MODERN INDUSTRIAL HERITAGE: A CATALYST TO NEW SUSTAINABLE DEVELOPMENT

Darshik J. Parejiya
Faculty of Architecture & the Built Environment, Delft University of Technology
Julianalaan 134, 2628BL Delft

ABSTRACT

To reduce the carbon emissions and restrict global average temperature rise, coal power plants are being decommissioned in EU under the Paris Agreement. In the next few decades, defunct coal-powered plants would pop-up all over EU and the world. This raises concerns regarding the modern industrial landscapes, their possibilities and opportunities. New strategies and frameworks are required to protect and highlight our modern industrial heritage. The thesis explores the possibilities of integrating defunct coal-power plants into the city by using existing structures and materials on site to promote sustainability and circularity. The topic is researched by understanding the basic functionality of these power plants, various facilities and the machinery housed in them, the environmental impacts, the urban contexts, heritage value assessment and various strategies of decommissioning. Inferences from the research topics would be vital in taking decisions regarding demolition/repurpose/reuse, reflect potential reuse opportunities, and programmatic ideas which would be useful while designing a time-line phase redevelopment for these power plants to act as protagonists in achieving the sustainable development goals.

KEYWORDS: *Industrial Heritage, urban development, coal power plants, usage value, revival potential, material and structure harvest, landscape reclamation, sustainable development.*

I. INTRODUCTION

A long-term temperature goal to restrict the increase of global average temperate was adopted by 195 parties at the 21st session of the Conference of Parties (COP21) under the Paris Agreement (Rocha *et al.*, 2017). Coal-fired powered plants are the biggest source of greenhouse gas emissions. They account for 40 percent of energy production but are responsible for over 70 percent of emissions in 2010 (Foster and Bedrosyan, 2014). To meet the guidelines of the agreement "to restrict the global average temperature rise below 2°C and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels" requires rapid de-carbonizing of the energy production system to reach the climate objectives of 2030 and 2050 (Jones *et al.*, 2016).

There are over 300 coal-powered plants in the EU which contribute greenhouse emissions by burning coal. Ultimately all countries part of the European Green Deal are phasing out coal and fossil-fuel-based powered plants and transitioning towards renewable sources of energy to achieve the climatic goals. This would result in non-functioning/decommissioned/empty thermal power plants pop-up all over the EU in the coming decades. This provides great opportunity to re-use and adapt these industrial landscapes, for their adaptability and quantity. Even though they are challenging due to its technical complexity, scale, negative perceptions, economic and social consequences they can help deliver sustainable development goals. Coal power plants can act as protagonist in achieving the sustainable development goals (SDG) by 2030. There are 17 SDGs developed by the United Nations that can be categorized into three sections; biosphere, society and economy. Out of the 17, the coal power plants can help achieve 6 of them; 3. Good health and well-being, 7. Affordable and clean energy, 8. Decent work and economic growth, 9. Industry, innovation and infrastructure, 11. Sustainable cities and communities, and 12. Responsible consumption and production.

Modern industrial heritage consists of scientific, technological, historical values in the history of production and engineering, or aesthetical qualities deriving from the planning, design or architecture. These values are intrinsic to the site, machinery, components, buildings, industrial landscape and also to intangible records like memories, tradition and people (Douet and International Committee for the Conservation of the Industrial, 2012). The industrial heritage embodies the values of a past providing an important sense of history and identity. With the cities expanding these industrial complexes offer the opportunity to integrate them within the system and provide a second life to these landscapes.

New strategies and frameworks are required to protect and highlight our modern industrial heritage. An idea to conserve the local distinctiveness and landscape generating an enhanced sense of place. This paper presents design principles to re-purpose nonfunctioning modern industrial landscapes (coal-powered plants) to integrate them within the expanding city and create a multi-cultural hot-spot promoting circular and sustainable future. How does the refurbishment of vacant thermal plants using existing structures and materials on site promote sustainability and circularity in social way?

1. UNDERSTANDING THE FUNCTIONING OF POWER PLANT

What is the general functioning flow of coal power plants? How are the spaces utilized and what is the composition of the machinery, instruments and structure? Understanding the functioning of coal-powered plant is crucial in revealing the possibilities and reusing the site or building. It provides a better understanding of the various components, building, planning and structure which is vital information for the sections to follow. Literature study, drawings from archives and site visit (to Vattenfall coal power plant at Hemweg 8, Amsterdam) were the methods adopted for research.

1.1. General functioning flow of coal power plants.

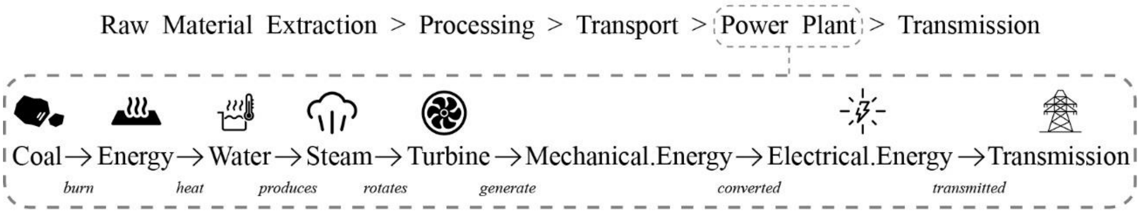

Figure 1: Diagrammatic basic principle of coal powered plant.

Extracted coal is transported to the power plant where coal is burned to produce energy in the form of heat which is used to produce steam by heating water that rotates turbines to generate mechanical energy which is converted to electrical energy that is transmitted using transmission towers (Figure 1). This is the basic fundamental of the working of coal power plant, but the processes are much more complex and elaborated.

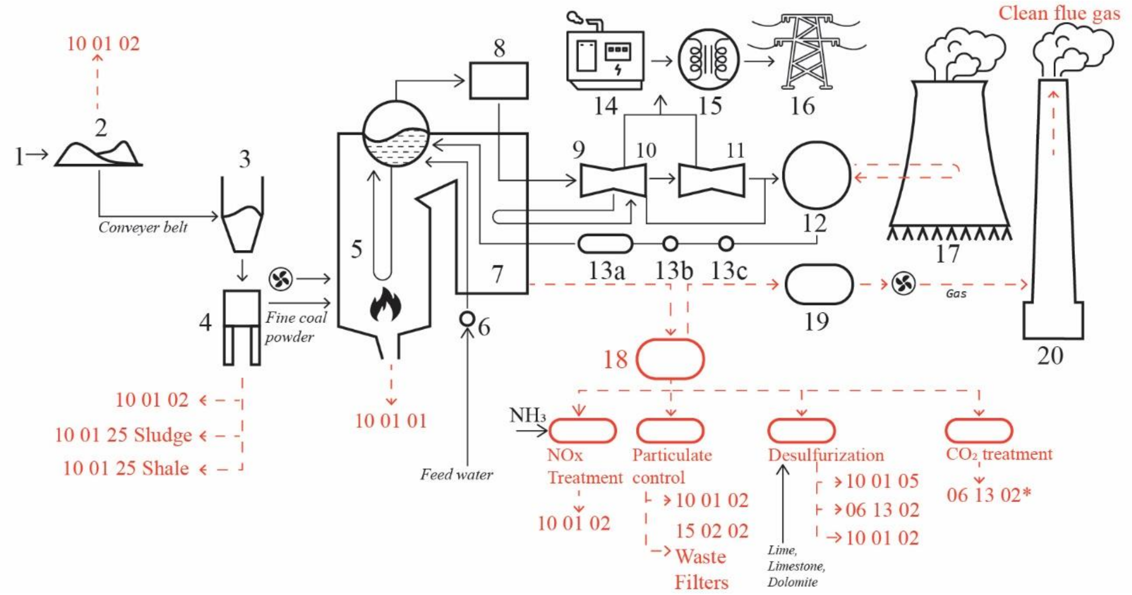

Figure 2: Schematic diagram of coal-fired conventional steam turbine plant and waste points. (Demir, Yetiş and Unlü, 2018, p. 213; G Boncimino; W Stenzel, 2005, p. 13; Żyrkowski, Costa Neto and Santos, 2014, p. 15; McBean, 1987)

Legend: 1.) Coal 2.) Coal Landfill 3.) Coal Bunker 4.) Coal pulverization 5.) Boiler 6.) Feed water pump 7.) Economizer 8.) Superheater 9.) High-pressure Turbine 10.) Intermediate pressure turbine 11.) Low pressure turbine 12.) Condenser 13a.) Feed Heater 13b.) Deaerator 13c.) Boiler feed pump 14.) Generator 15.) Transformer 16.) Transmission tower 17.) Cooling tower 18.) Flue gas treatment 19.) Precipitator 20.) Chimney stack.
[For waste points refer Appendix A.1 Table 1 and Table 2.]

Coal from the mine is transported to the coal storage supply area (Fig.2-1,2). Then the coal is transported to coal bunkers (Fig.2-3) via conveyors which are located adjacent to the boiler above the pulverizes (Fig.2-4). The coal is pulverized to powder which is blown through the pipes inside the boiler (Fig.2-5) along with a stream of air. This mixture of fuel and air is injected into combustion by several burners. Feed water from a nearby source is pumped (Fig.2-6) inside the boiler through pipes lined along the surface of the boiler that get heated to produce steam. The steam produced is passed through the superheater (Fig.2-8). High pressure and high temperature steam from the superheater is sent to the High-pressure turbine (Fig.2-9). Steam from the HP is reheated before passing it though the Intermediate-pressure turbine (Fig.2-10) and then Low-pressure turbine (Fig.2-11). Steam at the turbines converts high pressure and temperature energy to mechanical energy which is turned into electrical energy at the generator (Fig.2-14). This electricity is sent to the transformer (Fig.2-15) before transmitting it through towers (Fig.2-16). Steam from the LP-turbine flows to the condenser (Fig.2-12), where it is converted into liquid state with the help of cooling towers (Fig.2-17). This liquid returns back to the boiler for improved efficiency. The main byproducts formed at the boiler during combustion process are slug, bottom ash and fly ash. Heavier slug is collected at the bottom of the boiler, whereas the lighter ash soars up and is separated using electrostatic precipitator (Fig.2-19). The Flue gas is treated (Fig.2-18) and fly ash collected from it stored at silos, before exporting them to fly ash utilization units. Clean Flue gas is exhausted out into the atmosphere via chimney stacks (Fig.2-20).

1.2. Composition of site, components and machinery.

The site is divided into several facilities, housing structures with specific programs.

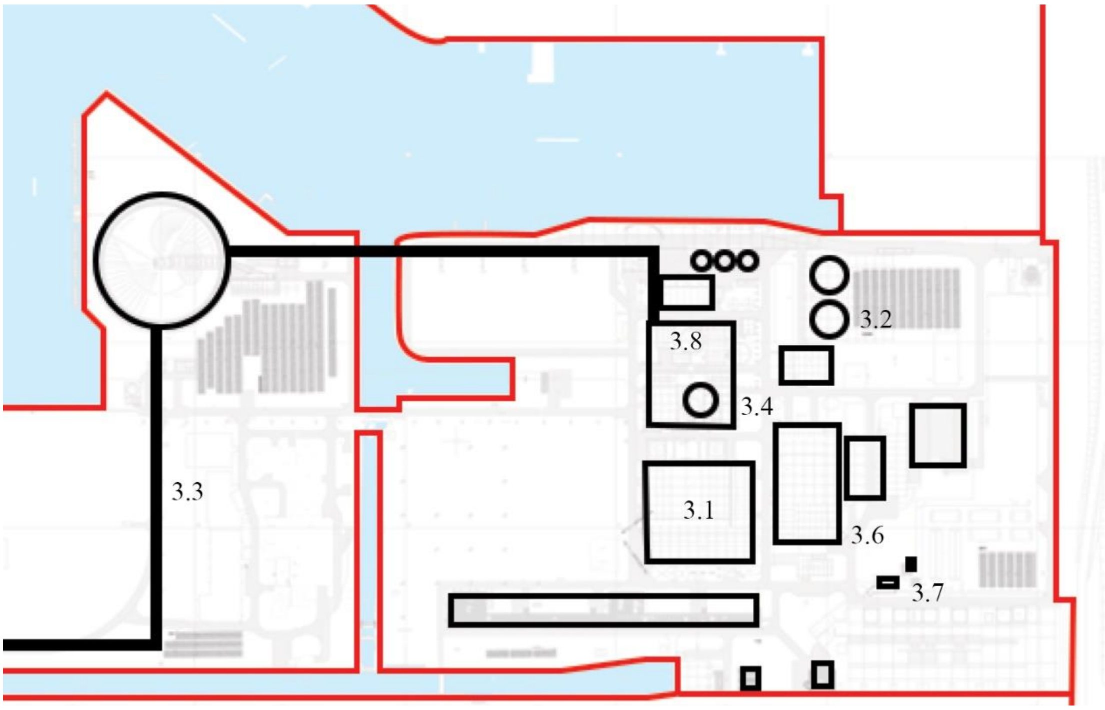

Figure 3: Site plan of Vattenfall coal power plant in Amsterdam.

The generation building (Fig.3-1), is the most prominent building that consists the boiler, turbine area and fan areas. For a large boiler areas can be as big as 70x70m in plan and up to 90m in height (McBean, 1987). Silos (Fig.3-2), there are several reinforced concrete silos' on site for various purposes but frequently used for coal, fly ash and limestone storage. Often they're 12-15m in diameter and 20-30m tall (McBean, 1987). Coal handling structures (Fig.3-3), comprise of the conveyor galleries and their support systems. These are long-span galleries that transport coal from the landfill to the boiler room where they enter around 45m above ground. Chimney (Fig.3-4), generally constructed of reinforced concrete chimneys are the tallest structures present on site they can go as high as 180m. Chimney stack can also be constructed from steel, but they cannot achieve similar heights to its counterpart. Cooling towers (Fig.3-5), steam from the power plant is condensed into liquid form at the cooling towers. These hyperbolic paraboloid geometric structures are constructed from reinforced concrete (150m height). Other than the most prominent structures, there are structures for transmission line, administrative, logistics, pumping stations and substation structures. Workshop spaces (Fig.3-6), auxiliary structures like pump room, administration (Fig.3-7), and Flue-gas treatment plant (Fig.3-8) sizes can vary for every facility. The site plant does not mark the cooling tower because the facility in Amsterdam does not have one. [Refer for Appendix A.2 for detailed drawings of these structures and machinery housed]

1.3. Byproducts and environment issues.

Coal combustion products (CCP) arise from the coal power plant due to the combustion of coal. CCP are one of the most copious waste materials worldwide. Fly ash, bottom ash, boiler slag and flue-gas desulfurization residues (or synthetic gypsum) comprise majority of these pollutants. The environmental impacts of these pollutants are concerned with the heavy metalloids and toxic metals that leach out when they enter the soil. Lasting environmental impacts have been attributed to release of CCP in to lagoons, because these metalloids have a tendency to enter the food chain (Sajwan and International Conference on the Biogeochemistry of Trace, 2006).

The cleanup decisions are dependent on the site reuse options. Complete decommissioning requires the plant site to be cleaned or remediated to meet the environmental requirements for future use. Site-specific remediation requisites are defined by the needs of redevelopment. For example, the cleanup requirements for future industrial land use may be less stringent than what is required for residential purpose, because the prolonged exposure to pollutants will be less. Many operations addressed as a part of the cleanup are removal of hazard materials like asbestos, PCBs, other materials, cleanup of coal ash disposal areas, contaminants from surface soil and water are removed.

2. URBAN STRATEGIES

Where are the coal power plants situated and what is the context? This section would help reflect the potential reuse opportunities and provide a better understanding of the urban contexts of coal power plants. Research through studying maps and development strategies.

2.1. Urban context of power plants

Coal power plants are heavily dependent on connections to urban fabrics, transportation facilities like harbour, rail and road networks, and water bodies like canals, rivers or lakes to ensure a continuous supply of water. Due to environmental and health concerns usually, these plants are situated away from populated areas but it is not always the case. The site location of coal-power plant can vary: they can be situated close to the city, usually they are situated in industrial complexes or in remote areas easily accessible from metropolitan areas, sometimes they are situated in accessible reach from the city but over time as cities have expanded these coal-power plants have become an integral part of city fabrics. All site situations provide various opportunities for reuse. Facilities situated slightly farther from the city but accessible can be transformed as new locus for future developments, for example, it can be transformed into university towns or sister city. Similar situation for power plants in urban contexts, necessary reuse plans can be developed to integrate them with the context. Reuse plan for the powerplants should be developed in accordance with the urban context and its needs.

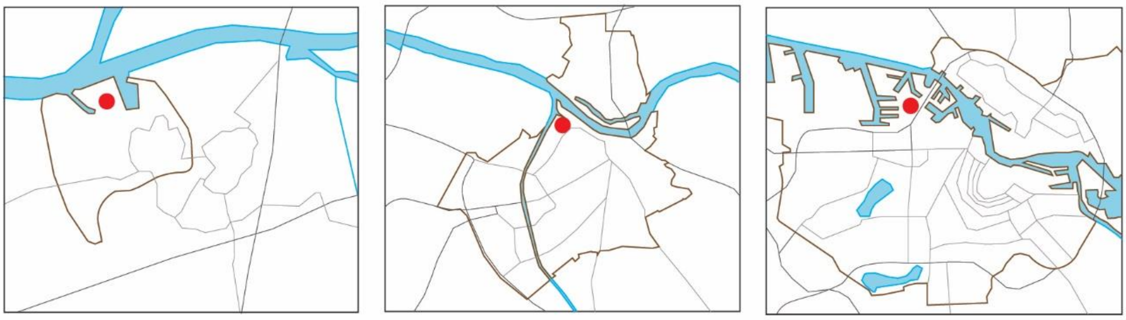

Figure 4: Schematic diagram of Nijmegen, Geertruidenberg and Amsterdam marking the location of power plants in respect to cities. (The diagrams are not relatively scaled.)

Figure 4 is a schematic diagram of the urban fabric of following power plants: Gelderland power plant in Nijmegen closed in 2016, Amercentrale (unit 9) in Geertruidenberg opened in 1993, Vattenfall power plant in Amsterdam closed in 2019. The schematic diagrams show the location of power plants in respect to the historical city and its proximity to water, road and rail networks.

2.2. Site introduction

Vattenfall coal power plant in Amsterdam is the site chosen as primary source and design site. The coal power plant in Amsterdam is close to the harbour, industrial area, Sloterdijk and Havenstad. The Havenstad has the potential of becoming a complete city close to Sloterdijk. The municipality of Amsterdam is also trying to transform the port into a sustainable harbour by 2030.

This provides a valuable opportunity for the power plant to be a protagonist for future developments.

3. HARVEST

How can we harvest from industrial landscapes? Which existing conditions on site should be reused/recycled/repurposed and why? Drawings from the archives, literature study and findings from the previous section were used to answer these questions. A heritage value matrix is created using the previous analysis. This assessment is beneficial for the designer in decisions regarding intervention, like re-use/demolition/conservation.

3.1. Analysis of the components

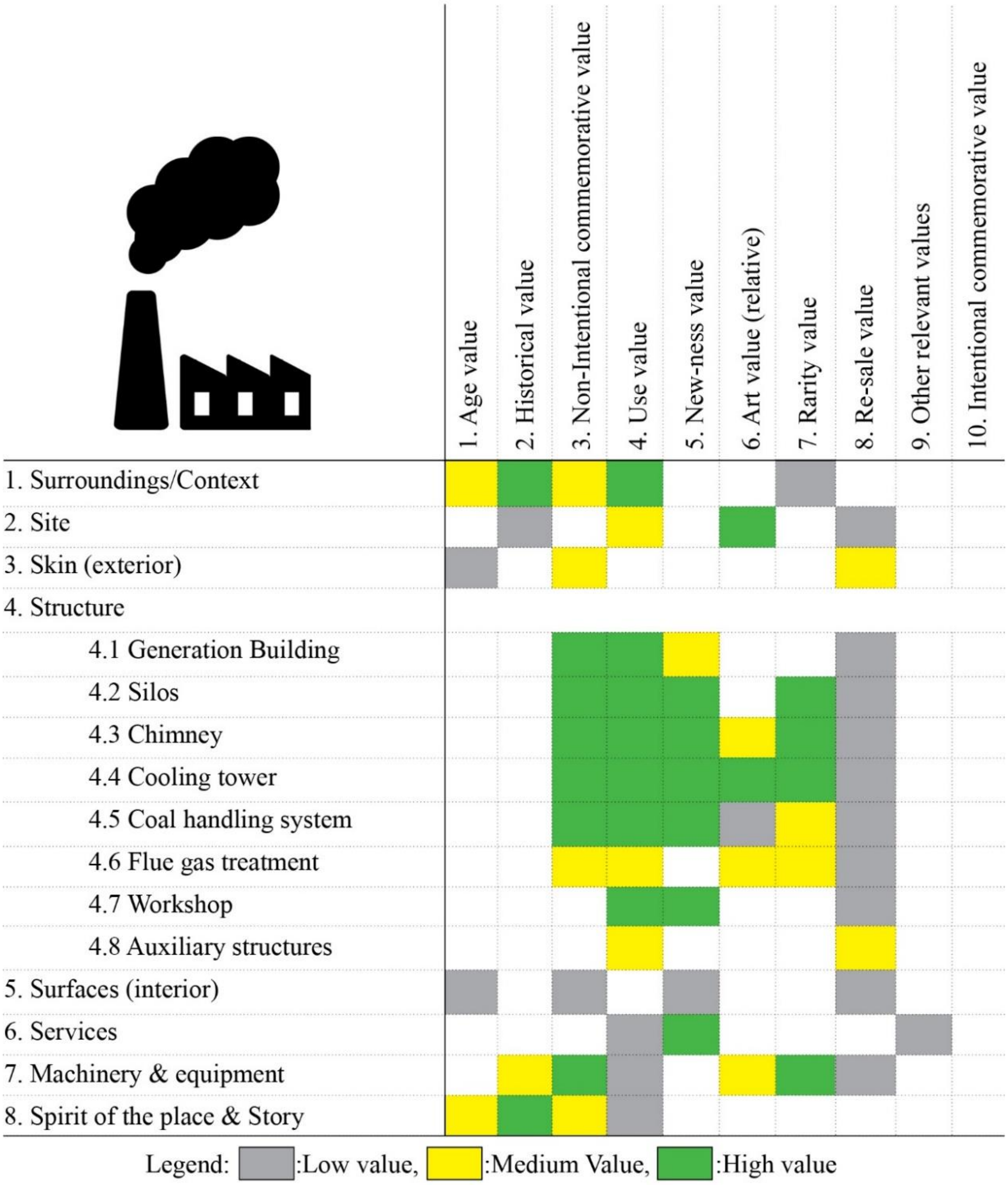

Figure 5: Heritage value matrix of a coal power plant.

The matrix assesses the building and site on tangible assets like site, context, structure, machinery(stuff), components, surfaces, but also on intangible assets like spirit of the place and story. They are valued across various categories ranging from ‘new-ness’ to ‘age’ to ‘functionality’ to ‘art’ value. Re-sale value is also included in the categories, since modern industrial heritage are relatively new there are certain assets which can possess re-sale value.

These pixels formulate a groundwork for redevelopment strategies. Categories with higher value should be retained/repurposed and given higher preference than elements with lower value. There can be several external factors that can influence the value assessment from the matrix. The value matrix should be adapted to every site-specific coal power plant. This value matrix is realized to coal-power plant in Amsterdam but it can be utilized for other coal-power plants.
[Refer for Appendix A.3 for detailed Value Matrix]

4. PHASE REDEVELOPMENT

What are the reuse opportunities for these sites? How can the rejuvenation of industrial plant bring added value on a neighborhood scale in contributing to sustainable development goal? Possibilities of integrating industrial landscapes within expanding cities by creating a timeline of phase redevelopment. Research through development strategies and generating an inventory of materials and structures would answer the sub-question.

4.1. Plant decommissioning and redevelopment.

All coal-power plants are faced with the question about what to do when the plant closes. Some plants are already facing these questions and some will in the near future. Decisions regarding the site reuse possibilities need to be discussed, so necessary actions can be taken. Preparing a site for reuse is a complex multi-year process that includes cleanup of site (contamination in soil, ground water, materials), decommissioning of necessary structures on site, and designing and implementing a redevelopment plan.

Redevelopment strategies can vary on several layers. Coal power plants can adopt various adaptations of the following strategies (EPRI, 2004):

- Minimal intervention- minimal cleanup done to meet environmental compliance.
- Minimal demolition & dismantling- in addition to site cleanup perform minimal dismantling like removing salvageable equipment, remove safety hazards.
- Planned reuse- in addition to the previous strategy; depending on the needs of redevelopment plan structures on site should be dismantled or demolished or restored. (this can involve the major facilities on site like generation building, chimneys, coal handling system, cooling towers, silos, workshop buildings, etc.) Necessary actions to be taken depending on the reuse plan, for example, the internals and externals of the buildings need to be removed such that those structures can be remodeled.
- Full decommission- Cleanup entire site as per environmental standards, dismantle all equipment and demolish all structures.

Inherent value of property is a significant aspect in decisive reuse possibilities. Sites close to river fronts or close to cities will attract a lot of attention compared to plants in remote areas. Reuse of such sites can result in significant added value for the company and local community. Some facilities of the plant are seen as important landmarks by the local communities and there is a strong desire to preserve the physical entities fully or partially for posterity. Structured planning and implementation of plant sites can result in great asset to the surrounding communities and city.

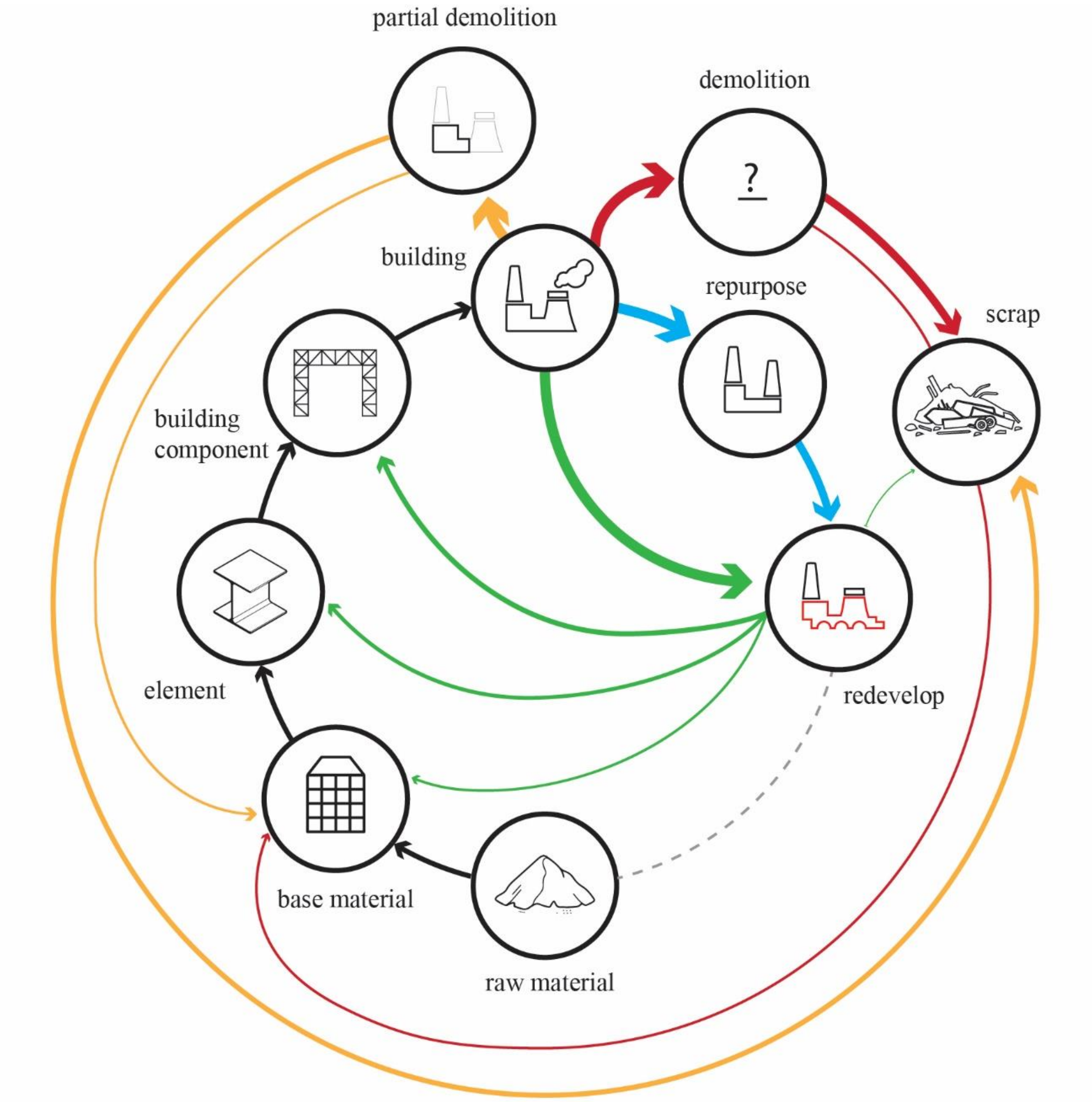

Figure 6: Flow diagram showing the various redevelopment strategies.

The property value reduces since decommissioning is a complex process and a financial burden. Decommissioning is financially taxing on the owner and if the reuse of the site will result in an economic advantage to the local community and city, then state governments might be willing to provide funds or tax intensives (EPRI, 2004). Maintaining a close collaboration between local and state governments, public organizations and environmental agencies would ensure the sites are not left abandoned, environmental norms are fulfilled and this would also provide incentives to the owner.

4.2. Redevelopment timeline.

Redeveloping these power plants is inevitable, it will happen in a few years or a few decades. If the coal-power plants get repurposed into biomass/other power plants after ‘x’ number of years the same situation of it being redeveloped would arise. The buildings on site offer a unique development opportunity to integrate them with the growing cities. These power plants have had a huge impact in the history of development and environment, both positively and negatively. Assessment from the value matrix and out of the above-mentioned strategies, ‘planned reuse’ of site will be the most beneficial in a longer period. ‘Full decommission’ is the only alternative other than 'Planned reuse' but the spirit of the place and its redevelopment potential is very high to ignore. Other strategies also hold merit for certain situations and sites, for example, if the facility is situated in remote areas then intervention decision would have to be taken accordingly or if the facility has several cooling towers and chimneys then it might be more beneficial to retain only a few.

Creating a timeline of redevelopment for a power plant from the above-mentioned strategies. Assuming a coal-power plant 'x' closes in the year 2020. It would be faced with 3 viable strategies. Adopting the 'Planned reuse' redevelopment strategy for a power plant considering a close collaboration between the owner, state government and public organization; a stepwise elaborated strategy is illustrated in the diagram:

- 2021: Site remediation and restoration- Investigation and cleanup of hazardous materials and contamination from site to meet environmental norms.
- 2023: Dismantlement/restoration of structures and machinery- depending on the reuse strategy and assessment from the value matrix necessary structures will be dismantled or restored. Introduction of recreational or small programs on site, for example pop-up exhibition spaces, concert spaces etc. Resale of interested facilities, machinery and structural components.
- 2026: Extended intervention- Remodeling of larger structures like generation building, cooling structure and introduction of new smaller developments on site. Introduction of more permanent programs like startup offices, studios, workshops etc. Development and planning on urban scale. This step would bring more notice to the site and help people familiarize with the next context.
- 2026-2030: Storage farm- Development on site if it is imagined as a storage plant for off-shore wind farms. This should be pre-planned before the earlier steps are taken, so necessary measures and planning decisions are taken. If there is no such intention of reuse, then skip.
- 2040: New structures- Ideas and development of new structures on site in synergy with the urban context. Programs like residential, commercial or recreational hubs can be introduced.
- 2050: Integration- The whole site is developed and become an integral part of the extended city fabric. Becomes the new center of attraction for research or recreation. New hot-spot of the expanding city.

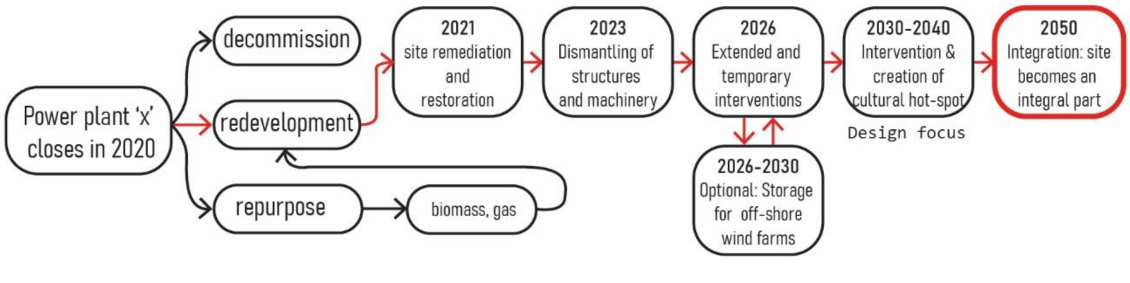

Figure 7: Stepwise elaborated strategy with design focus.

This strategy is a rough cut and the dates in this timeline are tentative which are intended to change due to external factors like finance, availability of resources, site etc. They are developed from the study of case studies (mentioned by EPRI, 2004) and literature. [Refer for Appendix A for detailed diagrams of this strategy, adapted to the Vattenfall power-plant in Amsterdam]

II. CONCLUSION

Industrial landscapes are important milestones in the history of development and humanity, that is responsible for modifying landscapes and life styles. Responsible for both creation and destruction, they are testaments to the achievements of humankind. Due to rapid technological advancements and scarcity of deposits have rendered several industrial facilities obsolete, and many soon to come in the coming decades. The new environmental regulations agreed under the Paris green deal has resulted into de-carbonizing energy generation. In next few decades over 300 coal power plants in EU would shut down. This would result in non-functional/abandoned/vacant coal power plant pop-up all over Europe and the world in a few decades. The 17 sustainable development goals (SDG) set-up by the United Nations provides the opportunity to rethink the re-use plans for coal-power plants. These facilities are abundant in resources with structural and urban capabilities to become protagonists to achieve the SDG goals by exploring alternative second-life options by harvesting materials and structures to integrate them into urban fabrics in a sustainable and circular way.

The powerplant can be understood as an agglomeration of several facilities that house numerous machines. It can be briefly divided as generation building, workshop, chimney, cooling tower, flue-gas treatment plant, coal handling system, silos, workshop, and auxiliary structures. With the machinery and structures not in use, they can be repurposed to house different functions due to their structural and spatial capabilities rather than being scraped. The re-use strategies can be developed by understanding the urban contexts, a value assessment and redevelopment strategies. Since these facilities are highly dependent on services, they are well connected to cities by road and water networks. Heritage value assessment creates a handbook to evaluate coal-power plants around the world. Assessing these facilities and grading them by value develops a heritage value matrix which is useful in developing a general re-use strategy. Materials and structures can be harvested depending on their value assessment; the spatial and non-spatial categories with high value assessment should be retained or given preference over low value. Materials, structures and machinery on these facilities can be harvested and repurposed to promote circularity and sustainability. Short coming of this method is that the value assessment might vary slightly from facility to facility. All plant conditions are different and the heritage value matrix needs to be adapted to specific plant conditions, but the value assessment brings common entities in coal-power plants and their values to light. Similar redevelopment intentions and sustainable develop goals will yield familiar outcomes. Re-use timeline differs for every strategy adopted; depending on the future program. Repurposing the site and structures while conserving several physical entities has more potential in becoming an asset to surroundings communities and urban fabric, rather than demolition or decommissioning. It has the possibility to introduce a new kind of building typology in cities. It has the potential of becoming a new landmarks as recreational centers or institution; every industrial city would have a place called ‘the power plant’. Should these sites be eradicated or conserved?

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APPENDIX A.1

Table 1: Waste codes for process-specific wastes (Demir, Yetiş and Unlü, 2018, p. 214).

EWC CODE	DESCRIPTION
06 13 02*	Hazardous activated carbon waste from desulfurization Unit (formed when such system is used to remove SO_2 and NOx together).
10 01 02	Fly ash from coal-fired power plants.
10 01 05	Calcium-based reaction wastes from flue-gas desulphurization in solid form. (limestone, gypsum)
10 01 07	Calcium-based reaction wastes from flue-gas desulphurization in sludge form. (limestone, gypsum in sludge form)
10 01 09*	Sulphuric acid produced in the acid gas removal unit in IGCC plants.
13 07 01*	Fuel-oil and diesel wastes that are used for boiler ignition.
13 07 02*	Petroleum wastes that are used for boiler ignition.
13 07 03*	Other fuels (including mixtures) that are used for boiler ignition
19 08 13*	Hazardous substance containing wastewater sludge from coal enrichment units, coal storage washed with rain, desulphurization unit, bottom ash cleaning and boiler acid cleaning.
19 08 14	Non-hazardous wastewater sludge from coal enrichment units, coal storage washed with rain, desulphurization unit, bottom ash cleaning and boiler acid cleaning.
19 09 04	Spent activated carbon from process water preparation/treatment unit.
19 09 05	Saturated or spent ion exchange resins from process water preparation/treatment unit.

Table 2: Waste codes for non-process-specific wastes (Demir, Yetiş and Unlü, 2018, p. 214)

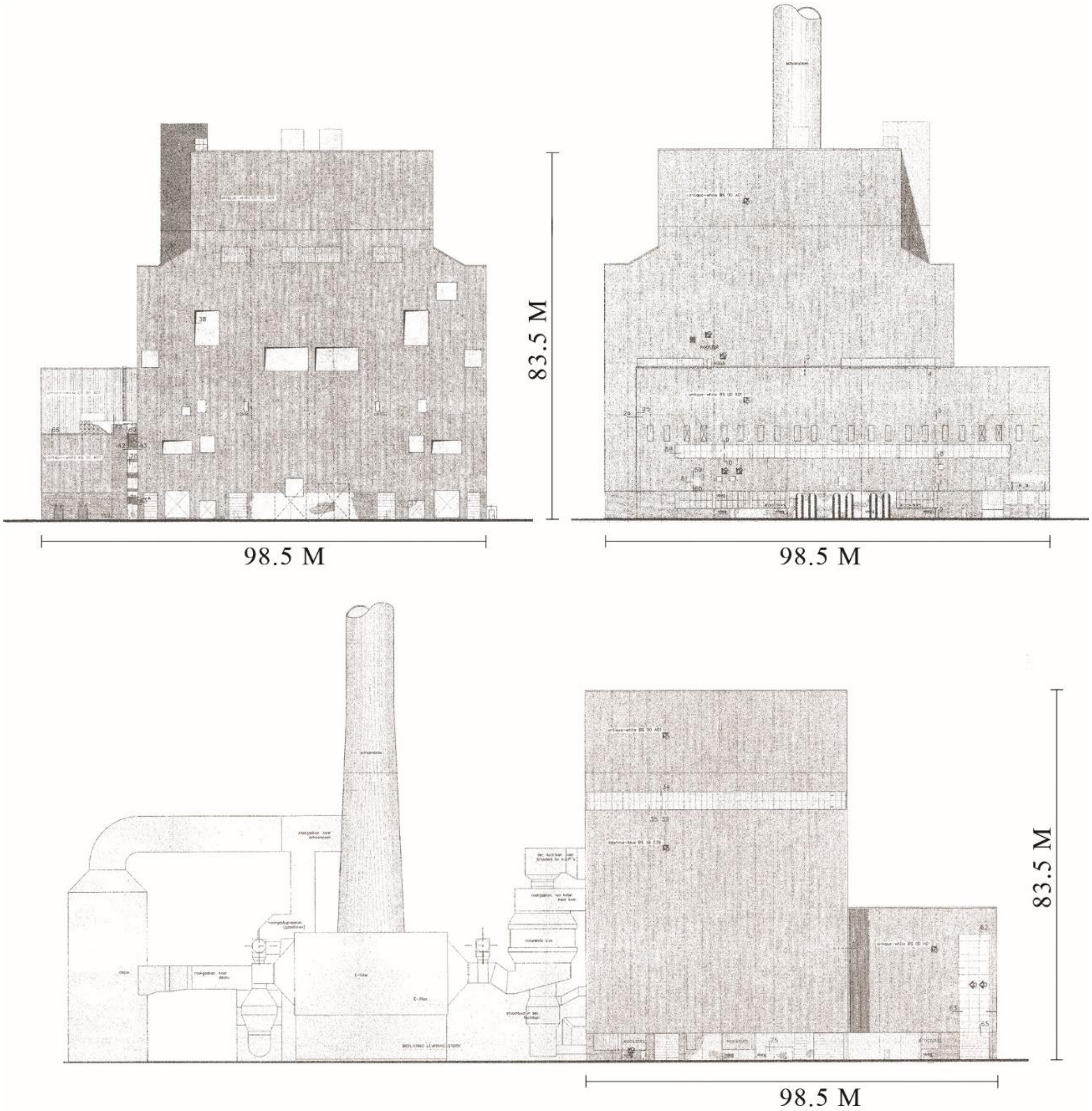
EWC CODE	DESCRIPTION	EWC CODE	
08 01 11*	Waste paint and varnish	13 05 06*	Oil/oil water from oil/water separators
08 03 17*	Waste printing toners.	15 01 01	Packaging waste
13 01 09*	Waste hydraulic oils	15 02 02*	Absorbents, filter materials, wiping clothes and protective clothing.
13 02 04*	Waste engine, gear	16 01 07*	Wastes from end-of-life vehicles and vehicle maintenance
13 03 01*	Waste insulating and heat transmission oils	16 02 13*	Waste from electrical and electronic equipment
16 05 04*	Gases in pressured containers	16 05 06*	Waste laboratory chemicals
16 06 01*	Waste batteries	18 01 03*	Wastes from human health care
19 08 05	Urban wastewater sludge	20 01 21*	Municipal wastes including separately collected fractions

More detailed descriptions of these waste codes can be accessed from European Waste Catalogue and Hazardous Waste List (EPA, 2002). (*indicates that the waste is hazardous.)

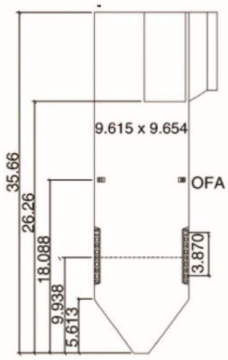
APPENDIX A.2

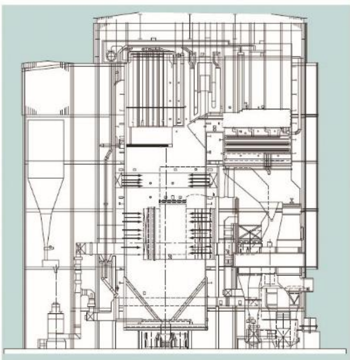
Generation building:

The elevations of the generation building in Amsterdam. These drawings were received from the archives of Vattenfall coal power plant in Amsterdam.

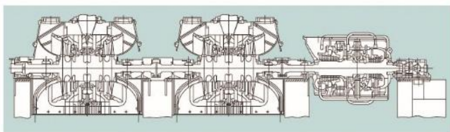


Boiler, turbine and generator (Basu, Cen and Jestin, 2000):

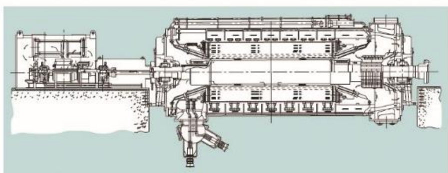




Boiler scheme



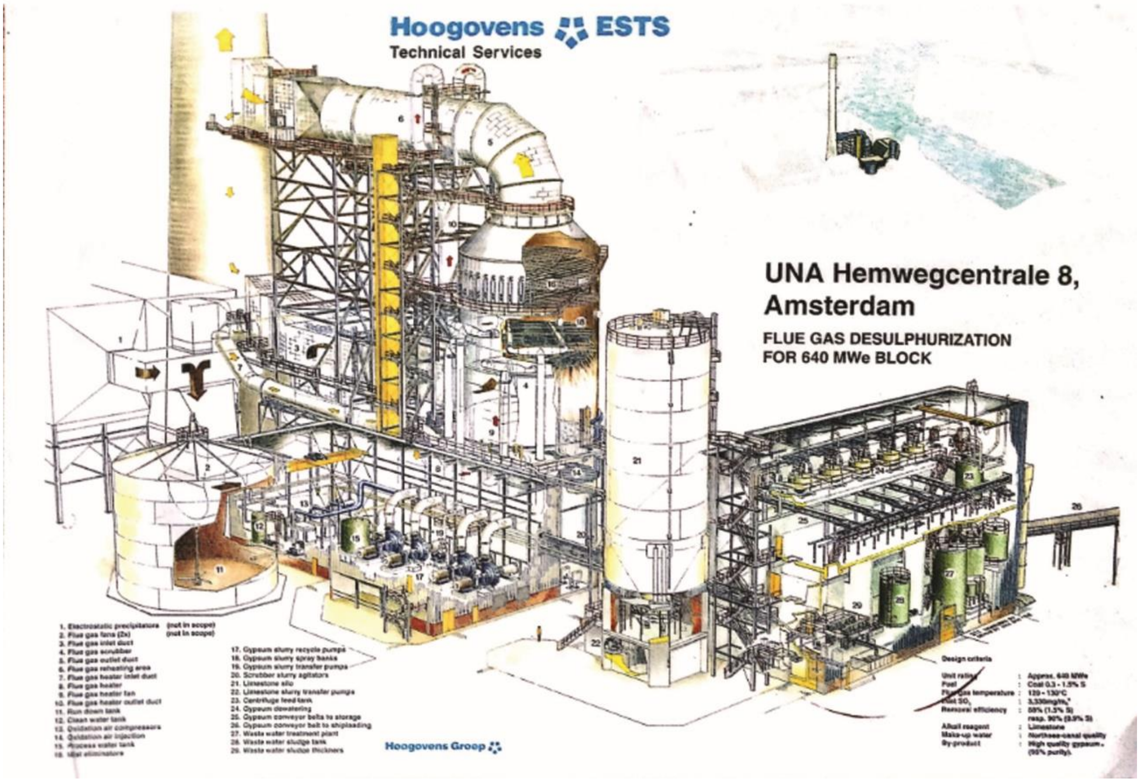
Steam turbine



Generator

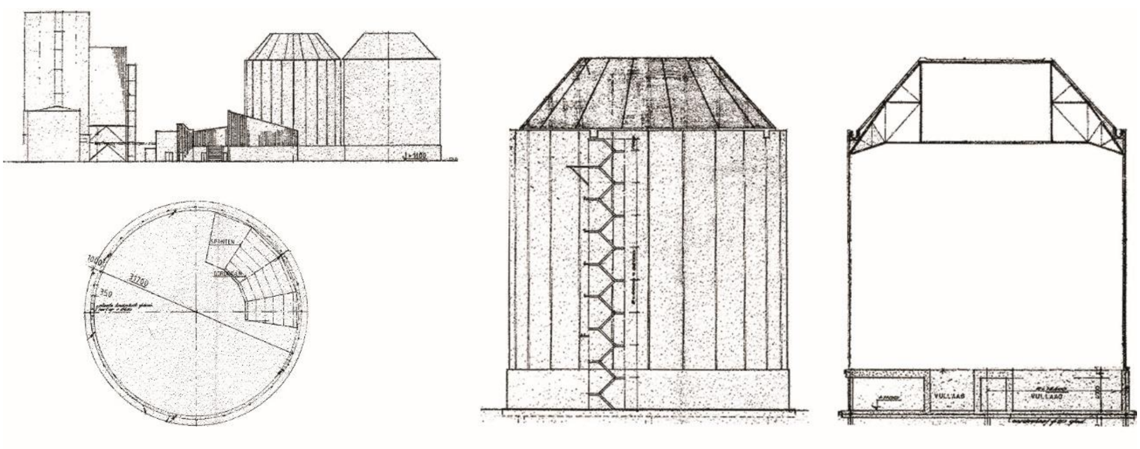
Flue gas treatment:

Exploded axonometric showing the structures and machinery inside Flue gas treatment plant. Drawing was received from the archives of Vattenfall coal power plant in Amsterdam.



Storage Silo:

These drawings were received from the archives of Vattenfall coal power plant in Amsterdam.



APPENDIX A.3

Hertiage Value Matrix:

	1. Age value	2. Historical value	3. Non-Intentional commemorative value	4. Use value	5. New-ness value	6. Art value (relative)	7. Rarity value	8. Re-sale value	9. Other relevant values	10. Intentional commemorative value
1. Surroundings/Context	Medium	High	Medium	High			Low			
2. Site		Low		Medium		High		Low		
3. Skin (exterior)	Low		Medium					Medium		
4. Structure										
4.1 Generation Building			High	High	Medium			Low		
4.2 Silos			High	High	High		High	Low		
4.3 Chimney			High	High	High	Medium	High	Low		
4.4 Cooling tower			High	High	High	High	High	Low		
4.5 Coal handling system			High	High	High	Low	Medium	Low		
4.6 Flue gas treatment			Medium	Medium		Medium	Medium	Low		
4.7 Workshop				High	High			Low		
4.8 Auxiliary structures				Medium				Medium		
5. Surfaces (interior)	Low		Low		Low			Low		
6. Services				Low	High				Low	
7. Machinery & equipment		Medium	High	Low		Medium	High	Low		
8. Spirit of the place & Story	Medium	High	Medium	Low						

Legend: :Low value, :Medium Value, :High value

The extended value matrix is included from the next page. Images in the value matrix were taken from site visit, except 1.Surroundings (first two images), 2.Site and 7.Cooling tower.

1	Age Value	Historical Value	Non-Intentional commemorative value	Use value
Surroundings/Context	Close to Petroleum: Monumental petroleum silos defined the context over the decades.	Landmarks: Petroleum port nearby has played a crucial role in the development of the harbour.	Industrial Markers like industries/silos/harbour nearby.	Proximity to Sloterdijk and Havenstaad, easy accessibility to port, road networks.
	Newness value	**Art value**	**Rarity value**	**Resale value**
			The context is one of kind and is a unique skyline of the city	

2	Age Value	Historical Value	Non-Intentional commemorative value	Use value
Site		Relation to water, harbour and city.		Large plot: sites have big plots and ample empty space.
	Newness value	**Art value**	**Rarity value**	**Resale value**
		Agglomeration of unique objects		Site has low re-sale value due to finances involved in decommissioning.

3	Age Value	Historical Value	Non-Intentional commemorative value	Use value
Skin (exterior)	Industrial cladding system.		'Metal' jungle	
	Newness value	**Art value**	**Rarity value**	**Resale value**
				Scrap/Repurpose value

4	Age Value	Historical Value	Non-Intentional commemorative value	Use value
Generation building (Structure)			Overwhelming scale.	Large span steel structure. Can facilitate numerous functional necessities
	Newness value	**Art value (relative)**	**Rarity value**	**Resale value**
	Structure is new and in good condition.			Scrap/Repurpose value

5	Age Value	Historical Value	Non-Intentional commemorative value	Use value
Silos (Structure)			Cylinderical structure.	Circular concrete structure with large column free space.
	Newness value	**Art value**	**Rarity value**	**Resale value**
	Good condition.		Shape and proportions are unique. Not found in urban fabrics.	Scrap/Repurpose value




6	Age Value	Historical Value	Non-Intentional commemorative value	Use value
Chimney (Structure)			Tall concrete chimney visible from far. Landmark to industrial landscapes.	Height difference from ground level to top of the chimney.
	Newness value	**Art value**	**Rarity value**	**Resale value**
	Good condition.		‘Image’ of industrial landscapes.	Scrap/Repurpose value

7	Age Value	Historical Value	Non-Intentional commemorative value	Use value
Cooling tower (Structure)			Support system and shape of the structure is one-of-a-kind/ distinctive.	Hyper parabolic concrete shells. Massive in scale and empty from inside..
	Newness value	**Art value (relative)**	**Rarity value**	**Resale value**
	Good condition.	Overwhelming, Meditative, encompassing monotonous shell.	Shape is distinctive tc coal power plants.	Scrap/Repurpose value

8	Age Value	Historical Value	Non-Intentional commemorative value	Use value
Coal handing system (Structure)			Bridging system: Connecting various components of the site and the context. (Parasitic).	Conveyor belt bridge elevated from the ground with steel columns.
	Newness value	**Art value (relative)**	**Rarity value**	**Resale value**
	Good condition.		Conveyor system.	Scrap/Repurpose value

9	Age Value	Historical Value	Non-Intentional commemorative value	Use value
Flue gas treatment (Structure)			Exposed structure gives the plant its image of being 'Metal' jungle.	Assembly of Buildings housing several instruments. Some part is exposed.
	Newness value	**Art value (relative)**	**Rarity value**	**Resale value**
			Ensemble of exposed structural system.	Scrap/Repurpose value

10	Age Value	Historical Value	Non-Intentional commemorative value	Use value
Workshop (Structure)				Large span steel trusses with skylights.
	Newness value	**Art value (relative)**	**Rarity value**	**Resale value**
	Good condition.			Scrap/Repurpose value

11	Age Value	Historical Value	Non-Intentional commemorative value	Use value
Auxillary structures				Regular ground floor structures.
	Newness value	**Art value (relative)**	**Rarity value**	**Resale value**
	Good condition.			Scrap/Repurpose value

12	Age Value	Historical Value	Non-Intentional commemorative value	Use value
Surfaces (Interior)	Rugged metal surfaces.		Metal finishes reflect the ruggedness of industries.	
	Newness value	**Art value (relative)**	**Rarity value**	**Resale value**
	Surfaces are either contaminated or beaten-up.			Scrap/Repurpose value

13	Age Value	Historical Value	Non-Intentional commemorative value	Use value
Services			Insulation: all structures are designed for isolation. Insulation layers missing. Accessibility: Designed for machinery and minimal human contact.	Several industrial elevators.
	Newness value	**Art value (relative)**	**Rarity value**	**Resale value**
	Lacks passive ventilation and natural lighting.			

14	Age Value	Historical Value	Non-Intentional commemorative value	Use value
Spirit of the place & Story	Modern industrial heritage.	Backbone to development. Period of production. Biggest impacts on the environment.	Spiritually provides an insight onto what charges our 'mobile phones'. Scale.	Coal power plant
	Newness value	**Art value (relative)**	**Rarity value**	**Resale value**

15	Age Value	Historical Value	Non-Intentional commemorative value	Use value
Machinery & equipment		Embody scientific and technological development.	Organs of the industry.	No functionality post-decommissioning
	Newness value	**Art value (relative)**	**Rarity value**	**Resale value**
		Aesthetically pleasing in their own way.	Customized to the industry and plant.	Except a handful machines most have scrap value.