007	0.025	0.015	20	10	30	m³/h	might be reduced in future phases (VE item)
RO Water local abatements (reclaim / permeate)					1	0.6	1.6	m³/h	
PCW	m³/h/m²	0.130	0.250	0.160	400	400	800	m³/h	recom. 0.16 m³/h/m² & delta T = 3.2K
PCW - Heatload	kW/m²	0.56	0.87	0.84	1,500	1,500	3,000	kW	
Exhaust - general	Nm³/h/m²	15	30	28	50,000	50,000	100,000	Nm³/h	
Exhaust - acid	Nm³/h/m²	12	30	28	50,000	50,000	100,000	Nm³/h	
Exhaust - caustic	Nm³/h/m²	2	9	12	22,000	22,000	44,000	Nm³/h	
Exhaust - solvent	Nm³/h/m²	4	10	12	22,000	22,000	44,000	Nm³/h	
Exhaust - total	Nm³/h/m²	39	79	80	144,000	144,000	288,000	Nm³/h	
CDA - total	Nm³/h/m²	0.5	1.1	0.7	1,260	1,260	2,520	Nm³/h	
N2 - total	Nm³/h/m²	0.34	0.94	0.45	810	810	1,620	Nm³/h	
H2	Nm³/h/m²	0.003	0.006	0.003	5	5	11	Nm³/h	to be rechecked (lower side)
He	Nm³/h/m²	0.0003	0.0009	0.0006	1	1	2.2	Nm³/h	
O2 - total	Nm³/h/m²	0.004	0.020	0.004	6	6	12	Nm³/h	no O2 for local abatement systems, tools only
Ar	Nm³/h/m²	0.002	0.007	0.004	7	7	14	Nm³/h	
Natural Gas	Nm³/h/m²			0.017	30	30	60	Nm³/h	local abatement
Proc. Vac.	Nm³/h/m²	0.020	0.035	0.030	54	54	108	Nm³/h	
Chemical Supply Systems	Quantity			25	25	-	25	Quantity	
Slurry Supply Systems	Quantity			10	10	-	10	Quantity	
Bulk specialty gas	Quantity				2	1	3	Quantity	Assumption: NF3, HCL and one future system
Specialty Gas Systems	Quantity			150	105	45	150	Quantity	Assume: 60/40 split between double and single cylinder cabinets
Solar Generated Energy (PV)	MWh				136	401	537	MWh/a	basic concept; pending PV surface area m² data
Facility Systems Fab Load	%			100.0%	3,390	3,390	6,760	kW	
Normal Loads (NPS)	%			54%	1,808	1,808	3,617	kW	NPS load in % of Facility Load
Emergency Loads (EPS)	%			38%	1,288	1,288	2,576	kW	EPS load in % of Facility Load
Critical Loads (UPS)	%			8%	284	284	568	kW	UPS load in % of Facility Load

Site Utilities Overview

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Available

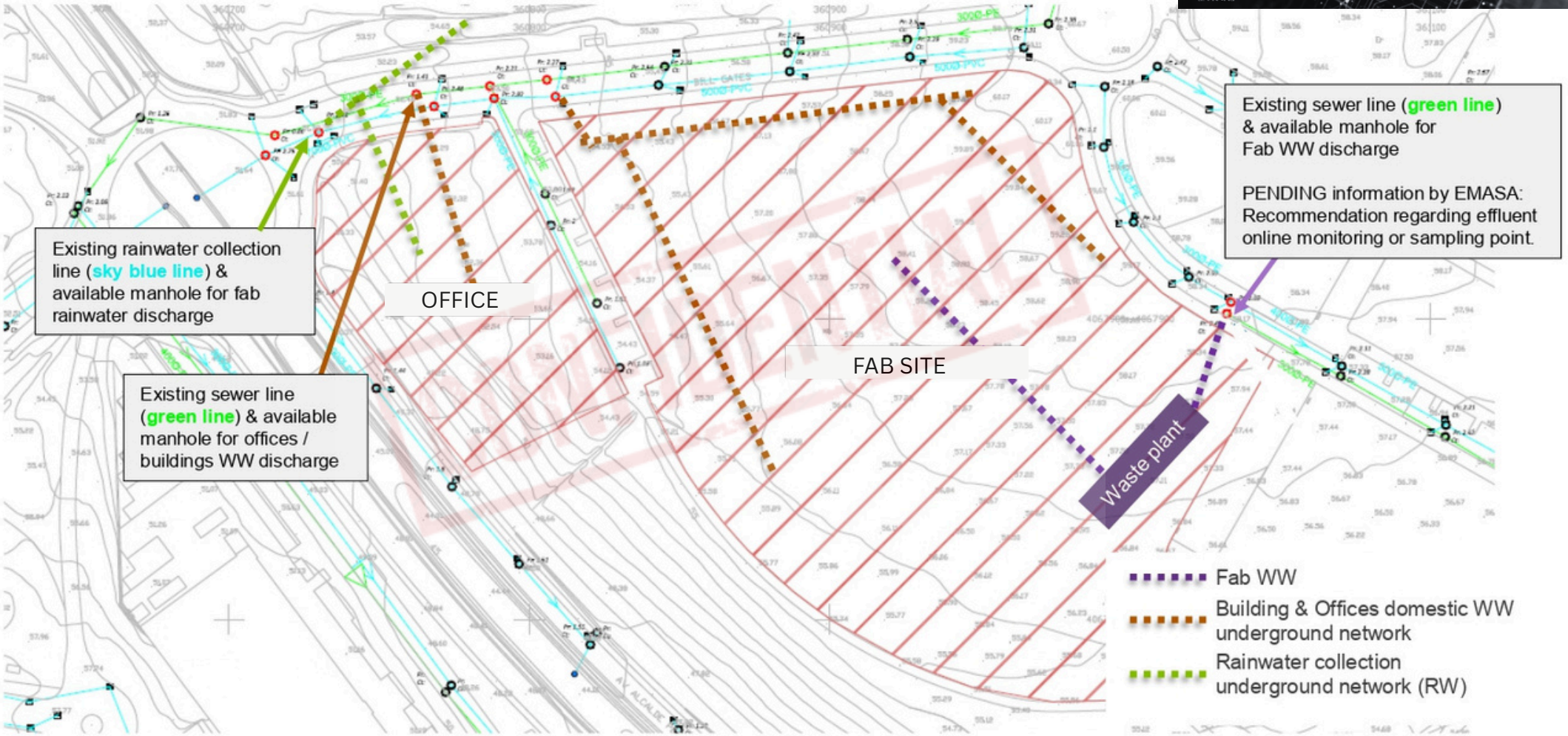
Utility / Provider	Capacity Rqd.*	Availability	Schedule	Comments
Power supply	11.2 MW – 66 kV	YES	2 years for deployment	Power not available at 20 kV
Water supply & Wastewater treatment	500 m^3/day PW 130 m^3/day RW 250-500 m^3/day SW	YES	< 6 months	RW (reclaimed water) owned by NEDGIA, operated by EMASA
Gas supply	400-500 Nm^3/h	YES	< 6 months	

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PW = potable water
RW = reclaim water
SW = Sewage (waste) water
*Phase 1 and Phase 2

Wastewater & Rainwater Sewage - EMASA

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Natural Gas

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Utilities – Summary & Conclusions



- **Power Supply**
  - 11.2 MW - redundant * & reliable power supply will be available at 66 kV (not available at 20 kV)
    ** Second 66 kV line under construction*
  - New 66/20 kV substation and 66 kV cable runs will be required (2 years execution - early start is required)
  - Power quality monitoring campaign in progress at 66 kV, results will be shared with Imec (ongoing)

- **Gas Supply**
  - 500 Nm^3/h (4 bar) available from existing nearby gas pipelines
  - Excellent supply reliability

- **Water Supply (PW & RW)**
  - Up to 500 m^3/day PW available from nearby aqueduct with acceptable quality.
  - 130 m^3/day RW available from nearby aqueduct with acceptable quality for the cooling towers only
  - RW (aqueduct & plant owned by and operated by contractual agreement will be required
  - Reliable supply (last 5 years), could be affected in the future by global warming & climate change (> 20 years)

- **Waste Water (SW)**
  - 250 m^3/day - 500 m^3/day SW drainage network available
  - SW treatment required to comply with pollutant limits

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Factory Concept and Site Master Plan

The concept contains the following key areas

- Process equipment overview
- Manufacturing system requirements
- Required facility systems and total capacities
- Area programming based on benchmarking
- Definition of buildings in fab complex, including:
  - Phasing considerations
  - Special requirements such as vibration isolation
  - Overall building areas by level (height, number of levels)
  - Outline concept per building (schematic sections with height development)
  - Building area layouts per level by function (manufacturing, support, logistics, facilities, labs etc.)
- Potential sustainability options
- Site considerations
- Factory layout
- Site master plan concept



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Production Model

Key production data

- A high-volume production is not planned for Fab 5.

- Manufacturing capacities:
  - Volume forecast (lot turns per year):

2027	2028	2029	2030	2031	2032	2033	2034
6000	10000	16000	24000	32000	41000	50000	55000

Note: based on plant operation, source Imec

- Plant operation mode:
  - Initially (Phase 1) 16 hours per day, 5 days per week
    - Two shifts - on weekends the Fab runs on standby in idle mode.
    - Five days per week and 220 days per year.
    - No scheduled shutdowns are scheduled, only if required, e.g. for utility tie-ins during conversions or cleanroom expansion.
  - Ramp up to 24 hours per day, 7 days per week
    - Final ramp up of Phase 1 may be achieved before starting installation of Phase 2.

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Process Equipment List

Proposed clustering and location

- On waffle table 300 mm
- On waffle table 200 mm
- Assembly on waffle table
- Metrology on waffle table

51 major tools
15 minor tools

- Support room assembly
- Support room logistics / wafer start

7 tools
6 tools



Source Exyte, Dec. 2023

- The tool list is representing Phase 1 only.
- The same number of tools should be considered for Phase 2.
- Dry bed scrubber planned for dry etch, ALD.
- Active burn - wet system planned for CVD, LPCVD.
  - Active burn wet scrubbers to be replaced with plasma abatement systems for sustainability reasons in the future.

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Production Environment

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Defined requirements

- Manufacturing environment:
  - Temperature: 21° C ± 1 K
  - Relative humidity: 45% ±3%
- Cleanroom specification ball room
  - Cleanroom class: ISO 6
- Cleanroom specification wafer start (FOUP cleaning)
  - Cleanroom class: ISO 3
- Cleanroom specification labs, support / test etc.
  - Cleanroom class: ISO 6
- Waffle table load:
  - Indicative floor load: 25 kN/m²
- Height development in the cleanroom
  - Clear height manufacturing area: 5.5 m
  - Raised floor height: 0.8 m
- Material Handling
  - 300 mm wafer: AMHS
  - 200 mm wafer: manual
- Vibration criteria waffle slab:
  - Vibration class waffle table: VC-D
  - Specific areas on waffle table: VC-C

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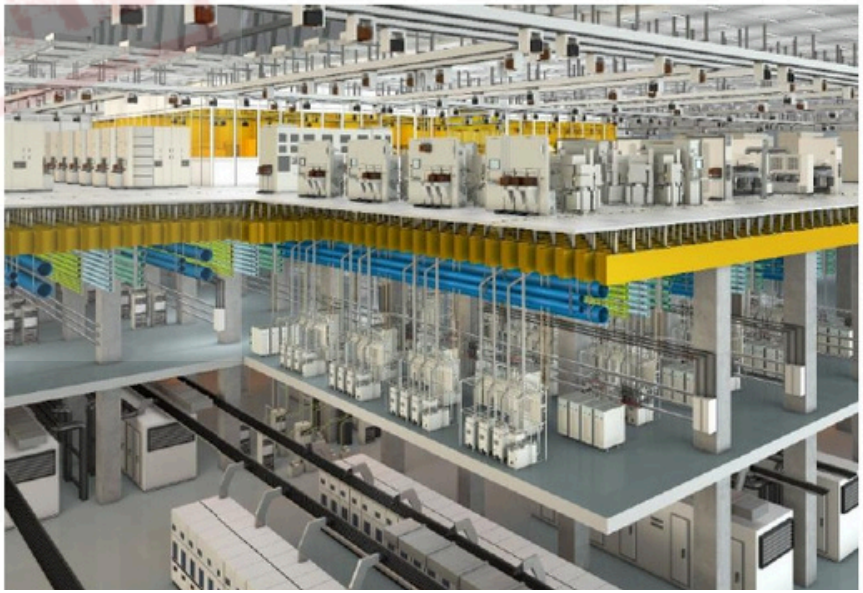
Functions and Capacities

Baseline

- Initial utility requirements based on HVM benchmarking and adjusted with Imec consumption data.
  - Area development for benchmarking:

	Phase 1	Phase 2	Total
Gross Manufacturing Area [m²]	2,000	2,000	4,000
Net Manufacturing Area [m²]	1,800	1,800	3,600

- Key considerations for Fab concept and development:
  - N+1 redundancy concept to support 24/7 operations.
  - Water conservation
  - Number of waste streams
  - Volumes for treatment vs. collection and off-site treatment
  - Optional: sustainability measures, e.g. dry cooling systems



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Estimated Utility Requirements

Based on HVM benchmarking – Initial status

Facility System	Benchmark Specific Consumptions (Average) Unit	low. limit	upp. limit	recom.	Average Consumptions Phase 1 24/7	Phase 2 24/7	Phase 1+2 24/7	Unit	Remark
Benchmarking Consumptions Process Equipment, Local Abatement and Facilities									
Electrical Fab Complex	kW/m²	2.3	3.5	3.0	5,400	5,400	10,800	kW	12 MVA @ 0.9 PF
Chilled water flow rate	m³/h/m²				690	690	1,380	m³/h	delta T = 8K
Cooling capacity (chilled water)	kW/m²				6,400	6,400	12,800	kW	cooling only + heat recovery chillers
Heating capacity	kW/m²				4,650	4,650	9,300	kW	
Natural Gas (total)	Nm³/h/m²				170	170	340	Nm³/h	Process tools (local abatement) and hot water generation
Exhaust - general	Nm³/h/m²	18	39	31	55,800	55,800	111,600	Nm³/h	
Exhaust - acid	Nm³/h/m²	14	39	30	54,000	54,000	108,000	Nm³/h	
Exhaust - caustic	Nm³/h/m²	2	12	11	19,800	19,800	39,600	Nm³/h	
Exhaust - solvent	Nm³/h/m²	4	12	11	19,800	19,800	39,600	Nm³/h	
Exhaust - total	Nm³/h/m²	54	94	83	149,400	149,400	298,800	Nm³/h	
Fab Make-up Air	Nm³/h/m²			66	118,800	118,800	237,600	Nm³/h	
Make-up Air - total	Nm³/h/m²			90	160,000	160,000	320,000	Nm³/h	
Benchmarking Consumptions Process Equipment and Local Abatement									
Electrical Tool	kW/m²	0.9	1.4	1.1	2,000	2,000	4,000	kW	excluding UPW-Heater
UPW	m³/h/m²	0.007	0.025	0.015	27	27	54	m³/h	to be evaluated again
PCW	m³/h/m²	0.130	0.250	0.150	270	270	540	m³/h	recom. 0.15 $m^3/h/m^2$ & delta T = 4.4K
PCW - Heatload	kW/m²	0.56	0.87	0.77	1,400	1,400	2,800	kW	
Exhaust - general	Nm³/h/m²	15	30	24	43,200	43,200	86,400	Nm³/h	
Exhaust - acid	Nm³/h/m²	12	30	18	32,400	32,400	64,800	Nm³/h	
Exhaust - caustic	Nm³/h/m²	2	9	9	16,200	16,200	32,400	Nm³/h	
Exhaust - solvent	Nm³/h/m²	4	10	9	16,200	16,200	32,400	Nm³/h	
Exhaust - total	Nm³/h/m²	38	78	60	108,000	108,000	216,000	Nm³/h	
CDA - total	Nm³/h/m²	0.5	1.1	0.7	1,260	1,260	2,520	Nm³/h	
N2 - total	Nm³/h/m²	0.34	0.94	0.45	810	810	1,620	Nm³/h	
H2	Nm³/h/m²	0.003	0.008	0.003	5	5	11	Nm³/h	
He	Nm³/h/m²	0.0003	0.0009	0.0006	1	1	2.2	Nm³/h	
O2 - total	Nm³/h/m²	0.004	0.020	0.016	29	29	58	Nm³/h	Including technical O2 (90% 2.8, 10% 8.0)
Ar	Nm³/h/m²	0.002	0.007	0.004	7	7	14	Nm³/h	
Natural Gas	Nm³/h/m²			0.017	30	30	60	Nm³/h	local abatement
Proc. Vac.	Nm³/h/m²	0.020	0.035	0.030	54	54	108	Nm³/h	
Chemical Supply Systems	Quantity			25	25		25	Quantity	
Slurry Supply Systems	Quantity			10	10		10	Quantity	
Bulk specilty gas	Quantity				2	1	3	Quantity	Assumption: NF3, HCL and one future system
Specialty Gas Systems	Quantity			150	105	45	150	Quantity	Assume: 60/40 split between double and single cylinder cabinets
Solar Generated Power (PV)	kW							kW	pending roof surface m2 data
Facility Systems Fab Load	%				3778	3778	7556	kVA	
Normal Loads (NPS)	%			53.5%	2021	2021	4042	kVA	NPS load in % of Facility Load
Emergency Loads (EPS)	%			38.1%	1439	1439	2879	kVA	EPS loads in % of Facility load
Critical Loads (UPS)	%			8.4%	317	317	635	kVA	UPS loads in % of Facility Load
Critical Loads (DUPS)	%			0.0%	0	0	0	kVA	DUPS not required

Estimated Utility Requirements

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Based on HVM benchmarking and current Imec KPIs – Final status

Facility System	Benchmark Specific Consumptions (Average) Unit	low. limit	upp. limit	recom.	Average Consumptions Phase 1 24/7	Phase 2 24/7	Phase 1+2 24/7	Unit	Remark
Benchmarking Consumptions & Capacities Process Equipment, Local Abatement and Facilities									
Electrical Fab Complex	kW/m²	2.3	3.5	3.1	5,580	5,580	11,160	kW	11.4 MVA @ 0.98 P.F.
Chilled water flow rate	m³/h/m²				1,230	1,030	2,260	m³/h	delta T = 8K (MT chilled water: 13/21)
Cooling capacity (chilled water)	kW/m²				11,400	9,600	21,000	kW	cooling only + heat recovery chillers + H R chillers / heatpumps
Heating capacity	kW/m²				4,860	3,960	8,820	kW	100% heating from boiler
Natural Gas (total)	Nm³/h/m²				230	230	460	Nm³/h	Process tools (local abatement) and hot water generation
Exhaust - general	Nm³/h/m²	18	39	35	63,000	63,000	126,000	Nm³/h	
Exhaust - acid	Nm³/h/m²	14	39	40	72,000	72,000	144,000	Nm³/h	
Exhaust - caustic	Nm³/h/m²	2	12	14	25,200	25,200	50,400	Nm³/h	
Exhaust - solvent	Nm³/h/m²	4	12	14	25,200	25,200	50,400	Nm³/h	
Exhaust - total	Nm³/h/m²	54	94	103	185,400	185,400	370,800	Nm³/h	
Fab Make-up Air	Nm³/h/m²			88	158,400	158,400	316,800	Nm³/h	
Make-up Air (total)	Nm³/h/m²			115	210,000	210,000	420,000	Nm³/h	
City water (total)	m³/h/m²						613	m³/day	
Waster water (total)	m³/h/m²						499	m³/day	
Benchmarking Consumptions Process Equipment and Local Abatement									
Electrical Tool	kW/m²	0.9	1.4	1.2	2,200	2,200	4,400	kW	plasma abatement systems considered, excluding UPW-Heater
UPW	m³/h/m²	0.007	0.025	0.015	20	10	30	m³/h	might be reduced in future phases (VE item)
RO Water local abatements (reclaim / permeate)					1	0.6	1.6	m³/h	
PCW	m³/h/m²	0.130	0.250	0.160	400	400	800	m³/h	recom. 0.16 $m^3/h/m^2$ & delta T = 3.2K
PCW - Heatload	kW/m²	0.56	0.87	0.84	1,500	1,500	3,000	kW	
Exhaust - general	Nm³/h/m²	15	30	28	50,000	50,000	100,000	Nm³/h	
Exhaust - acid	Nm³/h/m²	12	30	28	50,000	50,000	100,000	Nm³/h	
Exhaust - caustic	Nm³/h/m²	2	9	12	22,000	22,000	44,000	Nm³/h	
Exhaust - solvent	Nm³/h/m²	4	10	12	22,000	22,000	44,000	Nm³/h	
Exhaust - total	Nm³/h/m²	38	78	80	144,000	144,000	288,000	Nm³/h	
CDA - total	Nm³/h/m²	0.5	1.1	0.7	1,260	1,260	2,520	Nm³/h	
N2 - total	Nm³/h/m²	0.34	0.94	0.45	810	810	1,620	Nm³/h	
H2	Nm³/h/m²	0.003	0.006	0.003	5	5	11	Nm³/h	to be rechecked (lower side)
He	Nm³/h/m²	0.0003	0.0009	0.0006	1	1	2.2	Nm³/h	
O2 - total	Nm³/h/m²	0.004	0.020	0.004	6	6	12	Nm³/h	no O2 for local abatement systems, tools only
Ar	Nm³/h/m²	0.002	0.007	0.004	7	7	14	Nm³/h	
Natural Gas	Nm³/h/m²			0.017	30	30	60	Nm³/h	local abatement
Proc. Vac.	Nm³/h/m²	0.020	0.035	0.030	54	54	108	Nm³/h	
Chemical Supply Systems	Quantity			25	25	-	25	Quantity	
Slurry Supply Systems	Quantity			10	10	-	10	Quantity	
Bulk specialty gas	Quantity				2	1	3	Quantity	Assumption: HF3, HCL and one future system
Specialty Gas Systems	Quantity			150	105	45	150	Quantity	Assume 60/40 split between double and single cylinder cabinets
Solar Generated Energy (PV)	MWh				136	401	537	MWh/a	basic concept; pending PV surface area m^2 data
Facility Systems Fab Load	%			100.0%	3,380	3,380	6,760	kW	
Normal Loads (NPS)	%			54%	1,808	1,808	3,617	kW	NPS load in % of Facility Load
Emergency Loads (EPS)	%			38%	1,288	1,288	2,576	kW	EPS load in % of Facility Load
Critical Loads (UPS)	%			8%	284	284	568	kW	UPS load in % of Facility Load
Critical Tool Loads (DUPS)	%			45%	990	990	1,980	kW	DUPS load in % of total tool load

Overall Capacity Calculations

Cooling and heating capacity calculations

Item	Unit	Phase 1		Phase 2		Total		Remarks
		Cooling	Heating	Cooling	Heating	Cooling	Heating	
FAB CMAUs	kW	3,200	1,443	3,200	1,443	6,400	2,890	
FAB GMAUs	kW	819	418	819	418	1,640	840	
FAB Sensible Cooling Coils	kW	960		960	0	1,930	0	
Utility Level GMAUs	kW	328	170	328	170	660	340	
Utility HVAC	kW	540		540	0	1,080	0	
PCW	kW	1,500		1,500	0	3,000	0	
Raw Water	kW		420	0	420	0	840	
UPW	kW	105	796	105	796	210	1,600	
Fab Primary Support	kW	680	340			690	350	
Fab General Support	kW	972	486	62	31	1,040	520	
CUB MAUs	kW	546	130	546	130	1,100	260	
CUB HVAC	kW	230		230	0	460	0	
CDA	kW	50		50	0	100	0	
Admin MAUs	kW	299	135	254	115	560	250	
Admin HVAC	kW	1,095	512	930	435	2,030	950	
Total Plant Capacity (Cooling)	kW	**11,400**		**9,600**		**20,900**		*cooling only chillers + HR Chillers / Heatpumps*
Total Plant Capacity	Rtons	**3,241**		**2,730**		**5,943**		
Equipment Efficiency	kW/RT	0.55		0.55		0.55		
Equipment Required Power	kW	1,800		1,600		3,300		
Cooling Tower Capacity	kW	**13,200**		**11,200**		**24,200**		
Cooling Tower Capacity	Rtons	**3,753**		**3,185**		**6,881**		
Total Plant Capacity (Heating)	kW		**4,860**		**3,960**		**8,840**	*100% heating from boilers as load not consistent*
Boiler Capacity	kW		**4,860**		**3,960**		**8,820**	*for initial startup & full load*
Natural Gas (Boilers)	m^3/hr		260		260		520	
Natural Gas (Production)	m^3/hr		30		30		60	
Natural Gas (Total required)	m^3/hr		**300**		**300**		**600**	

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Chilled Water-Hot Water-Heat Recovery Plant

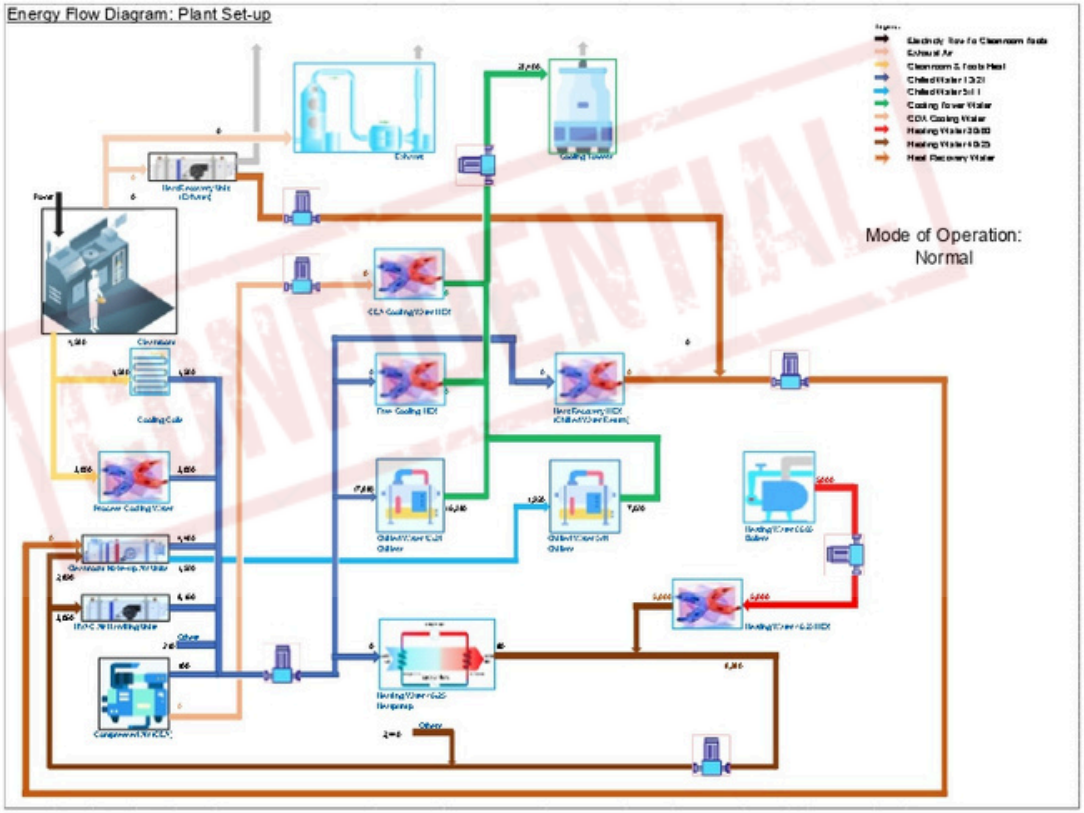
Mode of Operation: Normal

- The Chilled Water, Heating Water & Heat Recovery Water Plants are setup as illustrated in the schematic
- MT Chilled water serves mainly:
  - Cleanroom cooling coils
  - Process cooling water
  - Cleanroom make-up air units
  - General make-up units & HVAC systems
  - UPW, CDA & others
- LT Chilled water serves mainly:
  - Cleanroom make-up air units
- Heating water 40/25 serves mainly:
  - Cleanroom make-up air units
  - General make-up units & HVAC systems
- Heating water 80/60 serves mainly:
  - Used during the initial start-up & ramp-up phase
  - Provide additional heat for the heating water 40/25 system
- Free Cooling:
  - Used when the heating load & the weather is low
- Heat Recovery:
  - Used when the heating load is high & free cooling is not possible

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Chilled Water-Hot Water-Heat Recovery Plant

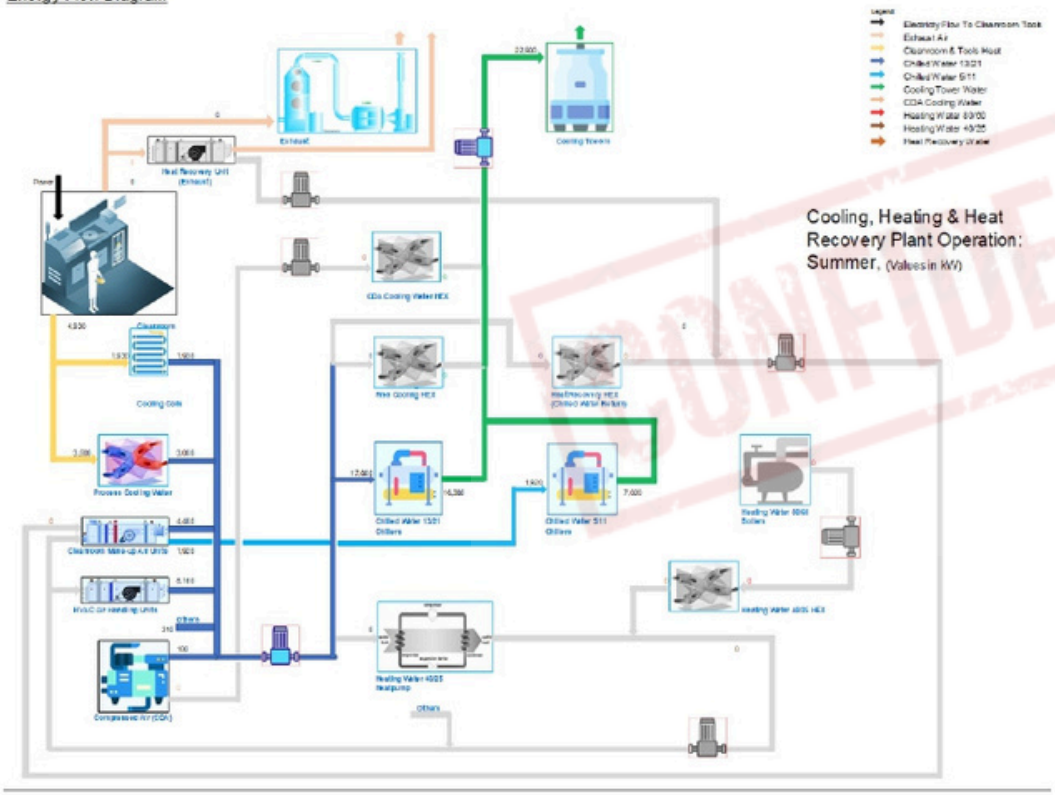
Mode of Operation: Normal – Schematic



Chilled Water-Hot Water-Heat Recovery Plant

Mode of Operation: Summer mode

Energy Flow Diagram



- Chilled water satisfies all cooling needs
- Heating water is not used except when a requirement arises



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Overall Water Balance

Reclaim basic approach

- The basic concept is a standard technical design and meets all environmental limits.
- The basis for the waste management and reclaim concept is the estimated UPW consumption of 30 m^3/h in total.
- Additional reclaimed water supply for facility systems, such as cooling towers etc. to reduce the amount of potable water is recommended by the utility provider.
- The overall waste management and reclaim concept is included in the annex.

- A reduction of the UPW consumption in Phase 1 from 20 m^3/h to 10 m^3/h has been identified as a Value Engineering item and will be further detailed during the next design phase.

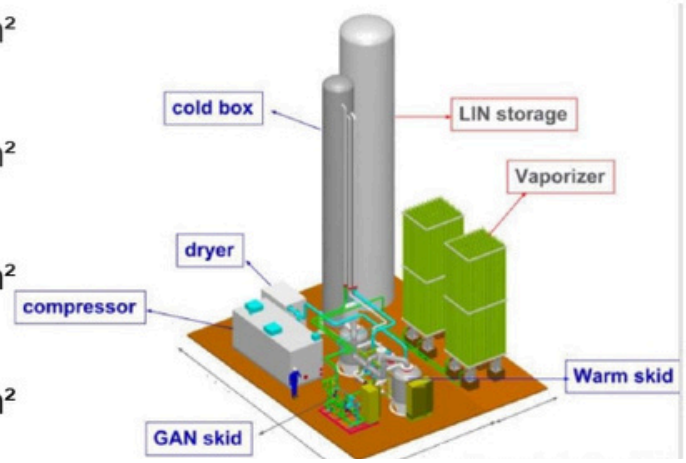
Item No	Source	Drains Lines	Drain Acronym	Drain Type
1	IMEC FAB 5	DI Reclaim Drain	DIRD	Reclaim
2	IMEC FAB 5	Back Grind Drain	BGDR	Reclaim
3	IMEC FAB 5	Acid Waste Rinse	AWR	Reclaim
4	IMEC FAB 5	Acid Waste Rinse (IPA)	AWOR	Reclaim (Optional)
5	IMEC FAB 5	Industrial Waste Drain	IWD	Neutralization Treatment
6	IMEC FAB 5	Industrial Waste Drain (Ozone)	IWDR (O)	Reclaim
7	IMEC FAB 5	Hot DI Drain	HDID	Optional for heat recovery
8	IMEC FAB 5	Condensate Drains	COND	Reclaim
9	IMEC FAB 5	CMP Drains	CMP (O)	Reclaim (Optional)
10	IMEC FAB 5	HF Waste Drain	HFD	HF Treatment
11	IMEC FAB 5	Dilute HF Drain	DHFR	Reclaim (Optional)
12	IMEC FAB 5	Dilute Copper Drain	CuDD	Copper Treatment
13	IMEC FAB 5	Local Scrubber Drain	LSRDR	Reclaim
14	IMEC FAB 5	Local Scrubber Drain (High COD)	LSRD(O)	HF Treatment
15	IMEC FAB 5	Central Scrubber Drain (Acid)	SCD(A)	Reclaim (Optional)
16	IMEC FAB 5	Central Scrubber Drain (Caustic)	SCD(C)	Reclaim (Optional)
17	IMEC FAB 5	Ammonia Waste Drain	NH4W	Reclaim (Optional)
18	IMEC FAB 5	CMP Copper Waste	CuCMPW	Copper Treatment
19	IMEC FAB 5	Dilute Copper Waste	DCW	Copper Treatment
20	IMEC FAB 5	Sliver Chloride Waste	SCW	Metal recovery treatment / haul off
21	IMEC FAB 5	Sliver Dilute Rinse	SDR	Metal recovery treatment
22	IMEC FAB 5	Nickel Waste (Place holder)	NIW	Metal recovery treatment / haul off
23	IMEC FAB 5	Platimum (Place holder)	PTW	Metal recovery treatment / haul off
24	IMEC FAB 5	Sulfuric Acid Waste	H2SO4W	Concentrate collection / disposal
25	IMEC FAB 5	Phosphoric Acid Waste	H3PO4W	Concentrate collection / disposal
26	IMEC FAB 5	Concentrated Copper Waste	CCW	Concentrate collection / disposal
27	IMEC FAB 5	IPA Waste Drain	IPAW	Solvent Collection and Disposal
28	IMEC FAB 5	General Solvent Drain	GSW	Solvent Collection and Disposal
29	IMEC FAB 5	Resist Waste Drain	RSW	Solvent Collection and Disposal
30	IMEC FAB 5	Corrosive Solvent Waste Drain	CSW	Solvent Collection and Disposal
31	IMEC FAB 5	Unassigned solvent	UA	Solvent Collection and Disposal

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Bulk Gas Systems

Source and related area estimation

• Nitrogen (N_2):	
– On-site generation	300 m²
– Two sets of air separation units incl. compressor station and filter units	60 m²
– Backup: Two cold gasifiers, evaporators incl. instrumentation and fittings	100 m² (+ logistics area for fill up)
• Hydrogen (H_2):	
– Supply via bundles (cylinders packs) or gas tank (gaseous storage)	20 m²
• Helium (He):	
– Supply via bundles (cylinder packs)	15 m²
• Oxygen (O_2):	
– Supply via bundles (cylinder packs)	15 m²
• Argon (Ar)	
– Supply via bundles (cylinder packs)	15 m²



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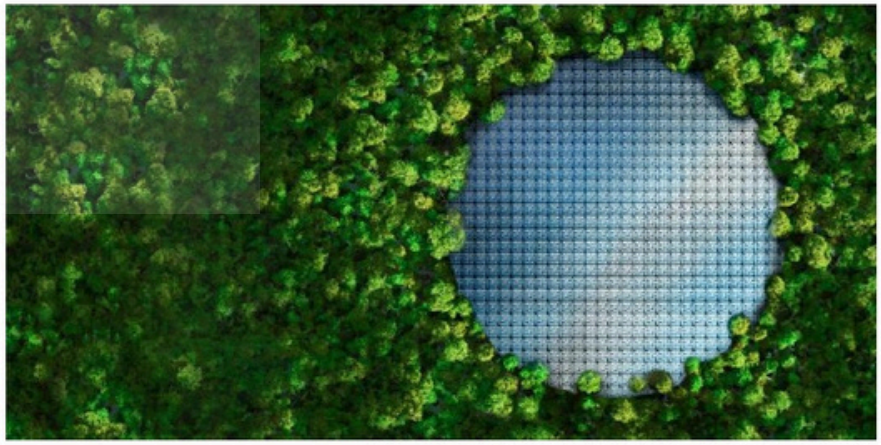
Sustainability Options

List of potential sustainability options

- Magnetic oil free modular chillers, aids in noise reduction too
- Utilize heat recovery chillers / heatpumps
- Absorption chillers using the waste heating water coming from an external (utility) provider
- Free cooling via cooling towers
- Free cooling via incoming water
- Heat recovery from CDA equipment
- Heat recovery from industrial wastewater
- Heat recovery from liquid cooled hybrid transformers
- Advanced reclaim process
- Minimal liquid discharge (MLD) approach
- Photovoltaics and direct current energy supply
- Combined heat power
- Manufacturing environment, temperature and relative humidity



Source https://www.imec-int.com/en/sustainability, Dec. 2023



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Sustainability Options – Heat Recovery

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Liquid Cooled Transformer Heat Recovery

Heat-exchanger

- Can be forced air-cooled (liquid to air) or forced water-cooled (liquid to liquid)
- Can be installed indoors or outdoors

Serves to extract heat from the transformer

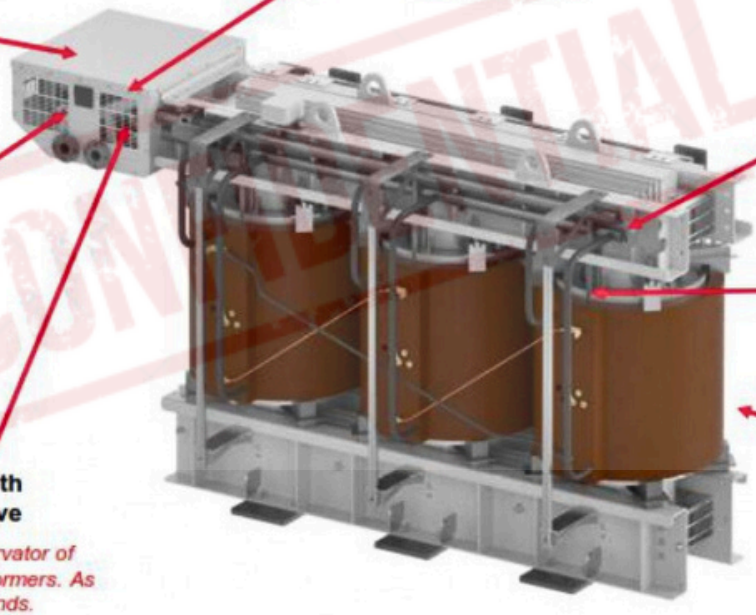
Monitoring

- Inlet/outlet temperature sensors
- Oil-pressure sensors
- Liquid-level sensor

Serves for monitoring purposes. Same functionality than the traditional monitoring devices

Expansion tank with pressure relief valve

Same logic with conservator of liquid immersed transformers. As liquid heats up, it expands.



Electric oil-flow pump

Pump distributes cold coolant to transformer coils

Internal, closed circuit cooling system

- High-temperature ester fluid
- Both, primary and secondary windings

Fluid flows through the windings to extract the heat

Winding temperature sensors

Nothing different than the regular winding temp sensors

Vacuum Cast Coil (VCC) windings

- Class H (180°C) dielectric insulation system
- Non-flammable materials

Maintains class H (180°C) dielectric insulation system

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Sustainability Options

Overview of baseline & optional sustainability options – Full build-out scenario (Ph.1 + Ph.2)

Item	Option	Baseline Concept (Y/N)	Potential Option (Y/N)	Energy Saving (MWh/a)	Water Saving (m^3/a)	CO2 Saving (t/a)	RoI in years	Building/ Site area impact	Remarks
SO1	Photovoltaics – fab building, parking, guard house	No	Yes	1,421		308	4		Parking area may change to buildable area with PV installations above
	Photovoltaics – office	Yes	--	537		117	--		
SO2	Heat recovery from liquid cooled hybrid transformers	No	Yes			25	7	Reduced size of MV/LV substations in FAB	
SO3	Advanced reclaim process	No	Yes		74,880		18	Additional space in FAB and CUB	
SO4	Minimal liquid discharge (MLD) approach	No	Yes		93,960		21	Additional space in FAB and CUB + additional area on site	
SO5	Ambient vaporized heat recovery	No	Yes	780		28	20		
SO6	Magnetic oil free modular chillers	No	Yes	1,900		412	10	More space required due to capacity limitation	Choice of refrigerant is limited
	Free cooling via cooling towers	Yes	–	300			--		Potential reduction in future chiller capacity
	Heat recovery from CDA equipment	Yes	--	150		33	--		Possible CDA in operation & heating is required
	Utilize heat recovery chillers / heat pumps	Yes	--	850			--		Choice of heat recovery chillers or heatpump depends on the heating temperature & heating load required
	Heat recovery from exhaust of admin building	Yes	--				--		
	Raised manufacturing environment, temperature and relative humidity	No	Yes	498		108	n.a.		Option to consider industry standards
	Free cooling via incoming water	No	Yes	300		65	n.a.		Temp range 11-25
	~~Combined heat power~~	No	No						Site limitations and permitting process
	~~Absorption chillers using district heating~~	No	No						District heating not available
	Heat recovery from industrial wastewater	No	Yes						not feasible if MLD option is selected

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Sustainability Options – PV

Solar PV (Photovoltaics)

- **High potential** – Annual aver. solar radiation of 1,847 kWh/m^2
- **Potential area** :
  - Included in basic concept: Admin Phase 1 and admin Phase 2 (total : **2,890 m^2**)
  - Optional Phase 1: Parking area, fab building area, guard house (total: 8,278 m^2)
  - Optional Phase 2: Parking area, fab building area, guard house (total: 7,648 m^2)
- **ROI : ~ 4 years** based on € 0.129 per kWh
- **CO_2 savings:**
  - Basic concept: ~ 116,532 kg
  - Options: Phase 1 ~ 333,790 kg / Phase 2 ~308,387 kg

Options & Considerations

- Option
  - Create a localized DC microgrid



- Considerations :
  - Additional CAPEX but long-term savings on OPEX
    - Basic concept: ~ 265,000 EUR
    - Phase 1: ~ 760,000 EUR
    - Phase 2: ~ 700,000 EUR
  - Increased roof loading
  - Risk of leakage from roof penetration
  - Fire hazard, additional insurance premium

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MLD: Biological Treatment & EoP Reclaim

Description

- Wastewater from the wafer manufacturing process is expected to have varying concentrations of organics.
- Low organics containing wastewater streams are reclaimed and sent back to the UPW system or to other facility uses.
- Typical organic concentration in organic wastewater stays around 1,000 -1,500 ppm COD (assumed).
- Biological wastewater treatment followed by end of pipe water reclaim is essential for achieving Minimum Liquid Discharge (MLD) or Zero Liquid Discharge (ZLD)



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MLD: Biological Treatment & EoP Reclaim

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Treatment steps (1)

- Equalization Tank
  - Wastewater is collected in this tank.
  - Equalizes both the hydraulic flow and pollutant concentrations.
- Anoxic Tank
  - Anoxic zones in wastewater are useful for nitrogen removal.
  - Breaks down nitrites and nitrates to nitrogen to avoid nutrient pollution and maintain Total Nitrogen (TN) level under control.
  - See a detailed description of nitrification and denitrification step on following slide **75**.

Treatment steps (2)

- Membrane Bioreactor (MBR)
  - Reduces COD and Total Nitrogen (TN) by using microfiltration (MF) or ultrafiltration (UF) and integrating them with a biological process like a suspended growth bioreactor.
  - The membranes are employed as a filter removing the solids which are developed during the biological process, which gives a clear and pathogen free product.
- Sludge Dewatering System
  - Sludge produced from the biological treatment is dewatered in the screw press.
  - Solid waste is disposed.

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MLD: Biological Treatment & EoP Reclaim

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Treatment steps (3)

- Odour Control
  - Odour-causing gases are scrubbed and treated with Activated Carbon Filter (Biofilter).
- Clear Water Polishing and Disinfection
  - Clear water from the biological plant is further polished in a Bio-ACF and disinfected with hypochlorite.
- Reclaim RO Pre-treatment
  - Suspender particles and colloids are removed from RO feed using ultra filtration process

Treatment steps (4)

- Reverse Osmosis
  - The biologically treated wastewater is reclaimed.
  - Product water is pumped to the non-process water tanks.
  - Reject water is combined with other wastewater streams before pumping to external municipal treatment system.



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MLD: Nitrification / Denitrification

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Nitrification

- Nitrification is a microbial process by which ammonia is sequentially oxidized to nitrite and then to nitrate
- In the first step of nitrification, ammonia oxidizing bacteria oxidize ammonia to nitrite
- The nitrification process is accomplished primarily by two groups of autotrophic nitrifying bacteria that can build organic molecules by using energy obtained from inorganic sources—in this case, ammonia or nitrite.

Denitrification

- Denitrification is the process by which nitrates are reduced to gaseous nitrogen by facultative anaerobes.
- Facultative anaerobes, such as fungi, can flourish in anoxic conditions because they break down oxygen containing compounds (e.g., NO3 -) to obtain oxygen.
- If oxygen is available, these bacteria use it for metabolism before they use the nitrate.
- Therefore, dissolved oxygen concentrations must be minimized for the denitrification process to function

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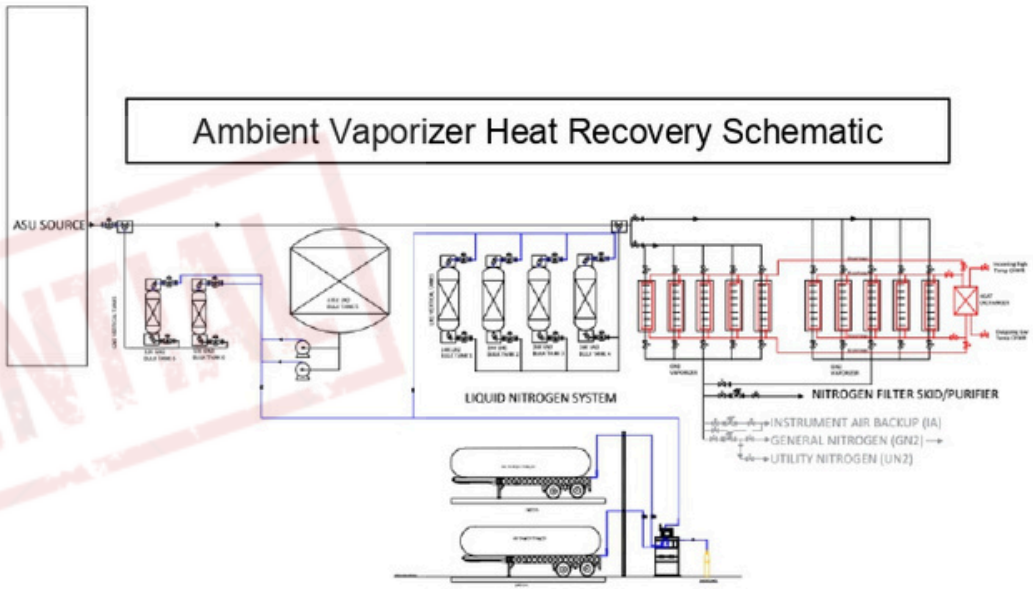
Sustainability Options – Heat Recovery

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Ambient Vaporizers Heat Recovery

- FUM data **Nitrogen consumption : ~ 1,620 Nm³/h**
- Potential **heat recovery : ~780,000 kWh per year**
- **ROI : ~ 20 years** based on € 0.129 per kWh
- **~ 28 tonnes CO_2 savings**

Ambient Vaporizer Heat Recovery Schematic



- Considerations :
  - Low Nitrogen consumption
  - High **CAPEX (~ € 300,000)**
  - **Complex controls** and engineering; liquid nitrogen can freeze heat exchangers
  - **Large distance** between gas yard and heat recovery consumer; **pump losses**
  - Collaboration between Exyte and gas supplier required

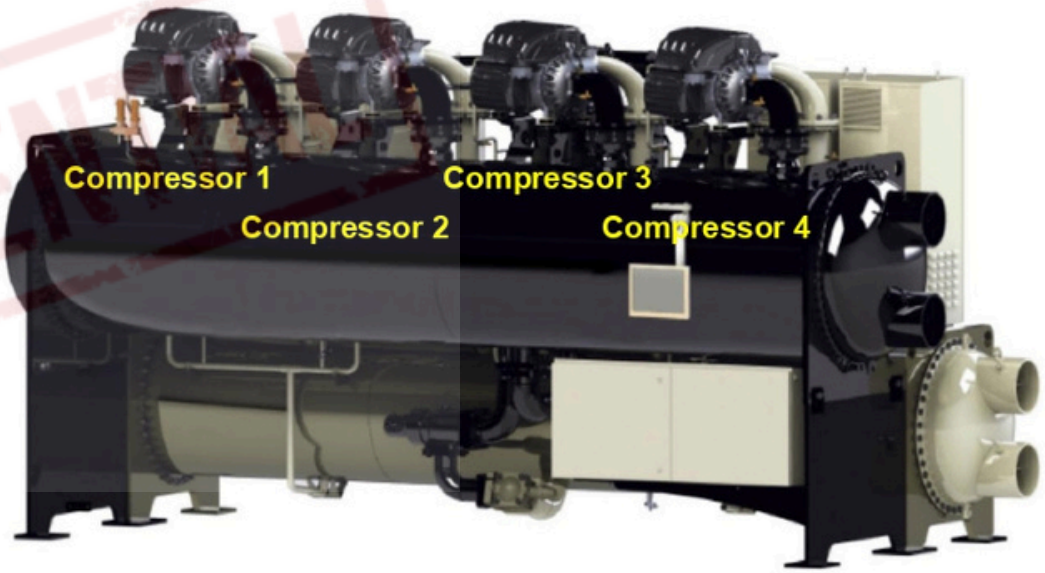
Low Potential

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Sustainability Options – Chillers

Magnetic oil-free modular chillers

- Multi-stage with magnetically levitated rotating compressors & shafts
- Compressors operate without the use of oil for lubrication
- Reduces energy losses due to friction
- Increases the heat transfer efficiency of the chiller
- No oil enters the evaporator or the condenser
- Variable speed allows greater efficiencies at partial loads
- Eliminates oil maintenance, resulting in operations and maintenance savings



- **ROI : ~ 10 years** based on € 0.129 per kWh
- Limitation: choice of refrigerant

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Sustainability Options – CR Environment

Raised manufacturing environment – Temperature and relative humidity

- The specified temperature and relative humidity for the manufacturing area are narrowly defined
  - Specified temperature: 21 °C ± 1 °C
  - Specified rel. humidity: 45% ± 3 %

  and stricter as the industry standard of :
  - Specified temperature: 22.5 °C ± 1 °C
  - Specified rel. humidity: 45% ± 5 %

- The raised parameters would result in:
  - A decreased chiller load of approx. 330 kW
  - Electrical power savings of approx. 57 kW_{elect}
  - Reduced energy demand of approx. 498,000 kWh/year (24/7 operation → 8,760 hours per year)



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Sustainability Options – Chillers

Magnetic oil-free modular chillers – Potential savings

- Savings achieved by an independent study:

PROJECT SITE	PROJECT TYPE	$/KWH	TONS	ANNUAL KWH SAVINGS	ANNUAL ENERGY $ SAVINGS	% SAVINGS	COST	$/TON	PAYBACK (YEARS)
"San Diego"	Add a third compressor	$0.121	240	176,717	$21,206	40%	$178,787	$744	8.4
"Newport"	Install a new chiller	$0.115	80	227,760	$26,192	65%	$100,783	$1260	3.8
"JAX"	Retrofit compressor with condensing water reset	$0.054	120	284,407	$15,358	41%	$107,592	$897	7.0

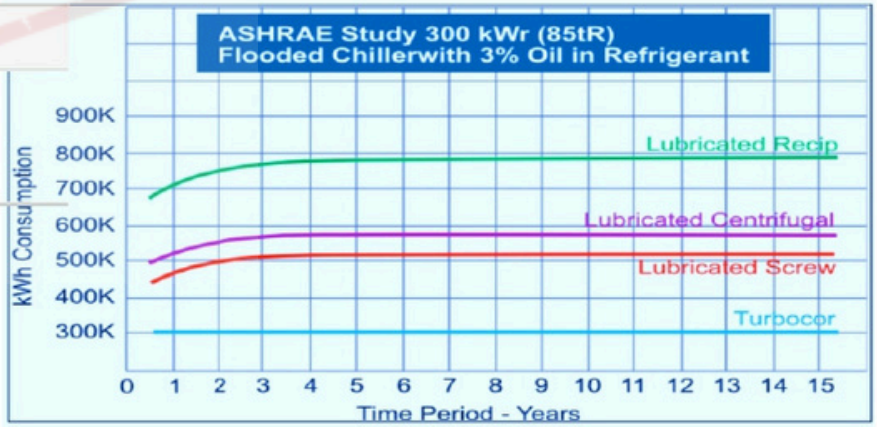


Figure 2: Energy Consumption of Various Chiller Types Over Time (from ASHRAE)

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Sustainability Options – CHP Plant

Combined Heat and Power

- **Fuel :**
  Options for power generation include natural gas or diesel, with an average ratio of 40% electrical output and 60% heat output.
- **Additional Footprint:**
  Engine-coupled generators require extra space for installation, adding to the overall footprint of the system.
- **Diesel Storage:**
  Diesel fuel carries a fire risk and necessitates special storage measures to ensure safety.
- **Natural Gas Supply:**
  Assuming natural gas is used, a direct pipeline connection may be required for a reliable fuel supply.
- **Heat Utilization:**
  Due to low heat demand, absorption chillers may be necessary to maximize the utilization of the generated heat.

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Low Potential

FAB Building Baseline

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- A 3 or 2+1 level FAB.
  - There is one manufacturing level and there are two Subfab levels with laterals .
- Suitable for R&D and low volume production of devices on 300 mm wafers in 24/7 operation mode.
- Suitable for 60 major process tools
  - Dry etch, CVD, PVD, ALD, lithography, wet clean, wet etch, plating, etc.).
  - Process tool park includes immersion lithography but no EUV.
- Indicative free height of the levels.
  - Manufacturing area - level 2: 5.5 m excl. raised floor,
  - (Clean) Subfab - level 1: 4.5 m,
  - Utility Subfab - level 0: 4.0 m.



FAB Building Baseline

- Waffle table distributed floor load indicative value 2,500 kg/m².
- Waffle table vibration class VC-D, although some areas are allowed to be VC-C.
- Designed to reduce disturbances like vibration, electromagnetic interference, airborne molecular contamination, electrostatic events.
- Raised floor indicative value 600 to 800 mm
  - Height depends on FAB concept: 3 level or 2+1 level.
  - Agreed to implement 800 mm RMF height.
- Ceiling grid compatible with AMHS systems for FOUPs.

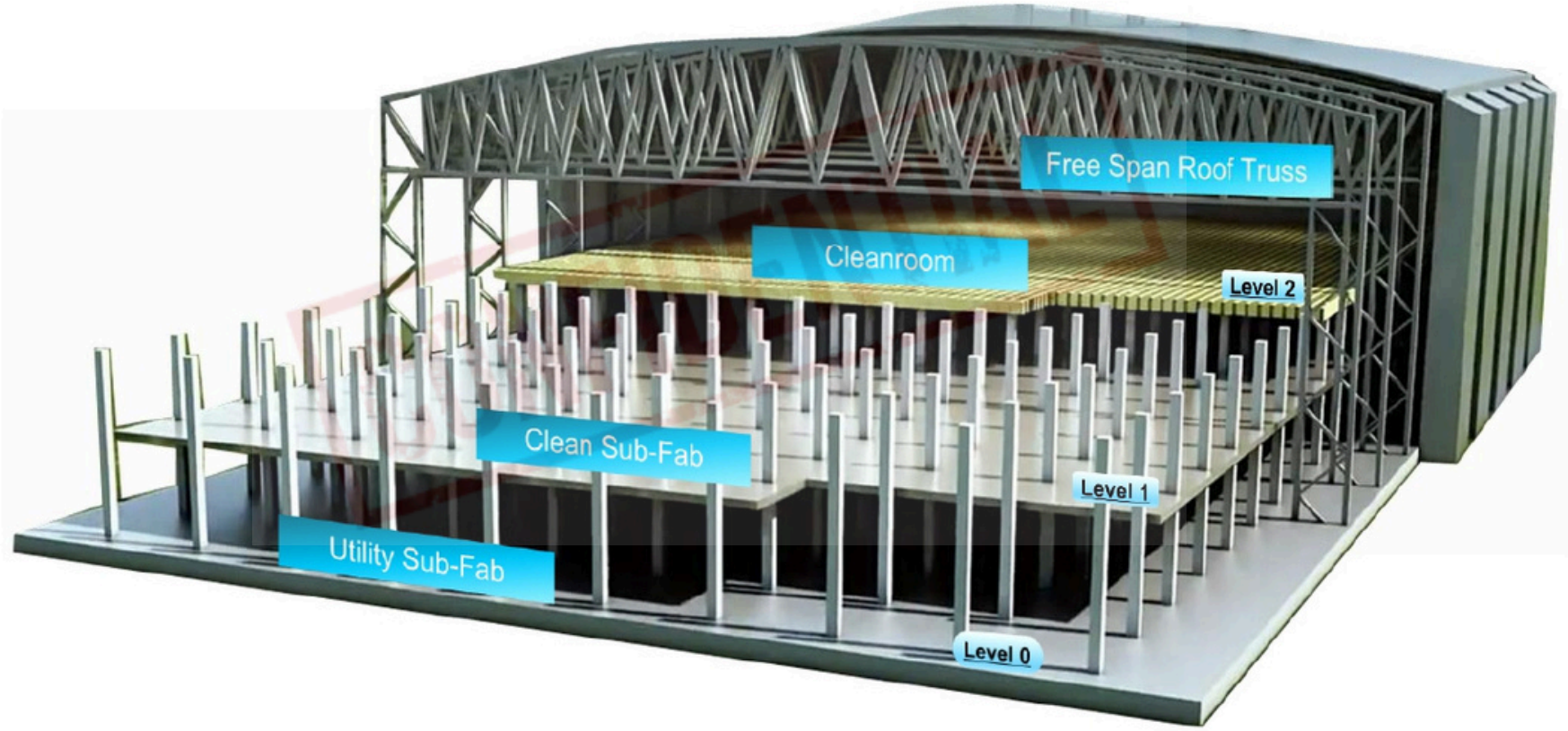


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Front-End Semiconductor Fabrication

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Typical “2+1 level” fab concept



Preliminary Area Requirements

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Fab area classification



Project rationale

Fab Area	Abbr	Rationale
Manufacturing	GMA	Phase 1: According to tool list → approx. 1,500 m² NMA → 1,800 m² as a baseline Total: 4,000 m² GMA (assumption: Phase 1 and Phase 2 are the same)
Subfab	SF	Refer to manufacturing
Primary Support	PS	Classified support areas, incl.: Wafer start / logistics, off-waffle assembly, gowning, laboratory, maintenance shops
General Support	GS	Warehouse, workshops, general storage, HPM storage
Administration	AD	Admin space required for 250 persons (Phase 1) + 150 persons (Phase 2)
Facilities	FA	All systems are required

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Preliminary Area Requirements



Benchmarking functional area breakdown (HVM) – Area sizing

Fab Area	Abbr.	% by function	Gross Floor Area Phase 1 [m²]	Gross Floor Area Phase 2 [m²]	Total Gross Floor Area [m²]
Manufacturing	(GMA)	16%	2,000	2,000	4,000
Subfab	(SF)	16%	2,000	2,000	4,000
Primary Support	(PS)	8%	1,300	700	2,000
General Support	(GS)	11%	1,800	1,000	2,800
Administration	(AD)	14%	3,600	2,500	6,100
Facilities	(FA)	35%	5,500	3,500	9,000
TOTAL	(TA)		16,200	11,700	27,900
Area Ratio	**TA/GMA**		**8.1**	**5.85**	**6.98**

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Fab Building – Support Area Requirements

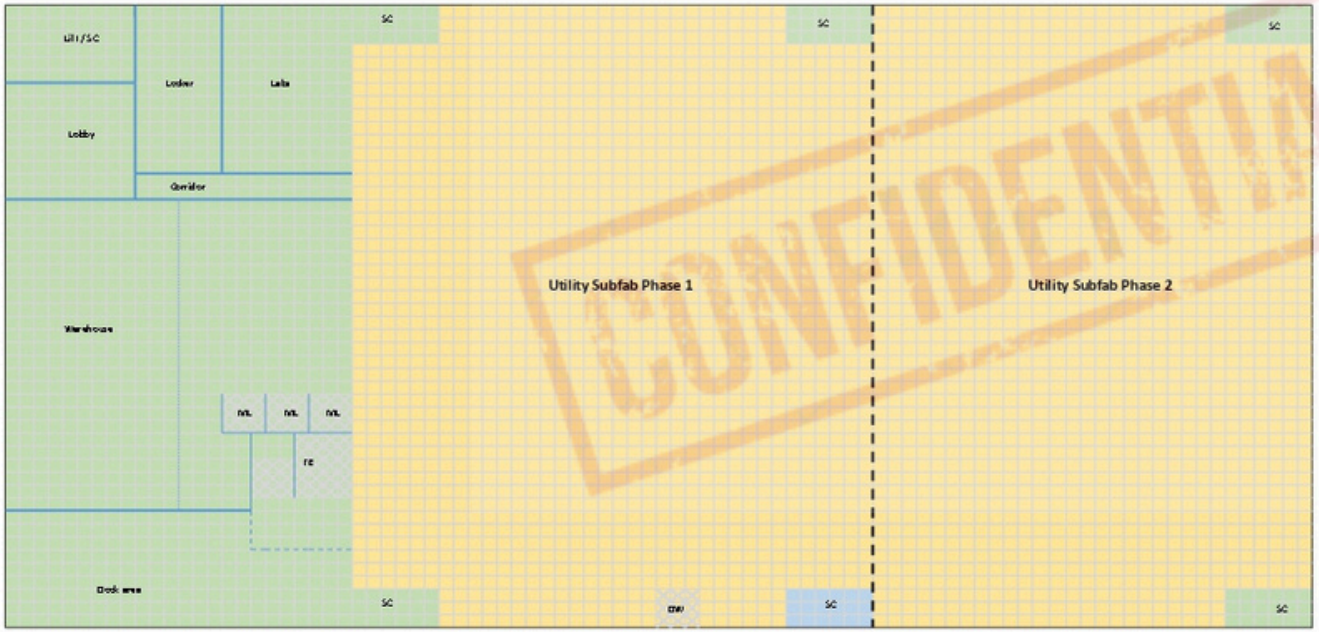


Category	Sub category I	Sub category II	Functional areas	Estimated area Total (m²)	Reserved area Phase 2 (m²)	Level
General Support Area (GSA)	Logistics	Warehouse	Storage, office, shipping	650		0
General Support Area (GSA)	Logistics	Dock area	Delivery, loading and unloading, tool unpacking, office	250		0
General Support Area (GSA)	Logistics	Vertical Logistics 1	Paternoster system incl. loading and unloading	50		0
General Support Area (GSA)	Logistics	Vertical Logistics 2	Paternoster system incl. loading and unloading	50		0
General Support Area (GSA)	Equipment move-in	Equipment move-in	Unpacking, tool elevator	75		0
General Support Area (GSA)	Equipment move-in	Equipment move-in	Tool elevator, unpacking	75		3
General Support Area (GSA)	Personnel	Locker	Locker and changing room incl. toilets	50		0
General Support Area (GSA)	Personnel	Social area	Meeting and Break rooms, bath rooms	200		1
General Support Area (GSA)	Personnel	Lobby	Lobby	100		0
General Support Area (GSA)	Personnel	Contractor offices	Offices, bath room etc.	200		1
General Support Area (GSA)	Personnel	Lift and staircases	Lift and staircases Level 1	200	50	0
General Support Area (GSA)	Personnel	Lift and staircases	Lift and staircases Level 2	200	50	1
General Support Area (GSA)	Personnel	Lift and staircases	Lift and staircases Level 3	200	50	2
General Support Area (GSA)	Personnel	Lift and staircases	Lift and staircases Level Interstitial	200	50	3
General Support Area (GSA)	Labs	Labs	Calibration, anaylitcs etc.	150		0
General Support Area (GSA)	Corridor	Corridor		400		
Primary Support Area (PSA)	Wafer start	Wafer start	Wafer start, FOUP clean, wafer storage	100	100	2
Primary Support Area (PSA)	AMHS Lab	AMHS Lab	AMHS maintenance etc.	50		1
Primary Support Area (PSA)	Equipment support	Equipment support	Parts clean, workshop, material handling etc.	200	50	1
Primary Support Area (PSA)	Equipment move-in	Equipment move-in Subfab	Elevator, Wipe down area, air lock	100		1
Primary Support Area (PSA)	Equipment move-in	Equipment move-in CR	Elevator, Wipe down area, air lock	100		2
Primary Support Area (PSA)	Logistics	Vertical Logistics Subfab	Paternoster system incl. loading and unloading and airlock 1	75		1
Primary Support Area (PSA)	Logistics	Vertical Logistics Subfab	Paternoster system incl. loading and unloading and airlock 2	75		1
Primary Support Area (PSA)	Logistics	Vertical Logistics CR	Paternoster system incl. loading and unloading and airlock 1	75		2
Primary Support Area (PSA)	Logistics	Vertical Logistics CR	Paternoster system incl. loading and unloading and airlock 2	75		2
Primary Support Area (PSA)	Labs	Labs	extra request by Wim	200		1
Primary Support Area (PSA)	Labs	Labs	Failure analysis etc.	100		1
Primary Support Area (PSA)	Assembly / Packaging	Assembly / Packaging	Off waffle assembly area	370	120	2
Primary Support Area (PSA)	Personnel	Gowning	Gowning CR incl. airlock and toilets	150	50	2
Primary Support Area (PSA)	Personnel	Gowning	Gowning Subfab incl. airlock and toilets	0	0	1
Primary Support Area (PSA)	Personnel	Staircase	Staircase Level 1	25		0
Primary Support Area (PSA)	Personnel	Staircase	Staircase Level 2	25		1
Primary Support Area (PSA)	Personnel	Staircase	Staircase Level 3	25		2
Primary Support Area (PSA)	Personnel	Staircase	Staircase Level Interstitiall	25		3
Primary Support Area (PSA)	Corridor	Corridor		75		

Total Net Area General Support:	**3,050**
Total Net Area Primary Support:	**1,845**

FAB Building Concept – Plan View

Level 0 (Utility subfab)



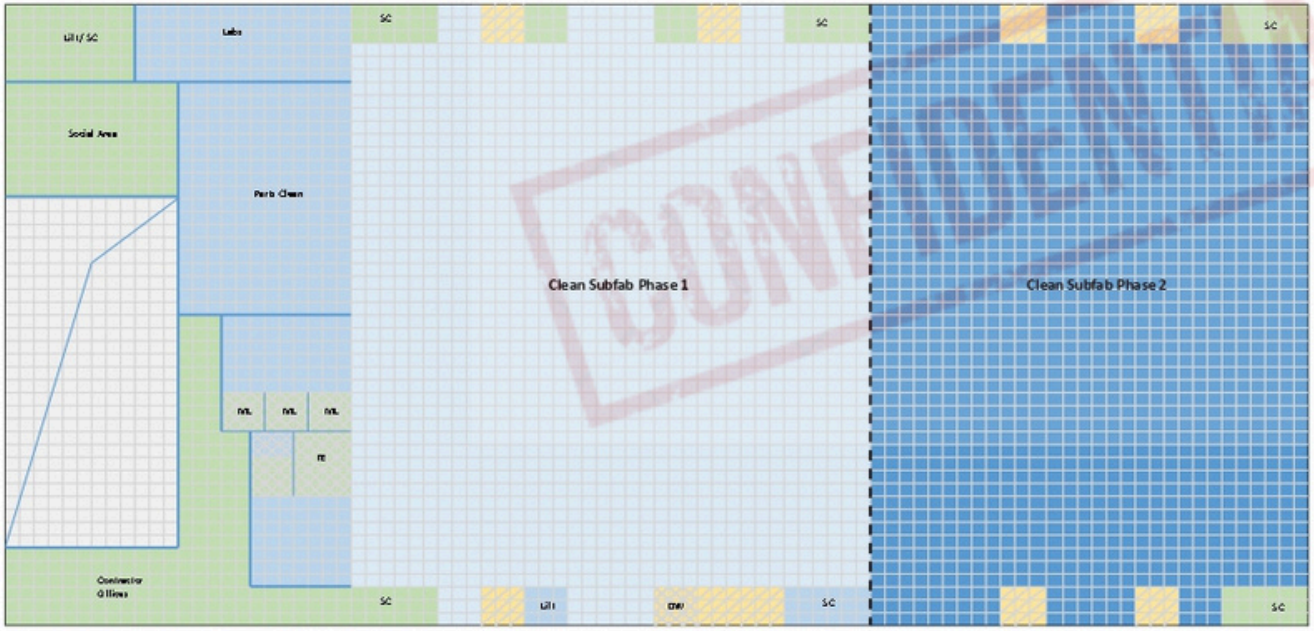
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- Logistics & warehouse in the support annex.
- Utility functions such as switchgears, gas / chem distribution systems etc. are located in the utility subfab area.
- Footprint:
  - Phase 1: 72 m x 57.6 m
  - Total: 108 m x 57.6 m
- Gross Floor Area (GFA)
  - Phase 1: 4,147 m²
  - Total: 6,221m²

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FAB Building Concept – Plan View

Level 1 (Clean subfab)



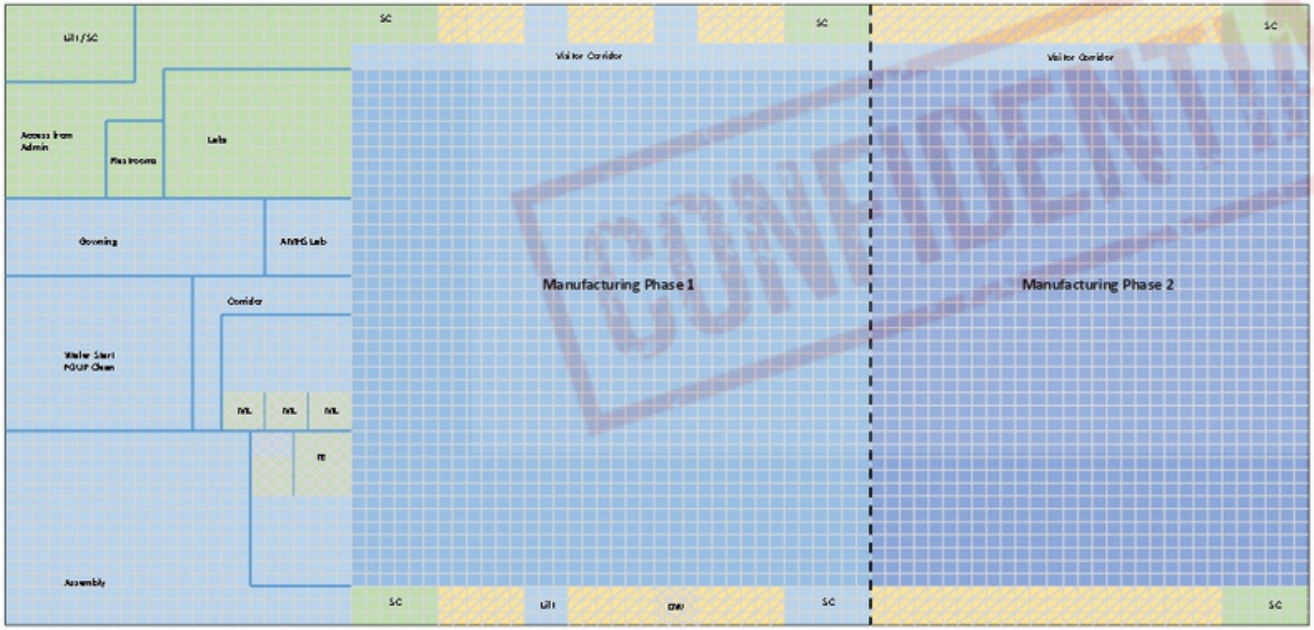
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- Support functions including logistics and opening for a high warehouse area in the support wing.
- Footprint:
  - Phase 1: 72 m x 57.6 m
  - Total: 108 m x 57.6 m
- Gross Floor Area (GFA)
  - Phase 1: 3,681 m²
  - Total: 5,754m²

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FAB Building Concept – Plan View

Level 2 (Cleanroom)

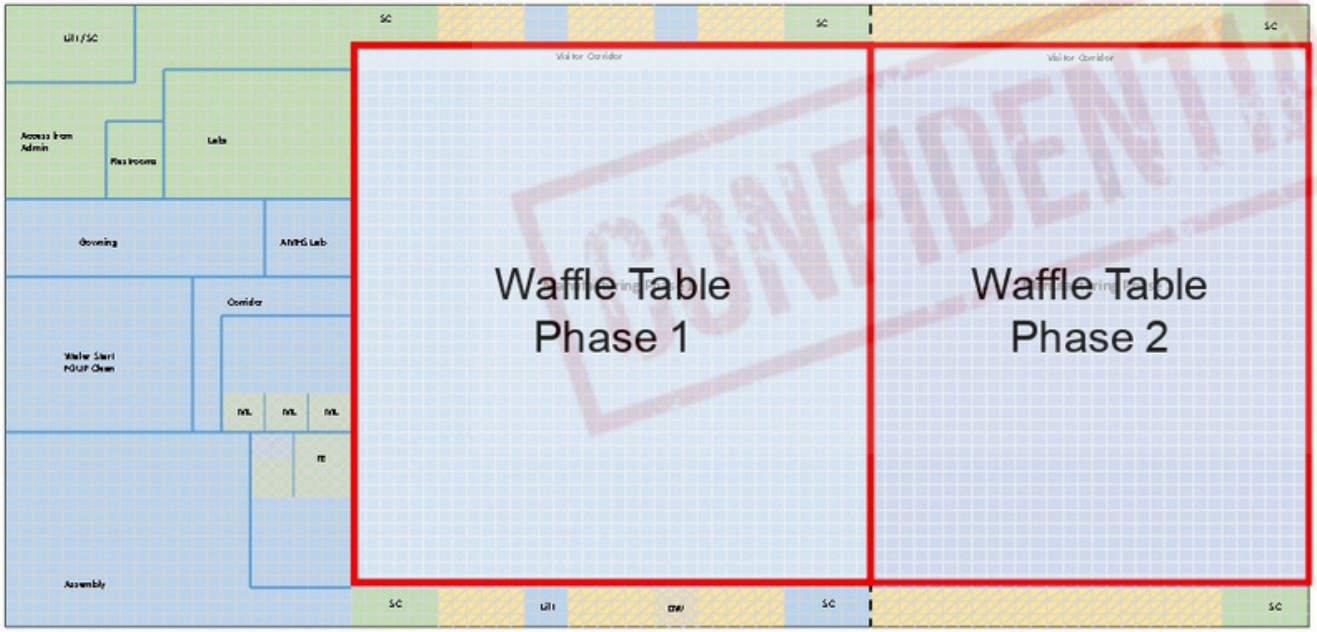


- Primary support functions and non-classified laboratories in the support wing
- Semi-classified visitor's corridor along the length of the main ballroom.
- Footprint:
  - Phase 1: 72 m x 57.6 m
  - Total: 108 m x 57.6 m
- Gross Floor Area (GFA)
  - Phase 1: 4,147 m²
  - Total: 6,221m²

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FAB Building Concept – Plan View

Level 2 (Waffle table)



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- The visitor corridor is located on the waffle table, can be elevated e.g. in Phase 2
- Waffle table area:
  - Phase 1: 43.2 m x 50.4 m = 2,177 m²
  - Total: 79.2 m x 50.4 m = 3,992 m²

FAB Building Concept – Plan View

Level 3 (Interstitial)



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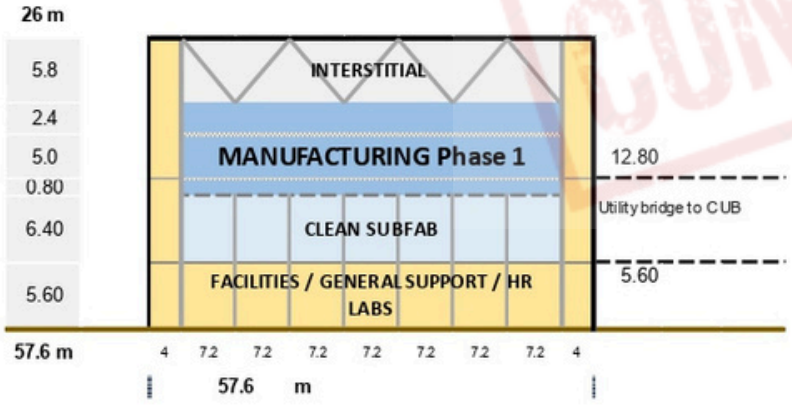
- Utility functions such as make-up air handling units and exhaust yard on the roof of the support wing.
- Footprint:
  - Phase 1: 72 m x 57.6 m
  - Total: 108 m x 57.6 m
- Gross Floor Area (GFA)
  - Phase 1: 28.8 m x 57.6 m = 1,659 m²
  - Total: same as phase 1

FAB Building Concept – Sections

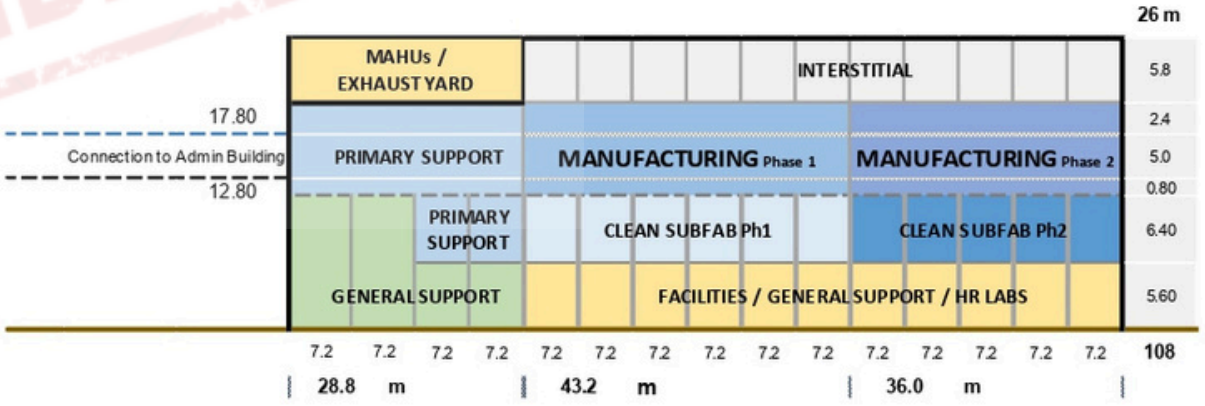
2+1 level building with rooftop facility installations

- Building height of approx. 26 m plus stacks (no basement)
- The building concept assumes a 7.2 m x 7.2 m grid
- A bridge connects the fab building and the R&D building

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Lateral section (north / south)



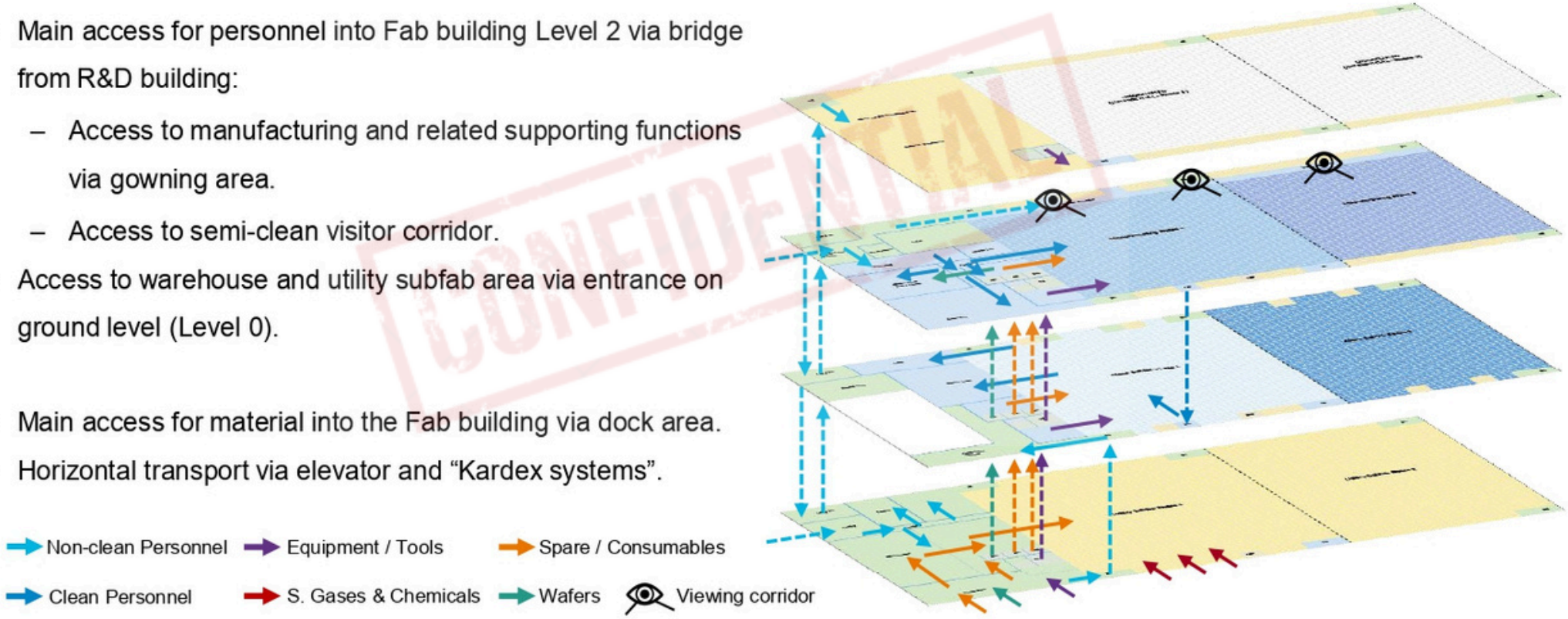
Longitudinal section (east / west)

FAB Building Concept – Logistics Overview

Personnel and material flows

- Main access for personnel into Fab building Level 2 via bridge from R&D building:
  - Access to manufacturing and related supporting functions via gowning area.
  - Access to semi-clean visitor corridor.
- Access to warehouse and utility subfab area via entrance on ground level (Level 0).

- Main access for material into the Fab building via dock area.
- Horizontal transport via elevator and “Kardex systems”.

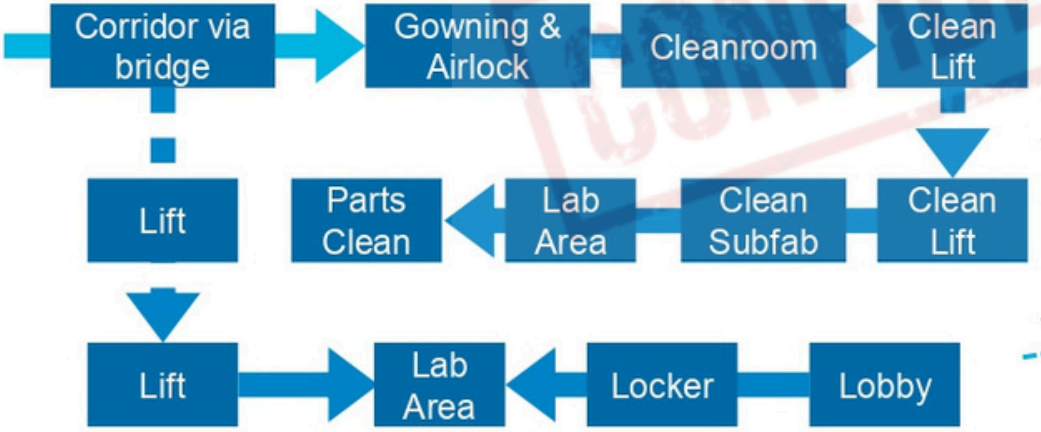


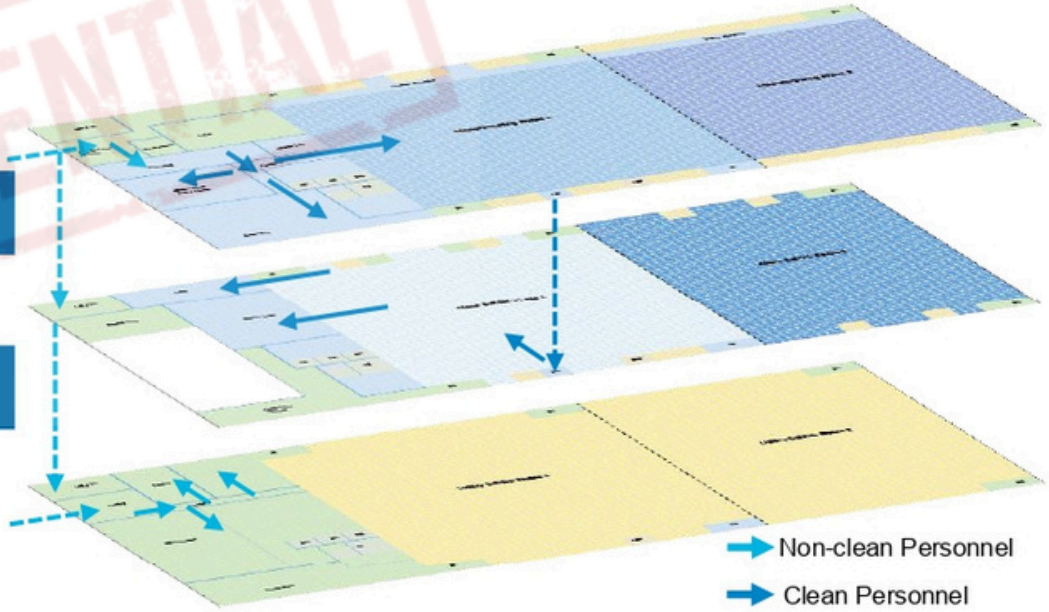
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FAB Building Concept – Logistics

Personnel flow production

- Main access for personnel into Fab building Level 2 via bridge from office building. A 2nd entrance is on Level 0.
- Cleanroom staff enter production are via gowning and an airlock, Level 1 can be accessed via a clean lift.
- Non-cleanroom staff access the Lab area in Level 0 via the lift.



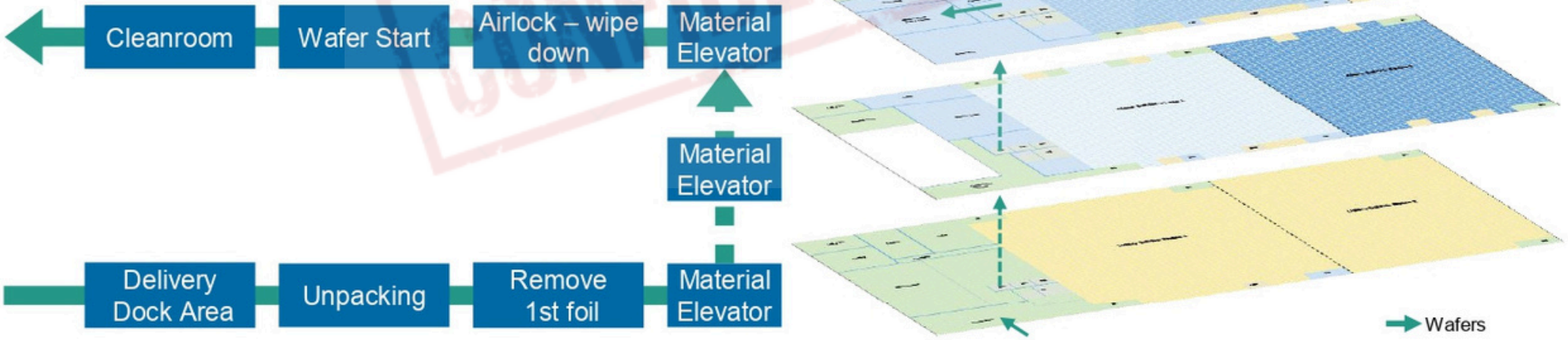


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FAB Building Concept – Logistics

Raw wafer flow

- Raw wafers arrive at the delivery dock area.
- Unpacking and removal of the 1st foil in the unpacking area.
- Storage in the vertical material storage system (e.g. Kardex).
- Removal of 2nd foil and wipe down in the airlock before entering the Wafer Start area.

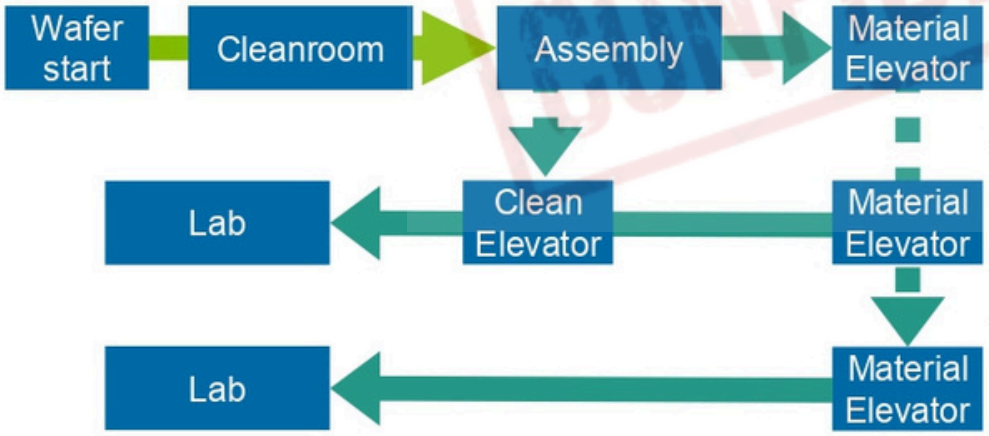


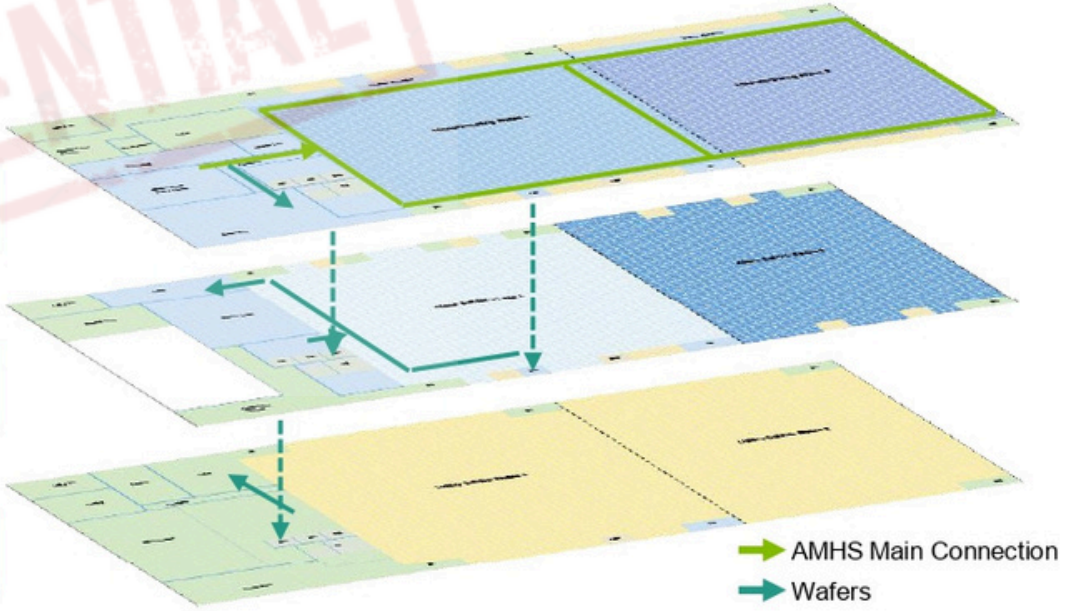
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FAB Building Concept – Logistics

Wafer transportation during production

- AMHS start in wafer start area transporting the wafer into the production area.
- Transportation into assembly area via trolly or automated.
- Transportation into Lab area via clean elevator or vertical material storage & transportation system.





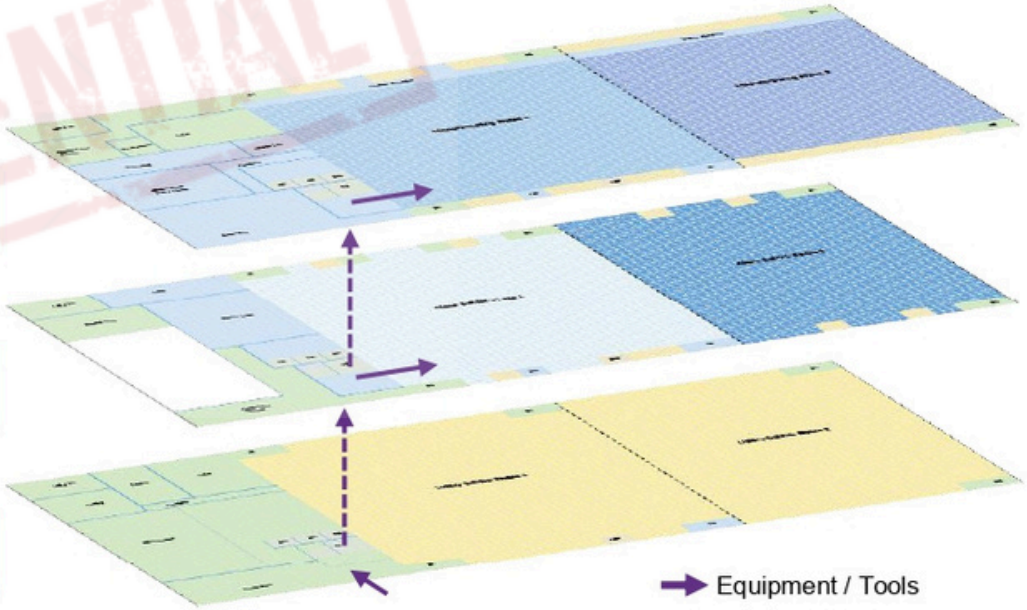
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FAB Building Concept – Logistics

Process tool move-in

- Process equipment is unloaded at the specific tool dock.
- Unpacking from the wood box and removal of the 1st foil in the unpacking area in front of the tool elevator.
- Removal of 2nd foil and wipe down in the airlock before entering the clean area.





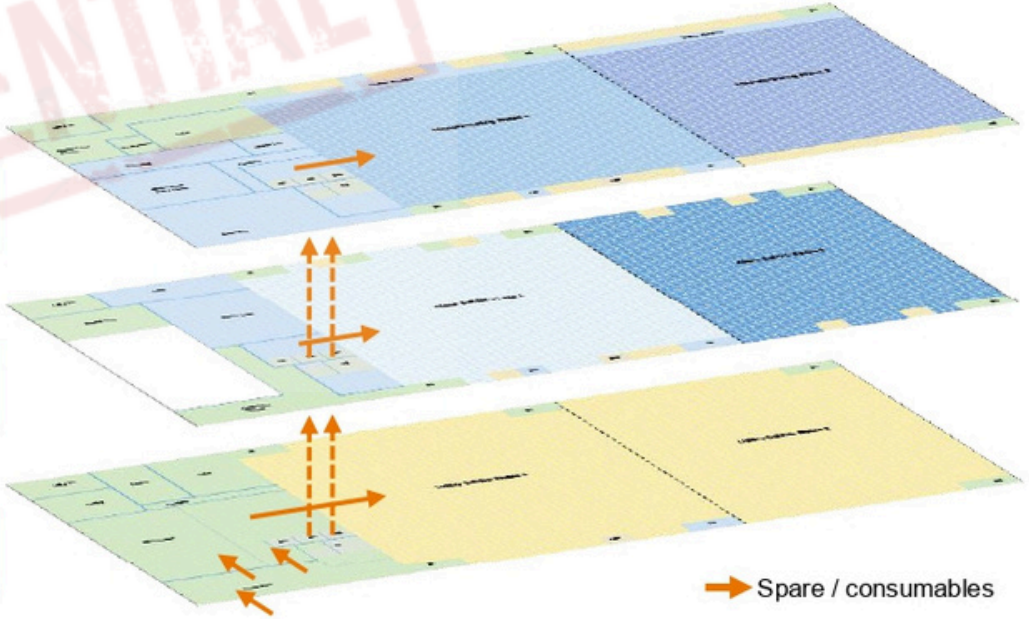
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FAB Building Concept – Logistics

Spare / Consumables

- Unpacking and removal of the 1st foil (if required) in the unpacking area, transportation to either vertical material. transportation system or warehouse and utility subfab area.
- Removal of 2nd foil and wipe down in the airlock before entering the clean area.

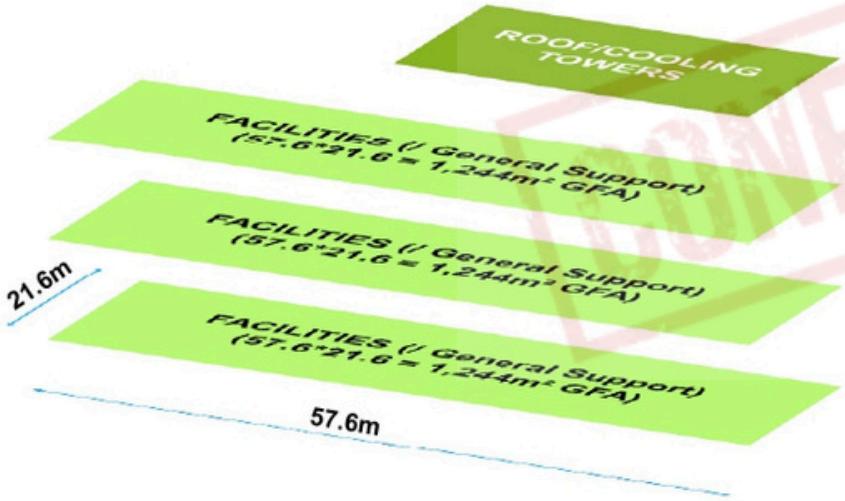




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CUB Building Concept

Sample plan view



- 3 Level building
- Roof level will accommodate the cooling towers.
- Total built-out in phase 1
- Footprint: 1,244 m²
- Total available GFA: 3,732 m²

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Overall Building Concept - Area Breakdown

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All buildings by fuctional areas

FUNCTION	Phase	CODE	FUNCTIONAL AREAS BY FAB BUILDING LEVEL [m²] L0	L1	L2	L3	Subtotal Ph 1 [m²]	SPLIT %	Subtotal Ph 2	TOTAL [m²]	SPLIT %
Manufacturing	Ph 1		-	-	2,125	-	2,125	10.1%		3,897	12.6%
Manufacturing	Ph 2		-	-	1,771	-			1,771		
Subfab	Ph 1		-	2,268	-	-	2,268	10.8%		4,238	13.7%
Subfab	Ph 2		-	1,970	-	-			1,970		
Primary Support	Ph 1		26	636	1,176	26	1,865	8.9%		1,908	6.2%
Primary Support	Ph 2		-	-	43	-			43		
General Support	Ph 1		1,737	698	711	215	3,361	16.0%		3,499	11.3%
General Support	Ph 2		52	52	17	17			138		
Facilities	Ph 1		2,385	78	289	1,221	3,973	36.7%		6,884	34.3%
Facilities	Ph 2		2,022	52	86	750			2,910		
Research & Development centers (separated buildings)							*3,650*	17.4%	*3,100*	*6,750*	21.8%
Central Utility Building (separated buildings)			*1,244*	*1,244*	*1,244*		*3,732*			*3,732*	
TOTAL GROSS FLOOR AREAS (TA)			**6,221**	**5,754**	**6,221**	**2,229**	**20,974**	**100.0%**	**9,933**	**30,908**	**100.0%**
					Area Ratio (TA/GMA)		**9.87**		**7.36**	**7.93**	

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Site Master Planning – Area Development

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Full build-out

Initial Building Dimensions & Areas - total built out of GMA of 4,000 m2	Length (m)	Width (m)	Footprint (m²)	Levels* (#)	Building (m²)	Area (%)	To be built on plot
Fab	**108.00**	**57.60**	**6,221**	**3.0**	**20,425**	**64.5%**	**I+DR-5**
Level 0 - Utility Subfab	108.00	57.60	6,221				
Level 1 - Clean Subfab	108.00	57.60	5,754				
Level 2 - Clean Room	108.00	57.60	6,221				
Roof level - Air intake, Exhaust	28.80	57.60	2,229				
CUB	**57.60**	**21.60**	**1,244**	**3.0**	**3,732**	**12%**	**I+DR-5**
Level 0	57.60	21.60	1,244				
Level 1	57.60	21.60	1,244				
Level 2	57.60	21.60	1,244				
Roof level - Cooling tower							
Admin 1	**23.00**	**20.00**	**730**	**5.0**	**3,650**	**12%**	**PS-D1**
Level 0 - Lobby, Canteen etc.	23.00	20.00	730				
Level 1 - Office	23.00	20.00	730				
Level 2 - Office	23.00	20.00	730				
Level 3 - Office	23.00	20.00	730				
Level 4 - Office	23.00	20.00	730				
Admin 2	**23.00**	**20.00**	**2,160**	**2.0**	**3,100**	**10%**	**I+DP-1 - I+DP-3**
Level 0 - Lobby, Canteen, Offic	23.00	20.00	2,160				
Level 1 - Office	23.00	20.00	940				
HPM Warehouse	**28.80**	**14.40**	**415**	**1.0**	**415**	**1%**	**I+DR-5**
Guard House 2	**10.00**	**21.60**	**180**	**2.0**	**360**	**1%**	**I+DR-5**
Level 0	23.00	20.00	180				
Level 1	23.00	20.00	180				
TOTAL AREAS of BUILDINGS			**10,950**		**31,681**	**100.0%**	
Gas pad (farm, tank, WH)	**40.00**	**15.00**	**600**	**1.0**			**I+DR-5**
Tank (incl. pump house)	**20.00**	**10.00**	**200**	**1.0**			**I+DR-5**
Substation			**1,304**				**I+DP-3 / I+DP-4**
Emergency power incl. tank			**350**				**I+DP-5**
Bin Center	**30.00**	**10.00**	**300**	**1.0**			**I+DR-5**
Dynamic UPS			**350**	**1.0**			**I+DR-5**
Potential Sustainability Area			**731**	**1.0**			**I+DP-3 / I+DP-4**
TOTAL AREAS			**10,950**		**31,681**	**100.0%**	

Total area benchmarking

- Gross Manufacturing Area (GMA): 4,000 m²
- Total Area (TA): 31,681 m²

  Includes:
  - FAB building
  - CUB building
  - Admin building
  - HPM warehouse
  - Guard house

- ➔ Ratio TA / GMA: 7.9

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2,000 m² Cleanroom

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1	FAB
2	CUB
3	Office Building
4	Warehouse
5	HPM Warehouse
6	Gas Pad
7	Waste Center
8	Guard Houses
9	Emergency Power DG
10	Dynamic UPS
11	Sprinkler Tanks and Pump Station
12	Future 66/20 kV Substation
13	Reservation: Potential Sustainability Measures

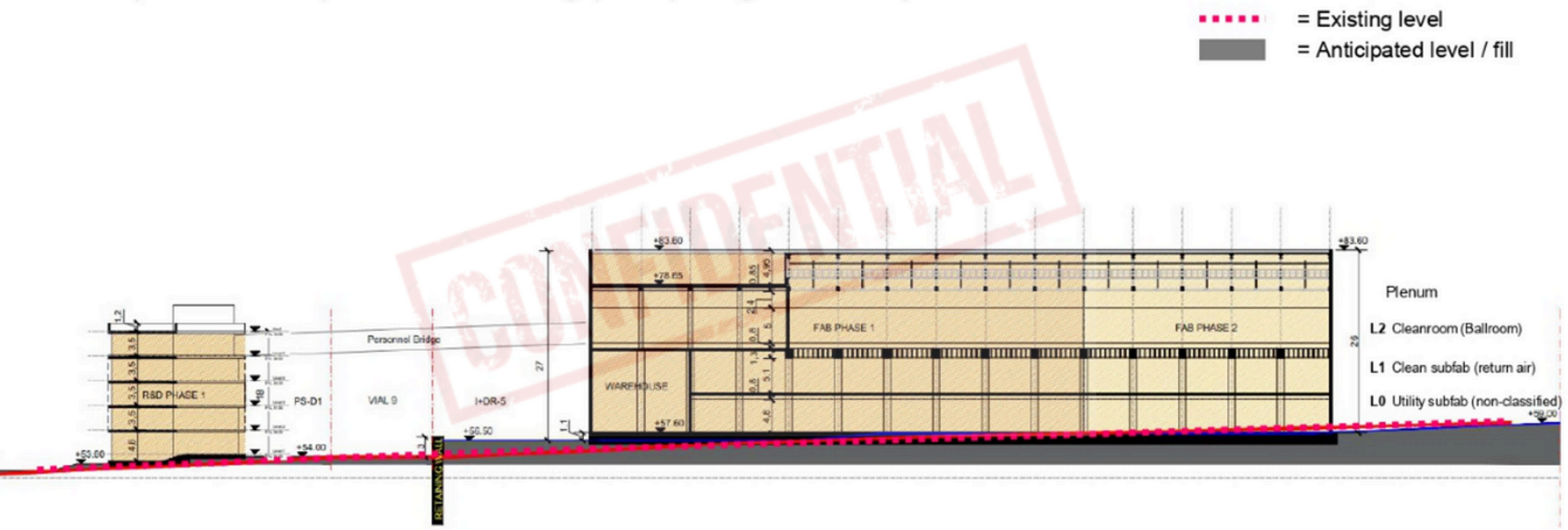
Material Entrance

Staff Entrance

Vibration measurement point

Site Master Plan – Concept Sections 1

FAB (Ph.1 & Ph.2) + R&D Building (Ph.1) height development

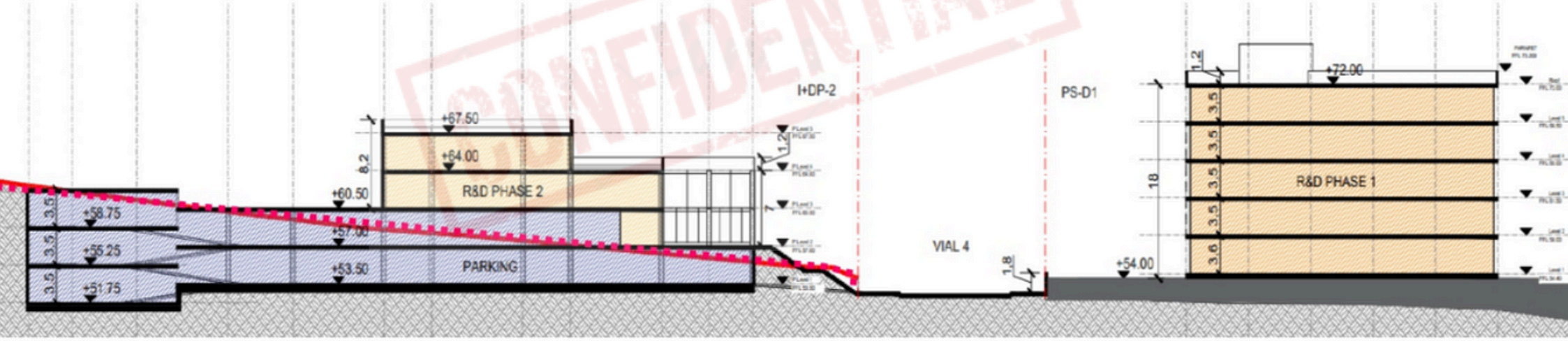


Site Master Plan – Concept Sections 2

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R&D Buildings (Ph.1 & Ph.2) height development - Section

= Existing level
= Anticipated level / fill

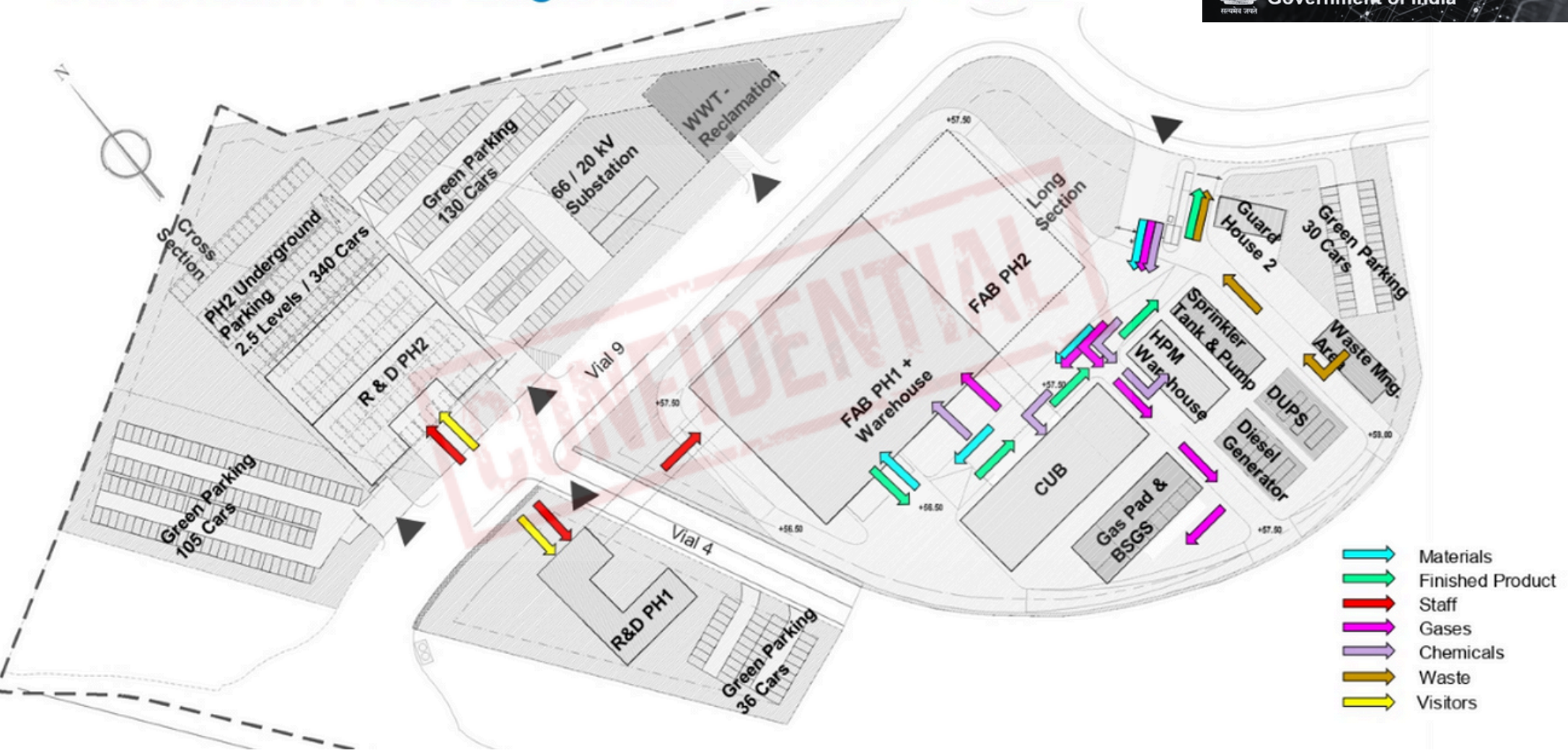


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Site Master Plan Logistics – Phases 1 & 2

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PART 2

ON REQUEST

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