The NW Ohio Innovation Consortium (NOIC) is requesting designation as a Tech Hub to decarbonize the solar panel value chain by accelerating the decarbonization of glass (the bulk of a solar panel) and advanced manufacturing techniques. Already the leader in solar R&D and domestic production, NW Ohio has the capacity and potential to become a self-sustaining global leader in affordable, sustainable solar within 7 years. Innovations in solar and glass will create a combined 9K jobs and $4B in economic impact,[1] driving equitable regional growth in an economically distressed area and strengthening U.S. economic and national security through production of the most sustainable solar energy with domestic manufacturing.

NOIC Brings Together 21 Cross-Sectoral Organizations to Achieve Global Competitiveness	
Higher education and secondary schools	Bowling Green State University (BGSU), Owens Community College (OCC), Toledo Public Schools (TPS), University of Toledo (UT)
Local government	City of Toledo, Lucas County, Wood County
Firms in relevant sectors	First Solar, Libbey Glass (Libbey), Owens-Corning (O-C), O-I Glass (O-I), Pilkington North America (PNA)
Economic development organizations	BGSU Center for Regional Development (CRD), ConnecToledo, JumpStart, NW Ohio Regional Growth Partnership (RGP), Toledo Chamber of Commerce
WFD organizations	Cherry Street Mission Ministries, Local Initiatives Support Corporation (LISC)
Worker organizations	Associated General Contractors of Northwest Ohio (AGCNWO), Laborers International Union of North America Local 500 (Local 500)

Decarbonizing the solar value chain addresses key focus technology areas in advanced energy and advanced materials and manufacturing. Our Letter of Commitment describes these linkages and includes our members' relevant assets, specific commitments, and roles and responsibilities in Figure 2. Our chosen geography, the Toledo Metropolitan Statistical Area (MSA), is an Energy Community and has relied on coal, natural gas, and oil.[2] In line with Administration priorities, EDA investment in NW Ohio constitutes a place-based approach to transform the region's production and consumption of energy and create generational change in the deep-rooted, hardworking communities across NW Ohio.

Factor 1: Technology-based Potential of the Region for Global Competitiveness

Identified Market Opportunity. The U.S. solar market is exploding—growing 24% a year over the past decade[3] and according to the National Renewable Energy Laboratory (NREL), will provide 40% of domestic electricity by 2035.[4] And yet America is not rising to the challenge—U.S. solar production declined from 13% of global production in 2004 to less than 1% today,[5] and only one-third of domestic panels are made by U.S. firms.[6] NOIC aims to capitalize on our regional strengths to meet the nation's need for sustainable, affordable solar panels made in America by American companies. NW Ohio is the leader in cadmium telluride (CdTe) solar, which the Administration considers "vital to diversifying the solar supply chain." The only solar technology made in the U.S. and cost-competitive with other solar technologies, CdTe is cheaper,[7] faster and simpler[8] to produce, offers significant operational advantages,[9] and has the lowest carbon footprint and fastest energy payback time in the industry.[10] CdTe is best suited for utility-scale (99% of U.S. energy) and has 40% of the domestic utility market but only 5% globally,[11] indicating significant untapped potential and investment opportunity. NW Ohio is already the undisputed leader in CdTe innovation and production and provides unmatched talent, capacity, and potential for growth, enabling the U.S. to reclaim its leadership in the global solar industry. Building on our members' efforts to increase CdTe efficiency, Tech Hubs will lower price even further, driving the market and accelerating NW Ohio to become the leader in sustainable, affordable solar, creating 10 more solar factories and nearly 6K jobs nationally.[12]

Glass accounts for 97% of the weight, 34% of the carbon footprint, and 47% of the cost of a solar panel. By using renewable energy and other innovations to manufacture lighter, thinner, and stronger glass, solar panels will become even more cost-effective and sustainable, reducing the embodied carbon of glass by up to 80%.[13] These innovations will cascade into other forms of glass, creating 4 factories and around 1K jobs nationally.[14] Our success in glass and solar harnesses unmet consumer demand for sustainable products

and will create 2K local jobs in construction. Due to the integrated nature of glass and solar and their impact on adjacent industries, Tech Hubs will create a positive feedback loop that spurs regional growth.

Demonstrated Potential to Achieve Global Competitiveness

Industry. Four leading glass companies, #1 or #2 in their respective markets—Libbey, O-C, O-I, and PNA—are headquartered in NW Ohio, providing the region with the best glass manufacturing capacity, infrastructure, R&D, and workforce in the U.S. Together, they have 5 local factories, including PNA's 500K sq. ft. local float plant that produces coated glass for First Solar. NW Ohio also has the largest solar manufacturing footprint in the Western Hemisphere. A pioneer in CdTe commercialization and former UT startup, First Solar is the largest domestic solar manufacturer and together First Solar and Toledo Solar produce 100% of domestic CdTe panels, made with 90% U.S. materials. First Solar has 3 factories in our region and is investing $4B to expand production. Both glass and solar benefit from our world-class manufacturing, ranked second in the nation and employing one-fifth of our workforce. With the most industrial robots per worker in the U.S., advanced manufacturing and automation are a regional discriminator and drive continuous innovation and efficiency. To become globally competitive, however, our industries need more workers and must transition from natural gas and optimize production.

R&D. Industry and academia work together to make NW Ohio the glass and solar R&D capital. Investing upwards of $270M a year, they have among the best R&D facilities in the world to support commercialization here in NW Ohio. First Solar is investing $370M in a 1.3M sq. ft. CdTe research facility. O-I offers a world-class glass laboratory and their cutting-edge Modular Advanced Glass Manufacturing Asset (MAGMA)'s modular production line enables rapid scale up. Partnerships with 6 national labs and deep university expertise and innovation, including UT's Center for Photovoltaics Innovation & Commercialization and BGSU's Center for Advanced Manufacturing, strengthen our leadership in R&D.

Infrastructure. In the last 2 years, NOIC firms invested $1.4B in manufacturing infrastructure and $30M in renewable energy infrastructure, including lines powered by hydrogen and biofuel (O-I, PNA) and furnaces using hybrid hydrogen (Libbey). NW Ohio also sits at the crossroads of major rail, road, air, and water transportation networks—making it cheaper and more efficient to bring innovations to market.

Workforce Development (WFD). Home to solar, glass, steel, and automotive industry hubs, NW Ohio offers an unmatched existing talent pool with deep manufacturing expertise. Workers have a powerful voice here, with union membership strong and growing. The NW Ohio Building & Construction Trades Council has 22 affiliated construction unions. Toledo ranks #1 in the country in jobs that do not require a degree but pay at or above the national median wage.[15] Industrial apprentice initiatives, such as Local 500's Registered Apprenticeships (RA), outpace state and national averages.[16] An EDA University Center, BGSU CRD has mapped our vast network of WFD assets, including community colleges, vocational schools, certificate programs, and wraparound services, with many targeted to underrepresented communities.

As prime age unemployment exceeds state and national averages,[17] however, WFD efforts need to be scaled up to meet future demand and strengthen education-to-workforce pathways that bring all voices to the table. We must also engage students and prepare them for a good career in their community before they graduate high school. TPS's industry-driven magnet schools offer specialized curriculum that provide skills and credentials for specific careers, including engineering and manufacturing.

Complementary Initiatives. The CdTe Accelerator Consortium (CTAC), led by UT and administered by NREL, boasts First Solar and Toledo Solar as key partners. Funded by the Department of Energy, CTAC is focused on making CdTe more efficient (i.e., more energy dense), while NOIC will decarbonize production, with both efforts making CdTe less expensive, more sustainable, and thus more competitive globally.

Factor 2: Role of the Private Sector

NOIC is private-sector led and market-driven. Firms with global competitive potential but needing more skilled workers spearheaded efforts to convene labor and WFD organizations whose constituents need greater access to good jobs—as well as university, government, and economic development stakeholders

key to regional competitiveness—to establish NOIC. Our 4 glass firms do not compete in the global market but work together to grow the industry as a whole, galvanizing prosperity and supporting related industries in NW Ohio for more than a century. Likewise, our region's 2 solar companies operate in different markets, First Solar in utility-scale and Toledo Solar in nonutility-scale. Glass and solar form a synergistic cluster in NW Ohio that draws on our advantage in manufacturing to create economies of scale and collaboration across the region that catalyze joint action. The private sector recognizes the benefits of the proposed Tech Hub—including increased profitability and market share, a skilled workforce, and pro-growth policies—and has committed to match funds for WFD projects, hire graduates, and fund NOIC on top of their commitments to decarbonization and diversity, equity, inclusion, and accessibility (DEIA), found in Figure 2.

We realize the catalytic potential of private capital to unlock financing and foster long-term, win-win business partnerships to provide competitive returns that foster a self-sustaining ecosystem. In addition to continued investment from NOIC firms, we propose to work with JumpStart to develop a blended-finance private capital strategy to amplify EDA support by addressing market gaps and lessening the perceived risk of investing in early-stage, high-growth firms and diverse entrepreneurs with lower access to capital.

Factor 3: Regional Coordination & Partnerships

NOIC unites members with a strong track record of working together around a joint vision of decarbonizing the solar value chain propelling long-term equitable economic growth. The strength and durability of the consortium is rooted in our shared values and aligned interests. This mutually beneficial partnership incentivizes cooperation, avoids duplication of efforts, and leverages resources to go faster and farther together—leading to collective impact greater than the sum of our parts.

Our Shared Values
- Market-driven, private sector-led
- Collaboration leads to greater success
- Focus on results and maximize impact
- People are our greatest asset
- Economic activity that doesn't lift communities is not true growth

A privately funded 501(c)3, NOIC has established a clear model to foster cross-sectoral collaboration and maximize impact. Members belong to thematic committees that align their expertise with anticipated projects: WFD & DEIA, Private Sector & Technology, Education & Research, and Economic Development & Policy. While each project will be led by an organization, the committee Chair will oversee the implementation of all projects under their committee to ensure they speak to each other and leverage members' combined expertise. Chairs will also work with committee members to share resources and lessons learned and to harmonize projects with ongoing efforts, e.g., the Comprehensive Economic Development Strategy and NW Ohio Workforce Recovery & Resilience Strategy, both supported by EDA, and the Toledo Racial Equity and Inclusion Council's Action Plan. Chairs will also work together to promote a coherent, integrated approach across Tech Hubs, e.g., the WFD & DEIA Chair will work with the Private Sector & Technology Chair to align the curriculum of earn-to-learn programs with industry needs.

Regional Innovation Officer (RIO) Roger Smith combines nearly 40 years of experience driving innovation in glass and related industries with a clear talent for inspiring leaders to work together. He provides overall leadership, management, and general technical direction for NOIC, ensuring an integrated vision across all partners and projects with a focus on achieving results. Mr. Smith oversees NOIC committee chairs and heads the Board of Directors, which provides high-level strategic planning and oversight. He will have ultimate responsibility for project quality, financial oversight, reporting, monitoring, evaluation, and learning.

Factor 4: Equity and Diversity

We believe that active participation across our diverse community can lead to empowerment and prosperity across our region. NW Ohio is more diverse than regional peers and the state as a whole. Yet inequality is rising, driven by disparities in wages, employment, and educational access and attainment created by entrenched and intersecting systems of oppression.[18] For example, 17% Black vs. 32% white residents have at least a bachelor's.[19] EDA data indicates economic distress, with nearly 40% of census tracts designated high poverty areas[20] and per capita personal income lagging the nation.[21] As coal and oil will see the largest decline in jobs in NW Ohio in the next decade, Tech Hubs offers a valuable opportunity to

reskill these workers for the green economy. EDA support will forge new avenues of opportunity within underserved populations—including low-income, rural, Black, and Latinx residents, people with disabilities (PWD), and veterans—unlocking a vast reservoir of untapped potential and catalyzing structural change.

Inclusive Pipeline Development. NOIC will build sustainable career pathways in solar and glass that start in middle school, link to paid skills-based training, and ultimately lead to good, family-sustaining jobs. Our efforts enable all residents to participate in and benefit equally from growth while providing the skilled, diverse workforce firms need. We understand that a systems- and evidence-based approach is needed to reduce or eliminate barriers and create incentives for entry and advancement. OCC and TPS will reach into communities to reskill and upskill those who have been underserved by existing approaches, engage employers to identify opportunities for career placement, and work with partners like LISC and Cherry St. to bridge structural gaps, e.g., basic skills training and wraparound services. We will also engage diverse entrepreneurs, who own just 7% of the firms in the MSA,[22] and create greater opportunities for business development, e.g., access to capital and professional networks. NOIC, whose members bring a strong track record of advancing DEIA (e.g., TPS magnet schools have a Black student body 5x the county and a 100% graduation rate), will create jobs with averaging $89K a year, well above the MSA $59K median.

Inclusive Community Engagement. NOIC members are committed to inclusive community engagement, an intentional, iterative process needed to build trust and ensure equitable access, process, and outcomes. We will actively involve community members in project planning, decision-making, and implementation. The WFD & DEIA Chair, for example, will conduct a participatory kick-off community mapping exercise that will be updated annually and lead to an Action Plan that embeds our shared commitment to DEIA (see Figure 2 for specific commitments) program-wide and measures progress. NOIC will convene an advisory board of community-based organizations, which will have a seat on the WFD & DEIA committee and connect NOIC to communities through listening sessions at churches, surveys, and virtual Ask Me Anything sessions.

Factor 5: Composition and Capacity of the Regional Workforce

We have an experienced union-strong workforce, able to meet the needs of today and ready to scale to meet the needs of tomorrow. A Tech Hub in NW Ohio will create an estimated 5500 jobs in our MSA, including nearly 3K jobs in solar with average wages of $96K a year, 500 jobs in glass averaging $76K, and 2K jobs in construction averaging $98K. UT and BGSU's specialized programs produce highly trained scientists and engineers to fill many of these roles. Most jobs, however, will not require a degree (key as 61% have a high school diploma or less) and all will be consistent with the Good Jobs Principles, well-paying jobs with benefits, worker voice, and opportunities to advance. With the labor force shrinking 4% while the nonwhite population grows 18%, NOIC will engage diverse communities to bring in more workers.

WFD will be employer-driven to ensure training aligns with position requirements and leads to job offers. Through Local 500 and AGCNWO, workers will actively contribute to project design and implementation. NOIC will also leverage state funds, such as ApprenticeOhio, where employers receive $2500 for each new RA, and TechCred, which gives employers $2K for each credential employees complete. NOIC will coordinate and amplify successful WFD initiatives, such as Local 500's RA program; LISC's Advanced Manufacturing Certification, where last year 116 participants earned 161 credentials; and RGP's work, funded by EDA and JobsOhio, that has brought in 16K jobs since 2015, 1420 in 2022 alone. In Phase 2, TPS will scale up its magnet school model to create a 7th–12th grade school where students will graduate with stackable certifications and real-world experience that lead to careers in solar and glass. TPS will coordinate with the private sector to develop curricula, teach classes, and offer internships. OCC will expand its Workforce & Community Services program to develop a certification program for industrial trainers, who will in turn be hired by Nexus NWO (see below), unions, companies, and more. This will establish a sustainable career pathway for trainers in the solar, glass, and other industries and create the capacity and infrastructure necessary to scale WFD programs in the future.

We will also engage in new efforts to attract, retain, and grow a skilled workforce. OCC will lead the creation of Nexus NWO, a network of training centers that offer earn-and-learn programs, including RAs,

and portable solar and manufacturing certifications. Firms commit to match EDA funds, supply a family-sustaining wage with progressive increases, and hire graduates, and will work with OCC to develop apprenticeship standards and pair apprentices with an experienced mentor. LISC will furnish a pool of pre-screened, qualified candidates, lead inclusive recruitment efforts, offer basic skills preparation, and provide ongoing mentorship and case management that connects apprentices to wraparound services and jobs. Given our large rural and PWD populations, OCC will offer remote learning options that help attract talent.

Factor 6: Innovative "Lab-to-Market" Approaches

We have identified an illustrative portfolio of evidence-based, market-driven projects and policies for Phase 2. (For WFD, see Factor 5.) Together, they form a suite of interconnected activities that overcome key inhibitors of global competitiveness, accelerate commercialization, and drive inclusive economic growth.

Technology maturation. With support from UT and BGSU, Libbey, O-C, O-I, and PNA will join forces to decarbonize glass production by using renewable energy to power manufacturing. While our members have used hydrogen and biofuels to make glass without compromising performance for the first time in history, improvements in glass furnace construction techniques and materials are needed for commercialization. Firms will also collaborate to make glass thinner, lighter, and stronger through improved process controls, automation, and glass composition. These efforts will leverage private sector and university assets to commercialize these technologies first for PNA's production of coated glass for First Solar, and then for their own product lines. Firms will also work with First Solar, drawing on their local R&D facility and pilot manufacturing line, to integrate this technology and modify their operations as necessary.

Business & Entrepreneur Development. Drawing on UT's EDA-funded Business Incubator and Minority Business Development Center, JumpStart will lead efforts to foster an equitable ecosystem of diverse small businesses along the solar and glass value chains and deliver community solar solutions. Tailored support will provide access to capital, office space, mentorship, business services, and networking opportunities.

Infrastructure. NOIC will establish a physical space near underserved communities to co-locate the Nexus NWO training center hub, entrepreneur support, and a solar makerspace. The cross-pollination of diverse ideas will promote a vibrant culture of innovation and collaboration and increase access to clean energy.

Policy. We will create a nonpartisan Policy Center to identify and advance key policy changes, e.g., increase renewable energy uptake, reduce solar panel placement restrictions, and resolve the benefits cliff.

Factor 7: Impact on U.S. Economic and National Security

Together, NOIC and EDA will reestablish the U.S. as a global leader in solar energy. Making solar panels even more sustainable and cost-effective will drive down the cost of solar energy and help to achieve the Administration's goals of a clean power grid by 2035 and net-zero emissions with half of all electricity coming from solar by 2050. This will provide clean, affordable power to millions of Americans and mitigate climate change, a critical national security issue that increases instability and undermines military readiness. The largest global institutional energy consumer, the military has said that solar will increase operational capability and decrease dependence on dangerous fuel convoys.[23] It is vital that this solar infrastructure be made in America to strengthen supply chain resilience, energy independence, and cybersecurity, as U.S. adversaries are weaponizing dependence on fossil fuels. Given exponential growth in the global market, we agree with the Administration that CdTe is vital to diversifying solar and improving our domestic position.[24] A Tech Hub in NW Ohio will bolster domestic manufacturing and ensure that the jobs created by the increase in demand for solar start, grow, and remain in America.

Tech Hubs will create a positive feedback loop that fosters regional prosperity and ensures NW Ohio remains a place where talented, hardworking people live, work, play, and thrive. With a skilled workforce, supportive business environment, and a lower cost of living and more affordable housing than regional peers, firms will increasingly relocate operations, generating even more jobs and tax revenue. Together, NOIC and EDA will revitalize economically distressed fenceline communities and provide fossil fuel workers with a just transition to a more sustainable, equitable, and prosperous future.

Appendix

[1] Economic impacts are estimated using input-output models in 2022 dollars. Job creation is based on assessed industry needs to scale adequately to support the estimated increase in global market share. Job gains are expected across 6 industries, both nationally and regionally: solar panel production (4600 positions), flat glass production (800), skilled industrial maintenance (700), robotics/physical science (400), engineering (300), and process management (200). This assumes that roughly 50% of this growth would happen within the MSA with the other 50% distributed across U.S. Local impacts are estimated using Lightcast Type II, which assumes impacts on local tax revenue and has broader local multiplier effects. National impacts are assessed using Lightcast Type I, which assumes slightly narrower multiplier effects and does not estimate impacts for tax revenue. Another 2K jobs are estimated in commercial construction to support factory, lab, and auxiliary business expansions. These impacts are expected within the MSA and assessed using Lightcast Type II. In addition to job creation, economic contributions for non-wage industry spending are assessed using IMPLAN, assuming a $1.1B investment with impacts distributed nationally and equal investments in solar and glass industry expansions and supply chains.
[2] The MSA meets both the Fossil Fuel Employment threshold and the unemployment threshold for Energy Communities. Parts of the MSA are Coal Closure Communities and two coal-fired power plants that supply 40% of electricity will be decommissioned in the next 5 years. NW Ohio is the second-largest oil refining region in the Midwest and has 3 active refineries, generating $35B in revenue and employing more than 20K residents. Coal and oil represent 74% of total exports. https://energycommunities.gov/energy-community-tax-credit-bonus/
[3] https://www.seia.org/solar-industry-research-data
[4] https://www.energy.gov/articles/doe-releases-solar-futures-study-providing-blueprint-zero-carbon-grid
[5] https://www.csis.org/analysis/us-solar-industry-strategy
[6] https://www.solarpowerworldonline.com/u-s-solar-panel-manufacturers/
[7] https://solarbuy.com/solar-101/cdte-cadmium-telluride-solar-panels/
[8] https://www.firstsolar.com/en/Technology/Manufacturing
[9] Advantages include a higher energy yield, superior degradation rate, more reliable energy output, more stable and efficient performance in suboptimal conditions, and greater theoretical efficiency.
[10] https://www.solarpowerworldonline.com/u-s-solar-panel-manufacturers/
[11] https://pubs.usgs.gov/periodicals/mcs2023/mcs2023-cadmium.pdf
[12] Based on projected market share increase in global solar production by doubling global market share with standard domestic solar staffing levels.
[13] https://www.glass-futures.org/article/?p=xGmTimLjCtCgCffiBpH9R1I49LnntTeBCK1BqH7bRl1E33gRnlBiT5x
[14] Estimate based on projected market share increase by customer demand of sustainable products.
[15] "10-Year Action Plan," Toledo Racial Equity and Inclusion Council, 2022
[16] https://clustermapping.us/region/economic/toledo_fremont_oh/performance
[17] Recompete Mapping Tool, https://disgeoportal.egs.anl.gov/Recompete/
[18] Toledo MSA 0.84 diversity index vs. 0.76 Ohio. Lower outcomes in MSA vs. Ohio/U.S.: poverty: 16% vs. 14%/13%, median HH income $52K vs. $56K/$62K. Source: RGP Ohio Labor and Target Industry Study, November 2022. In Toledo, 40% of the MSA population, Black/Latinx vs. white–home ownership: 31%/41% vs. 62%; median HH income $26K/$35K vs. $45K; % earning $75K+/year: 7%/6% vs. 14%; unemployment rate 26%/21% vs. 11%; loan approval: 64%/65% vs. 80%. Source: TREIC, 10-Year Action Plan.
[19] U.S. Census, Census.gov
[20] EDA-Census Poverty Status Viewer, https://mtgisportal.geo.census.gov/arcgis/apps/experiencebuilder/experience/?id=ad8ad0751e474f938fc98345462cdfbf&page=page_0
[21] Measuring Distress – County Tool, StatsAmerica funded by EDA, https://www.statsamerica.org/distress/
[22] U.S. Census Bureau, https://data.census.gov/
[23] Department of Defense Climate Risk Analysis, October 2021, https://media.defense.gov/2021/Oct/21/2002877353/-1/-1/0/DOD-CLIMATE-RISK-ANALYSIS-FINAL.PDF
[24] https://www.energy.gov/eere/solar/building-bridge-more-robust-and-secure-solar-energy-supply-chain