

Carbonnegative waste-to-energy in Oslo

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Green goals for Oslo

- **“We will hand over the city in a better environmental condition than we inherited it”**

- **Oslo’s sustainability vision**

- 50 % material recycling within 2018
- 50 % reduction in CO_2-emissions within 2020
- 95% reduction in CO_2-emissions within 2030
- 60% reduction in NO_x-emissions within 2022

- Phase out fossil energy from heating
- Car free city centre
- Carbon capture and storage/use from Waste-to- Energy

Cyclic wastemanagementsystem in Oslo

- Two optical sortingplants
- Two waste-to-energy plants – Municipal Waste and Commercial Waste
- One biological treatment plant

Whats the next step?

- High energy utilisation
- All rest products can be converted to products
- Can we do something about the flue gas – can it be utilised?

Klemetsrud well suited for CO_2-capture

- Large single source
- BioCCS
- Excisting plant
- 365/24/7
- Energyflexible
- Industrial know-how
- Global potential
- Business opportunities

Opportunities – CCS in WtE

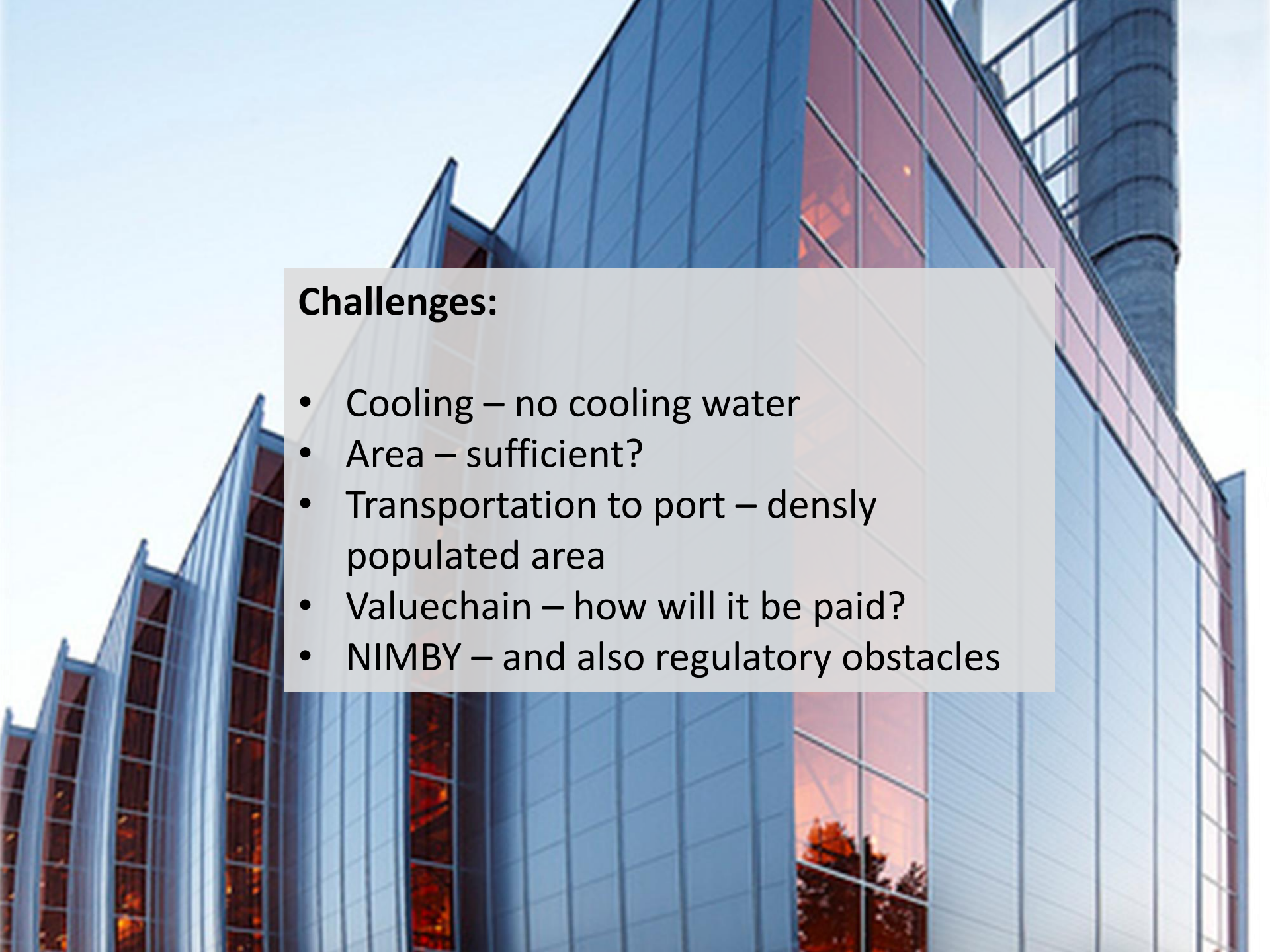
- A business well governed – will oblige to new regulations
- WtE will always be needed
- A tradition for transparency and best practice
- Local business – less chance for carbon leakage than global businesses

Why study CCS in Oslo?

- Part of a larger CCS-study in Norway
- On behalf of the Norwegian Government
- 3 capture studies (cement, fertilizer, waste)
- 2 transport studies (ship to the Northern Sea basin)
- 1 storage study, 3 sites in the Northern Sea Basin

- Waste-to-Energy Agency, City of Oslo
- Yara, 2nd largest fertilizer producer in the world
- Norcem – part of the Heidelberg Cement group
- Transport study done by Gassco, the norwegian stateowned gaspipecompany
- Storage study done by Statoil


Smeaheia
/Kollsnes
Heimdal
Utsira
Klemetsrud
Yara/Norcem
Førde
Dalo
Sande
Hafslo
Øvre Årdal
Fåvang
Tretten
Lillehammer
Vikøyri
Lærdalsøyri
Heggenes
Fagernes
Brumunddal
Aurlandsvangen
Hemsedal
Bagn
Dokka
Hamar
E16
Gol
Raufoss
Hol
Voss
Ulvik
Leknes
Bjoneroa
Bergen
Indre Arna
Ålvik
Dagali
Gran
Jondal
Rødberg
Osøyro
Hardangervidda
Hønefoss
Hardangerfjorden
Høyland
Rjukan
Sandvika
Fitjar
Rauland
Stord
Haukeli
Tuddal
Drammen
Sauda
Ski
Vestby
Hjartdal
Notodden
Haugesund
Sand
Hovden
Dalen
Moss
Akkerhaugen
Åkrehamn
Kopervik
Bykle
Sandefjord
Halden
Larvik
Stavanger
Jørpeland
Kragerø
Sandnes
Risør
Tonstad
Byglandsfjord
Vikeså
Kilsund
Arendal
Egersund
Kungshamn
Flekkefjord
Vennesla
Kristiansand
Høvåg
Skagerrak
Mandal
Skagen
Hirtshals
Hjørring
Brønderslev
Aabybro
Nordsjøen

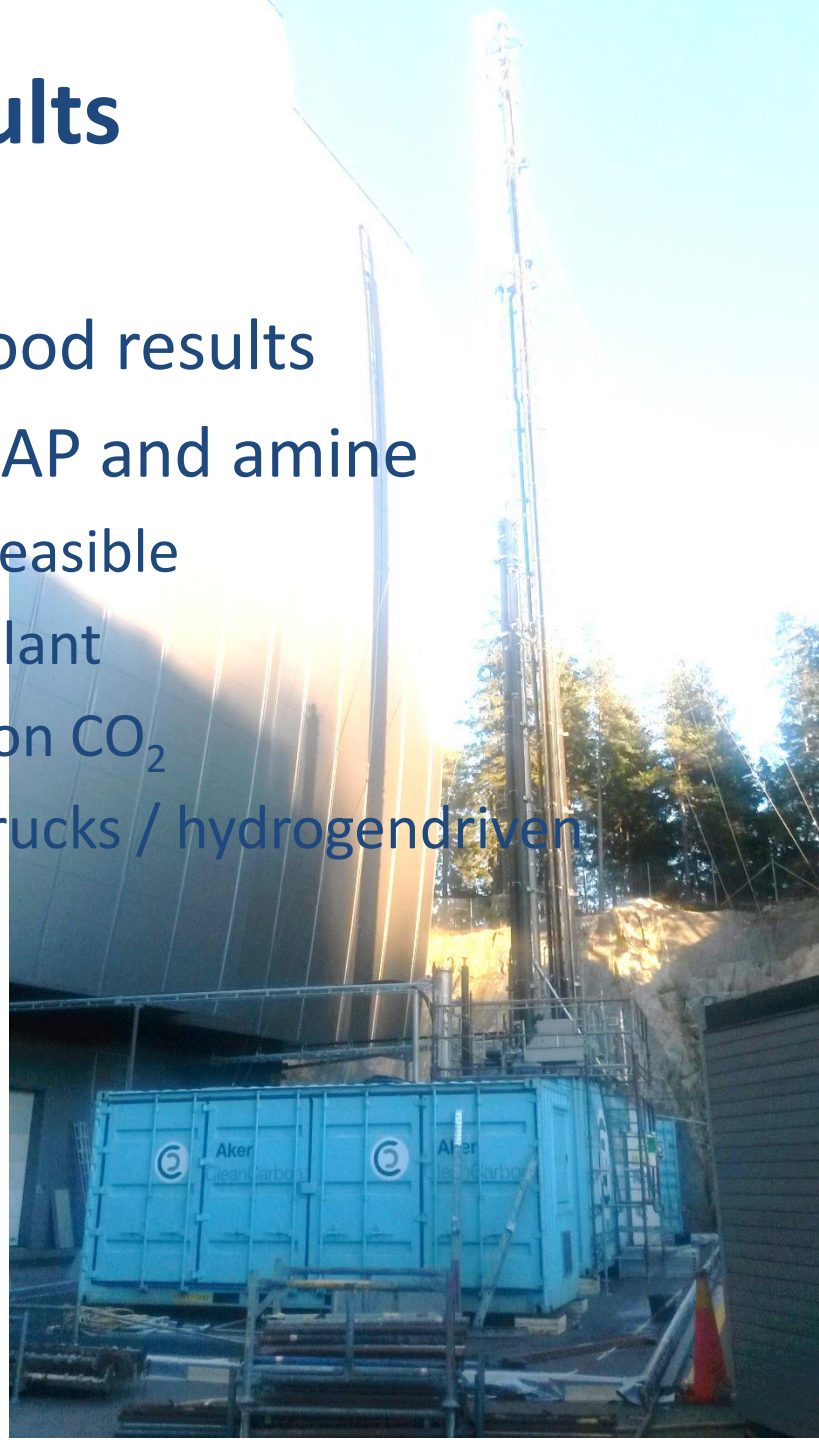


Challenges:

- Cooling – no cooling water
- Area – sufficient?
- Transportation to port – densly populated area
- Valuechain – how will it be paid?
- NIMBY – and also regulatory obstacles

Some results

- Mobile test unit have shown good results
- 2 different capture solutions, CAP and amine
  - Good results , 90 % capture fully feasible
  - 5000 m^2 is sufficient for capture plant
  - Energy penalty below 0,5 MWh/ton CO_2
  - Transport to port: Use electrical trucks / hydrogendriven trucks as a showcase
- Some economical figures
  - CAPEX up to 230 mill Euro
  - OPEX up to 25 mill Euro/year
  - High end of calculations – 40 % uncertainity



Carbonpricing in the future

-Sell carbon quatas for Biological carbon

- Carbonpricing on products
- Carbonpricing for delivery

Heat
Power –
Replacing
fossile fuel

- Capturing CO_2
- CO_2 for use in industrial applications
- CO_2 for storage

What happens next?

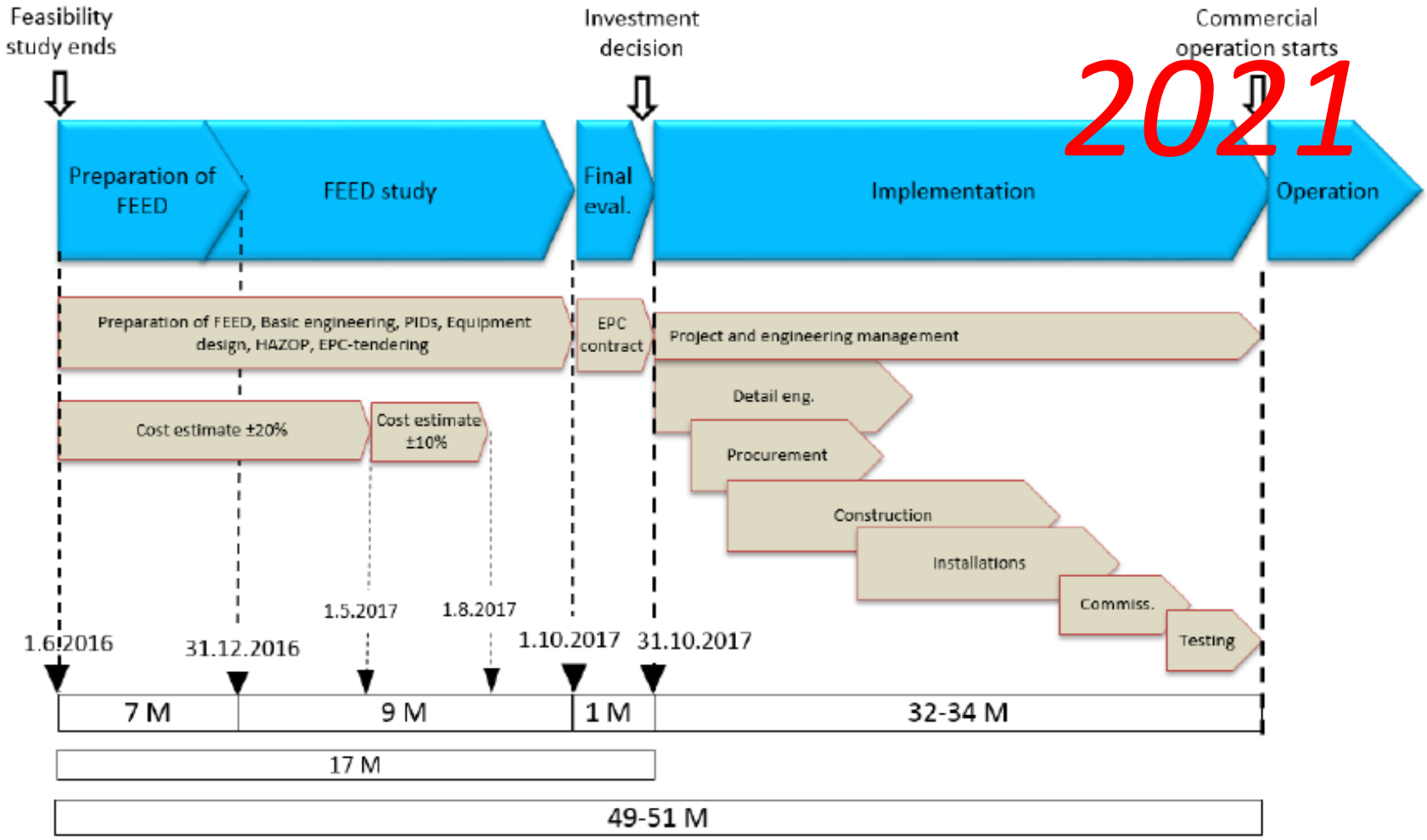
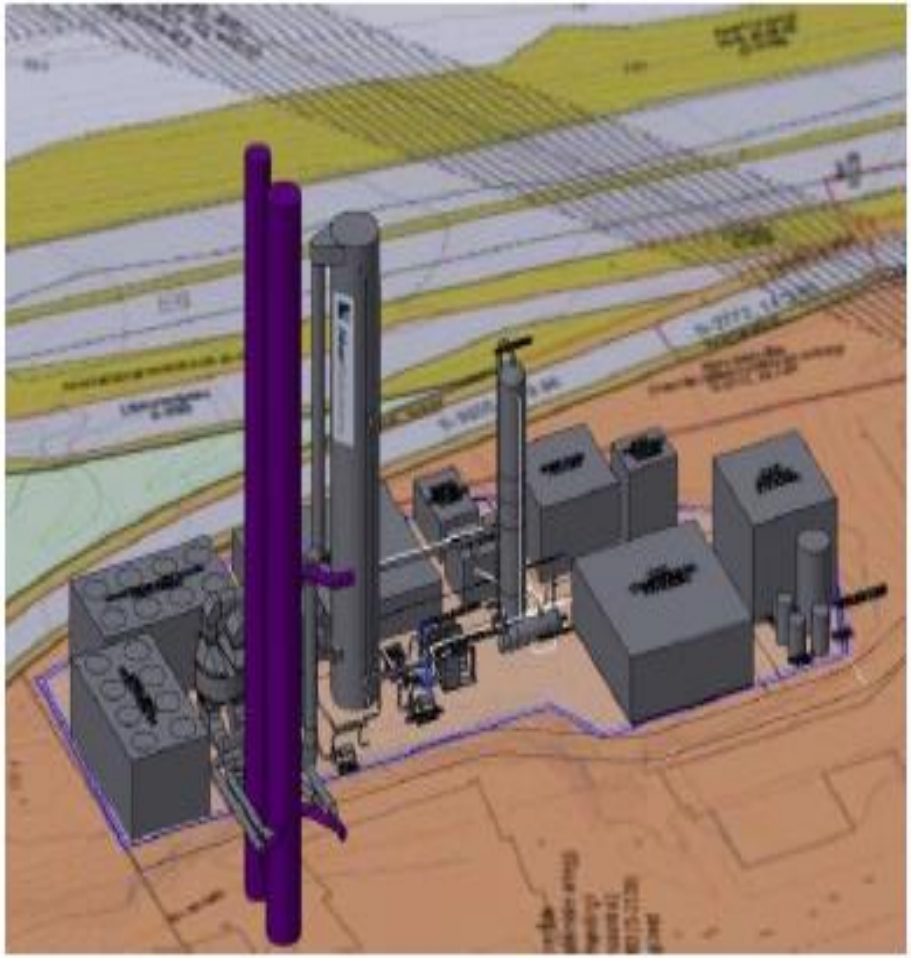
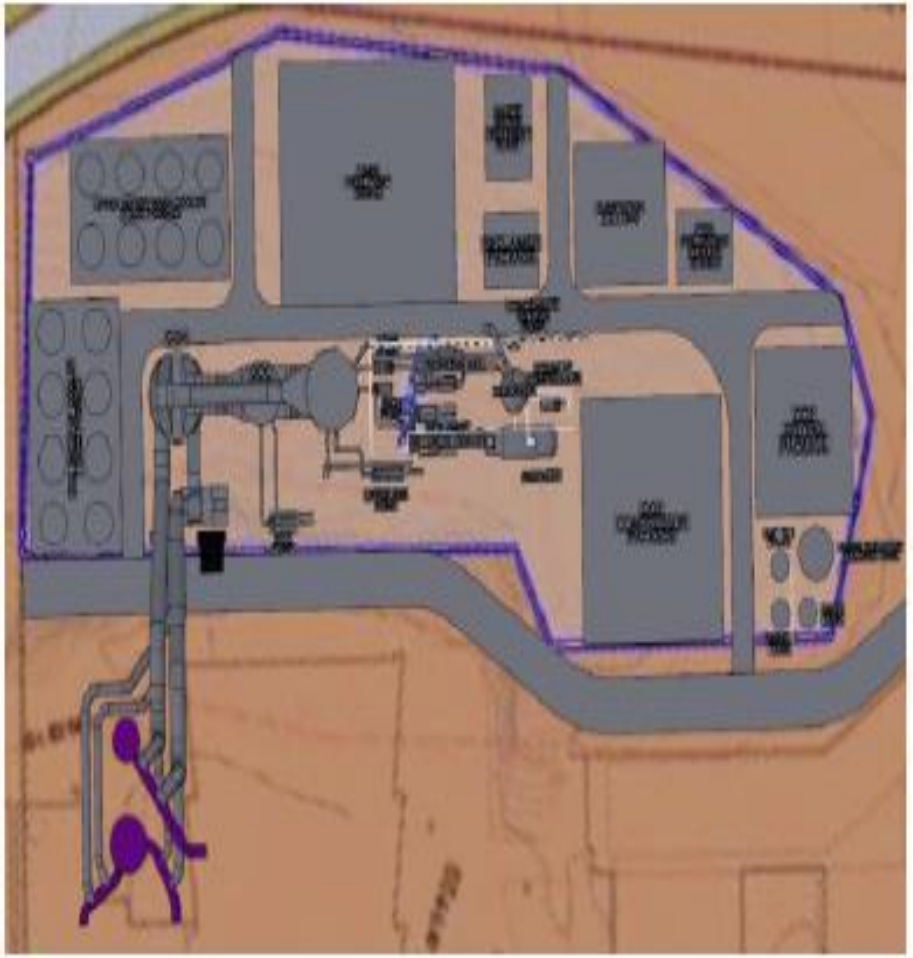


Figure 1: Preliminary time schedule for next phases of this project





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