

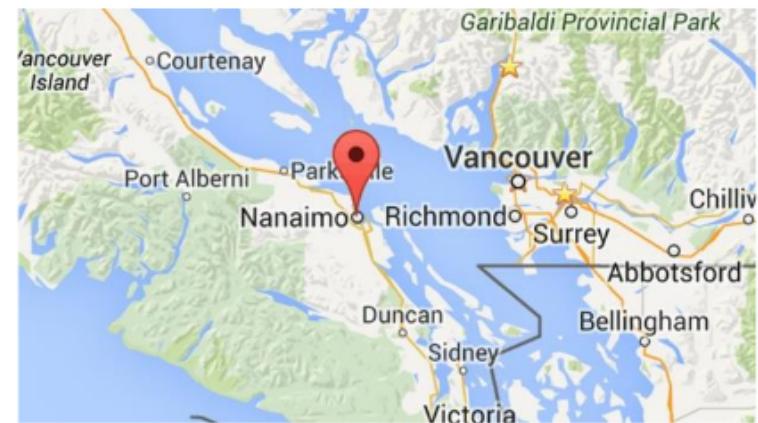
# **Modeling Complex Energy Systems at City Scale using the CityGML UtilityNetworkADE**

**Case Study of a Hydroelectric Energy Reclamation  
Facility in Nanaimo, British Columbia, Canada**

# Context

## Nanaimo

- Small coastal city in British Columbia, Canada
- Recently published open utility network data on their website



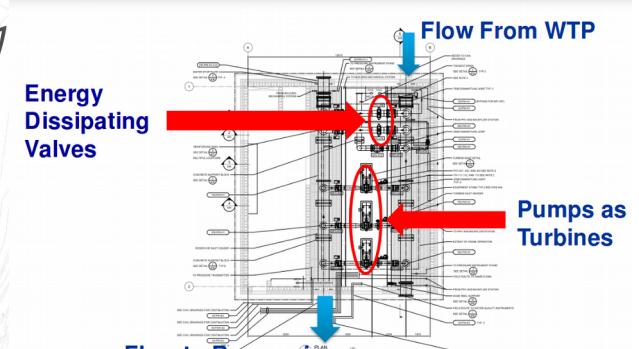
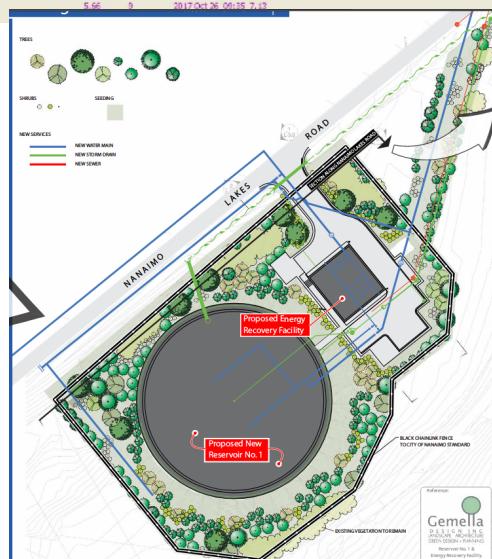
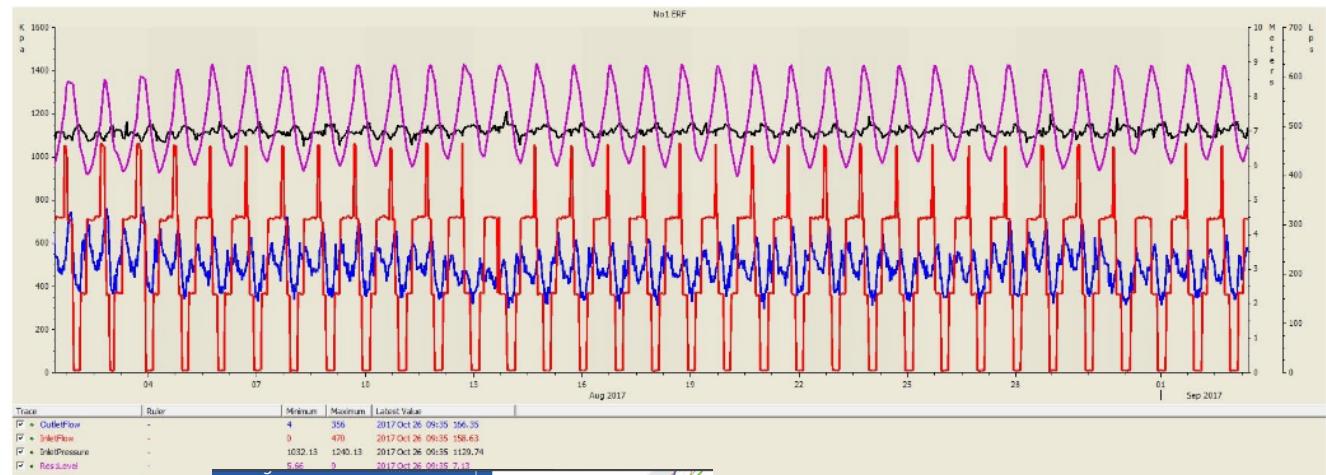
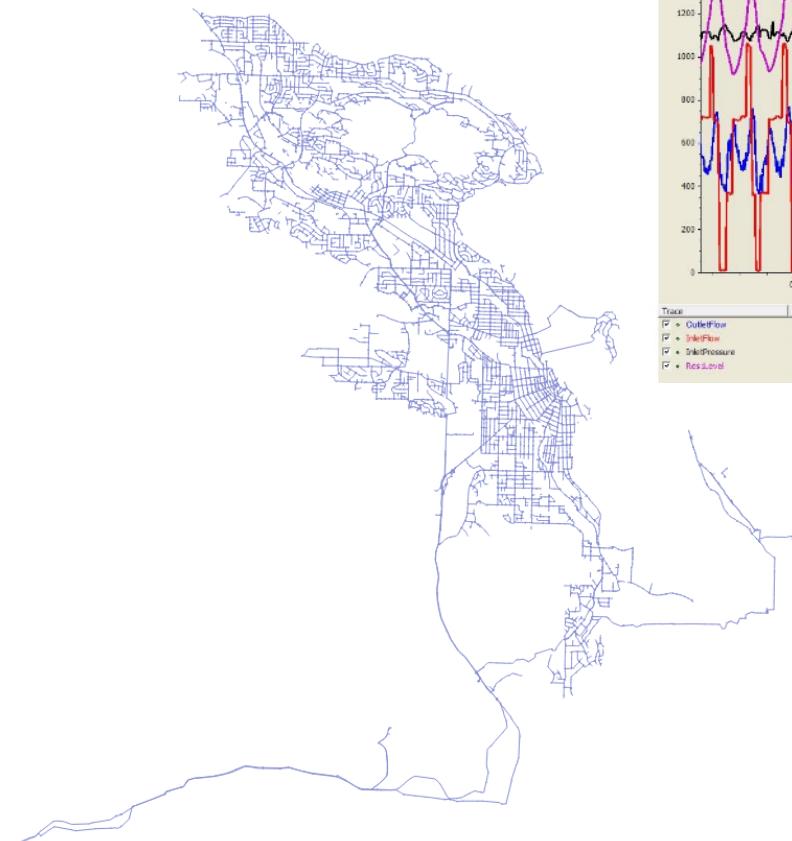
# Context

- Acquired open data for Nanaimo water pipes.
- Developed the first public data sample for the UtilityNetwork ADE using the aforementioned pipes & FME.
- Thoroughly researched the “Nanaimo Reservoir #1” project and made contact with Bill Simms, the water resources manager in Nanaimo.
- Received a month's worth of usage data from the “Reservoir #1” facility, including various water pressures & electric generation.

# Available Data

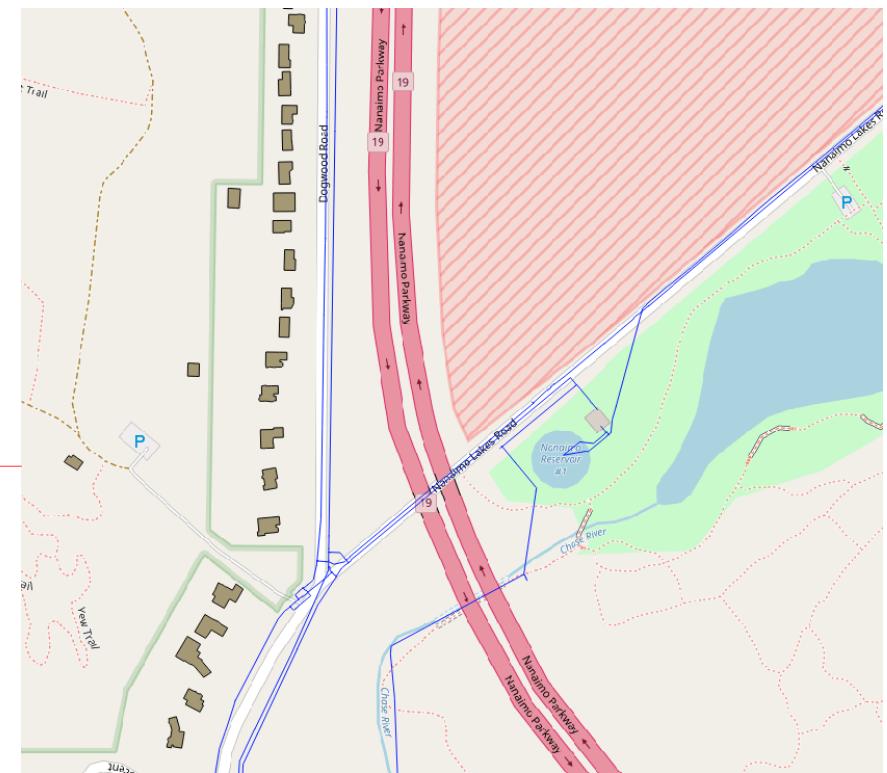
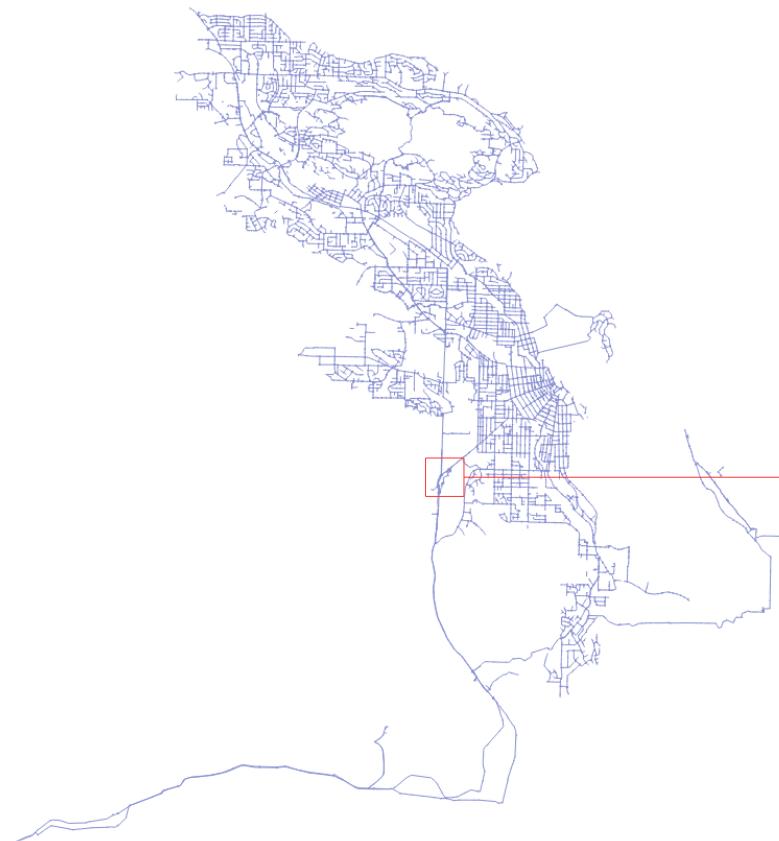
- Nanaimo Water Pipes (City of Nanaimo Open Data Catalogue)
- Nanaimo Buildings & Parcels (City of Nanaimo Open Data Catalogue)
- One month of usage data from the Nanaimo Reservoir #1 Facility (Bill Simms)
- Various engineering diagrams & site plans for Nanaimo Reservoir #1 Facility (Various, but all public)

# Available Data



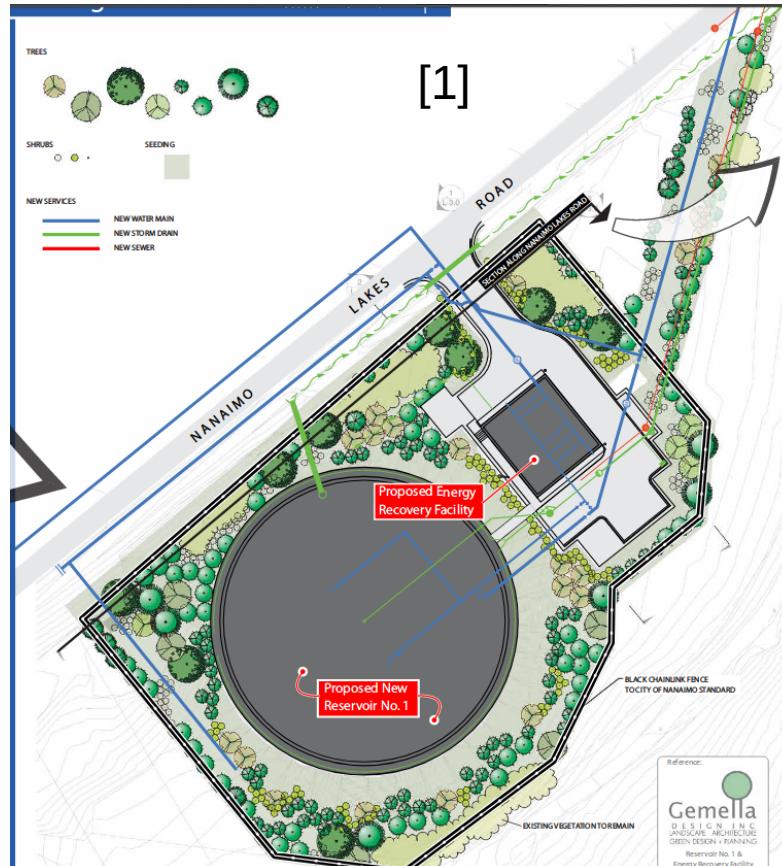
# Goals - Build data in CityGML (+ UtilityNetwork ADE)

- Improve the water network sample to include specific details around the Reservoir #1 facility.

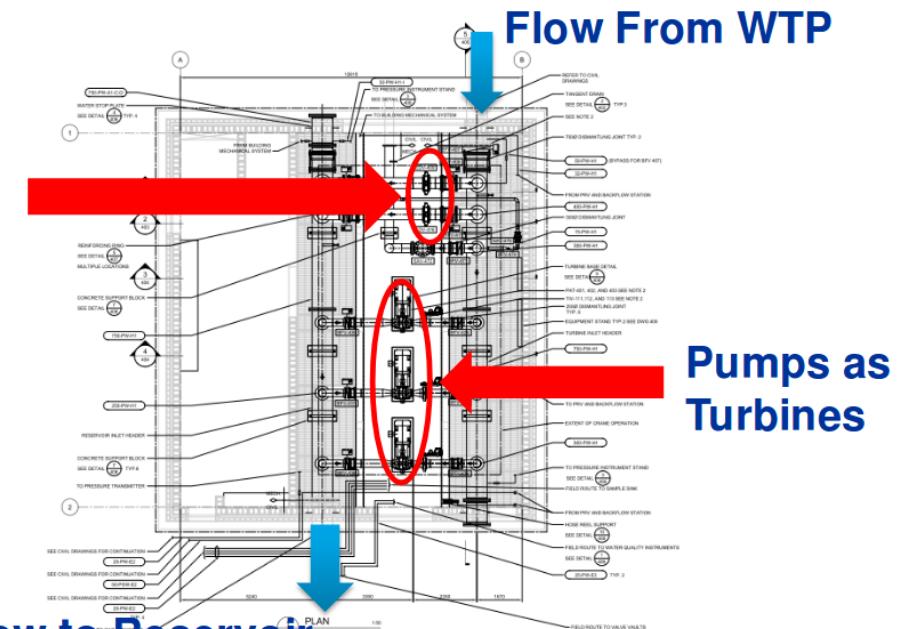


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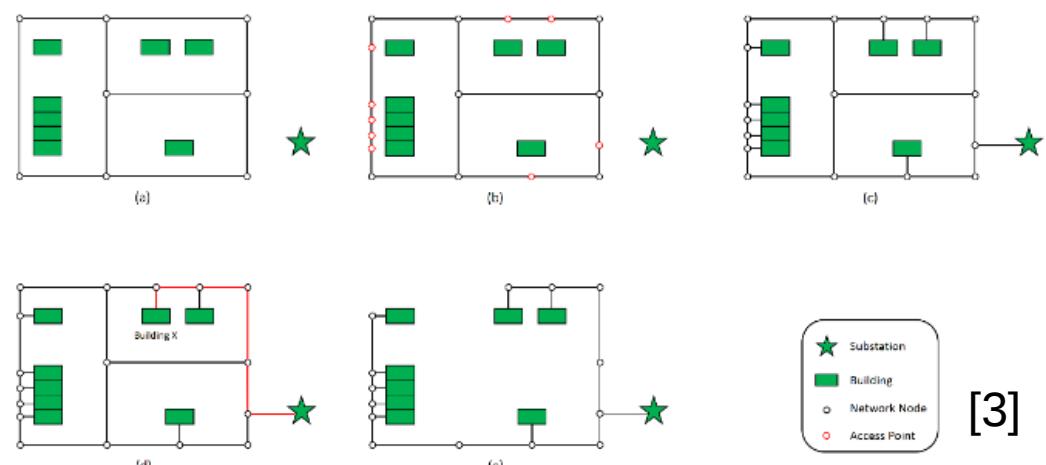


## [2] Energy Dissipating Valves



# Goals - Build data in CityGML (+ UtilityNetwork ADE)

- Create an electrical network to compliment the water network
  - Contact Bill Simms to get the layout of the local electric plan.
  - If not available, use a heuristic model to infer the electrical network from the roads, developed by Ji Q et al. At Newcastle University (and also concurrently at EIFER!).



## Goals - Port CityGML model to 3DCityDB

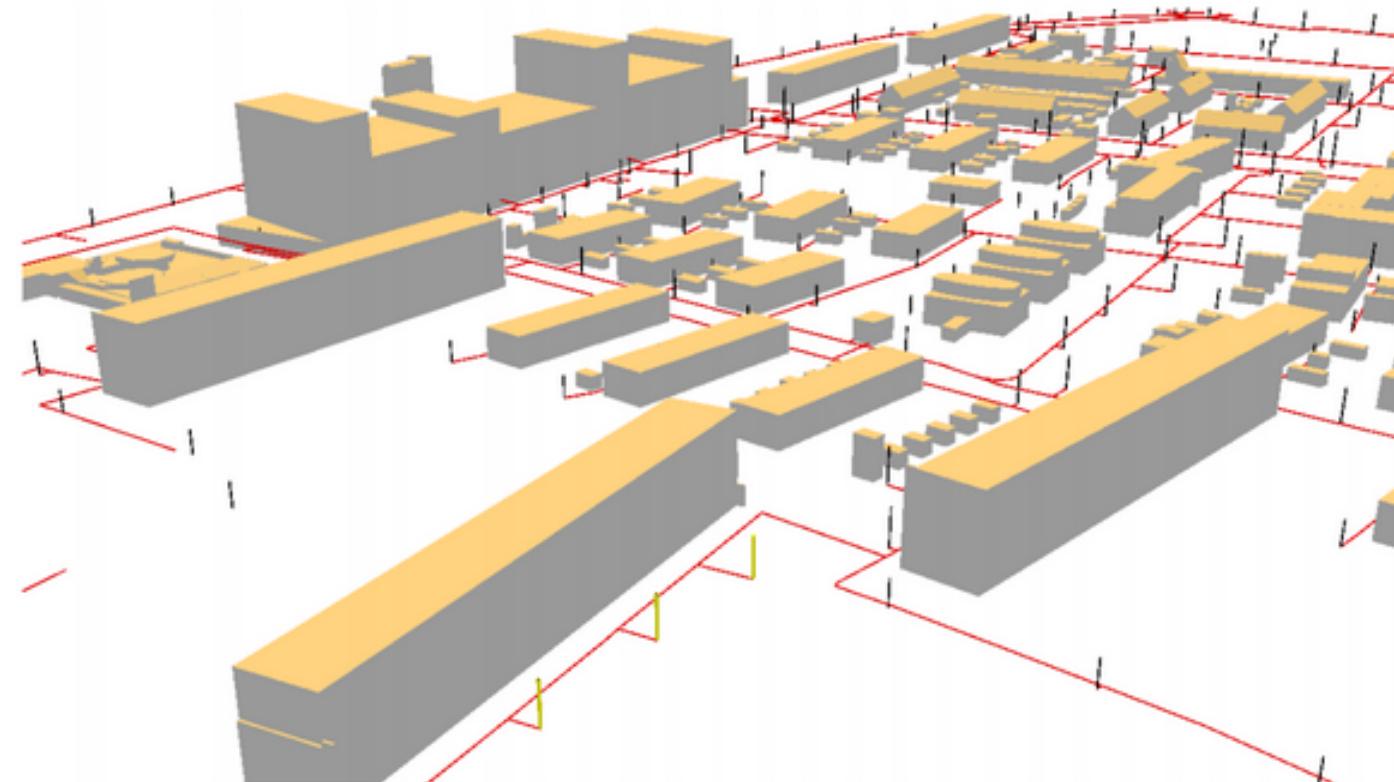
- Once the model is complete in CityGML, it can be imported to 3DCityDB.
- There exists an extension for 3DCityDB to support UtilityNetwork ADE features, developed by Giorgio Agugiaro at the Austrian Institute of Technology (AIT).
- He has also developed methods for importing data into the database, which he is eager to see applied in a real-world context.

## Goals - Port CityGML model to 3DCityDB

- Xander den Dujin, recently did his master's thesis at TU Delft using the 3DCityDB UtilityNetwork ADE extension with the Rotterdam sewer & electrical network.
- He was able to perform routing analysis on the data in the 3DCityDB schema using the pgRouting library.
- His work will be valuable in working with the network features in the 3DCityDB.

# Goals - Port CityGML model to 3DCityDB

Affected streetlights in ArcGIS



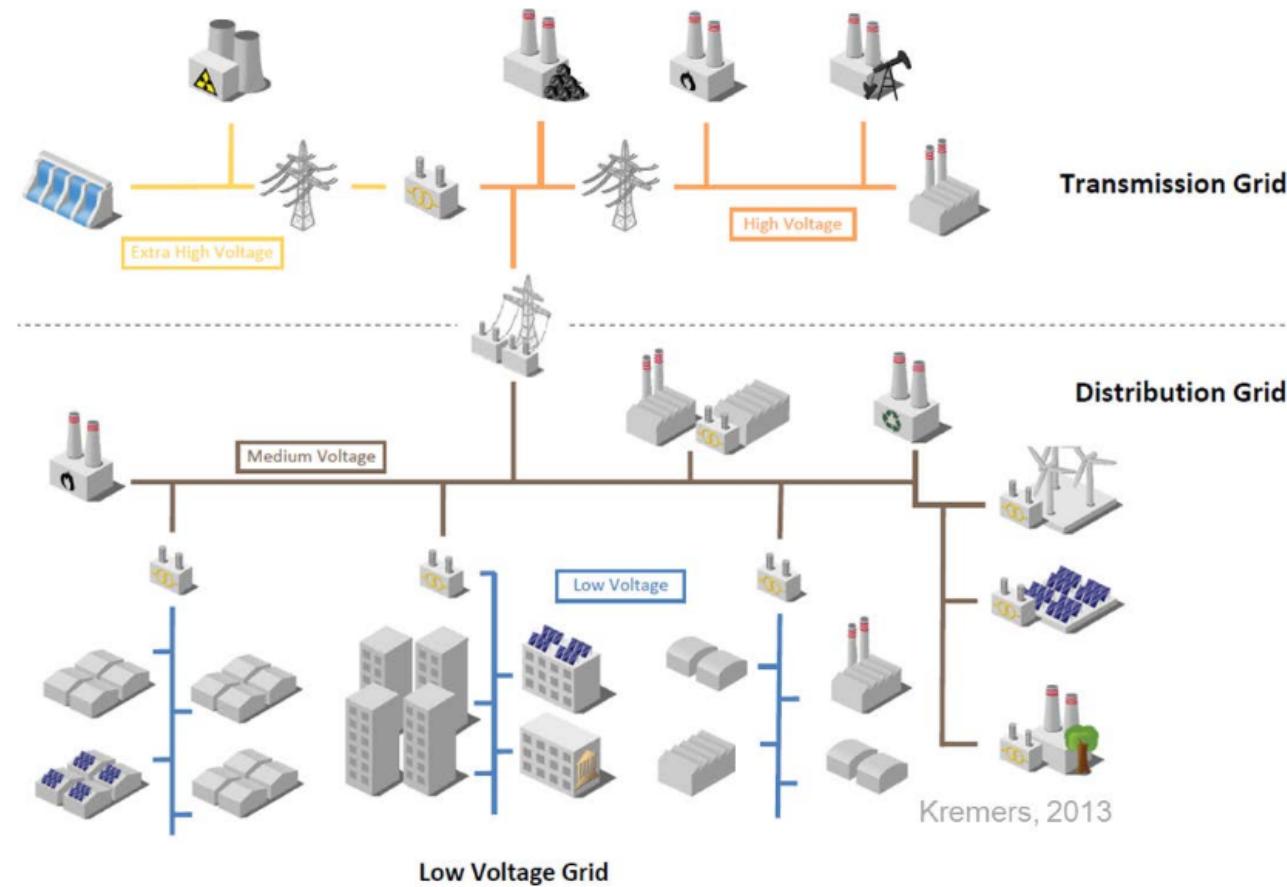
Gemeente Rotterdam

**TU**Delft [4]

# Goals - Develop Functional Model

- The final step is to develop a model that can be used to simulate various scenarios, such as:
  - Adding / removing building endpoints
  - Adding new energy sources (solar panels, wind turbines, upgrades to existing equipment...)
  - Varying input water flow (droughts, floods)
  - Simulating network breaks & cascading failures
- AnyLogic was used by Dr. Enrique Kremers at EIFER to model a multi-scale electrical network on Île de la Réunion.

# Goals - Develop Functional Model

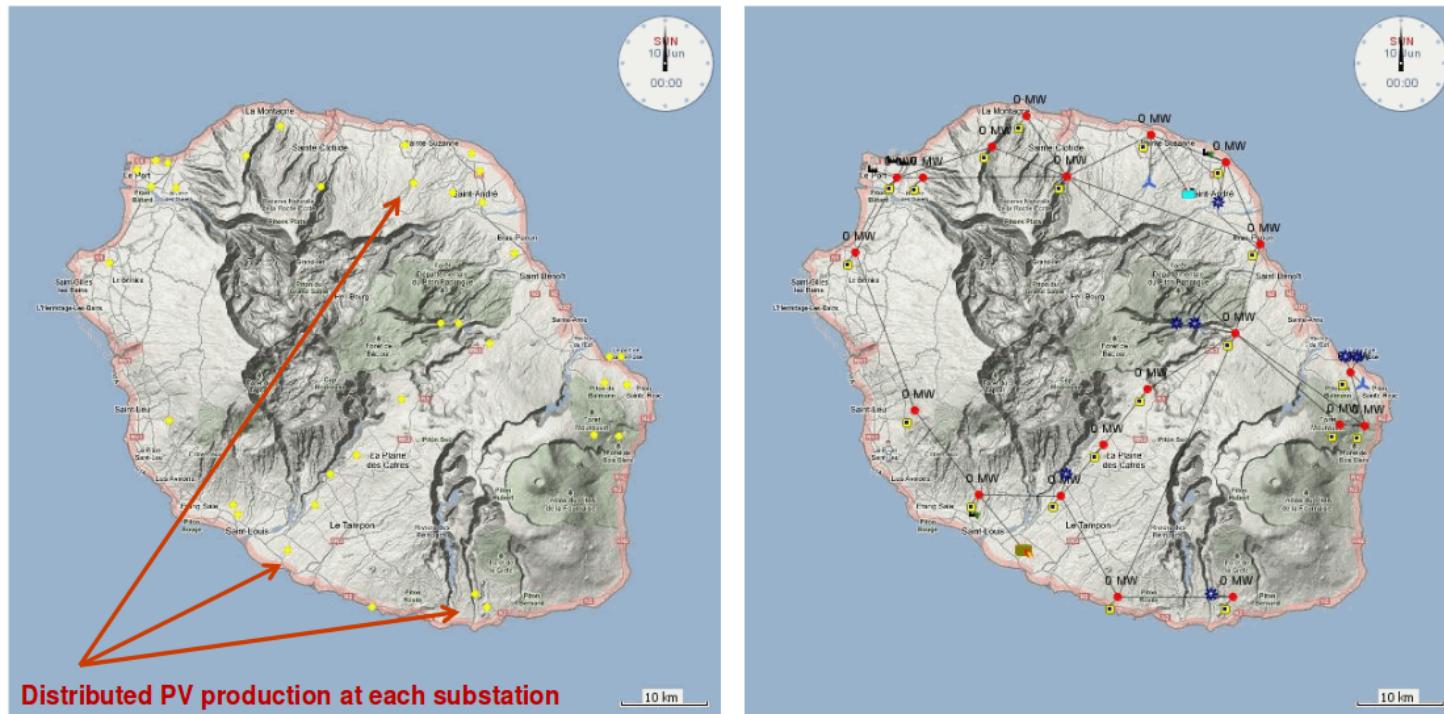


- Different networks & levels
- Interconnected
- Large scale
- Dynamic behaviour (time, space) [5]

# Goals - Develop Functional Model

Scenario: 2010

Installed PV peak power (distributed): 85 MW



Balance: **SUPPLY – DEMAND**

07.12.2017 | Enrique Kremers, CityGML AD

Load flow

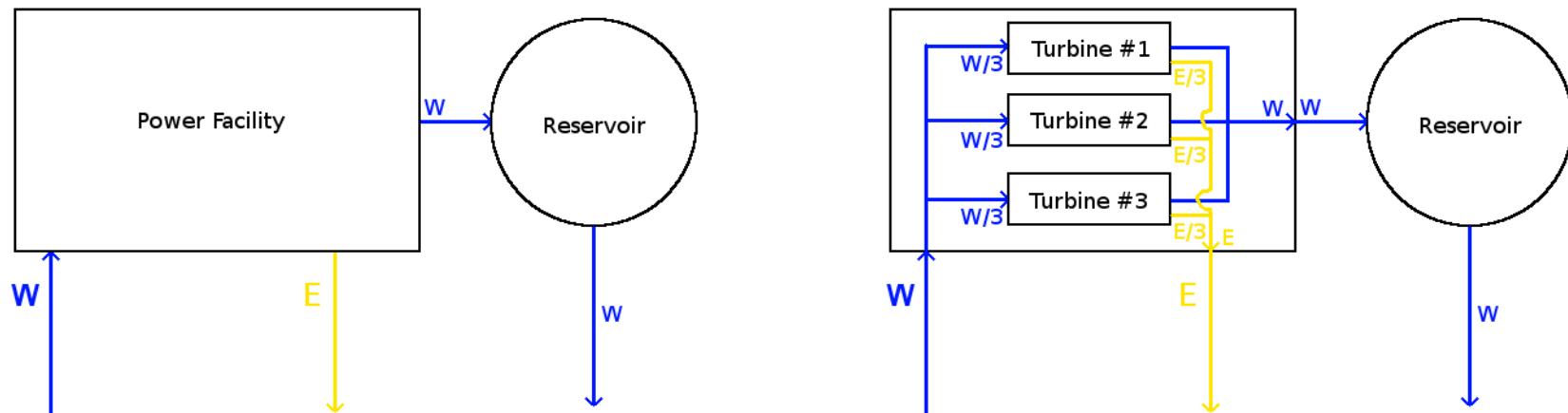
$S < 100\%$     $S < 110\%$   
 $S < 120\%$     $S > 120\%$

In relation to base scene with  
no wind  
 KIT  
Karlsruhe Institute of Technology

12 [5]

# Goals - Develop Functional Model

- AnyLogic will allow us to interface with the 3DCityDB containing our network data and perform the aforementioned scenario simulations.
- It will also allow us to model the system on different levels of detail, which will be useful given the different possible levels of representation.



# Conclusions

- This thesis will:
  - Provide a working example of a multi-network interdependency modeling scenario using a holistic data format.
  - Serve as an experimental real-world application of the UtilityNetwork ADE, which is still in development.
  - Demonstrate the research & development value of publishing open utility network data.

# Sources

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- [3] Ji Q. et al.: "A heuristic algorithm for generative fine-scale infrastructure distribution networks". Newcastle University.  
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