Toolkit:

Energy-efficient technologies

Municipal Services and Utilities: Session 4

John Dulac

New Delhi 11 December 2018

#energyefficientworld

Energy Efficiency Training Week: Municipal and Utility Services

1. **Where to start:** Energy use in municipalities
2. **Where to start:** Energy efficiency potential in municipalities
3. **Toolkit:** Energy-efficient municipal planning
4. **Toolkit:** Energy-efficient technologies

   Where do I get help? IEA's Technology Collaboration Programmes
5. **What are the steps:** Implementing energy efficiency programmes – target setting
6. **What are the steps :** Implementing energy efficiency programmes - implementation
7. **What are the steps:** Enabling public energy efficiency investment
8. **What are the steps:** Enabling private energy efficiency investment

   Special session: Multiple benefits of energy efficiency for municipalities
9. **Did it work:** Evaluation and energy efficiency indicators

   Special session: International and regional initiatives that can help
10. **Energy Efficiency Quiz:** Understanding energy efficiency in municipal and utility services

4. Toolkit: Energy-efficient technologies

Trainer(s): John Dulac

Purpose: To show the energy-saving opportunities using energy-efficient technologies, including use of digital management systems and potentials for sector coupling.

Scenario: The municipal commissioner wants to be known for innovative solutions at low costs.

Question: What are the technologies or technology strategies that you can put in place in order to boost energy efficiency?

Energy Efficiency Training Week: Municipal and Utility Services

1. **Public buildings**
   - insulation
   - windows
   - heat pumps
   - interior lighting
   - energy management systems
2. **Transport**
   - Electric and hybrid vehicles
3. **Utilities: lighting**
   - LED
   - Intelligent street lighting
4. **Utilities: water and sewage**
   - Efficient motors
   - Energy management systems
5. **Utilities: energy**
   - Efficient motors
   - Energy management systems
   - Insulations
6. **Waste**
   - Waste to energy

1. Public buildings

Summary of key technologies for envelope and equipment & systems

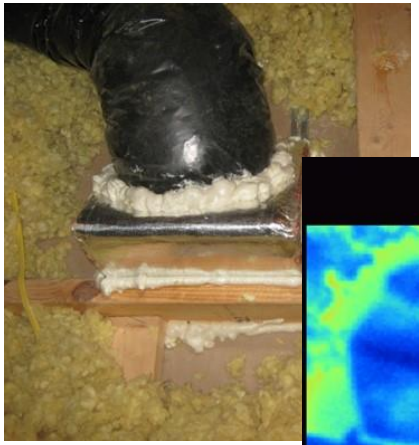
1. Buildings: envelope

- **Insulation:** Exterior insulation is best approach to reduce thermal shorts/thermal bridges and can applied with external material.

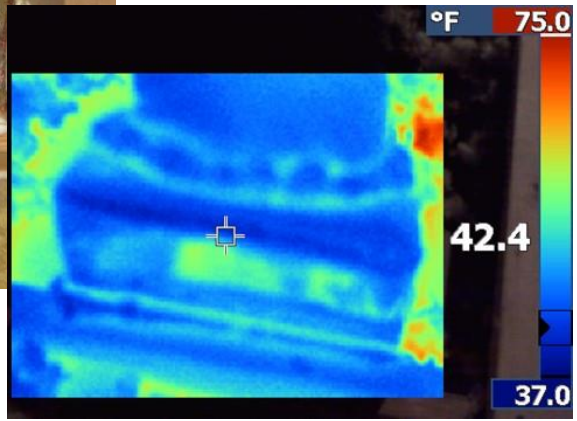
BEFORE

AFTER

- **Sealing:** Air sealing typically accounts for 10-30% of heating and cooling loss, but can be easily applied and verified with infrared camera and air pressure tests.

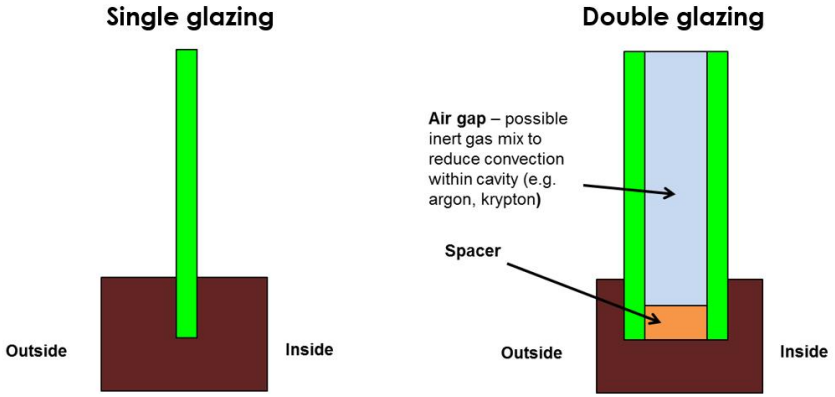


IMAGING

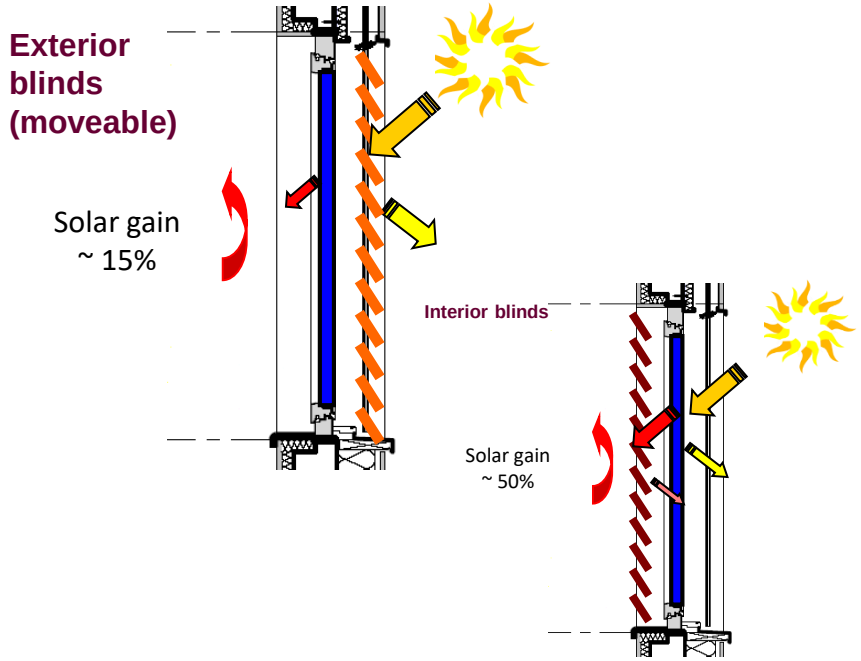


1. Buildings: envelope

- **Windows:** single glazing windows are highly inefficient in all climate types.

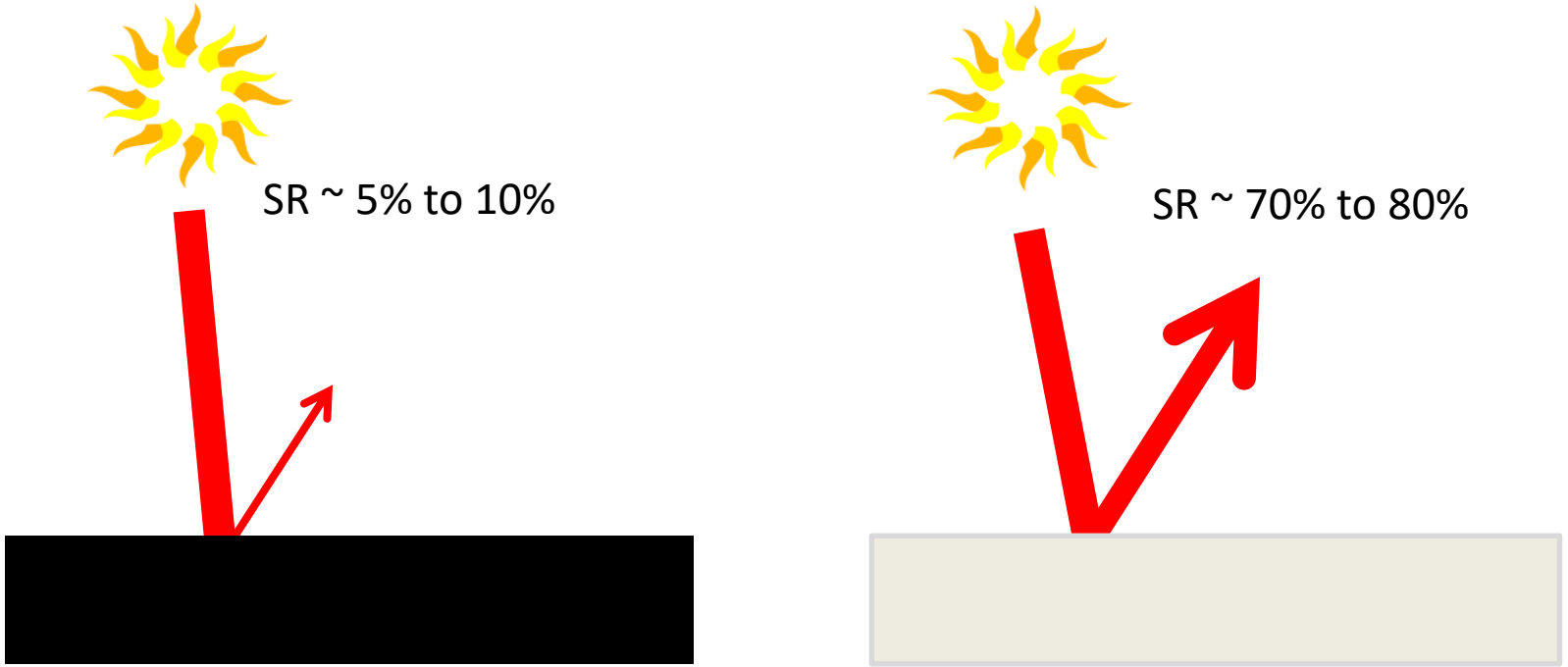


- **Shading:** External shades keep out much more heat while interior blinds keep in more heat



Source: BEEP India

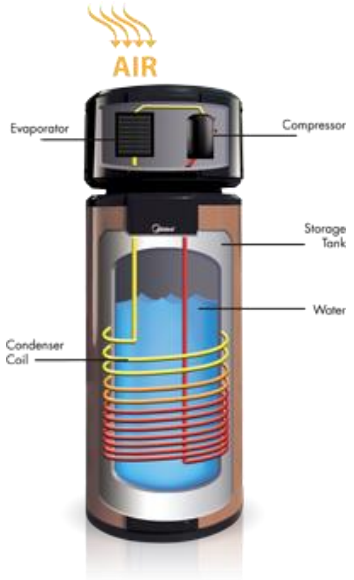
1. Buildings: envelope - roof reflectance (visible color)

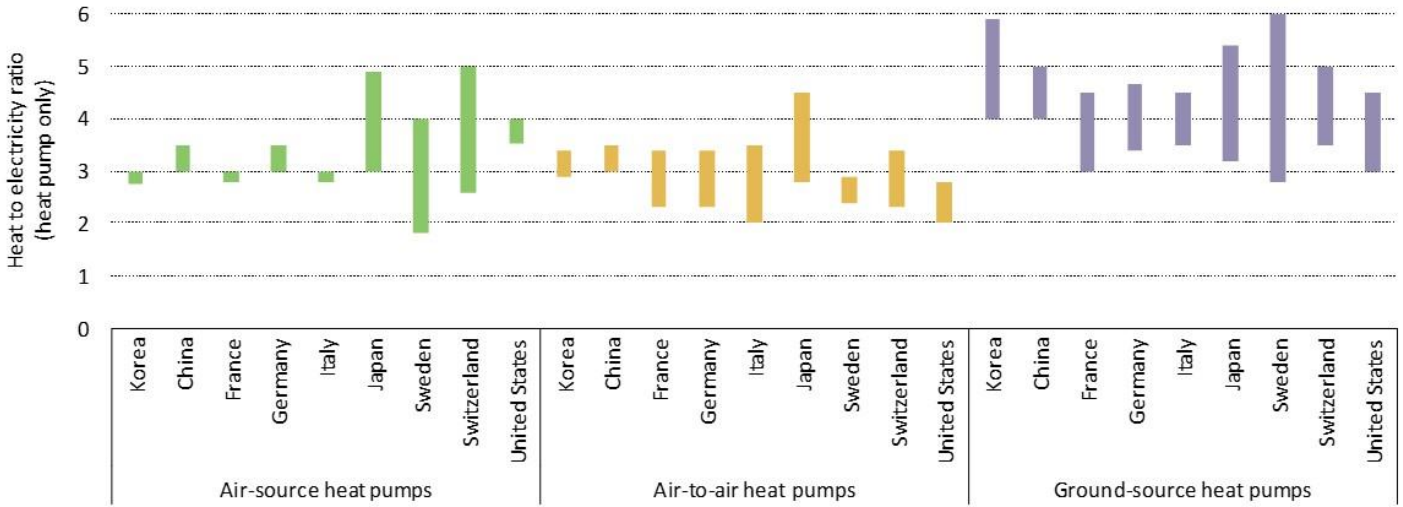


Solar reflectance rejects heat from sun.
Visible colour can change the amount of heat that enters the building.

Source: IEA Energy Efficiency Training Week

1. Buildings: equipment & systems – water/space heating/cooling

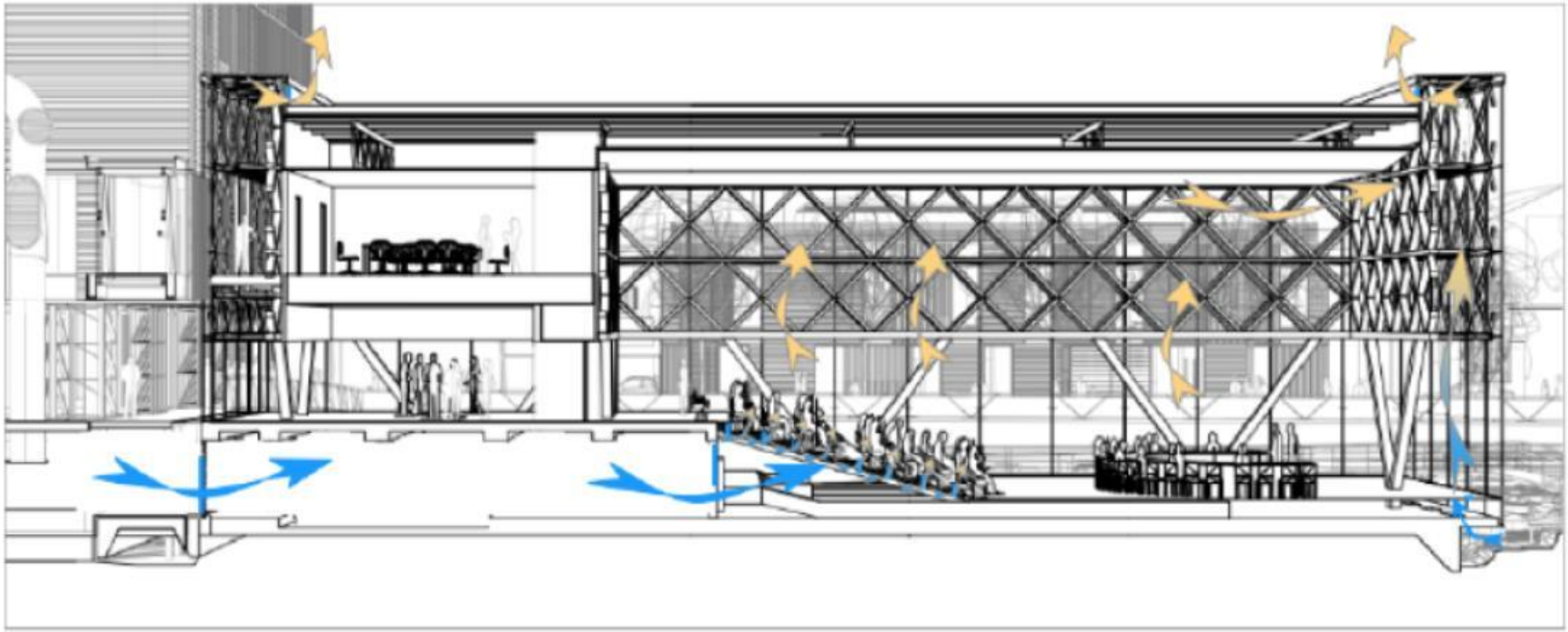




Heat pumps reduce energy consumption > 60%.
Can free up electricity for other uses (e.g. electric vehicles).

Source: IEA

1. Buildings: equipment & systems – hybrid ventilation



Natural ventilation (stack/stratification) in combination with mechanical ventilation to enable comfort

Source: IEA EBC Annex 62 – Ventilative Cooling

1. Buildings: equipment & systems – lighting

Shifting to high performance technologies can cut energy consumption drastically.

Source: premierlightbulbs.com

1. Buildings: equipment & systems - integrated solutions

Passive solar lighting can reduce lighting energy use but increase heat.
Shading can reduce heat but increase lighting energy use.
Dynamic windows and shading could balance this with renewable integration (passive and active).

Source: Sage Electrochromics

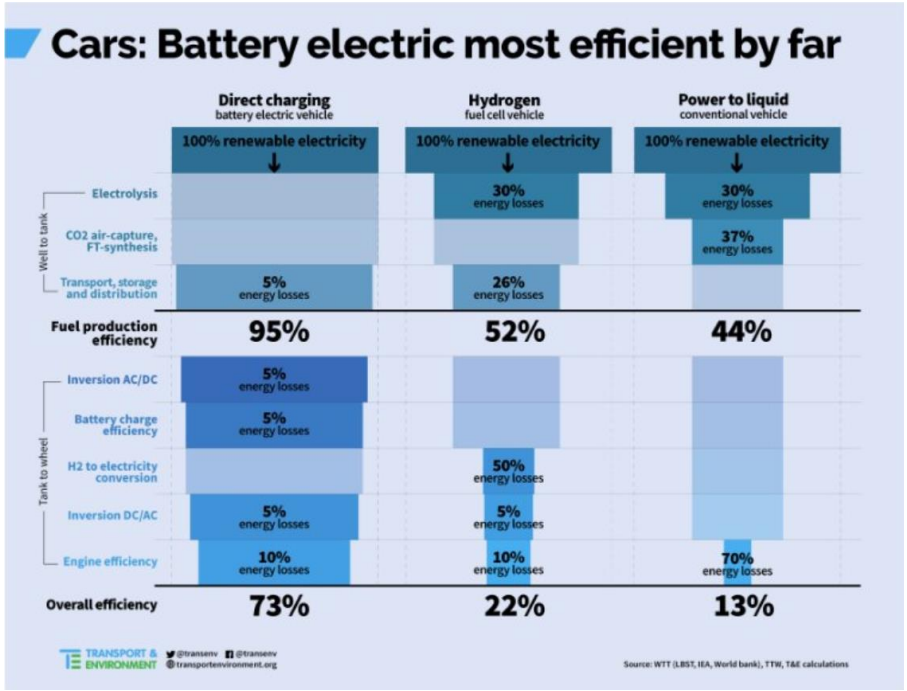
2. Transport

A look at electro-mobility

2. Transport

Electric mobility

- EVs more efficient than ICE



- Electric mobility not limited to cars

Electric 2-wheelers
China: 250 million stocks,
30 million sales/yr

Low Speed EVs
China: ~4 million stocks,
>1 million sales/yr

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>1 million sales/yr

Source https://www.transportenvironment.org

2. Transport

Electric mobility : Charging infrastructure

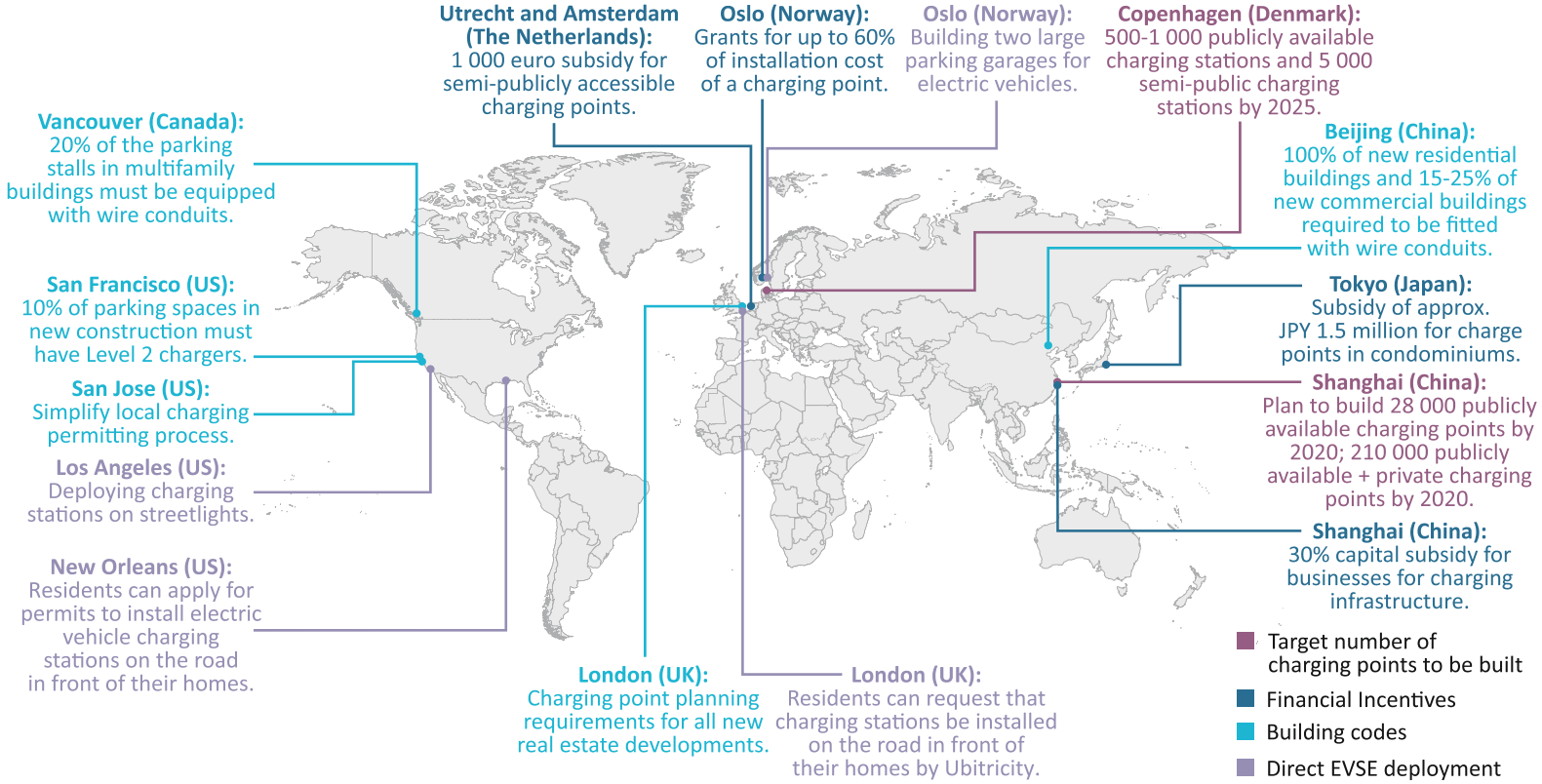
- Charging infrastructure supports the roll-out of electric vehicles. In the municipal level the following would be necessary:

CHARGING INFRASTRUCTURE ROLLOUT

PARKING SPOTS FOR EV CHARGING

SUCCESSFUL GRID INTEGRATION

Electric mobility : Charging infrastructure



3. Utilities: Lighting

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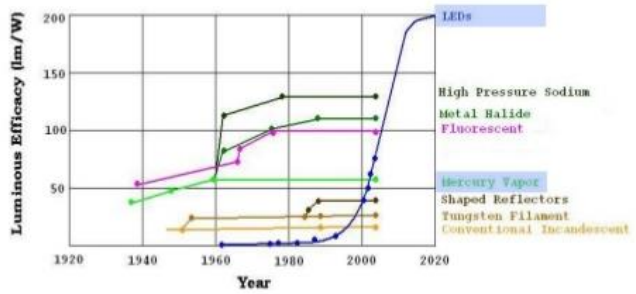
Lamp technology : more efficient technology

- **LED** lamps significantly more efficient than other street lighting technology



Light Source	Lumens/watt
High Pressure Sodium	80-140
LED	114-160

Type of Lamp	Luminous Efficacy (lm/W)	Color Rendering Properties	Lamp life in hrs.	Remarks
High Pressure Mercury Vapor (MV)	35-36 lm/W	Fair	10000-15000	High energy use, poor lamp life
Metal Halide (MH)	70-130 lm/W	Excellent	8000-12000	High luminous efficacy, poor lamp life
High Pressure Sodium Vapor (HPSV)	50-150 lm/W	Fair	15000-24000	Energy-Efficient, poor color rendering
Low Pressure Sodium Vapor (LPSV)	100-190 lm/W	Very Poor	18000-24000	Energy-Efficient, very poor color rendering
Low Pressure Mercury Fluorescent Tubular Lamp (T12 & T8)	30-90 lm/W	Good	5000-10000	Poor lamp life, medium energy use, only available in low wattages
EE Fluorescent Tubular Lamp (T5)	100-120 lm/W	Very Good	15000-20000	EE, long lamp life, only available in low wattages
Light Emitting Diode (LED)	70-160 lm/W	Good	40000-90000	High energy savings, low O&M, long life, no mercury, high capital cost and evolving technology.

Source https://www.slideshare.net/ChristineGupta/2012-hps-comparison

Source: World Bank/USAID

3. Utilities: Lighting

Lamp technology : also increases visibility

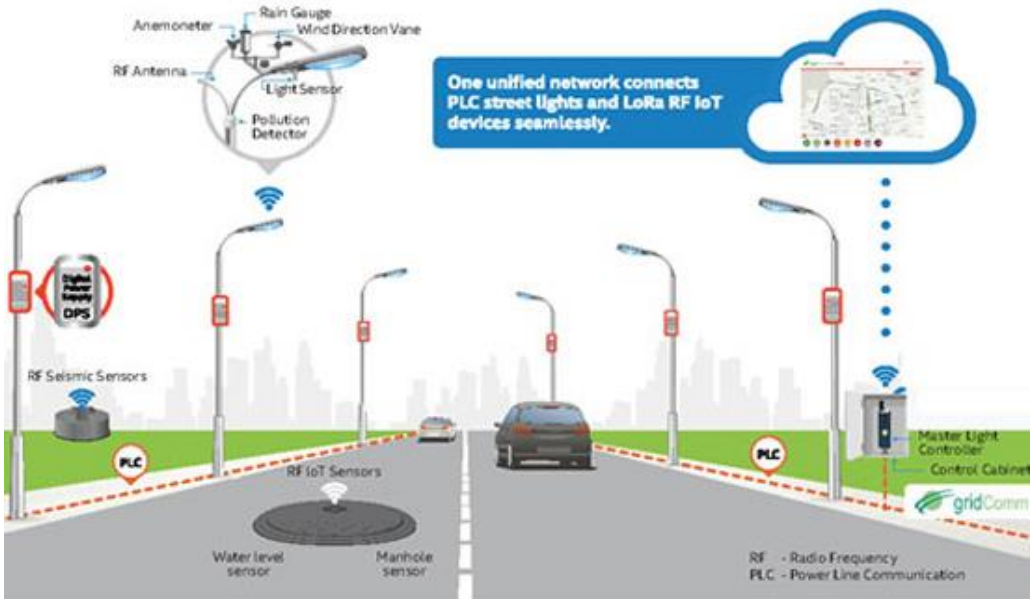
- Before and after illustration of street lighting retrofit in Los Angeles, CA that saw the installation of over 140 000 LEDs

Source CleanTechnica - https://cleantechnica.com/2013/09/12/worlds-largest-led-streetlight-retrofit-completed-in-los-angeles/1514840416

3. Utilities: Lighting

Intelligent lighting systems

- Automatic systems can further **increase energy savings** and extend **lifespan of LED lights** by dimming



Source http://www.gridcomm-plc.com/streetlightsolution.htm, https://www.ledsolutions.co.uk/hole-story-norways-new-led-lighting-system/

4. Utilities: water and sewage

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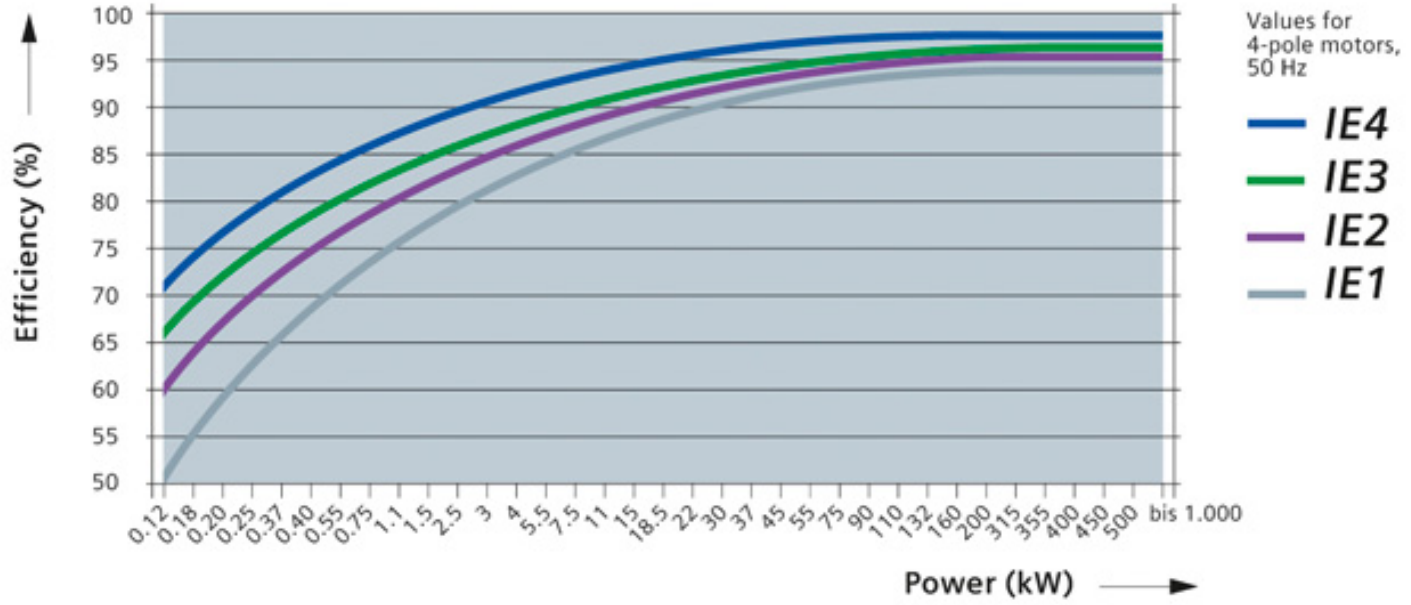
Motor efficiency standards (IE1 to IE4)

- The difference in efficiency might seem small but with continuous running (especially for water supply systems), the differences could be huge!

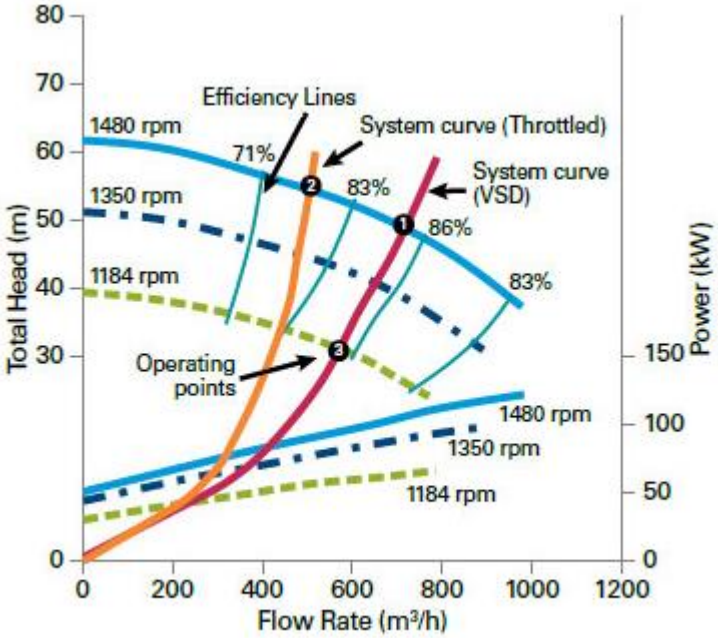


Source https://w3.siemens.com/drives/global/en/motor/low-voltage-motor/efficiency-standards

4. Utilities: water and sewage

Variable frequency drives

- The difference in efficiency might seem small but with continuous running (especially for water supply systems), the differences could be huge!

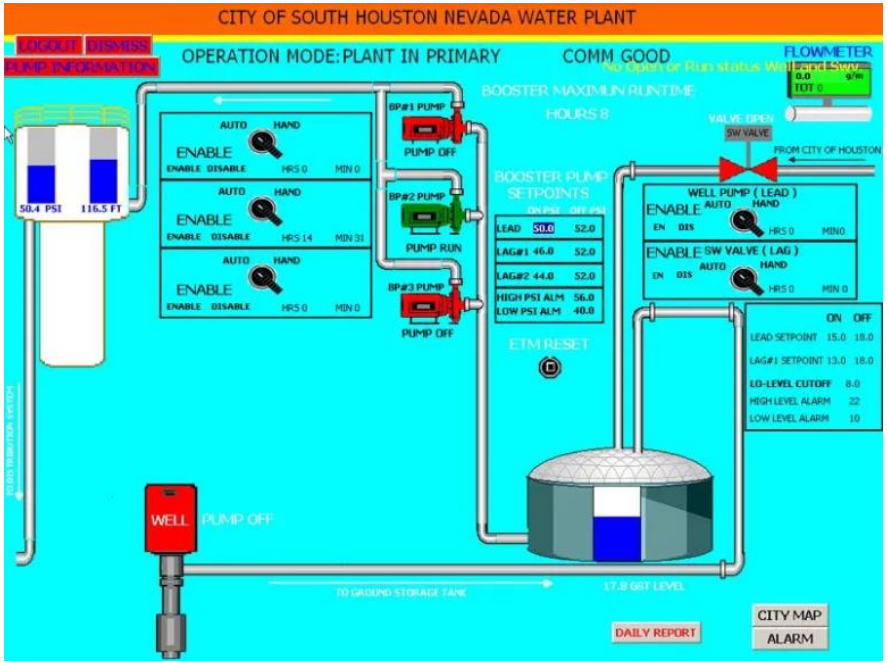


Source http://www.gozuk.com/applications/vfd-for-pumps.html

4. Utilities: water and sewage

Energy management systems

- Installing SCADA (Supervisory Control and Data Acquisition) to determine real time performance.



Source https://www.defensemedianetwork.com/stories/water-utilities-scada-systems-proven-vulnerable-cyber-attack/

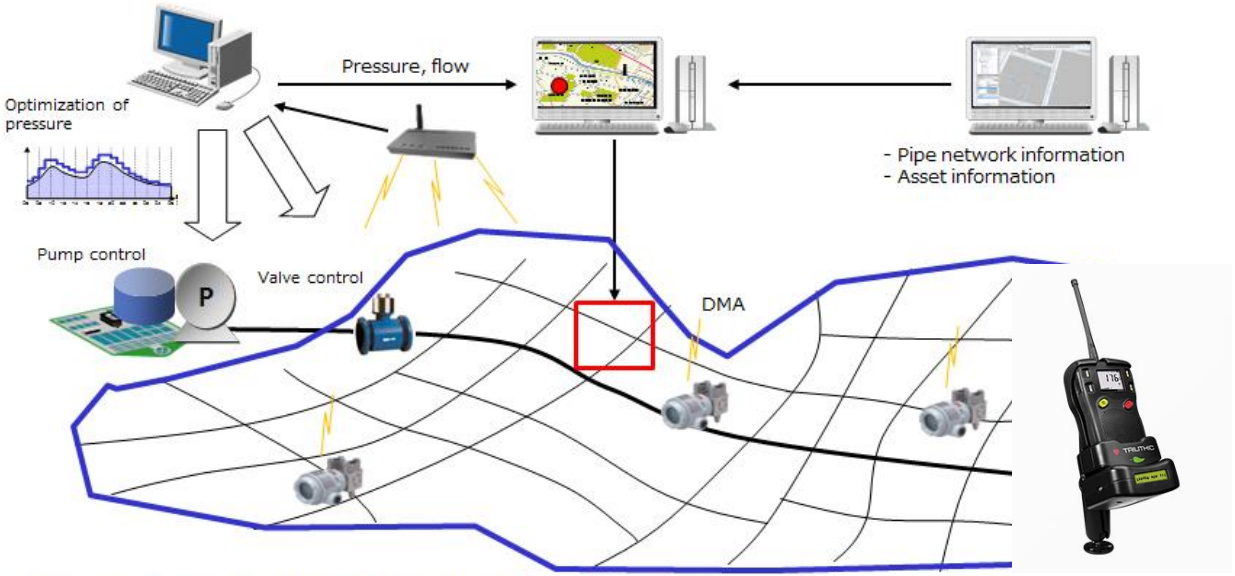
4. Utilities: water and sewage

Leak management system

(A)Water distribution control System
- Real-time pipe network simulation
- Pump control and unnecessary pressure suppression

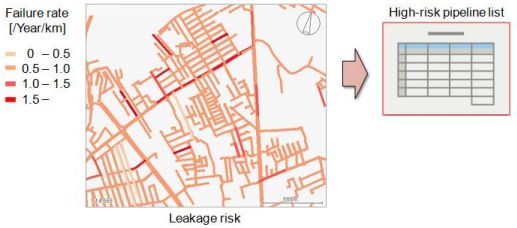
(B)Water Leakage Management System
- Real-time NRW Monitoring
- Management of historical leakage trouble
- Leakage Risk Evaluation
- Area Leakage Estimation

(C)Pipe network management system
- Improvement of operational efficiency by GIS and Pipe network simulation

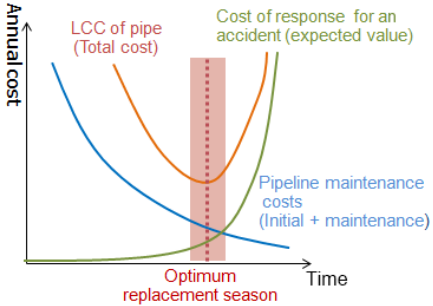


SCADA : Supervisory Control And Data Acquisition, DMA: District Metered Area
GIS : Geographic Information System
NRW : Non-Revenue Water

Preventive maintenance



Timing of replacement

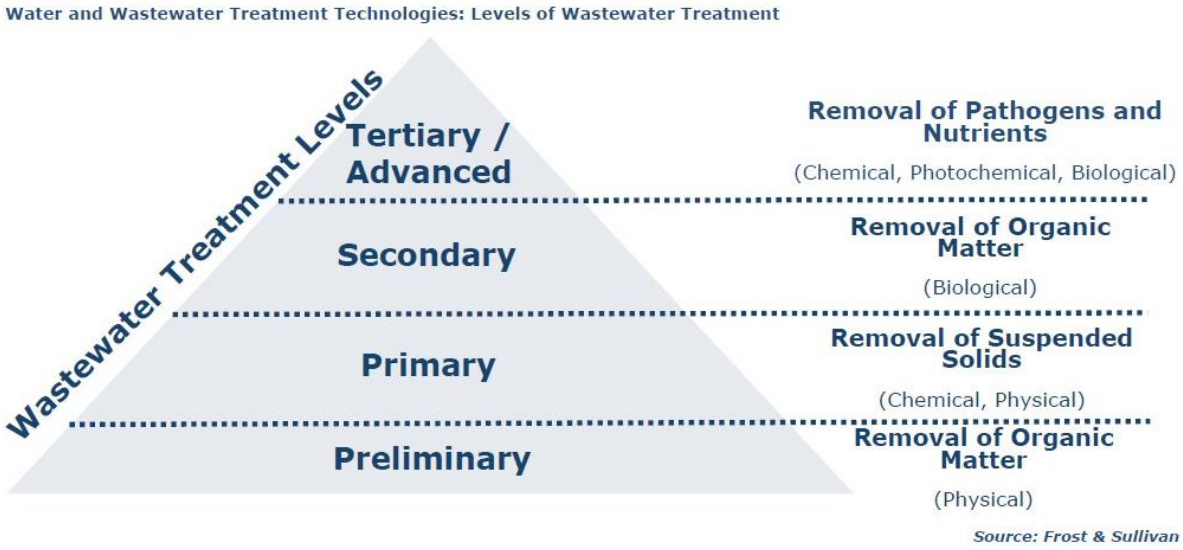


Source http://www.hitachi.com/businesses/infrastructure/product_site/water_environment/water_leakage/index.html, https://www.viavisolutions.com/en-us/products/seeker-d-mca-iii

4. Utilities: water and sewage

Optimised wastewater treatment levels

- Increasing levels of treatment means more energy consumption. Optimising the usage of treated water depending on end-use could avoid excess energy consumption.

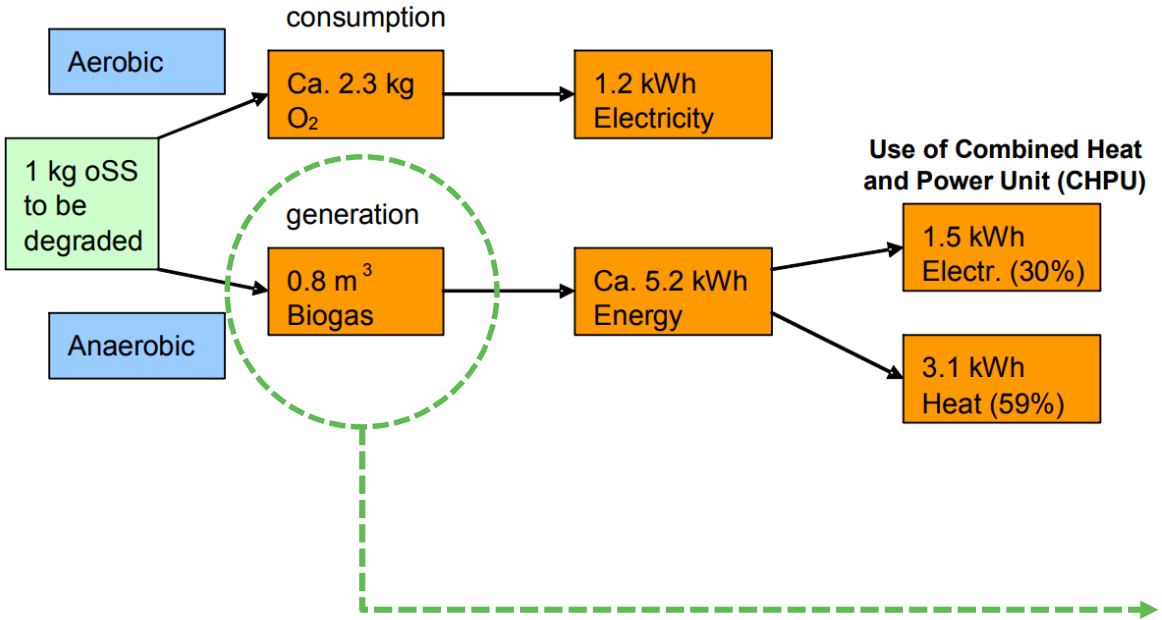


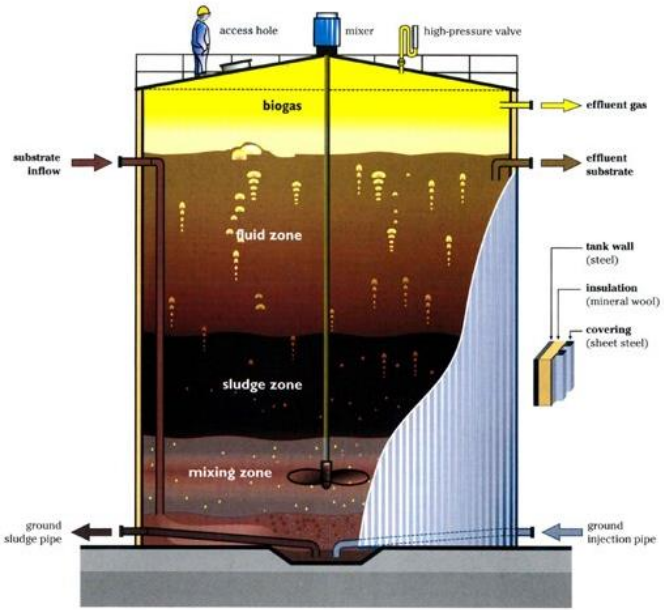
- **Primary effluent** → wetlands, industrial cooling, non-food crop irrigation
- **Secondary effluent** → food crop irrigation, toilet flushing, industrial systems
- **Tertiary effluent** → potable water use

Source http://www.frost.com/prod/servlet/cpo/207381519 , https://www.researchgate.net/figure/Types-and-levels-of-wastewater-Treatment-processes-modified-from-44-45_fig1_320450605

4. Utilities: water and sewage

Aerobic to anaerobic treatment processes to recover energy





Source http://siteresources.worldbank.org/EXTWAT/Resources/4602122-1213366294492/5106220-1234469721549/21.3_Energy_efficiency.pdf , https://civildigital.com/anaerobic-sludge-digestion/

5. Utilities: energy

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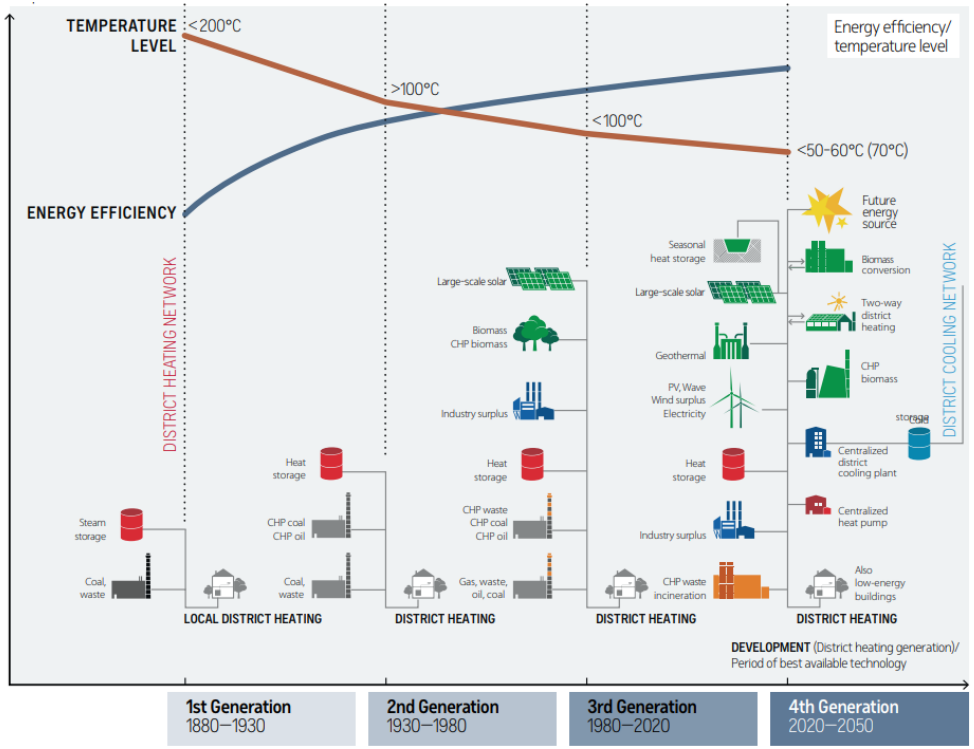
District Energy Networks



1G
STEAM
Steam system, steam pipes in concrete ducts

2G
IN SITU
Pressurized hot-water system
Heavy equipment
Large "build on site" stations

3G
PRE-FABRICATED
Pre-insulated pipes
Industrialized compact substations (also with insulation)
Metering and monitoring

4G
4TH GENERATION
Low energy demands
Smart energy (optimum interaction of energy sources, distribution and consumption)
Two-way district heating

Source http://wedocs.unep.org/bitstream/handle/20.500.11822/9317/-District_energy_in_cities_unlocking_the_potential_of_energy_efficiency_and_renewable_ene.pdf?sequence=2&isAllowed=y

5. Utilities: energy

District Energy Networks : elements

- **District Heating**
  - Geothermal
  - Municipal Waste-to-energy
  - District heating boiler
  - Waste heat recovery (from industrial processes)
  - Combined heat and power (CHP)
  - Heat pumps
  - Solar thermal

- **District Cooling**
  - Electric chillers
  - Free cooling
  - Absorption chiller from surplus heat or renewable heat source

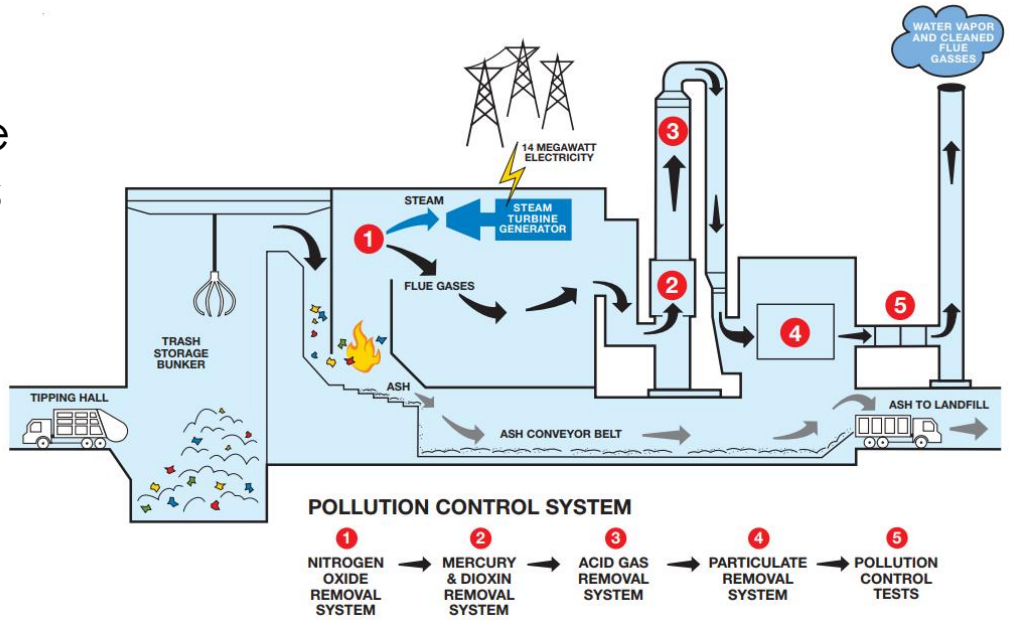
- **Thermal Storage**
  - Short-term storage
  - Demand-side response
  - Seasonal storage

6. Waste

6. Waste

Waste-to-energy : incineration

- Recovery of high value energy that can be use for **electricity generation** and **heating** if there is high amount of combustibles in the municipal waste (less organic waste)
- Reduces stronger GHG emissions (landfill methane converted to CO_2 instead)
- High capital costs

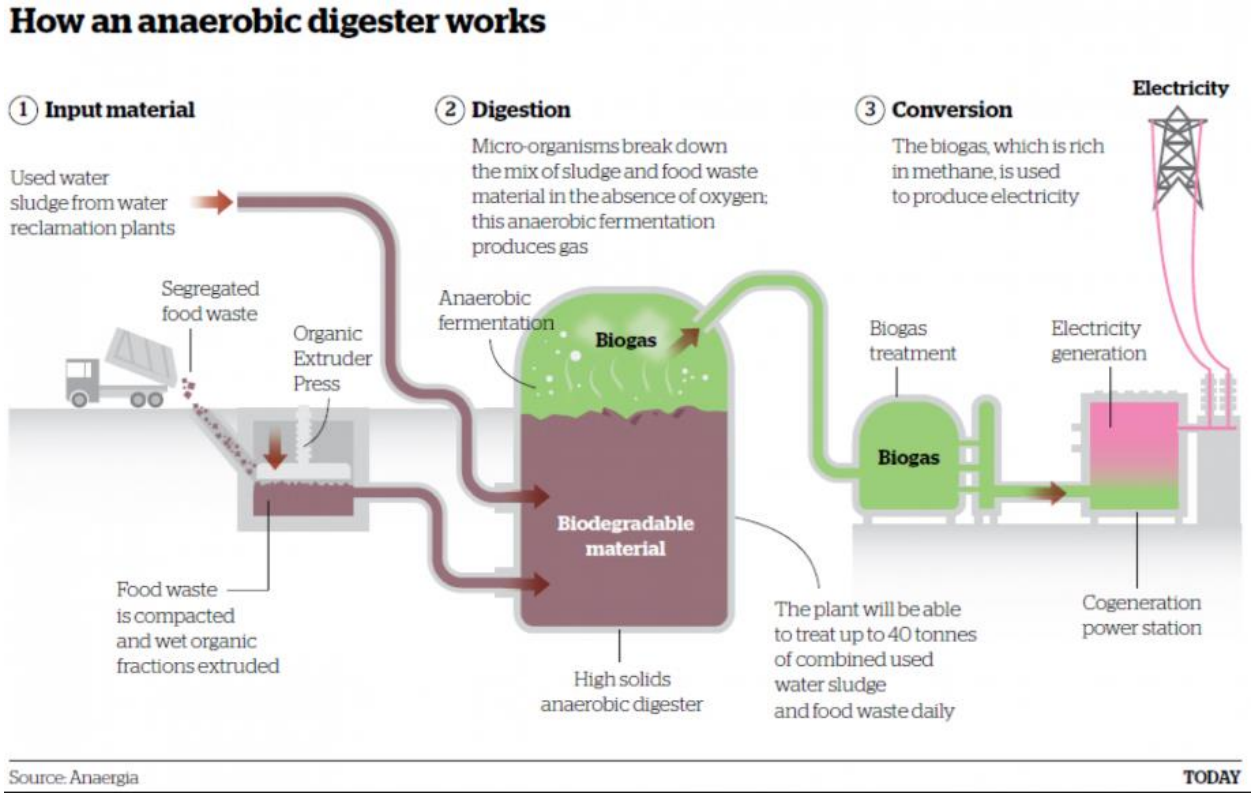


Source https://www.ecomaine.org/our-facility/waste-to-energy-plant/

6. Waste

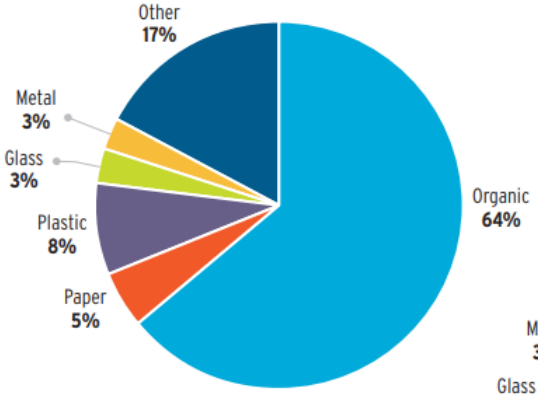
Waste-to-energy : biodigestion

- For municipal waste with high organic wastes, it could be **digested to produce biogas**
- Controlled methane generation for gas networks or cogeneration use
- Requires land space

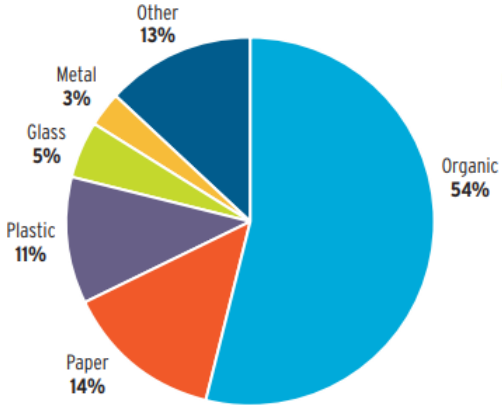


Source https://www.todayonline.com/sites/default/files/styles/photo_gallery_image_lightbox/public/22695557.PNG?itok=6ws-YEFQ

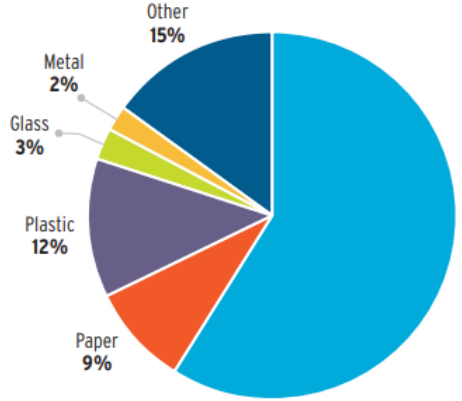
6. Waste



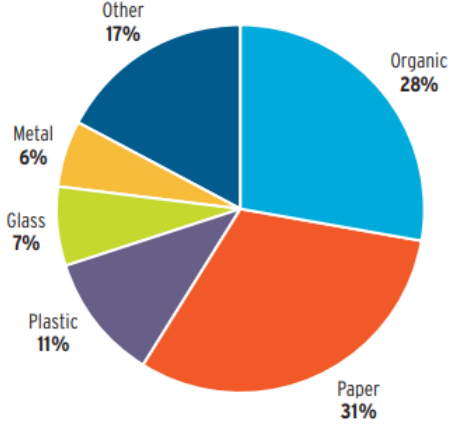
Low-income countries



Lower middle-income countries



Upper middle-income countries



High-income countries

Composition of municipal waste: greater share of paper and packaging (combustibles) compared to organic waste as average income increases

Source: World Bank

Additional Resources

Additional Resources

- Energy Efficient Cities: Assessment Tools and Benchmarking Practices http://www.esmap.org
- C40 Municipal Building Efficiency (MBE) Network https://www.c40.org/networks/municipal-building-efficiency
- Building Efficiency Accelerator http://buildingefficiencyaccelerator.org/
- District Energy in Cities Initiative http://www.districtenergyinitiative.org/

Scenario: The municipal commissioner wants to be known for innovative solutions at reasonable costs.

Question: What are the new technologies that you can put in place in order to boost energy efficiency?

www.iea.org

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