Energy from the Catawba River

Citizens' Water Academy

Catawba-Wateree Water Management Group

January 25, 2022

Presented by: Duke Energy

- Ed Bruce, Lead Engineer, Water Resource Planning
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Lets Talk About…

- Water-Energy Nexus
- Catawba-Wateree River Basin Drought Management
- Duke Energy Power Plants on the Catawba
- Impacts of Working Reservoirs
- What will the Next Century Look Like?

Catawba Nuclear Station

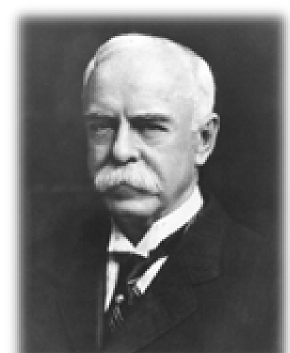
In the Beginning, There was Water

In 1899, James Buchanan Duke (b. Durham, NC) organizes the American Development Company and begins acquiring land and water rights along the Catawba; financial vision

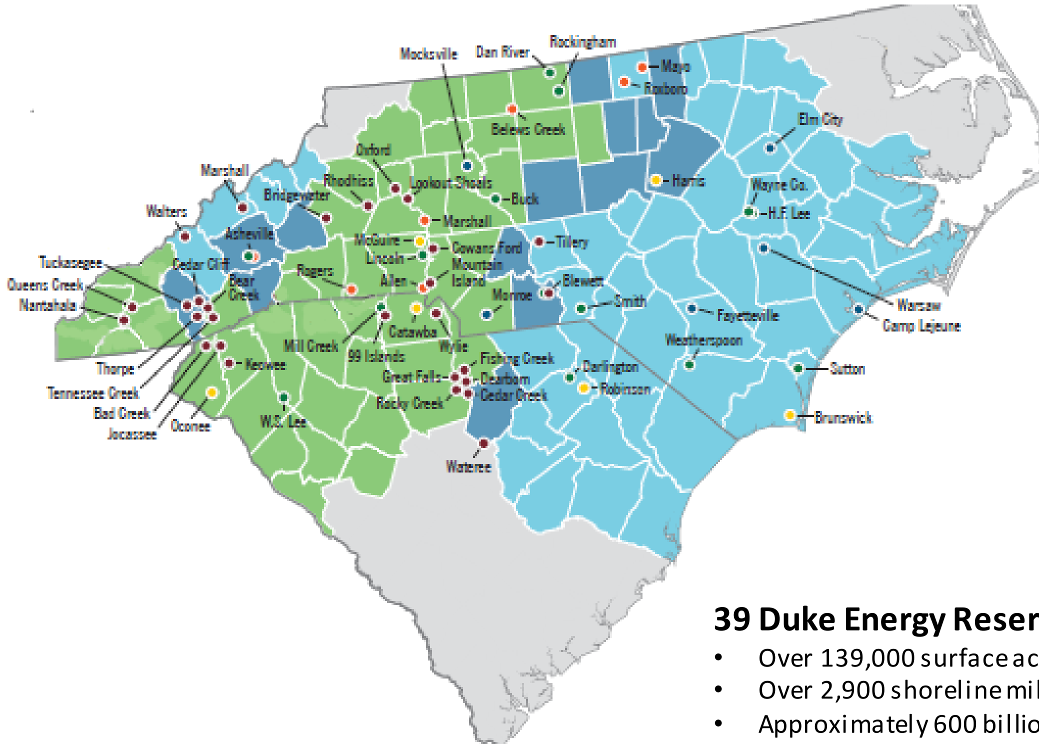
April 30, 1904 -- Catawba Hydro Station, located in York County, SC, begins operation. This is our first generating station, and is considered the birth date of Duke Power Company (now Duke Energy Carolinas).

William States Lee, Sr. (left, b. Lancaster, SC) was company's first engineer; vision for inter-connected grid

Dr. Walker Gill Wylie (right, b. Chester, SC) was company's first president; vision for the Catawba hydro stations



Water is Required to Keep the Lights on



39 Duke Energy Reservoirs in the Carolinas

- Over 139,000 surface acres
- Over 2,900 shoreline miles
- Approximately 600 billion gallons of usable water storage
- Raw water supply for about 3 million people

(Map updated 1/2020)

Service Territory
Counties Served*

- Duke Energy Progress
- Duke Energy Carolinas
- Overlapping Territory

Portions may be served by other utilities.

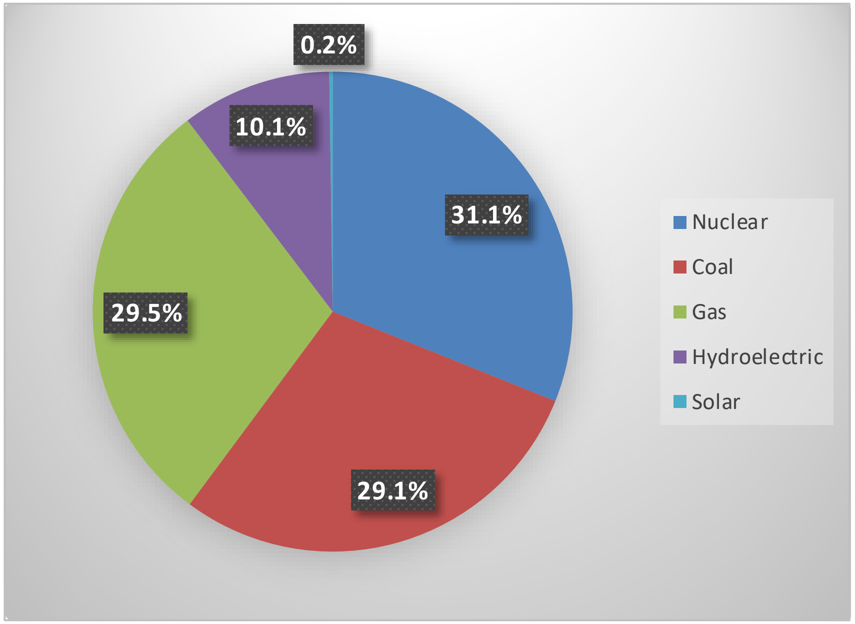
Plant Locations
Generation Type

- Nuclear
- CC/CT
- Hydro
- Solar
- Coal

Duke Energy in the Carolinas

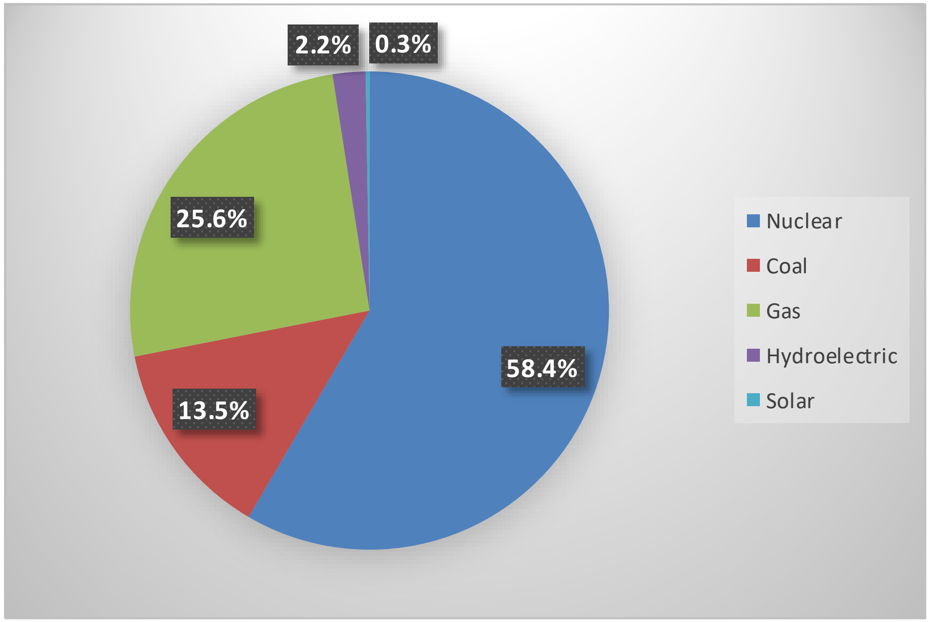
Capacity and Generation
(DEC and DEP)

Total 2021 Capacity = <u>34,656 MW</u>



Total 2020 Generation = <u>152,926,564 MWh</u>

(latest available data; excludes purchased power)

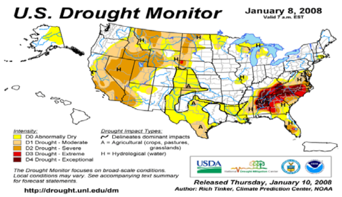


~61% of 2020 electricity production was carbon-free
~99% of 2020 electricity production used water

Catawba-Wateree River Basin – Drought Indicators

The Low Inflow Protocol (LIP) designates 5 stages of drought in the Catawba-Wateree River Basin as determined by the following indicators:

1. How much total remaining usable water is in the reservoirs - Volume of water between current reservoir elevations and each reservoir's Critical Reservoir Elevation
2. How much water is flowing into the reservoirs - As measured by 4 tributary US Geological Survey (USGS) streamflow gages
3. Reports from U.S. Drought Monitor, a government index indicating areas experiencing drought and the severity, specific to the Catawba-Wateree River Basin



- Indicators are evaluated and reported at least monthly
- Duke Energy coordinates with the Catawba-Wateree Drought Management Advisory Group (CW-DMAG) to manage the shared water supply

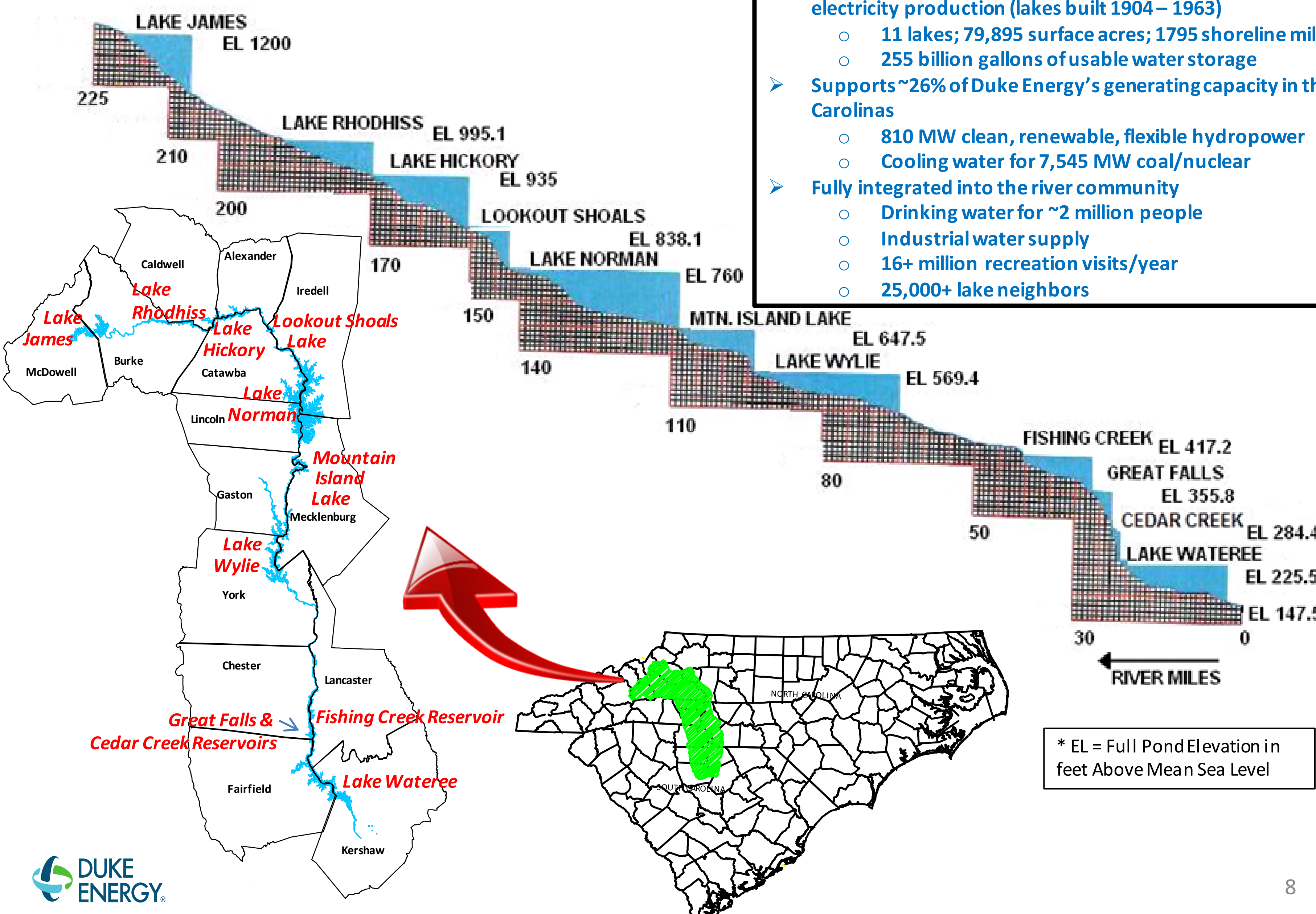
Catawba-Wateree River Basin - LIP

Purpose – Slow rate of water storage loss to buy time for return to more rainfall

Stage		Action Summary
0		***Licensee*** - Activate Catawba-Wateree Drought Management Advisory Group (CW-DMAG).
1		***Licensee*** - Reduce downstream, bypass, recreation flows and Normal Minimum Elevations. ***Public Water Suppliers (PWS)*** – Voluntary water use restrictions, 2 day/wk irrigation, reduce vehicle washing; **water reduction goal of 3-5%.** ***Other Large Water Intake (LWI) Owners*** – Notify employees and customers and request voluntary cutbacks.
2		***Licensee*** – Further reduce flows and Normal Minimum Elevations. Eliminate recreation flows. ***PWS*** – Mandatory water use restrictions, 2 day/wk irrigation, eliminate vehicle washing; **water reduction goal of 5-10%.** ***Other LWI Owners*** – Notify employees and customers and request voluntary cutbacks.
3		***Licensee*** - Reduce downstream and bypass flows to critical flows, and further reduce Normal Minimum Elevations. ***PWS*** – Mandatory water use restrictions, 1 day/wk irrigation, limit other outdoor water uses; **water reduction goal of 10-20%.** ***Other LWI Owners*** – Notify employees and customers and request voluntary cutbacks.
4		***Licensee*** – Maintain downstream and bypass flows at critical flows, and reduce Normal Minimum Elevations to critical elevations. ***PWS*** – Restrict all outdoor water use, implement emergency restrictions; **water reduction goal of 20-30%.** ***Other LWI Owners*** – Notify employees and customers and request voluntary cutbacks.

Catawba-Wateree Hydro Project – A Hard Working River

- First river in US comprehensively planned/developed for electricity production (lakes built 1904 – 1963)
  - 11 lakes; 79,895 surface acres; 1795 shoreline miles
  - 255 billion gallons of usable water storage
- Supports ~26% of Duke Energy's generating capacity in the Carolinas
  - 810 MW clean, renewable, flexible hydropower
  - Cooling water for 7,545 MW coal/nuclear
- Fully integrated into the river community
  - Drinking water for ~2 million people
  - Industrial water supply
  - 16+ million recreation visits/year
  - 25,000+ lake neighbors



* EL = Full Pond Elevation in feet Above Mean Sea Level

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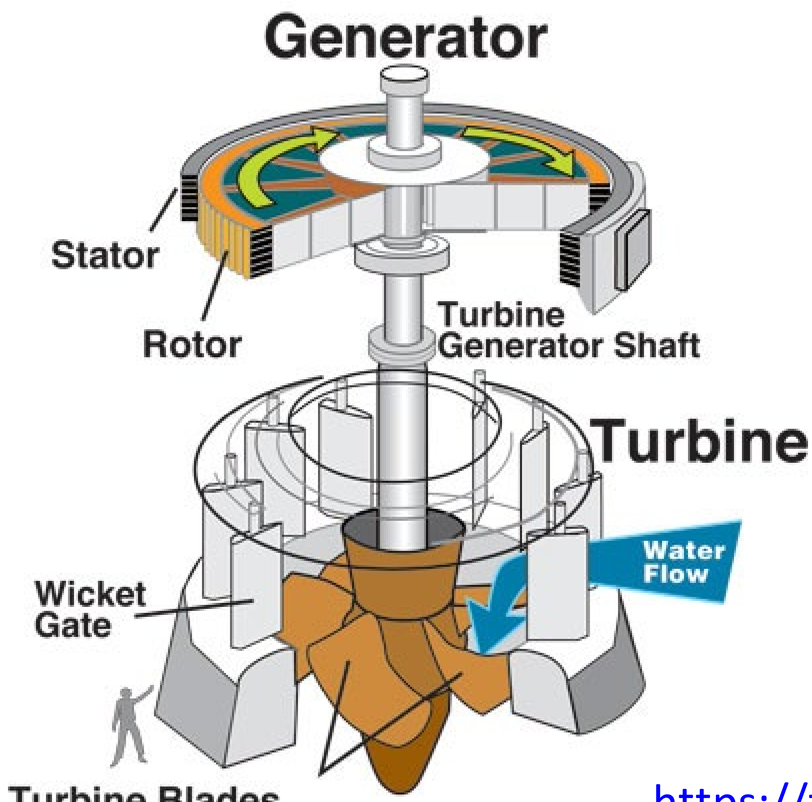
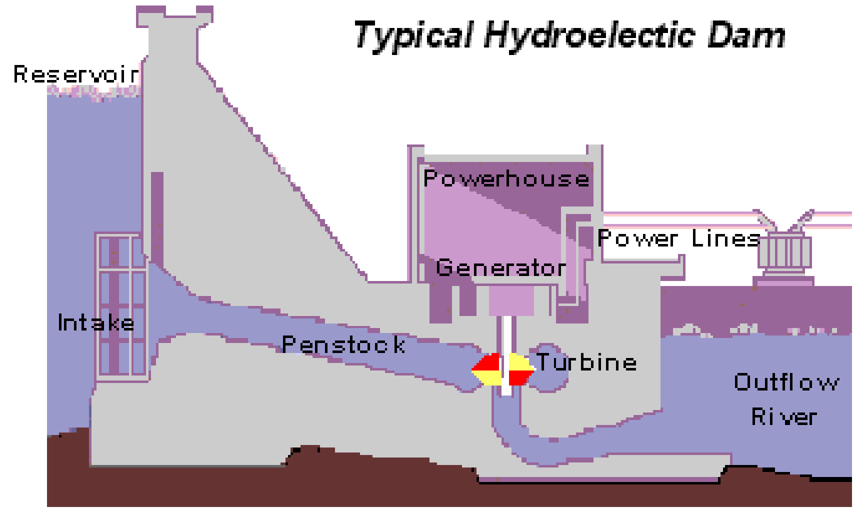
How Does a Hydro Turbine Work?





https://fwee.org/nw-hydro-tours/walk-through-a-hydroelectric-project/

Benefits of Hydropower

- **Clean, renewable and very efficient** *(most efficient energy source for Duke Energy)*

- **Very responsive to electric customers' changing needs**
  - Shortest cycle time – less than 10 minutes from shutdown to full load and back to shutdown
  - Peaking - Often used to meet electric load during peak demand *(highest value of electricity)*
  - Load following - Relatively small power units so easier to adjust and match electric load on the grid
  - Stabilizes grid - Helps stabilize the electric grid *(voltage support, spinning reserve, black start)*
  - Lowest variable cost of production - largely due to "free fuel"

- **Hydro reservoirs store water and provide many extra community benefits**
  - **Shock absorbers** for extreme weather patterns *(floods, droughts)*
  - Water supply for:
    - Drinking water
    - Thermoelectric power plants *(e.g., nuclear, coal-fired, gas-fired)*
    - Industry
    - Agriculture
  - Recreation *(both on-lake and in the rivers downstream)*
  - Treatment of wastewater
  - Aquatic habitat for reservoir species

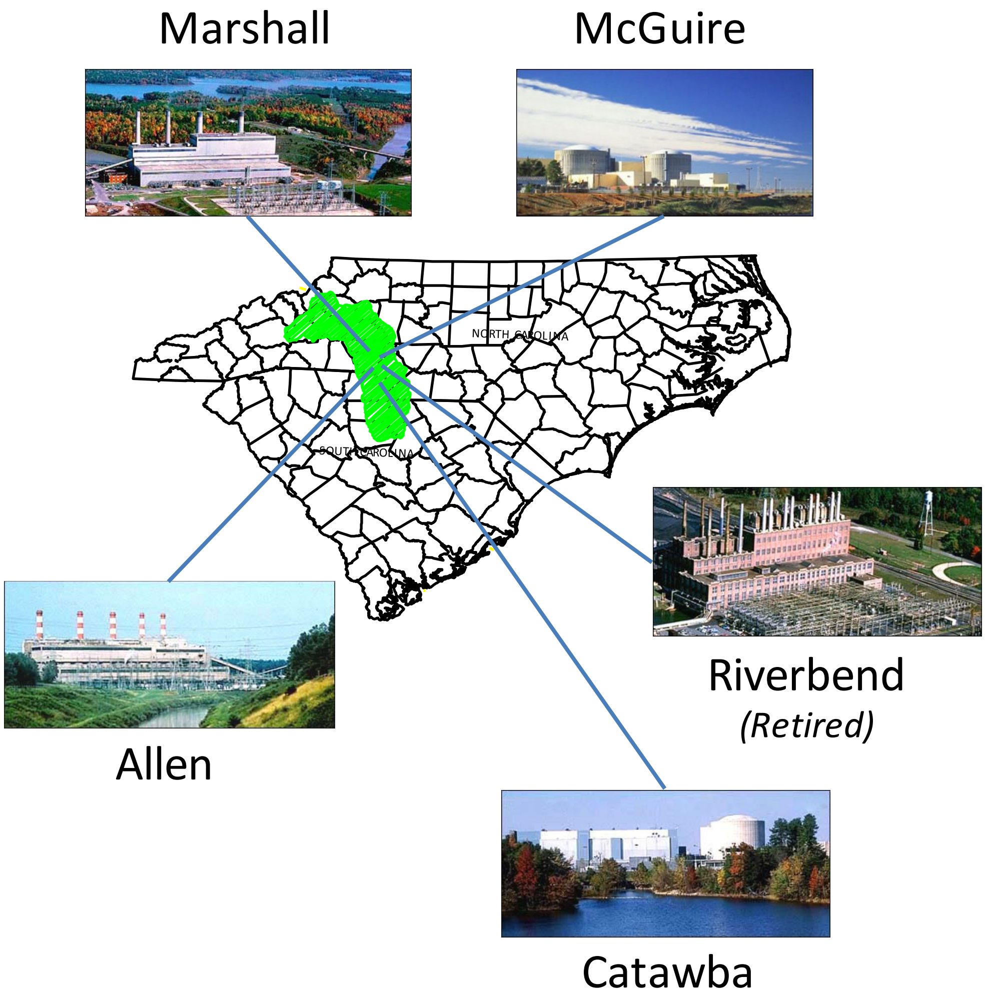
Wylie Hydro Station

Downside of Hydropower

- **Some impacts of hydropower**
  - Very difficult to construct if a new lake is required
    - Relocating large numbers of homes, roads, utility lines, businesses, cemeteries, etc.
    - Obtaining governmental permits and a license
    - Very high costs for real estate acquisition and construction
  - **Permanently changes river** - Long-term conversion and/or loss of habitat for plants and animals
  - Reservoir sedimentation over time

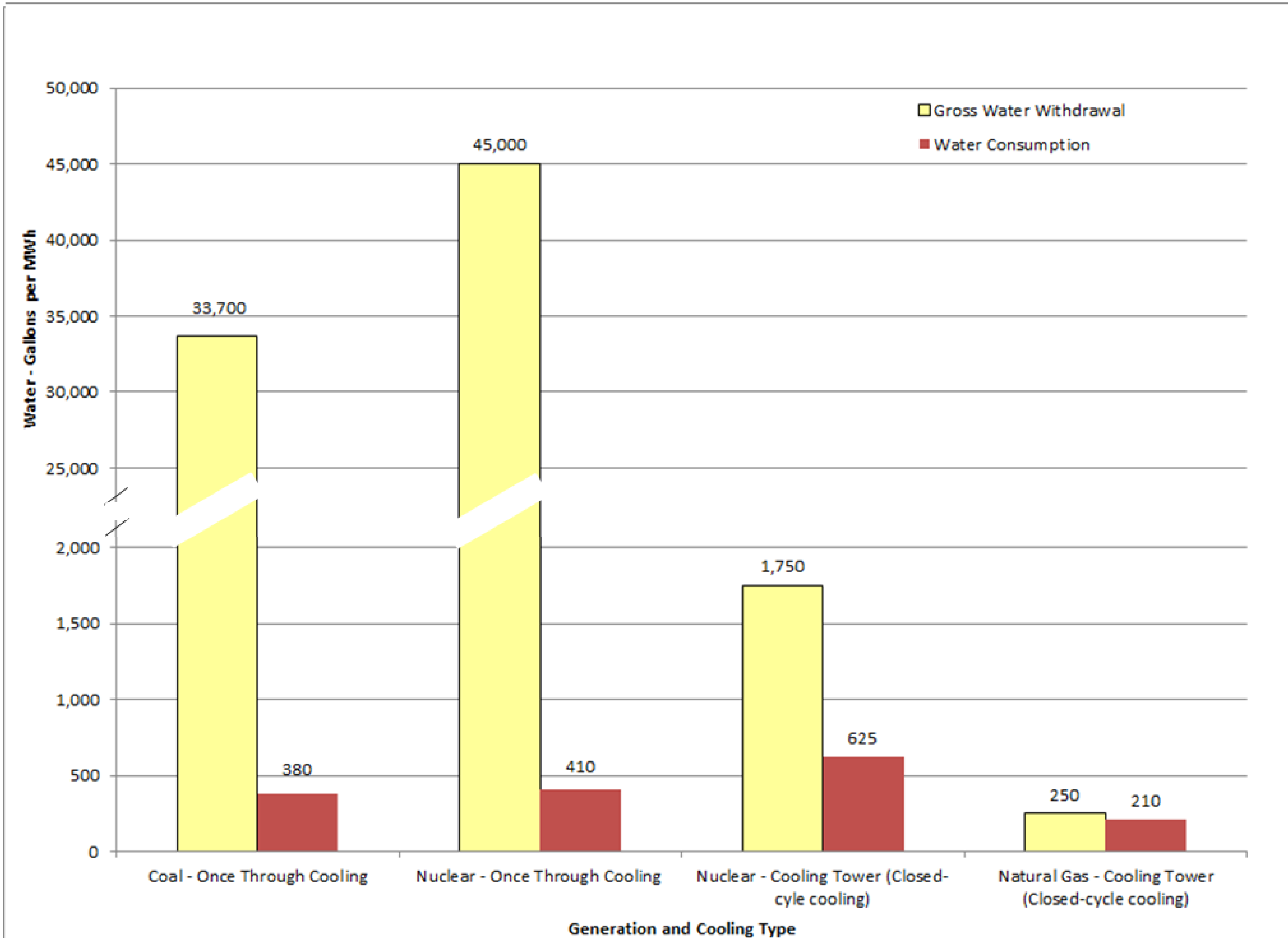
- **Other Limitations**
  - Rainfall dependence *(i.e., can't order another load of "fuel")*
  - Competing water uses
  - **Licenses can "prescribe" the value away**
  - **Licensing proceedings are very long and very costly**
  - Dam construction and maintenance are very costly

Duke Energy Steam Plants on the Catawba River



- **Nuclear Plants**
  - McGuire (Norman, 2,466 MW)
  - Catawba (Wylie, 2,473 MW)
- **Coal Plants**
  - Marshall (Norman, 2,180 MW)
  - Allen (Wylie, 426 MW (3 units retired))
  - Riverbend (Retired) (Mountain Island)
- **Total Typical Water Use**
  - Gross withdrawal ~ 4 billion gallons per day (BGD)
  - Consume ~ 67 million gallons per day (MGD) = less than 2%

Gross Water Withdrawal and Consumption for Thermal Electric Generation Cooling (based on averages of representative Duke Energy power plants)



What is an Integrated Resource Plan (IRP)?

- An Integrated Resource Plan (IRP) explains how an electric utility will meet the projected peak demand and energy requirements of its customers in a cost-effective, reliable manner.
- IRP's balance multiple objectives including system reliability, environmental responsibility, and cost impacts.
  - Least-cost planning principles
  - Reliable resource portfolio
  - Manage risk through diverse resource mix
  - Reduce environmental impacts

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- Changes in Load Forecast
- Impacts of Energy Efficiency (EE)
- Impacts of Renewable Energy

- Plant Retirement
- Purchase Power Contract Expiry

- Load Resource Balance
  - Inclusive of Reserve Margin
- Remaining Resource Gap

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Portfolios	Portfolio Description
Deliver lowest cost	**Base case with no CO_2 prices** (Economic coal retirement dates)
	Base Case with CO_2 Prices (Economic coal retirement dates)
Close coal by 2030	**Earliest Practicable Coal Retirement** (All coal by 2030; Cliffside 6 100% gas)
Reduce CO_2 by 70%	**High Wind** (Aggressive build of carbon free resources: solar, batteries, on/off-shore wind)
	High SMR (Small Modular Reactors) (Aggressive build of carbon free resources: solar, batteries, on-shore wind, SMR)
No new gas generation	**No new gas under economic coal retirement dates**

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Some Results

LEGEND:

- ● Completely dependent
- ◕ Mostly dependent
- ◑ Moderately dependent
- ◔ Slightly dependent
- ○ Not dependent

	Base without Carbon Policy		Base with Carbon Policy		Earliest Practicable Coal Retirements		70% CO_2 Reduction: High Wind		70% CO_2 Reduction: High SMR		No New Gas Generation	
Portfolio	A		B		C		D		E		F	
System CO_2 Reduction (2030 | 2035)[1]	56%	53%	59%	62%	64%	64%	70%	73%	71%	74%	65%	73%
Present Value Revenue Requirement (PVRR) [$B][2]	$79.8		$82.5		$84.1		$100.5		$95.5		$108.1	
Estimated Transmission Investment Required [$B][3]	$0.9		$1.8		$1.3		$7.5		$3.1		$8.9	
Total Solar [MW][4, 5] by 2035	8,650		12,300		12,400		16,250		16,250		16,400	
Incremental Onshore Wind [MW][4] by 2035	0		750		1,350		2,850		2,850		3,150	
Incremental Offshore Wind [MW][4] by 2035	0		0		0		2,650		250		2,650	
Incremental SMR Capacity [MW][4] by 2035	0		0		0		0		1,350		700	
Incremental Storage [MW][4, 6] by 2035	1,050		2,200		2,200		4,400		4,400		7,400	
Incremental Gas [MW][4] by 2035	9,600		7,350		9,600		6,400		6,100		0	
Total Contribution from Energy Efficiency and Demand Response Initiatives [MW][7] by 2035	2,050		2,050		2,050		3,350		3,350		3,350	
Remaining Dual Fuel Coal Capacity [MW][4, 8] by 2035	3,050		3,050		0		0		0		2,200	
Coal Retirements	Most Economic		Most Economic		Earliest Practicable		Earliest Practicable[9]		Earliest Practicable[9]		Most Economic[10]	
Dependency on Technology & Policy Advancement	○		◔		◑		◕		●		●	

[1]Combined DEC/DEP System CO_2 Reductions from 2005 baseline

[2]PVRRs exclude the cost of CO_2 as tax. Including CO_2 costs as tax would increase PVRRs by ~$11-$16B. The PVRRs were presented through 2050 to fairly evaluate the capital cost impact associated with differing service lives

[3]Represents an estimated nominal transmission investment; cost is included in PVRR calculation

[4]All capacities are Total/Incremental nameplate capacity within the IRP planning horizon

[5]Total solar nameplate capacity includes 3,925 MW connected in DEC and DEP combined as of year-end 2020 (projected)

[6]Includes 4-hr and 6-hr grid-tied storage, storage at solar plus storage sites, and pumped storage hydro

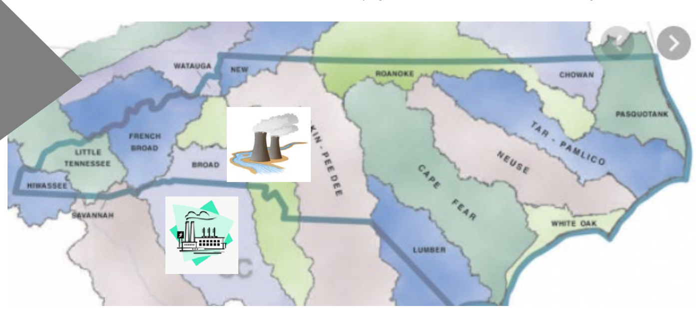
[7]Contribution of EE/DR (including Integrated Volt-Var Control (IVVC) and Distribution System Demand Response (DSDR)) in 2035 to peak winter planning hour

[8]Remaining coal units are capable of co-firing on natural gas, all coal units that rely exclusively on coal are retired by 2030

[9]Earliest Practicable retirement dates with delaying one (1) Belews Creek unit and Roxboro 1&2 to EOY 2029 for integration of offshore wind/SMR by 2030

[10]Most Economic retirement dates with delaying Roxboro 1&2 to EOY 2029 for integration of offshore wind by 2030

- Existing Infrastructure
- Land
- Transmission
- Water
- Environment



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What happened in 2021?

- 2020 IRP Approval
  - SC required Duke Energy resubmit with lower renewables & higher fuel cost and pick a preferred Portfolio.
    - Duke selected Portfolio C
    - SC required a 2021 update (due Feb 2022) with portfolio A (w/lower renewables and higher fuel cost).
  - NC Approved but required an additional case with limited natural gas supplies with Portfolio B
    - Due February 2022

- NC Clean Energy Plan
  - Passed with bipartisan support from the general assembly and signed by Governor Cooper 10/21
  - Requires 70% CO2 reduction (from 2005 baseline) by 2030 and net Zero CO2 by 2050
  - Plan due to NC PUC May 16, 2022

Questions?


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