Electricity Generation III
GEOS 24705/ ENST 24705
Industrial generation design specs

• Generator should be large for heat dissipation

• Current carried in stator to avoid any sliding mechanical connections that carry big current

• Magnet in stator is electromagnet for bigger B-field

• Voltage higher than 110 V to minimize resistive heating

• Many loops to increase voltage and power output
Generators are virtually unchanged in 100 yrs

Stator, 3-phase generator, Wellluck Co., China, 12.5 MW, 2010

Stator, 3-phase generator, Brakpan, South Africa, 1897. Photo: Siemens
Rotor carries electromagnet

Old mill rotor (source unknown)

Small Hydro Generator rotor - Rotor Assembly Area - Alstom Hydro Manufacturing site in Galindo (Spain)  
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Turbo-generator power grew very quickly
(though seems to be leveling off)

* Requires growth not just in generators but in turbines that power them

* exponential growth in several stages

* topping-out of steam P and T ca. 1960

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* From Vaclav Smil, “Energy at the Crossroads”
First major hydropower station, Niagara Falls, 1895

Adams power station, 10 5MW AC generators. Photo: Tesla Society
Hoover Dam hydropower station, upgraded 1961

17 generators, average 120 MW. Photo: source unknown
First commercial generating stations

1) Used reciprocating engines rotating at around 2000 rpm (33 Hz)

2) Turn generators via belt drives

3) AC frequency didn’t matter much – each grid was separate, and electricity was used mostly for lighting anyways (where frequency doesn’t matter)

Westinghouse commercial AC generating station, 1888
Edison vs. Tesla: “war of the currents”

**DC**

**Edison’s company:** General Electric, founded 1890, now ranked (Forbes, 2009) the largest company in the world. Precursor: Edison Illuminating Co., 1880

**Technical achievement:** First steam-powered electricity & electric utility, 1882, first U.S. transmission standard, multiple power plants (1.5 mi. transmission) (for lighting only)

**PR stunt:** invented (AC) electric chair, attempted execution, 1890

**AC**

**Tesla’s company:** Westinghouse Electric Company, founded 1886, now (after purchase of CBS) knows as CBS Corp. (sold power generation to Siemens, itself provider of first electric street lighting in 1881). Hired first woman electrical engineer in 1890s.

**Technical achievement:** long-distance transmission of hydropower at Niagara Falls to factories in Buffalo New York, 1895 (25Hz)

**PR stunt:** lit Chicago World’s Fair, 1893
Electric lighting common only a decade after invention

Individual private grid systems operation on their own standards, DC or AC from 25-133 Hz

W.L. Sontag, 1895, "The Bowery at Night"
Tesla’s system already had most characteristics of the modern electricity system in 1893.

World’s Fair + choice at Niagara 2 years later committed us to AC

Comparatively little evolution after choice was made – standardization of frequencies.
Tesla’s AC is “three-phase”

3-phase generation animation

(http://www.koehler.me.uk/animation/e_and_m_3phase_gen.htm)