Impact of Transition to Offshore Wind and Renewable Energy on the Power and Electronic Industry

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NWS
NATIONAL WIND SERVICES

Why should we talk about this?

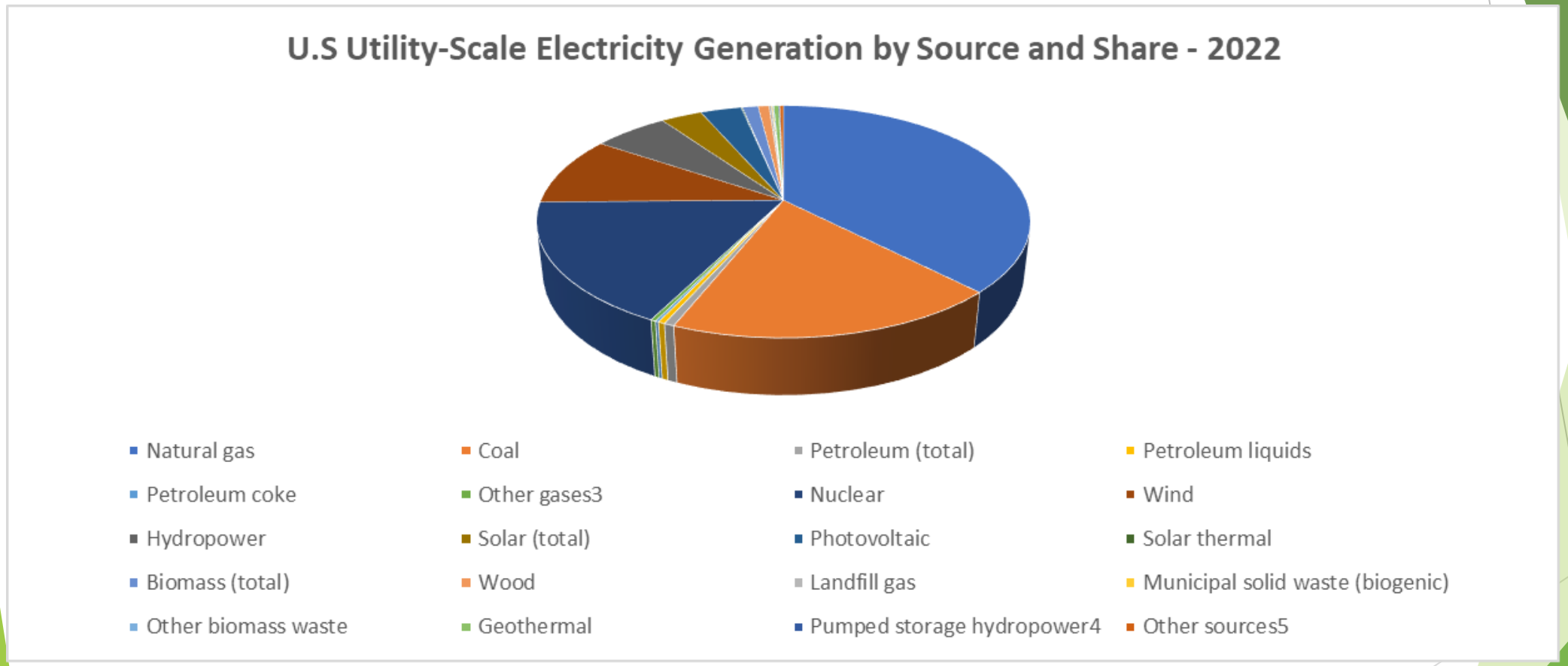
- Climate Change is real and is here. How do we reverse or slow it down:
  - Electricity Generation
  - Transportation
  - Global impact, local source
- Political will and Emerging importance and financial support(Federal and State) for implementation and creating curriculum:
  - IRA- Inflationary Reduction Act as it relates to Clean Energy Technologies?
  - CLCPA- Climate Leadership Community Protection Act and “ Local Content” /”DEIJ” requirements?

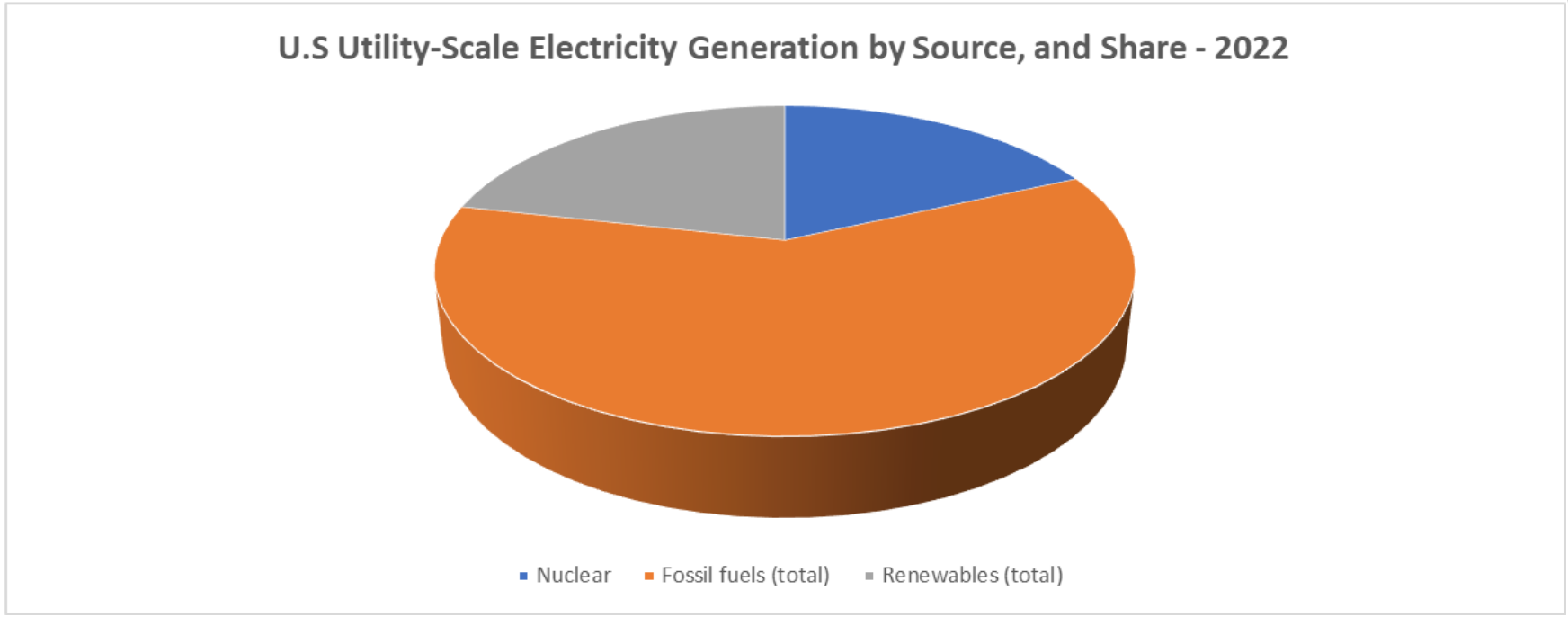
Section 1: State of Transition

Renewable and Sustainable

- Our Future electric grid will be powered by Large scale Solar, On/Off shore Wind. Once you have green/clean electric power then the society will move towards:
  - EV car and EV infrastructure will grow and be expanded
  - Home heating will convert away from oil and gas boilres and :
    - Heat pumps (Air Sources)
    - Geothermal(Ground Source)
  - Energy efficiency and Solar as part of the home designs
  - Roof top gardens, etc…

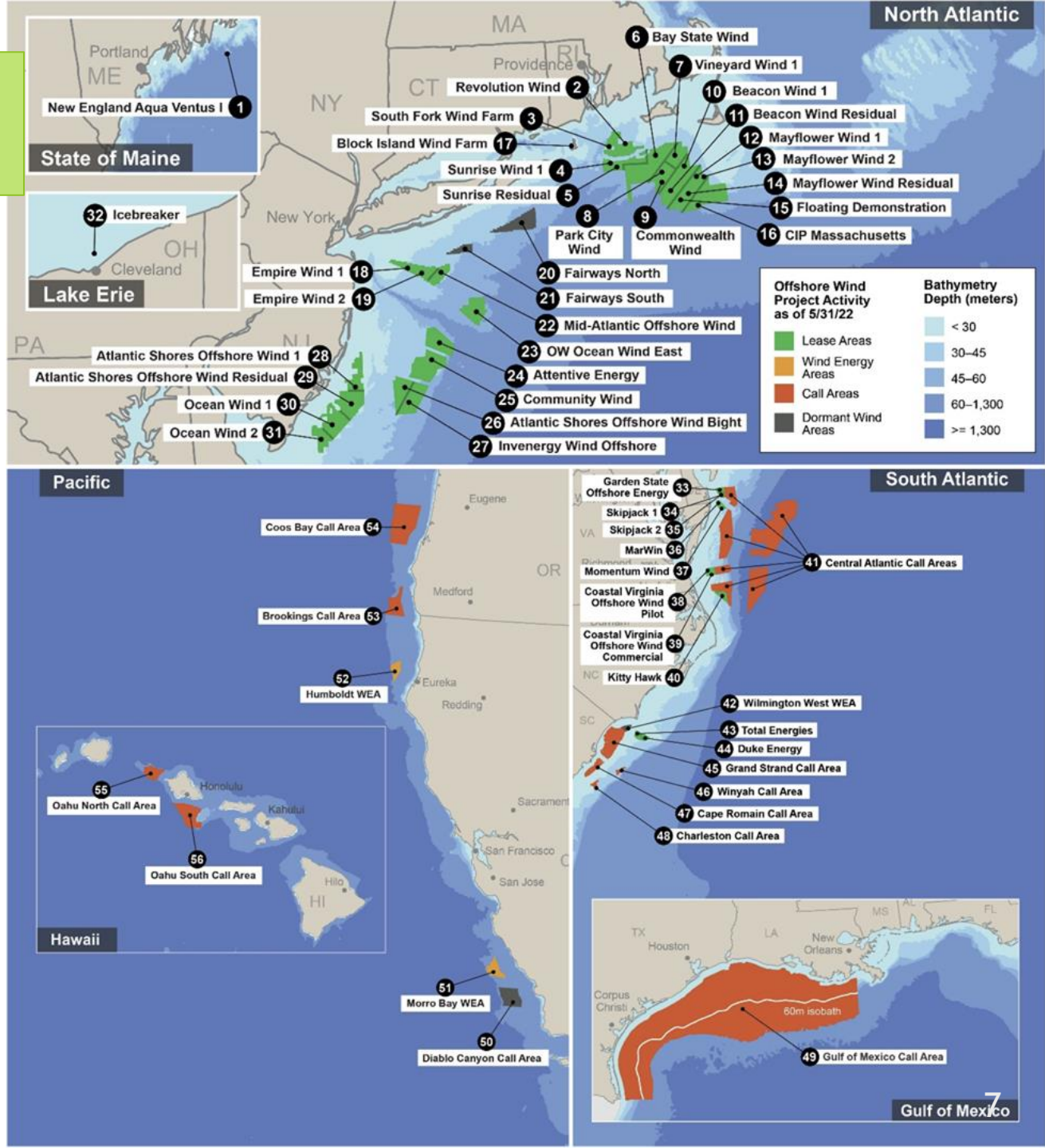
Electricity Source today




U.S Utility-Scale Electricity Generation by Source, and Share - 2022
Nuclear
Fossil fuels (total)
Renewables (total)

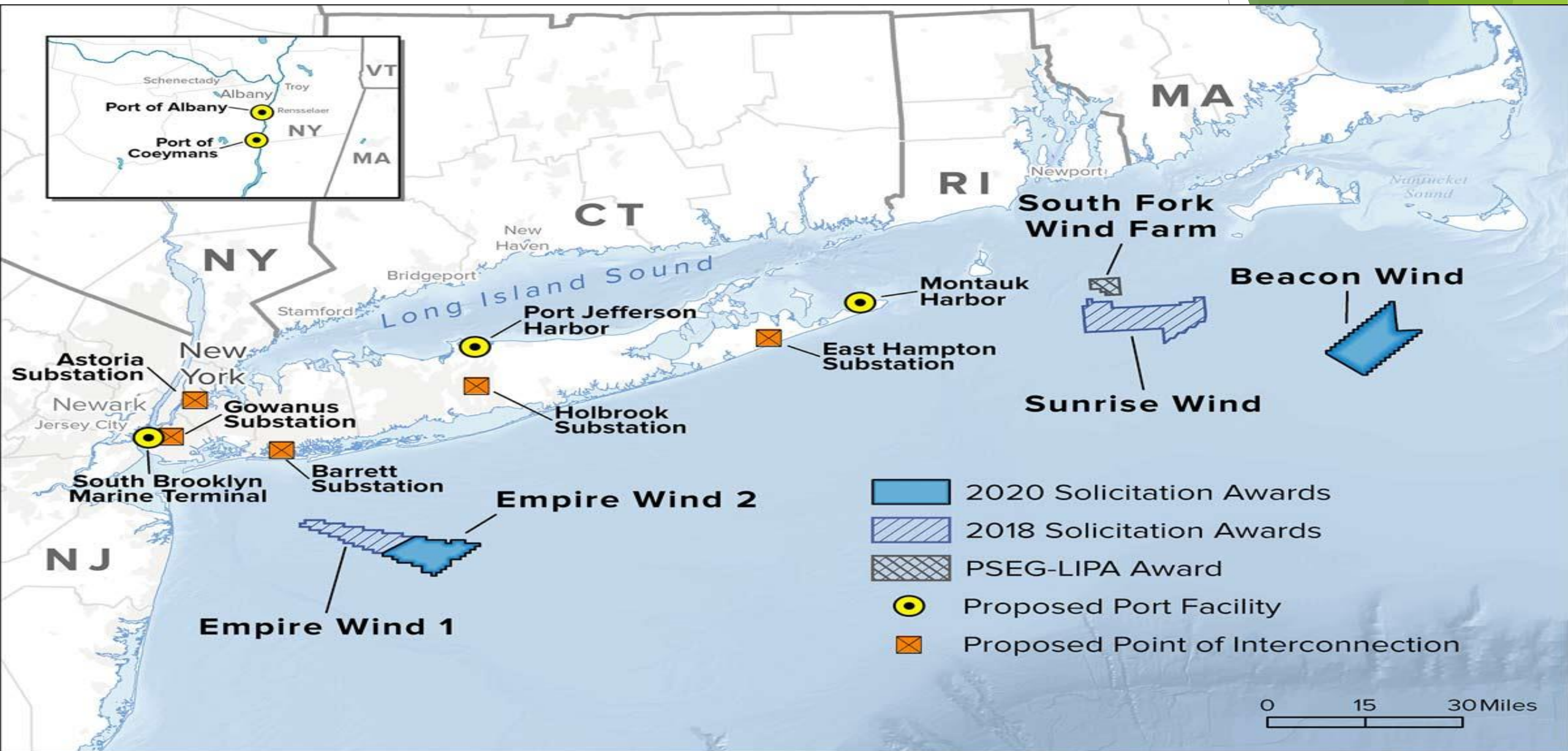
Off Shore Wind in the U.S.

- OSW is thriving in many coastal areas in the U.S.
- Coastal markets also have higher utility/electricity costs, making OSW more competitive
- Active lease areas in the Northeast (ME, RI, NY) and Mid-Atlantic (DE, MD, NJ)
- New developments on the horizon in the South (NC, SC) and West (CA, HI)

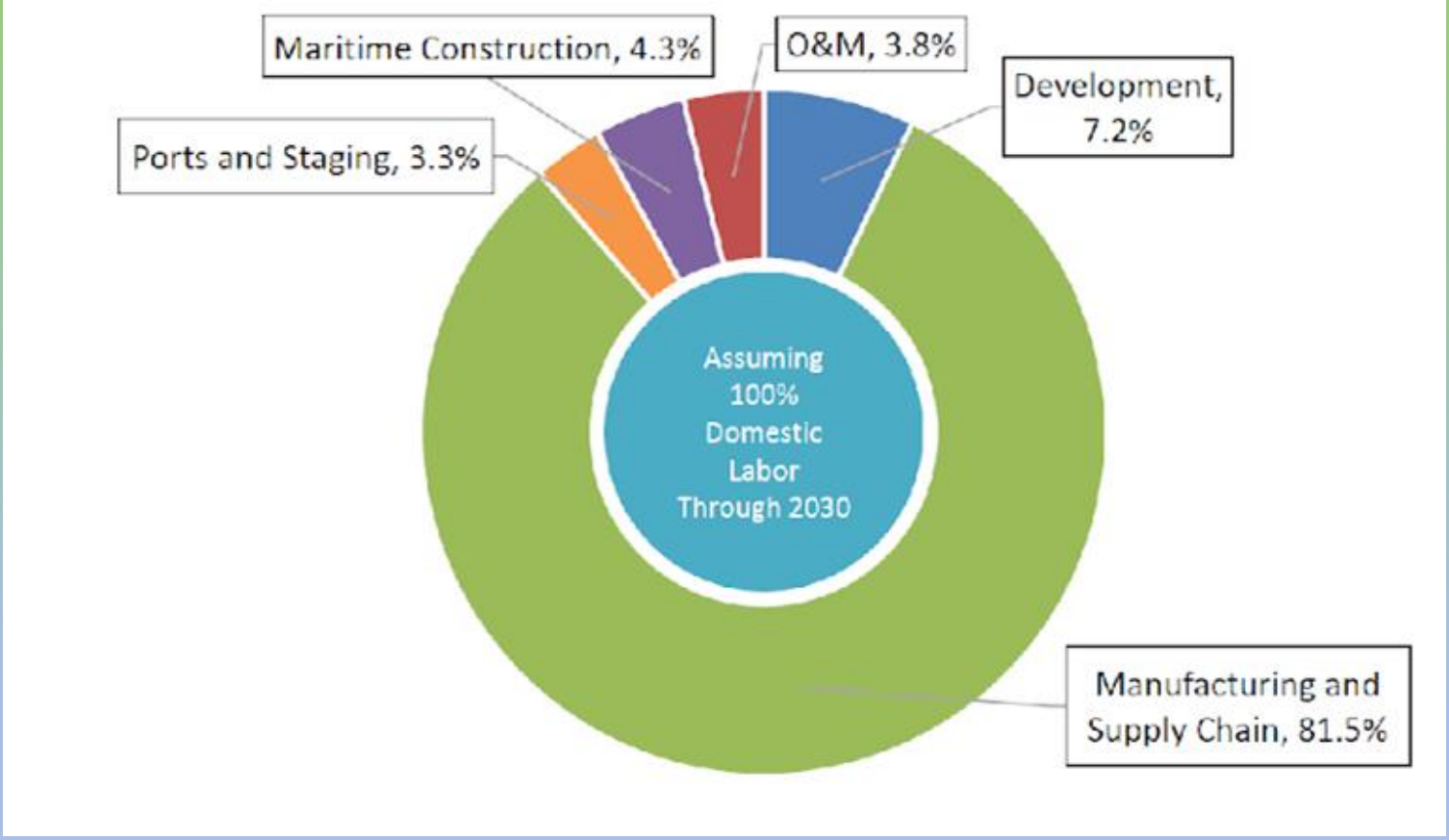


Source: NREL

Offshore Wind Projects – New York State



National Opportunities for the OSW Workforce (from NREL)



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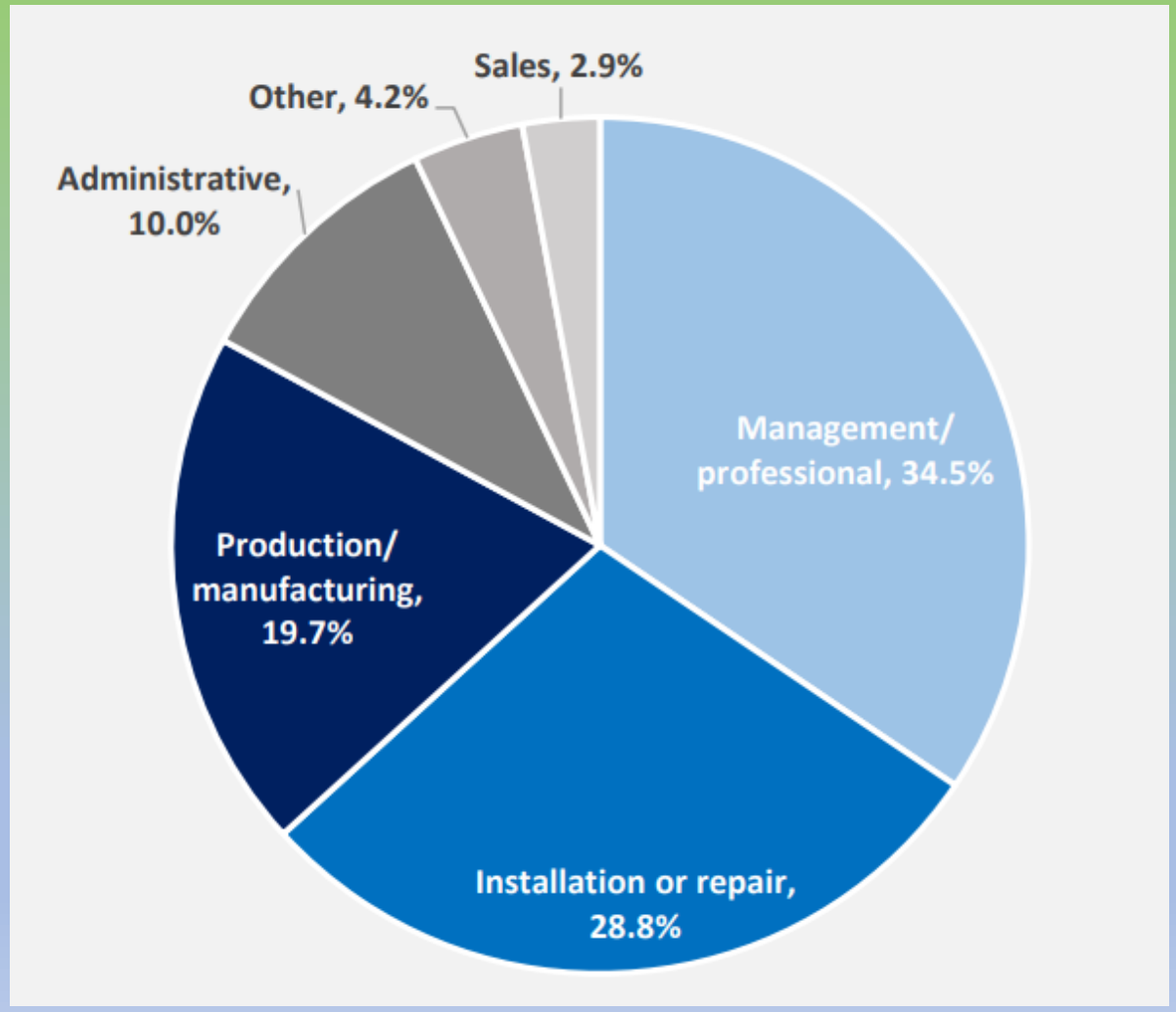
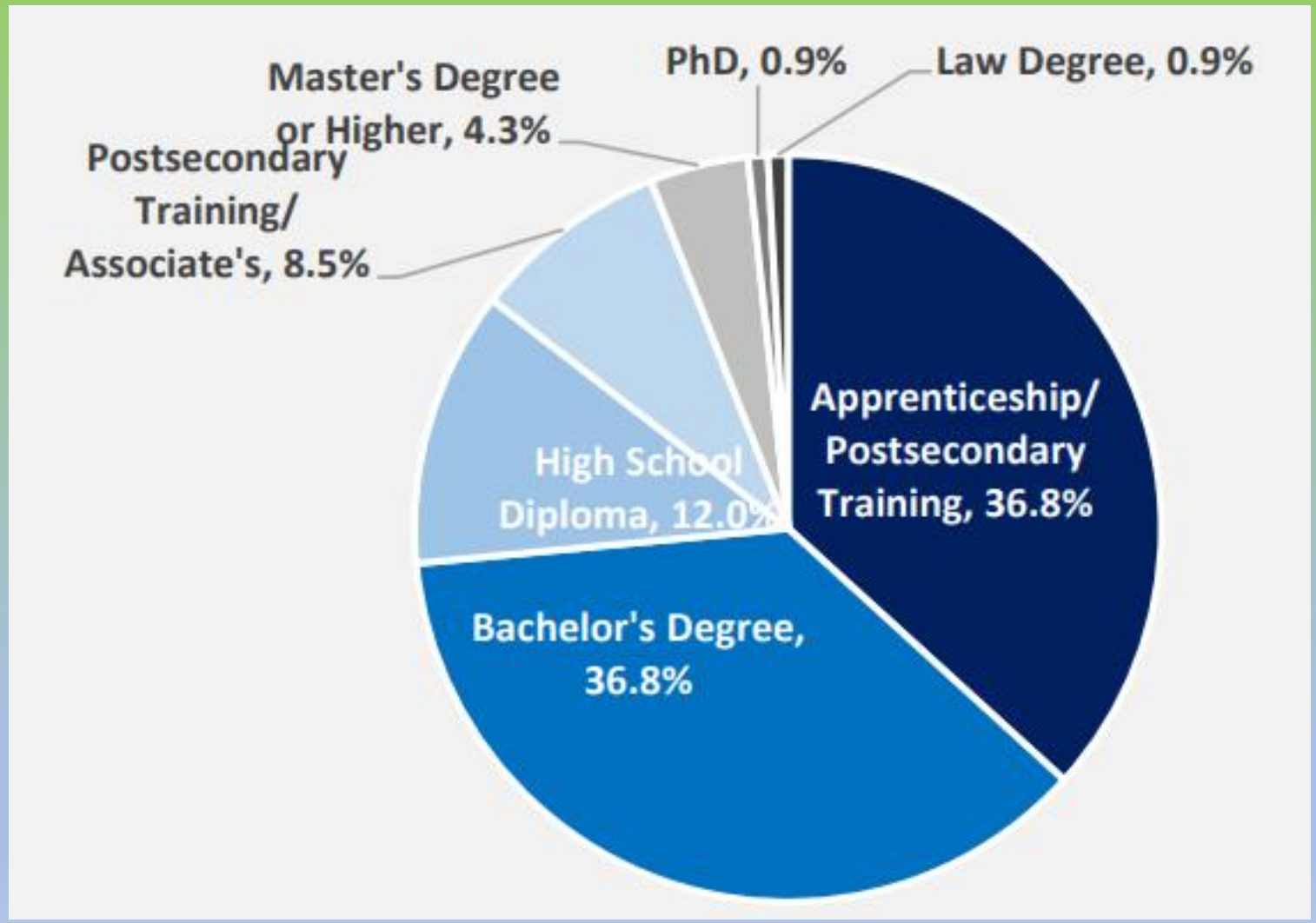
New York State Opportunities for the OSW Workforce (from NYSERDA)



Projected Distribution of Offshore Wind Employment by Occupational Group in 2030

Required Education level



Typical Educational Attainment of OSW-Related Occupations

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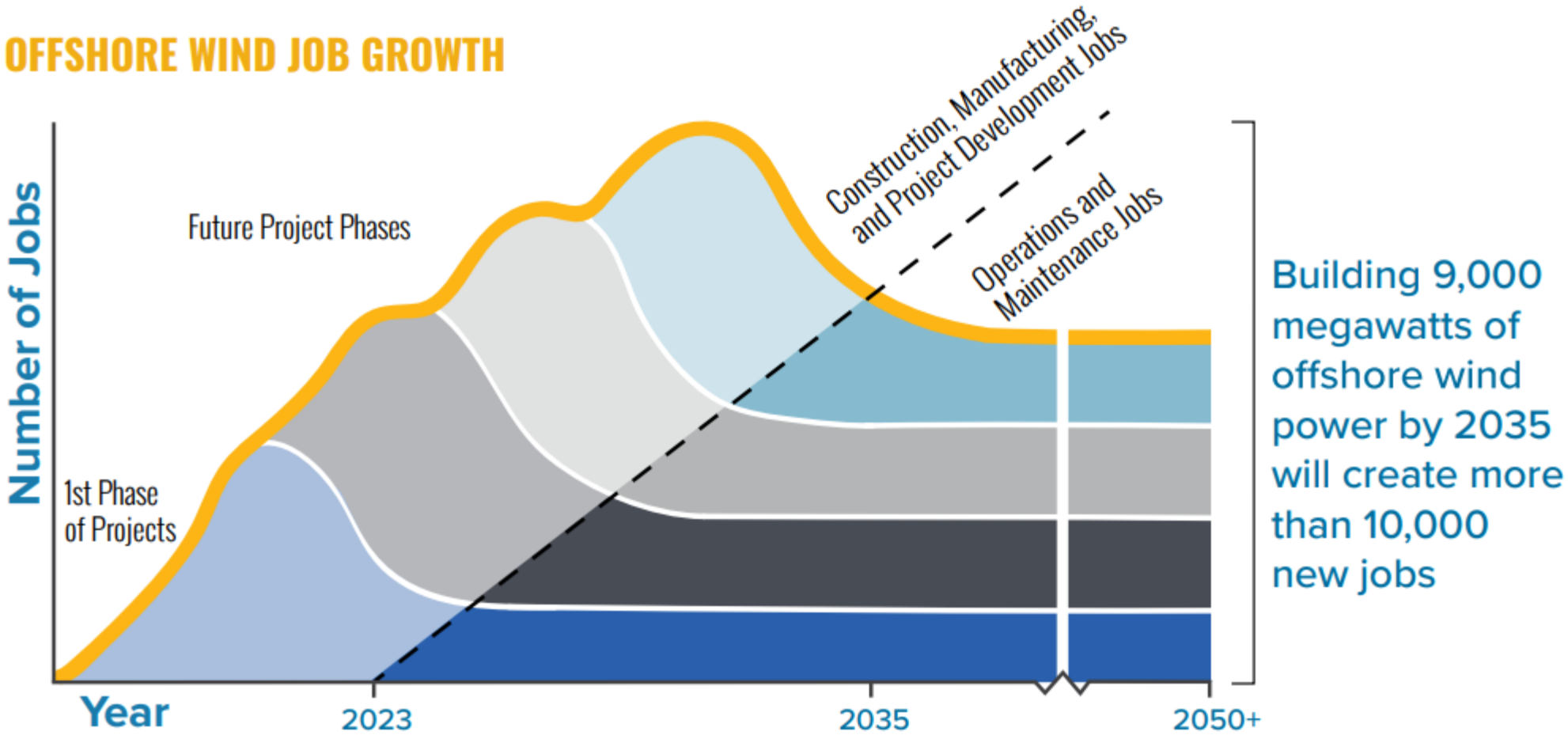
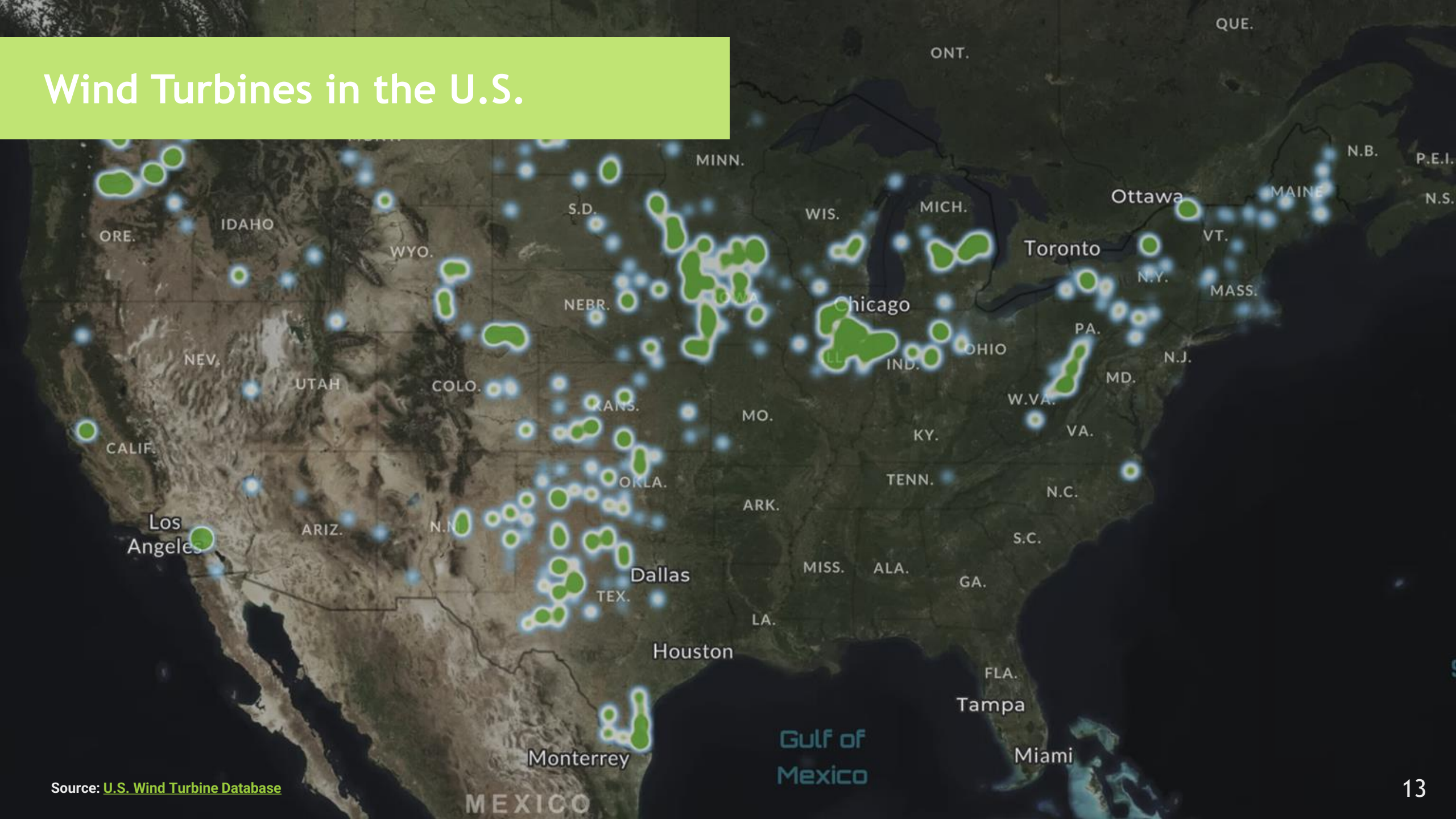
Market Overview



Building 9,000 megawatts of offshore wind power by 2035 will create more than 10,000 new jobs

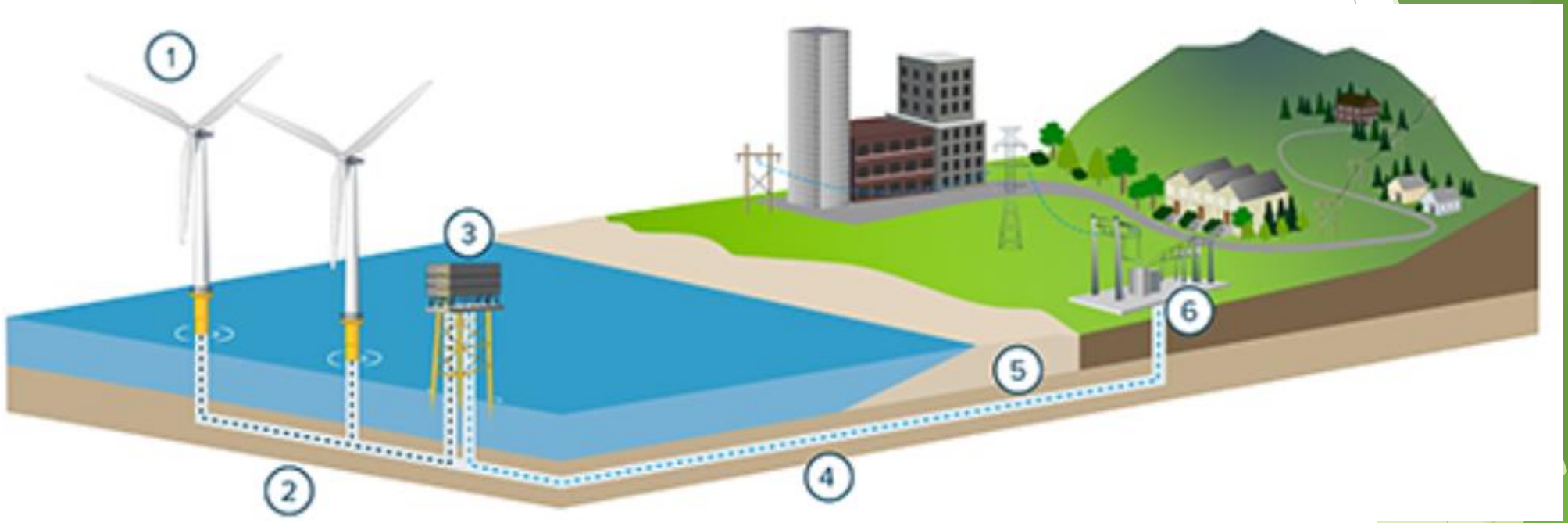
Wind Turbines in the U.S.



Source: U.S. Wind Turbine Database

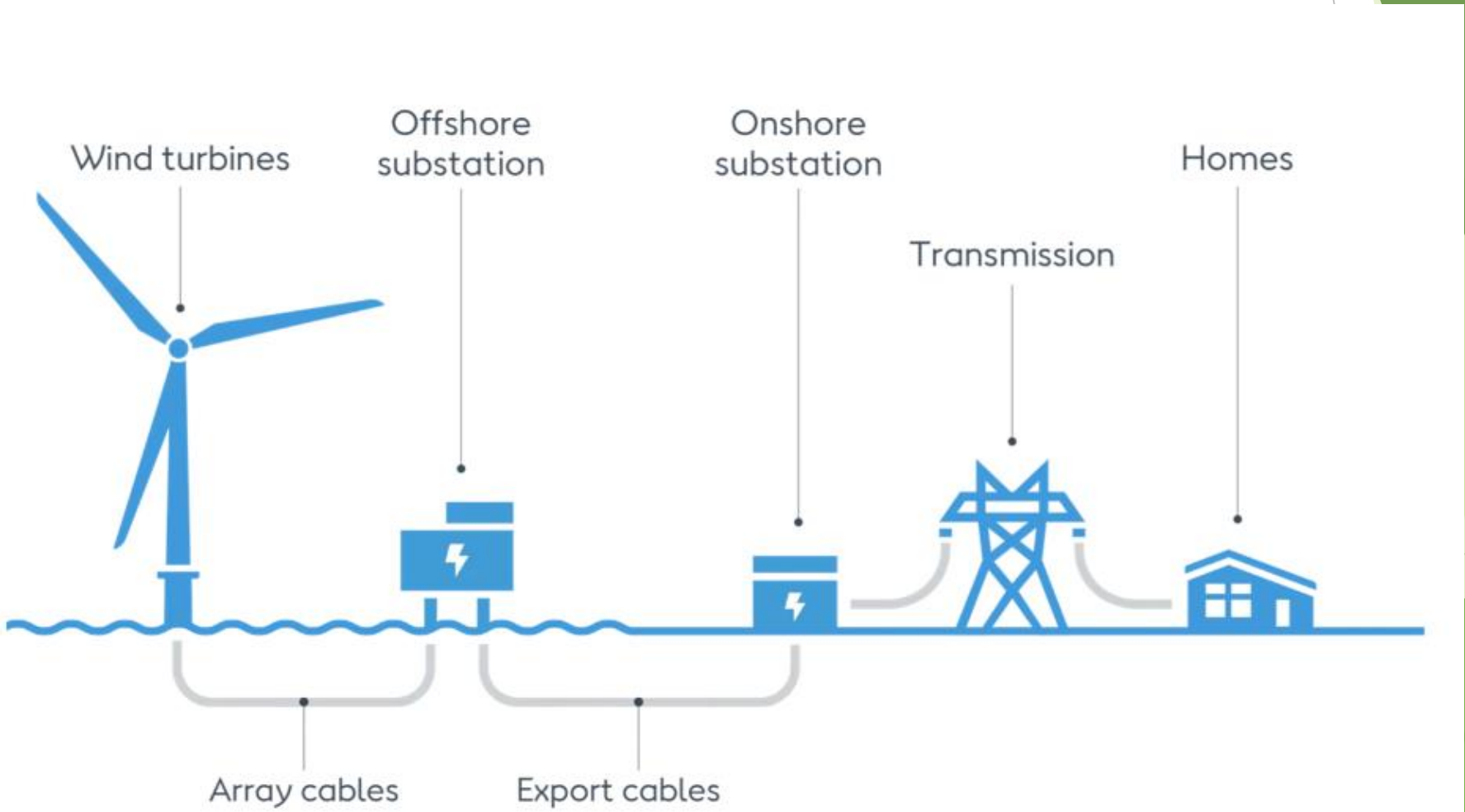
Section 2: Impact on the Grid

How Does a Wind Turbine Connect to My Home? (



1. **OSW**
2. **Foundations**
3. **Electricity**

How Does a Wind Turbine Connect to My Home?



Developing an Intelligent Transmission Network

Challenge: Ensuring our transmission networks are fit for future. Transformational shifts include:

- High integration of renewable energy
- Increased electric vehicle demand and ultra-fast charging
- Integration of distributed system platforms integrating distributed generation into wholesale markets
- Sustained resiliency and self repair from severe weather events

Opportunity: Execute Intelligent Transmission Network Roadmap to build the networks of the future with a focus on ensuring our networks are clean and affordable.

Roadmap

Foundational	Leading Edge	Leapfrog
1. Invest in critical infrastructure to ensure reliability and address asset condition issues. 2. Installation of a fiber optic backbone. 3. Enhance the resiliency of physical/cyber security of networks.	1. Utilize digital technologies to enhance awareness of operations and asset condition. 2. Utilize power electronic technologies that enhance integration of renewables and storage of energy.	1. Enable greater electrification of transportation 2. Implement Machine Learning to enhance asset inspections. 3. Utilize Artificial Intelligence in our asset management and geospatial systems.

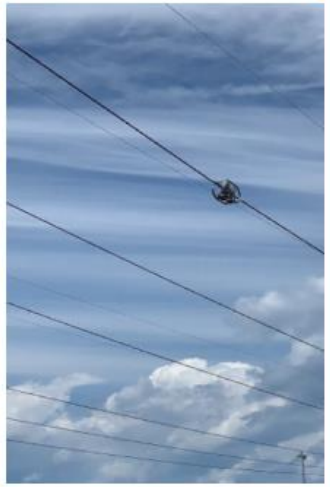
PROGRAMS / PROJECTS
Digital Substations
VOLT Systems Enablement
Transmission Online Monitoring
Transmission Optimization / Power Flow Control
Intelligent Substation Design
E-mobility and Energy Storage
AI/Machine Learning Systems/Process Integration Proof of Concepts
MIT Climate and Resiliency Study
Future Networks 2030/50

Non-Destructive Testing - *Kinectrics*

Objective: *Conduct a non-destructive corrosion assessment on energized transmission lines employing the Kinectrics robot to report actual physical condition of the conductor's steel core and detect any local breaks or deep pits in the steel core wire.*

Benefits to business

- Avoid conductor failure and ensure reliability
- Unlike time-consuming and labor intensive traditional processes that requires cutting a sample from a line:
  - No outage required
  - More efficient and less labor intensive
  - Can assess whole spans with higher degrees of condition information
  - Avoids lab testing/waiting times by providing the assessment results during the test
  - Avoid weak-points caused by removing transmission line sample sections



Kinectrics' robot on NY T-line

Line Health Assessment - *LineVision*

Objective: *Analyze measured conductor sag and temperature from LineVision tower-mounted monitoring system and compare against historical loading patterns and weather information to determine the transmission line tensile strength loss over time due to annealing events and accurately estimate the remaining life of transmission lines.*

Benefits to business

- Better decision making and asset planning
- Maximize conductor life
- Increased asset visibility

Data reported from LineVision monitoring:

- Historical ambient weather data summary
- Loss of strength from thermal annealing analysis
- Monthly mean and max conductor temp
- Thermal age of conductor
- Significant aging events
- Conductor sag distributions
- Estimated of remaining useful asset life

LineVision LiDAR optical sensor

Image Analytics

Objective: *Source a machine learning image analytics solution to automatically process overhead transmission line inspection images.*

Benefits to business

- Better decision making and resource planning
- Predictive analytics and preventative maintenance

Proof-of-concept (POC)

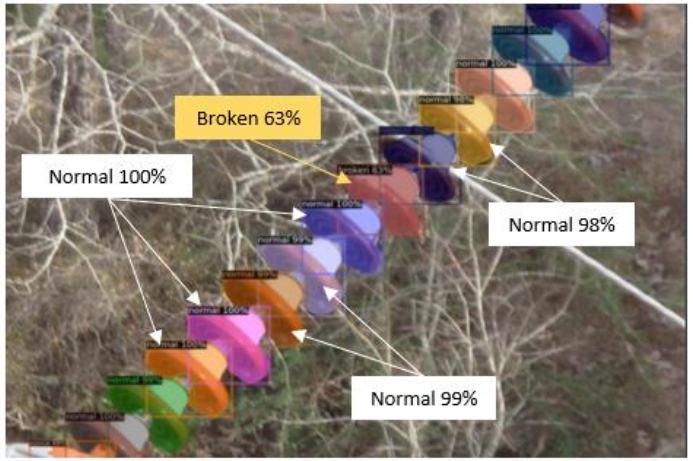
- Send pre-captured helicopter inspection images to vendors
- Vendors demonstrate abilities to organize, analyze, and report data findings
- Phase I scope limited to insulators (broken, flashed, missing, disc count, out-of-plumb)

Deliverables:

- Results and reports from each vendor
- Technology evaluation and recommendation report detailing findings from POC, technology business case, BCA, demands of large-scale development, recommendation of future partner

POC Partners:
Intel, eSmart, PrecisionHawk, Siemens, GE

Inspection image of insulator string automatically annotated by Intel's algorithm. Each disc is defined with a different color outline and labeled "normal" or "broken" with a degree of confidence (%).



Power Flow Control

In September 2020, National Grid commissioned its first Smart Valve Power Flow Controller.

Installation:

- **Installation on a 69kV line**
- **Integrated to EMS**
- **Remote control and monitoring**

Next steps:

- Evaluate the technology performance
- Identify opportunities that benefit from capital investment deferral and/or congestion relief

Benefits:

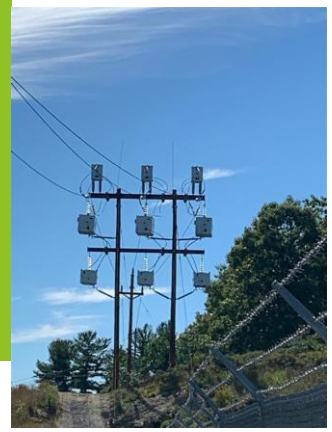
- Clean power delivery
- Potential deferred capital investment for reliability system upgrades

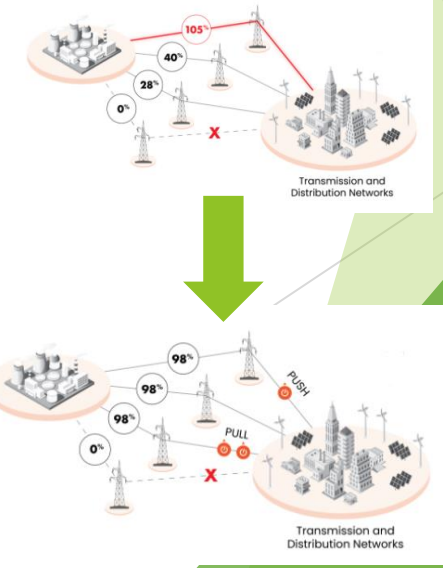
CURRENT

- ✓ No control over the magnitude of the power flow
- ✓ Traditional Line Upgrade Solutions
- ✓ Conservative Decision Making

FUTURE

- ✓ Control the power flow of the transmission lines
- ✓ Potential line upgrade deferrals.
- ✓ Smart decision making on power flow management





Digital Substation

Digital substations are a key to our strategy to *develop a highly intelligent transmission network* that meets customers' long-term needs and adapts to the rapidly changing energy landscape

- Technology: IEC 61850 & Online Monitoring
  - Enhanced use of intelligent microprocessor-based devices to optimize our systems
  - Network-connected operational technology
  - Enhanced data acquisition & remote access
- Embracing new ways of working
- Smarter investment & maintenance decisions

National Grid is an industry-wide leader in the implementation of Digital Substations

Industry Leader
1st operational fully networked IEC 61850 substation in North America

Digital Substation Benefits

Investments & Operational Efficiency

- CapEx efficiency improvement
- Reduced material and installation time
- Smaller physical/environmental footprint
- Improved investment and maintenance decisions

Optimize Business Agility

- Faster project deployments
- Standardized digital designs

Grid Availability & Reliability

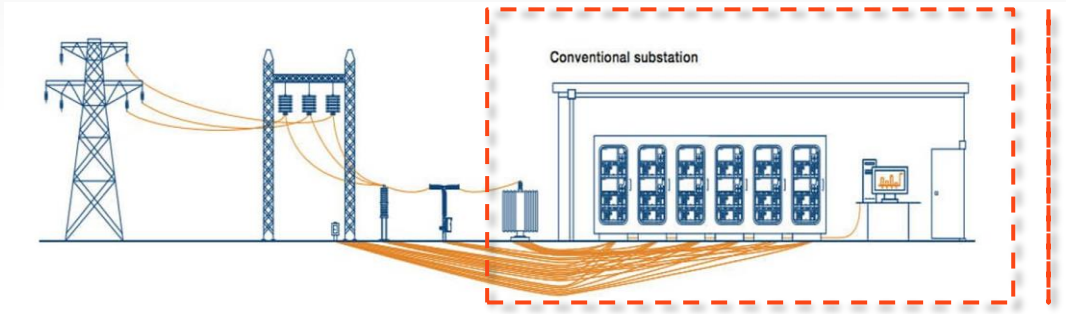
- Enable smarter investment and maintenance decisions
- Enhanced remote access and maintenance capabilities

IEC 61850 – The Big Picture

Macro-Level Transition Benefits:

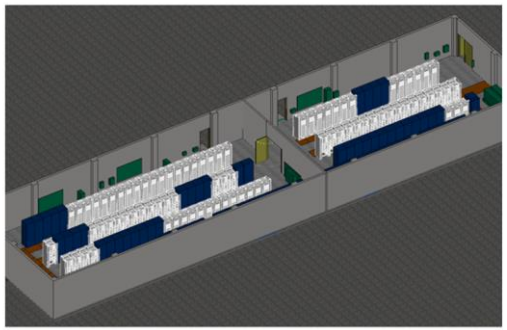
- Adopts internationally accepted standards
- Industry-standard communication protocols
- Advances use of intelligent devices
- Digitalizes protection & control systems
- Standardizes design & construction processes

CONVENTIONAL



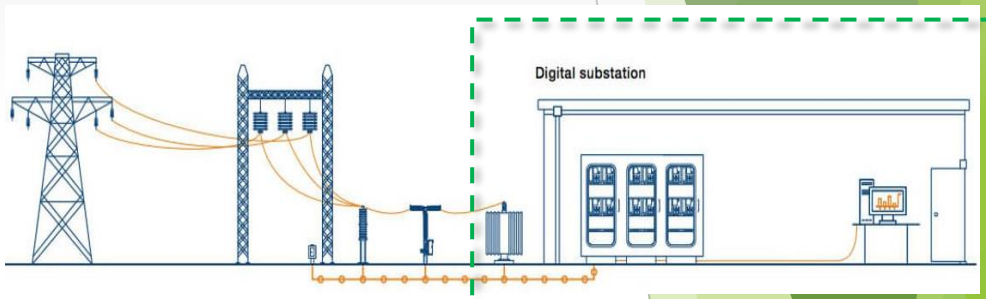
Recently constructed 345kV control house

- Hard-wired communication unchanged in 75+ years
- Substantial building footprint
- Larger & more customized control panel, analog interface



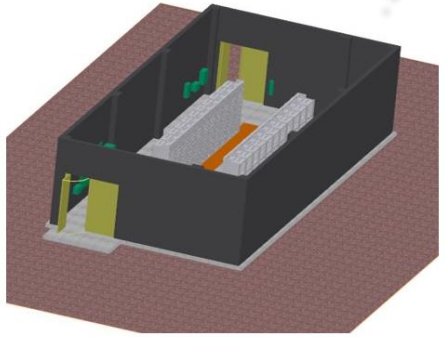
158’ x 41’

IEC 61850



Same 345kV control house using IEC 61850

- Fiber-optic network-based communication, reduces # of cables while increasing redundancy
- Significantly minimized control house footprint
- Consolidated digital interfaces for smaller, standardized, & cost-effective control panel



~60’ x 30’

Online Monitoring – Building the Intelligent Network

Benefits:

- Long-term OpEx Efficiencies
- Minimized Onsite & Flexible Maintenance
- Improved Safety
- Increased Equipment Reliability

CURRENT

- ✓ Time-Based Maintenance
- ✓ Lack of data driven intelligence
- ✓ Data collection requires site visits
- ✓ Early equipment replacement

FUTURE

- ✓ Condition-Based Maintenance (CBM)
- ✓ Advanced analytics
- ✓ Real-time information on condition, operation & performance
- ✓ Intelligent alerts & notifications

The Future Is Electric

- To meet the needs of our new increasingly digital world, we'll need sophisticated electricity networks. We must modernize our transmission and distribution networks. Distribution networks of the future will become highly complex platforms offering new products and services for customers.

Today

Invest in infrastructure today to ensure our networks are reliable, resilient and secure

Tomorrow

Integrate the renewables and enhance our technology to better understand our assets so we can optimize them.

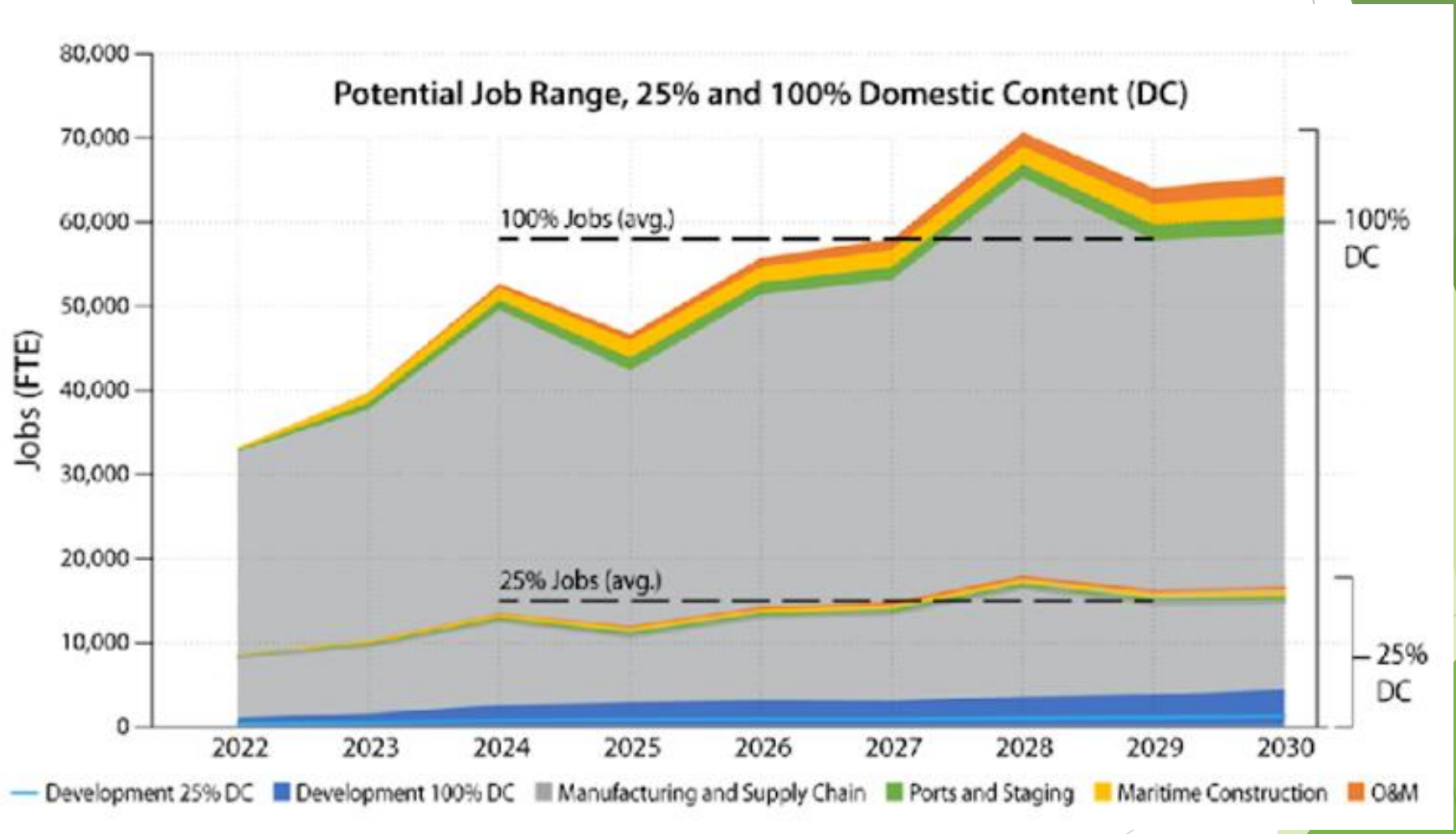
Future

Meet the needs of an electrified transportation system, leverage machine learning and artificial intelligence to build the most intelligent network

OSW Occupation Overview at the National Level

A conceptual organization of the assessment

Potential Job Estimates – Pipeline of 30 GW of OSW Energy (from NREL)



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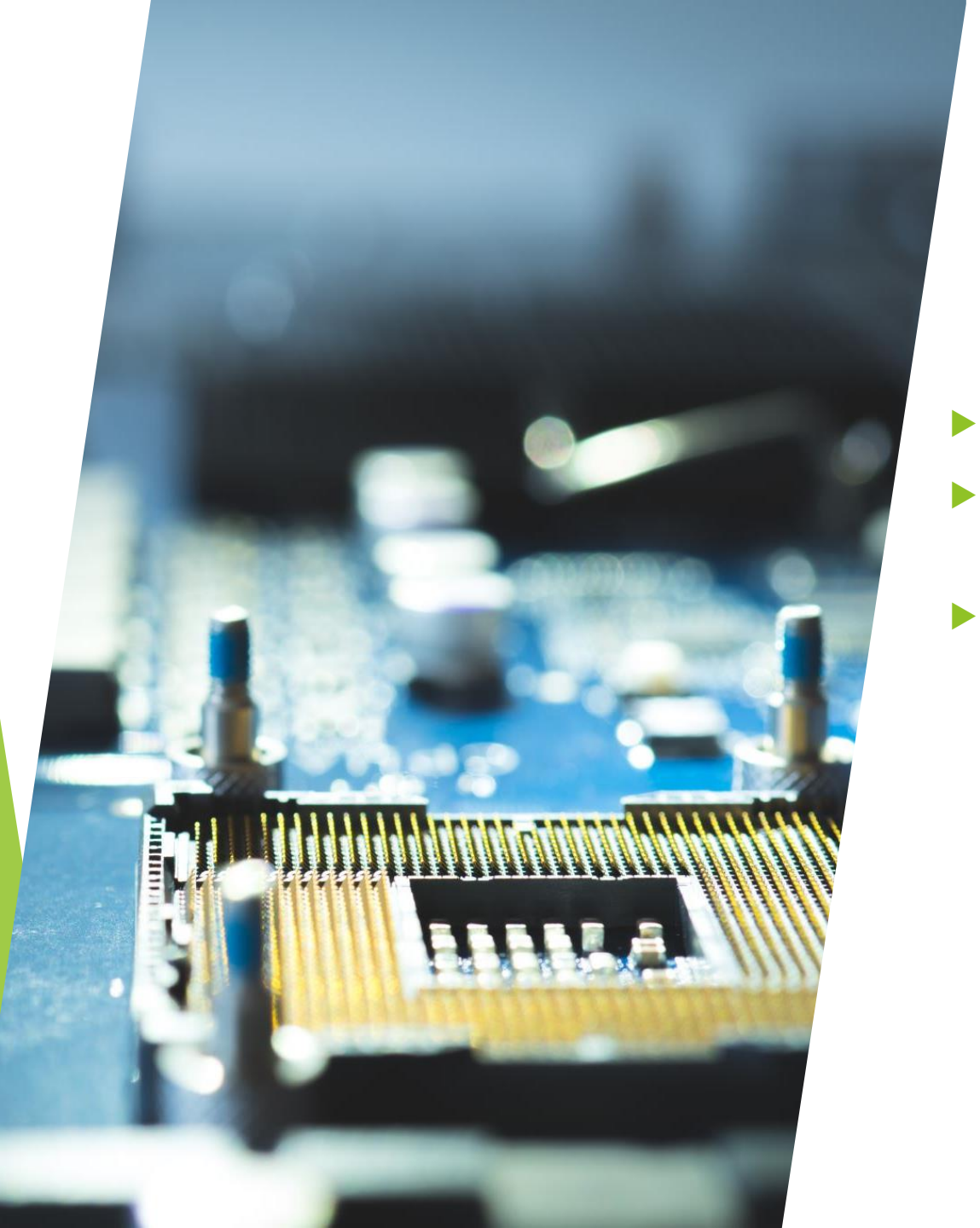

Implications for us as engineers

- Power Engineering & RD work
- Manufacturing and supply chain for new electronics
- Expansion of Cyber security both Hardware and software

References:

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Questions and Discussion

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