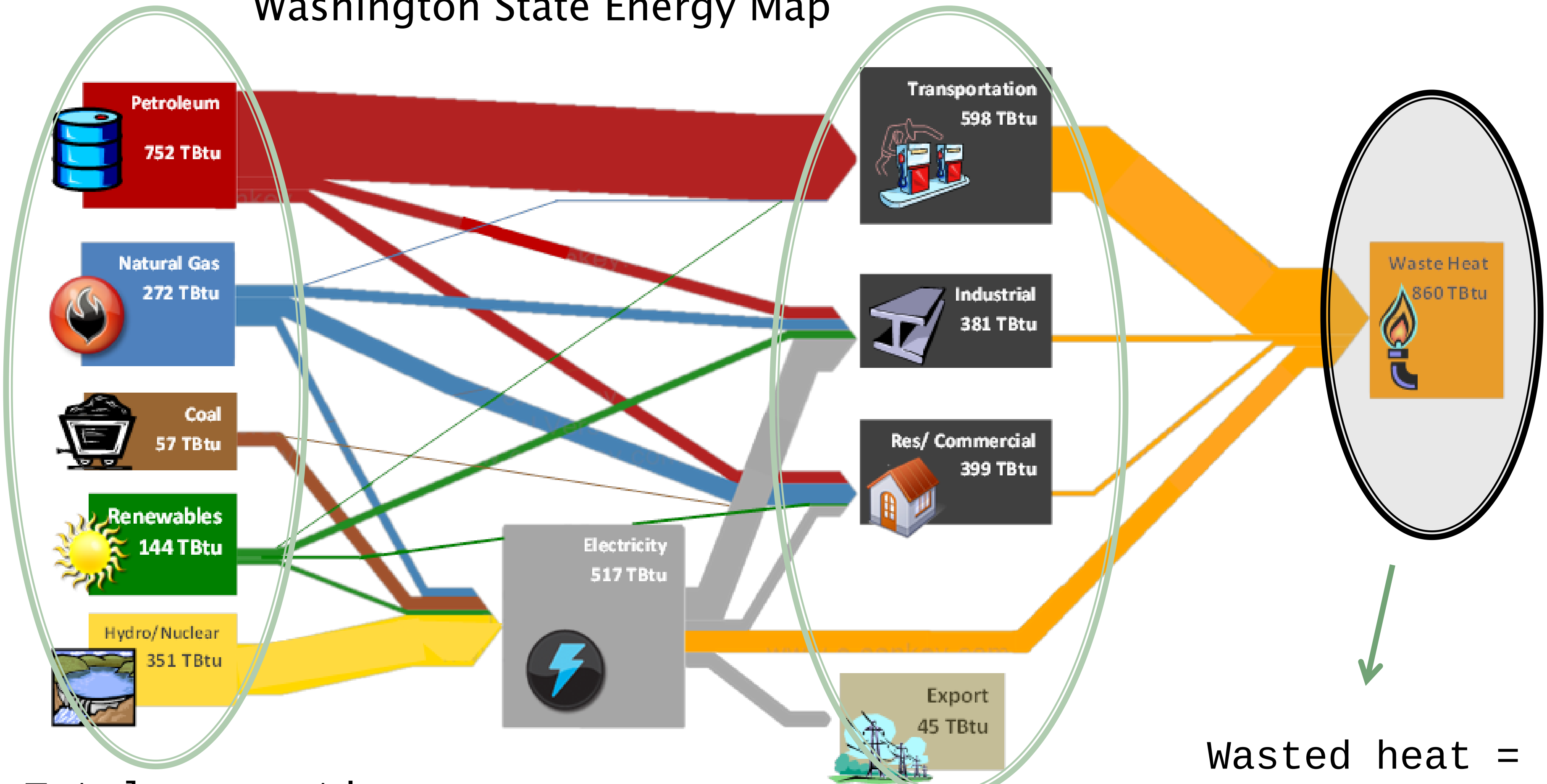
We waste a lot of heat

Washington State Energy Map



Total generation

Total consumption

Wasted heat = 860 Trillion BTU!

2011 US Dept of Energy EIA data

Where does our “wasted heat” go?

- Automobiles and trucks waste heat through tailpipes and into the air
- Per EIA data, Washington’s fleet of thermal power plant (natural gas, coal, MSW & nuclear) is 31% energy efficient meaning we waste 69% of the energy as heat rejected into the air
- Industrial plants often send their wasted heat through ‘cooling-towers’ into the air
- Commercial and residential buildings send waste heat into the ground (sewer) and into the air (chimney or flue)

Why do we waste heat?

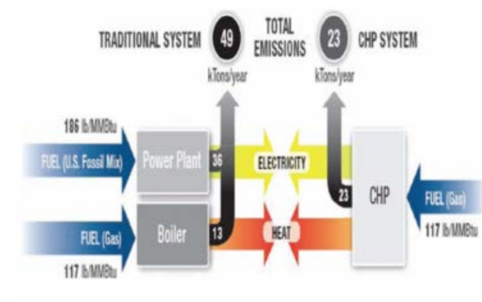
- For 3 decades State energy strategies and policies have been dominated by ‘electricity’ technologies and projects
- There is little to no incentive to capture and reuse wasted heat
  - Project “payback”?
    - Electricity is inexpensive in the Washington so it is not “cost-effective” to recycle and reuse wasted heat
  - Air emissions?
    - Electricity is clean in Washington so no need to recycle and reuse the wasted heat

Why do we waste heat?

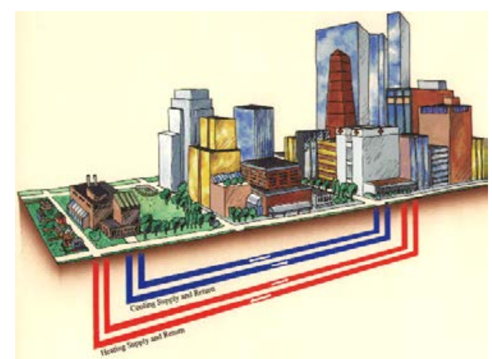
- Thermal energy has been largely forgotten – yet we waste 3x more heat than we use!
- Reusing wasted heat from power plants and buildings is "energy conservation", but is not included in the State's energy policy or the 2012 State Energy Strategy
- Energy conservation is a carbon reduction strategy
- We can recover and reuse wasted heat to conserve energy and reduce CO2 emissions

Waste Heat Recovery strategies

- Combined Heat and Power (CHP)
  - Also known as "high-efficiency cogeneration" in I937 but not integrated into IRP's
  - Used in power plants, industrial sites, and individual commercial and residential buildings



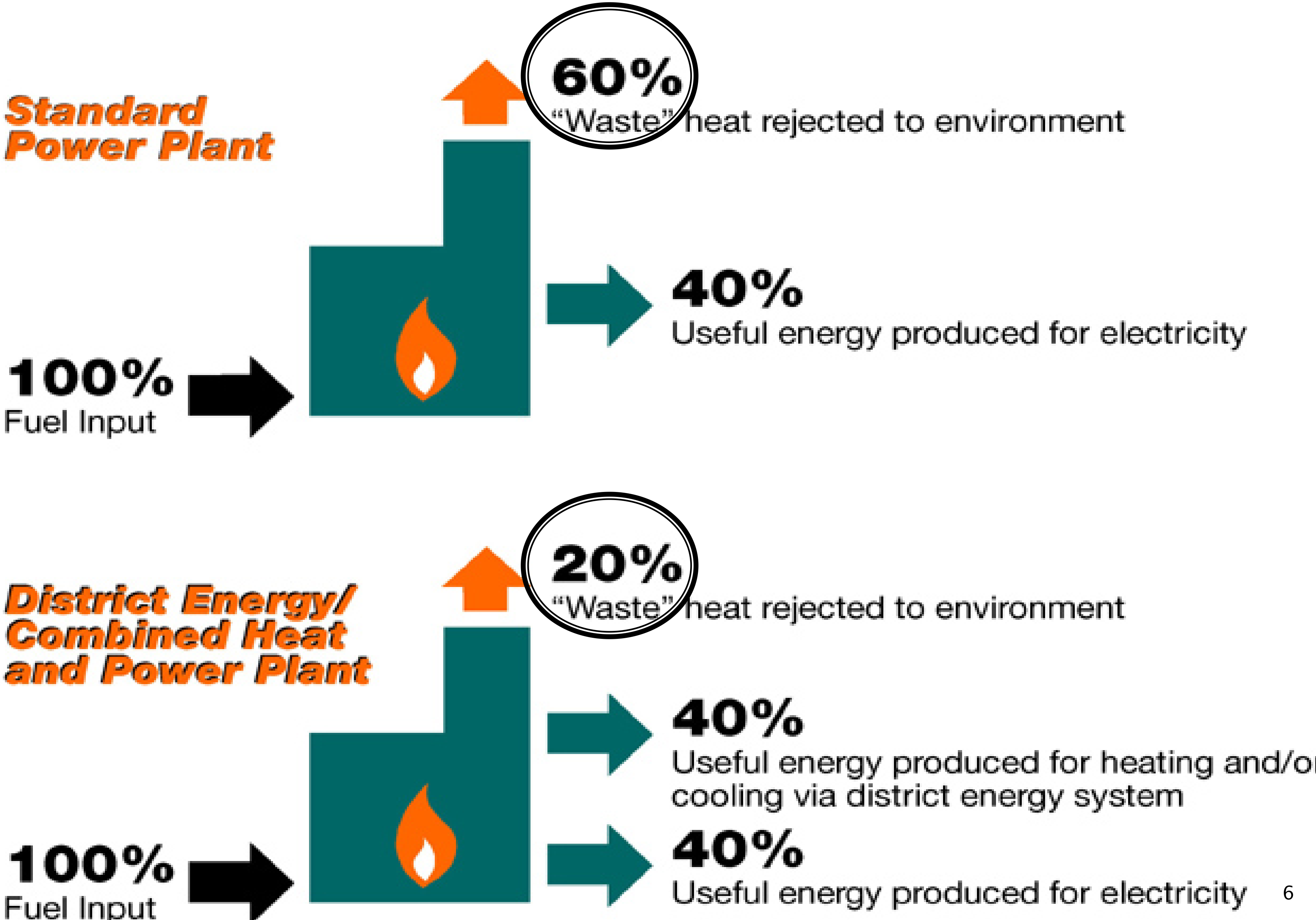
- District Energy (DE)
  - City or campus setup, distributes hot water/steam to buildings through a network of pipes; the heat sink that never goes away.



- Waste Heat to Power (WH2P)
  - Using waste heat to produce electricity Emerging technologies growing this field.

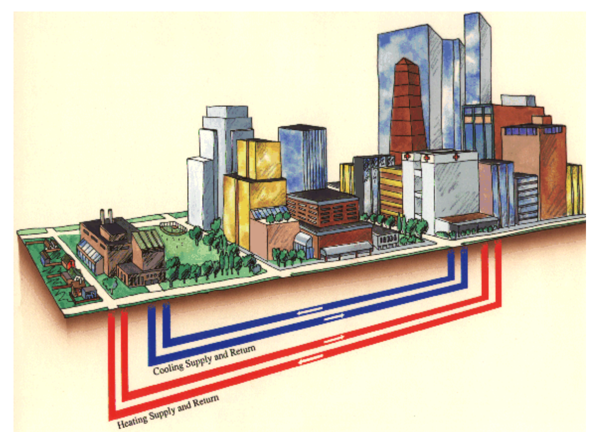
INTERNATIONAL DISTRICT ENERGY ASSOCIATION

CHP = Combined Heat and Power



Real Efficiency needs to address location:

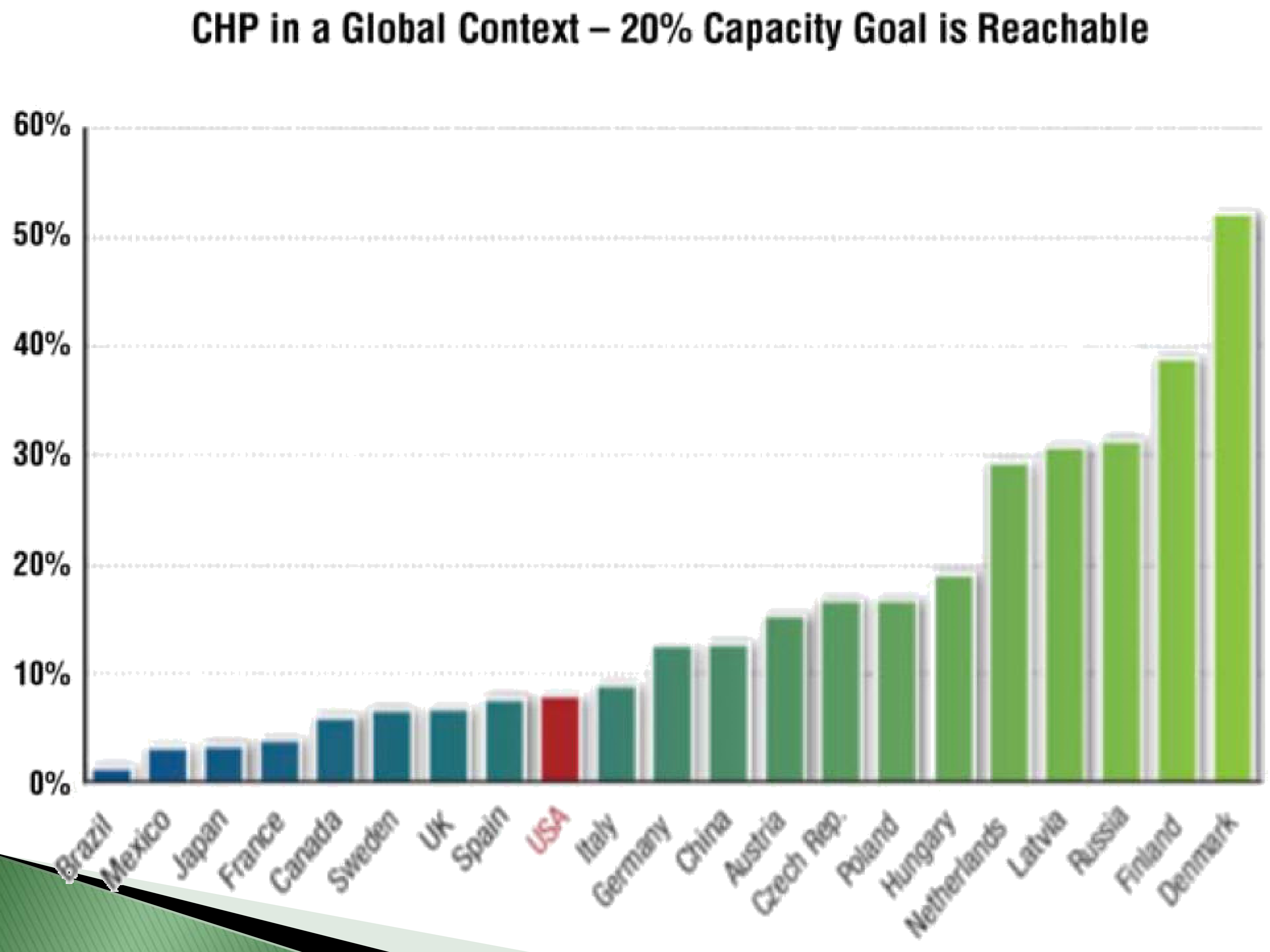
- Combined Heat and Power (CHP) paired with District Energy:
  - The use of the heat it tied to long term assets reducing risk significantly.
  - Heat load centers are the same as electric load centers; they are the same buildings.
  - Using generation at the load centers allows for other power features like:
    - Avoids 9% transmission loss
    - Allows local power factor management
    - Allows electric load balancing
  - Who are the heat load centers?
    - District heating utilities (Seattle Steam)
    - University Campus' across the state
    - Military campus's
    - And of course – Government centers



CHP and District Energy as 'Virtual Battery'

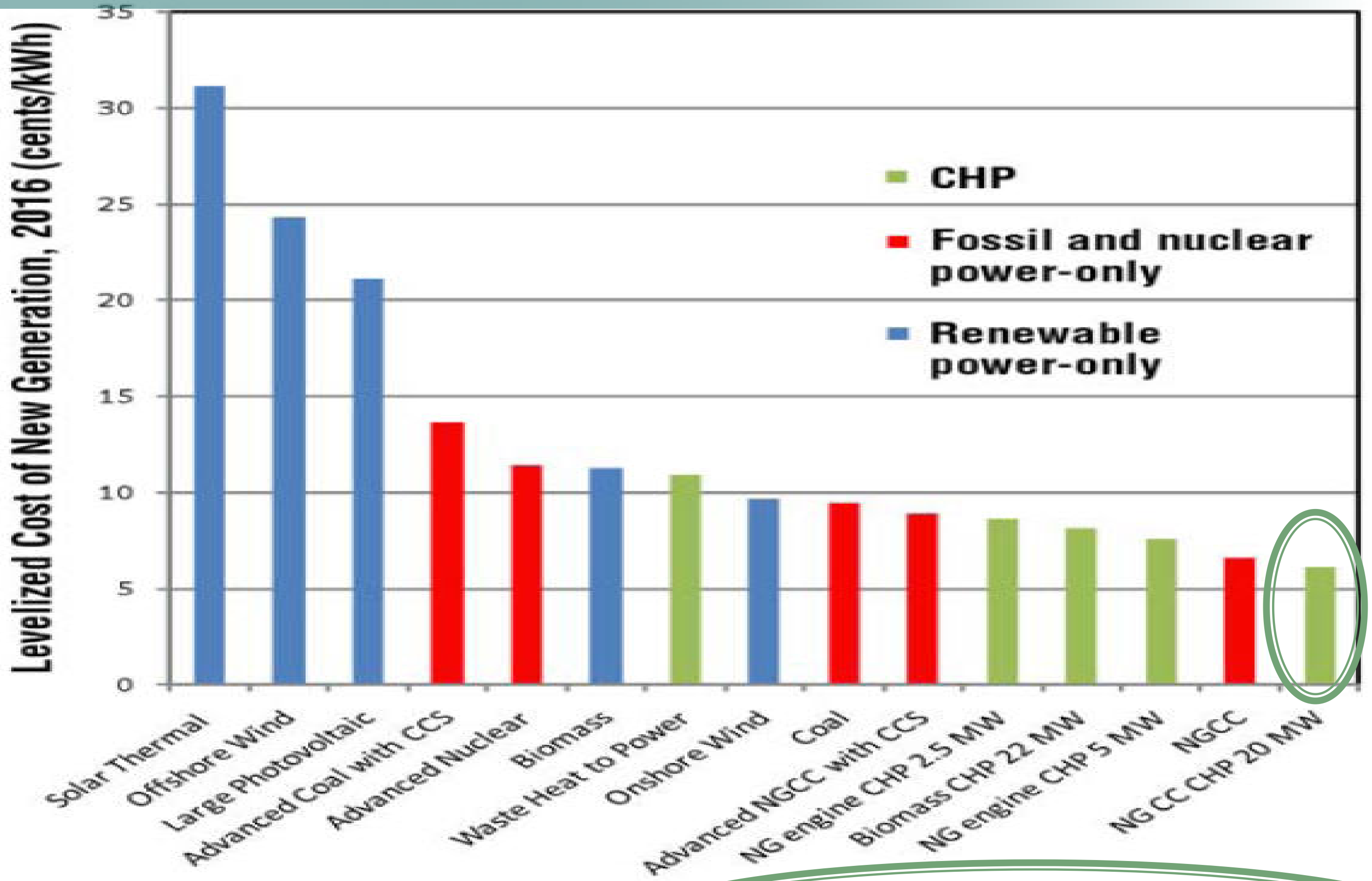
- Excess seasonal electricity (hydro, wind) is used to make heat in a district energy system
- Balances wind and hydro power by making heat
- Displaces fossil-fuel normally used to create heat
- Takes advantage of existing district energy systems and encourages development of more to balance further wind and solar development
- Currently no policy (and limited markets) to deal with complexity of 'fuel switching' or local area power factor (PF) support

Country Percentage of Electricity Provided by CHP



Cost impacts of CHP?

Summary of Levelized Cost of Generation Resources On Line in 2016



US Department of Energy/Energy Information Administration, "Levelized Cost of New Generation Resources in the Annual Energy Outlook 2011", Dec. 2010.

20MW CHP = $.06 – .07/kWh

Emissions from CHP?

Fossil Fuel Consumption and Greenhouse Gas Emissions from a Range of Generation Resources

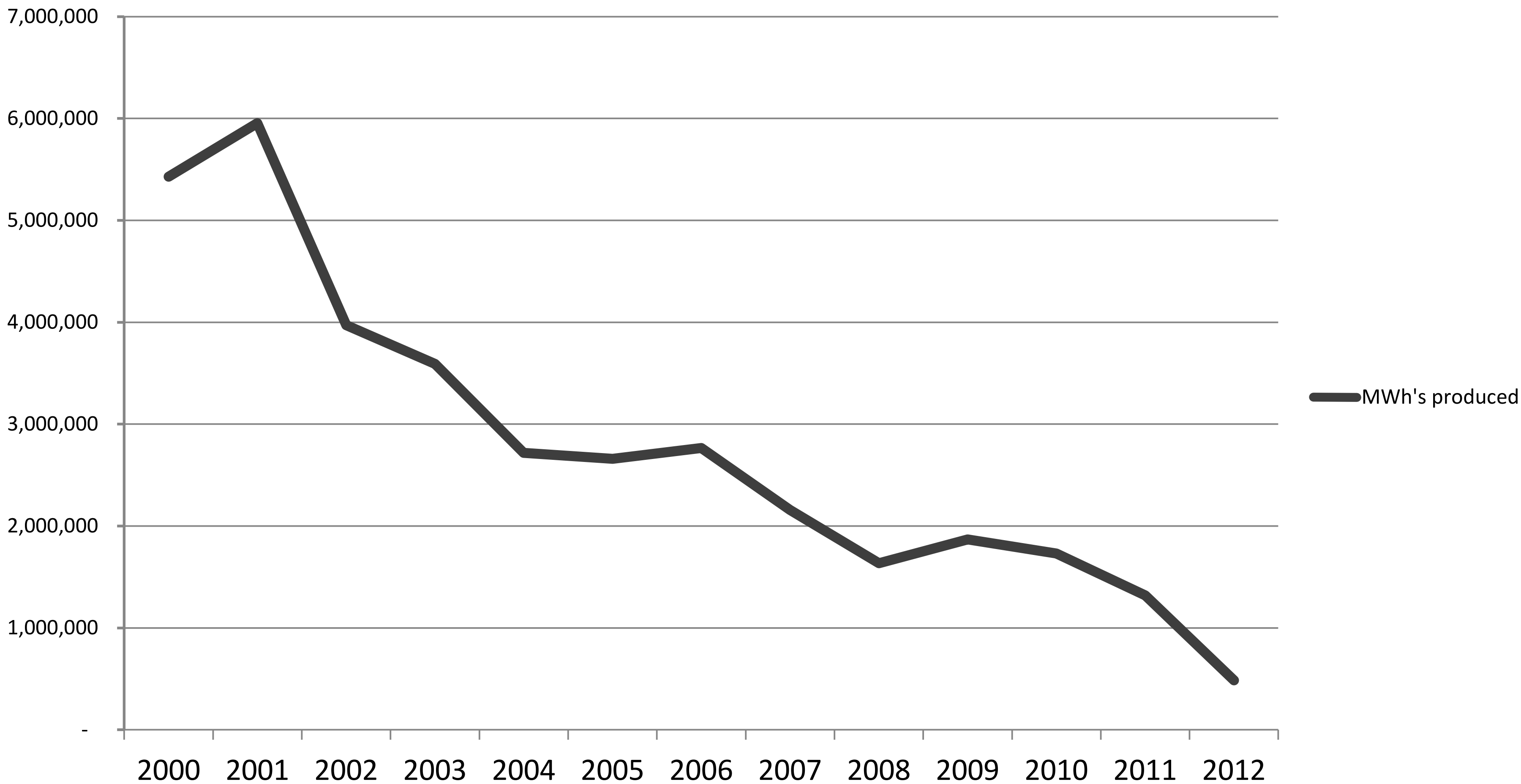
		Fossil fuel consumption (Btu/kWh)	GHG emissions (metric tons/MWH)
Fossil and Nuclear Power-only	Conventional Coal	8,784	0.82
	Conventional NGCC	6,967	0.37
	Nuclear	-	-
	Advanced Coal with CCS *	10,434	0.11
	Advanced NGCC with CCS *	7,521	0.04
Renewable power-only	Biomass	-	-
	Onshore Wind	-	-
	Offshore Wind	-	-
	Solar Thermal	-	-
	Large Photovoltaic	-	-
CHP	Waste heat to power	-	-
	Biomass CHP 22 MW	(767)	(0.43)
	NG engine CHP 2.5 MW	5,292	0.28
	NG engine CHP 5 MW	5,195	0.28
	NG CC CHP 20 MW	4,492	0.24

* Note: CCS is not a proven technology.

US Department of Energy/Energy Information Administration, “Levelized Cost of New Generation Resources in the Annual Energy Outlook 2011”, Dec. 2010.

35% lower emissions from CHP!

Annual electricity generation from 'cogeneration' sources in Washington State



Policy recommendations

- Establish a heat-rate benchmark for thermal power plants that can only be achieved by CHP (RCW 80.80: Greenhouse Has Emission Performance Standard for Baseload Electric Generation)
- Allow utility companies to 'rate-base' CHP <u>and district energy investments</u>
- Transmission and Distribution avoidance credit – <u>locational value is real, line loss is real, balancing is real.</u>
- Conservation-side of I937 needs strengthening
  - Set conservation targets higher than renewables – in line with intent of 'efficiency first'
  - Revise definition of "cost-effective conservation"
  - Introduce concept of "Energy Conservation Credits", similar to Renewable Energy Credits (RECs)
- Streamline local permitting for onsite power generation, including CHP
- Net Metering rules should be consistent with interconnection standards
  - 1MW generated onsite is equal to 1.12 to 2.25MW of avoided traditional power generation (Carnegie-Melon study 2010), range is dependent on variables
  - 1.75 multiplier for distributed generation (California's Impacts of DG report 2010)
- Allow for third-party ownership of CHP systems, not just for solar/renewables
- More transparency into utility company IRP process and other stakeholder workgroups that are traditionally: Olympia-centric or utility-company inclusive
- Include carbon emissions avoidance as part of future cost planning