# Exploring CLEWs in the Urban Space

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# Some City Characteristics

- Traditionally centralized, often old, systems with a built in inertia to change
- Demand Hub: puts pressure on Capacity of both resources and transmission
  - High vulnerability to system failure
- Cities' spatial concentration creates physical overlap and technical interaction between different resource delivery systems
  - Meeting one of the city's resource needs can have unintended consequences for the supply of another, but…
  - …by investigating these interlinkages we may be able to both avert unsustainable solutions and reveal potential (non-intuitive) co-beneficial paths!

# Integrated Climate, Land-Use, Energy, Water (CLEW) modelling

- Water is needed in almost all types of Energy Production
  - **Resource Extraction** ( e.g. growing bio fuels, shale-gas hydro-fracking)
  - **Electrical Generation** (Thermo-electric Cooling Hydro power)
- Energy is essential to make water of sufficient quality and quantity available in our (urban) societies
  - **Pumping** (e.g. between water sources/reservoirs and water distribution systems as well as within the distribution system)
  - **Treatment** (e.g. desalination, wastewater treatment)
- Water and energy is needed to produce food, feed and fuel from energy crops
- A changing climate impact the availability of these resources and the predictability of their supply

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# Exploring CLEWs in the Urban Space – Research vision

*At increasing rates the growing global population is moving into cities and urban areas - and with them the demand for reliable supply of water, energy and food. At the same time, a changing climate affects the land, energy and water systems that feed these supply chains – and these systems are in turn tightly linked*

*The scope of this study is to develop a modelling framework that captures the dynamics, and economics, of these urban resource flows in a way that accounts for co-benefits in "green" infrastructure and other integrated solutions.*

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# Underlying work: a New York City Case Study

## - Development of a NYC WaterMARKAL model -

*Building a foundation for modelling implications of long-term planning of water and energy in New York City*

A Collaboration between the division of Global Energy Systems, Uppsala University and the Energy Policy and Technology Analysis Group, Brookhaven National Laboratory, USA

Conducted in 2011

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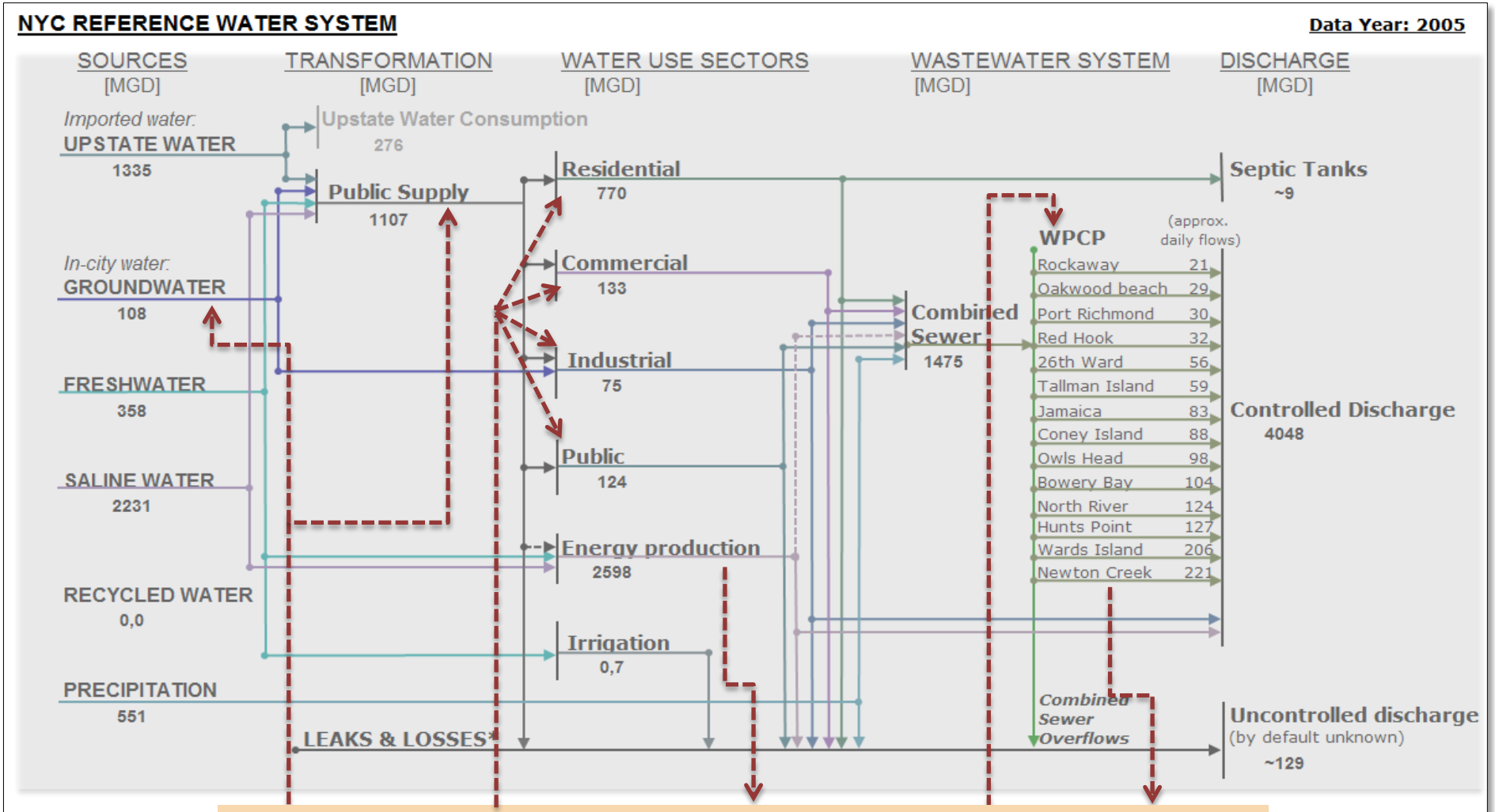
# Underlying work: a New York City Case Study

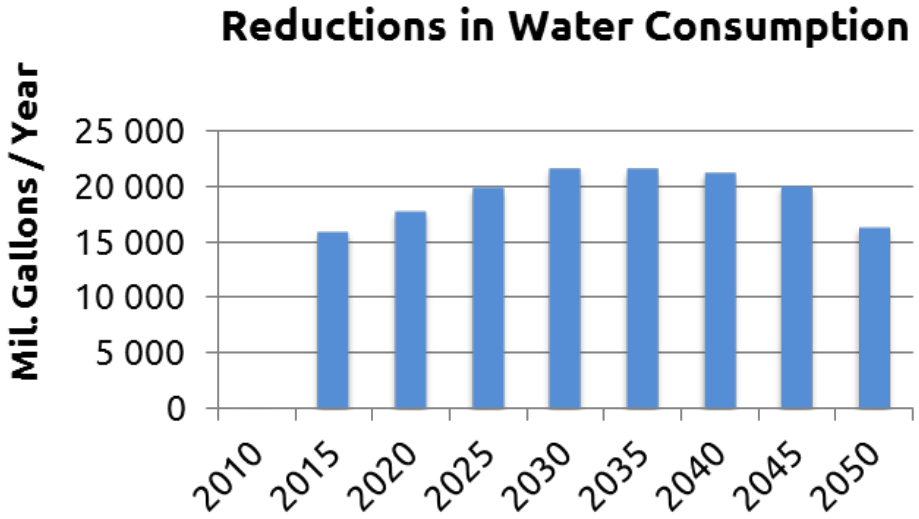


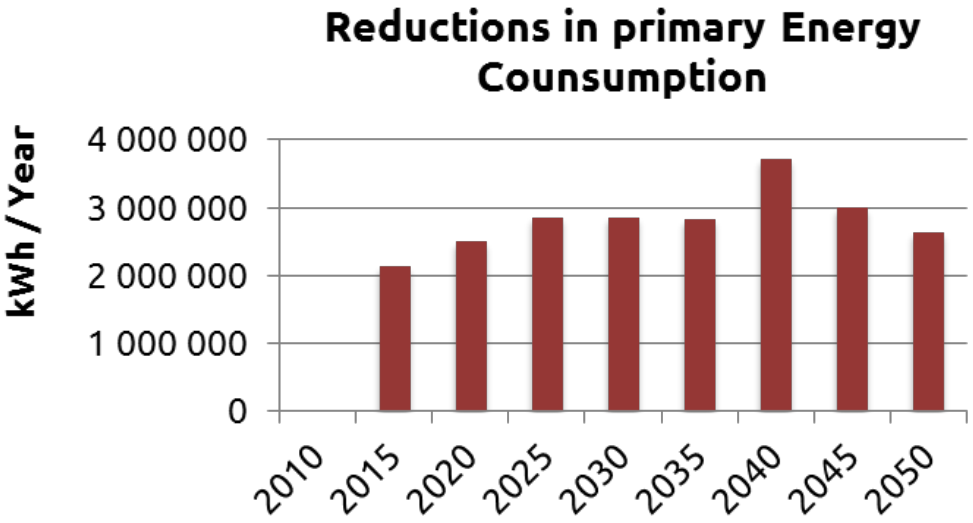

*Taken form R. Segerström's Thesis Work Performed at the Brookhaven National Laboratory, USA.*

# Underlying work: a New York City Case Study

*Early stage model testing where high and normal market shares of "low flow" appliances were compared*

Images from : http://permacbathrooms.ie/york-suite-c-33_250.html

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# Exploring CLEWs in the Urban Space - Strategy / Next steps

**Build generic/stylized city models:**

- For a "multi-region" city built on block-sized regions (matching spatial models)
- For a whole city (based on the NYC case study), to validate the rasterized (block-level) model

**Test models on partner cities, adapting the framework to varying local physical and economic conditions and policy climate**

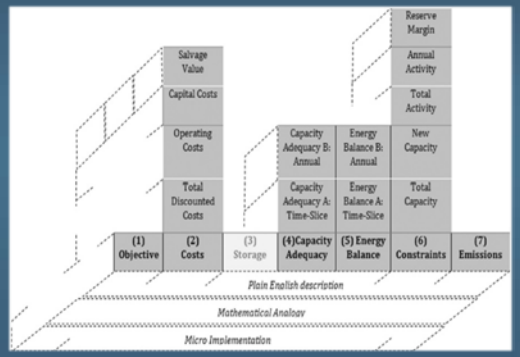
- Stockholm
  - Modelling the implementation of an ambitious GHG emissions reductions agenda in a challenging, and energy demanding, climate
- Chicago
  - Testing the Urban CLEW model on a city that wants to go green despite being hit by economic recession
- Cape Town
  - Political will and planning tools available where challenges related to unplanned growth and informal settlements can be studied

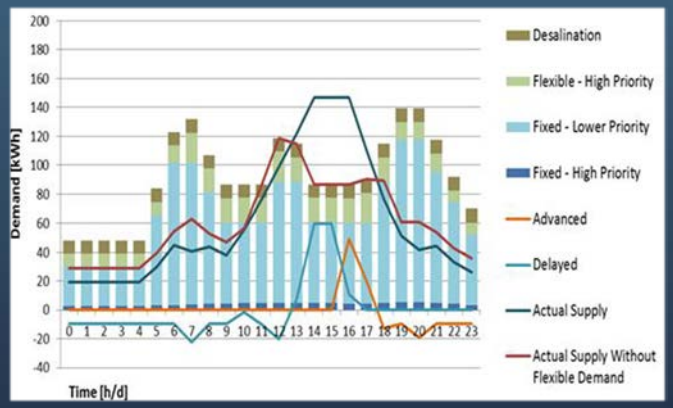
**Evaluate cross-system co-benefits from integrated solutions, e.g. "green infrastructure" and resource conservation measures**

# Proposed (Open-Source) Tools

## OSeMOSYS

The **Open Source Energy Modelling System**, is a deterministic linear optimization model with the ability to cover individual or interlinked energy sectors, including heat, electricity, transport, and (to be developed) water. In this project, block-level energy models will be created to match the geographical raster of LEAM.

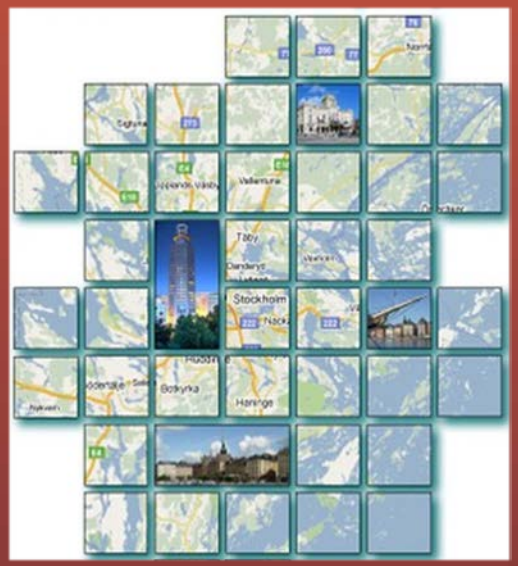



## LEAM

The **Land-Use Evolution and impact Assessment Model**, utilizes cellular automata and other technological advances in spatial simulation modelling to describes land-use changes across a landscape that result from the spatial and dynamic interaction among economic, ecological, and social systems in the region.

By employing LEAM on a City geography, the model will in this project provide the demand side input (primarily related to energy and water) to a rasterized OSeMOSYS City model.



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# Long-term Goal

Contribute to the research community addressing challenges of global population growth and urbanisation, knowing that most of this growth is expected to occur in *informal settlements* in large cities.

**Desired use of a built up Urban CLEW model**

- Evaluate integrated solutions for

  …energy access and

  …water & sanitation?
- Assessment of the technological opportunities

  …in combination with analysis of social dynamics

  …and political dialogue

Using easy to access, open source modelling tools with the potential to spur broader review and application (where it is most needed).

# Thank you!

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