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Accurate Cost Estimating in the Current Environment

Material Increases, Supply-Chain Issues, War and COVID

Wayne Richardson, PE LEED/ENV
Peter Bredehoeft, AACEI

1/05/2023

01 Accurate Estimating

02 Inflation

03 Material Impacts

04 Market Volatility

05 Current Environment - Best Practices

Accurate Estimating

How Estimates Go Wrong

- Examples:
  - Big Dig, Boston- $2.6 B (1985) to $14.6B (2005)
  - CA High Speed Rail ($26 B, now upwards of $76 B)
- Cost overruns due to inaccurate original estimates
- Misrepresentation or Political Spin
- Bias toward underestimating (Polyanna effect)
- Lack of experience, knowledge in cost management
- Requires significant effort for large complex (Public) projects
- Unrealistic schedules (time value of money)
- Intangibles and Unforseens
- Acquisitions
- Third Parties, Regulations, Envi. Permitting,, Labor Requirements Trends
- Pinning Down General and Special Conditions

Cost Estimating Terms

- Direct Costs - Cost of installed equipment, material, labor and supervision directly or immediately involved in the physical construction of the permanent facility
- Indirect Costs - Contractor Markups for mob/demob, home office overhead, general conditions, profit, bond and insurance.
- Soft Costs – Non-Construction Cost Professional Services, Capital Cost (Financing)
- Owner Costs – Legal, Administration, Land, and Easements.

Estimating New Projects

- Well-Defined Scope
- Must Have Quantities
- Look at Previous Estimates and Compare Costs/Unit
- Obtain Contractor “Courtesy” Quotes
- Look at Constraints and Market Conditions
- Prepare or Review **Basis of Estimate** document

Note: Every estimate (OPCC) ***must have a Basis of Estimate*** *document – outlining major assumptions, cost basis, methodology and excluded items.*

Basis of Estimate – DC Water – Blue Plans – HVAC Equipment Replacement
100% Design

General Methodology:

This estimate assumes a competitive bid environment with a minimum of 3 bidders. HDR estimators utilized standard industry knowledge to include anticipated labor, materials, and installation equipment to capture total construction cost. HDR produced a built-up cost estimate, adjusted for productivity and complexity of the project.

Overall – Opinion of Construction Probable Cost:

Summary of Opinion of Probable Construction Cost		
High Range		Low Range
+15%	Construction Cost	-10%
$ 903,000	$ 785,000	$ 707,000

Scope of Work:

The project is located in Alexandra, Virginia. The client is District of Columbia Water and Sewer Authority. The project includes demolition and replacement of various HVAC equipment item. The work includes replacement of packaged air handling units, ductless split air system, air filtration units, air cooled condensing units, roof exhaust fans, new ductwork. The project includes new electrical wiring and controls panels. The following is a list of facility HVAC improvements:

- Primary Sludge Screening and Degritting Building:
  - Package Air Handing Unit 1 EA
  - Ductless Split Air 1 EA
  - Filtration Units 2 EA
- Gravity Thickener Control Building:
  - Ductless Split Air 3 EA
  - Filtration Unit 1 EA
  - Air Cooled Condensing Unit 1 EA
  - Centrifugual Pad Mounted Exhaust Fan 1 EA
- Headhouse 2:
  - Air Filtration Unit 1 EA
- Gravity Thickeners 1-4:
  - Roof Exhaust Fan 2 EA
- Gravity Thickeners 7-10:
  - Roof Exhaust Fan 2 EA

General Assumptions:

- This is a class 2 OPCC.
- Work hours are assumed to be Monday through Friday, five days a week, 8-hour workdays, 7 am -4 pm.
- The project is anticipated to be bid as a design-bid-build, lump-sum contract.
- Single mobilization for any/all contractors.
- Assumed Haul for demolished building or imported materials – 10 Mile round trip.

Markups:

The estimate is based upon a single contractor qualified to perform these kinds of improvements and repairs. The estimate includes the following contractor markups:

- Labor Burden – 40%
- Mobilization/Demobilization – 4%
- Home Office Overhead – 3%
- HVAC General Conditions – 25% (small project)
- State Sales Tax – 0% - Exempt
- Profit – 15%
- Contingency – 0%
- Escalation – 2.97% for material, labor and construction equipment.
- Bond and Insurance 2.5%
- Market Volatility Adjustment Factor 10% for supply-chain, price and delivery issues.
- Allowance for Electrical – $150,000
- Allowance for Controls - $75,000

General Exclusions:

- Fire Protection System

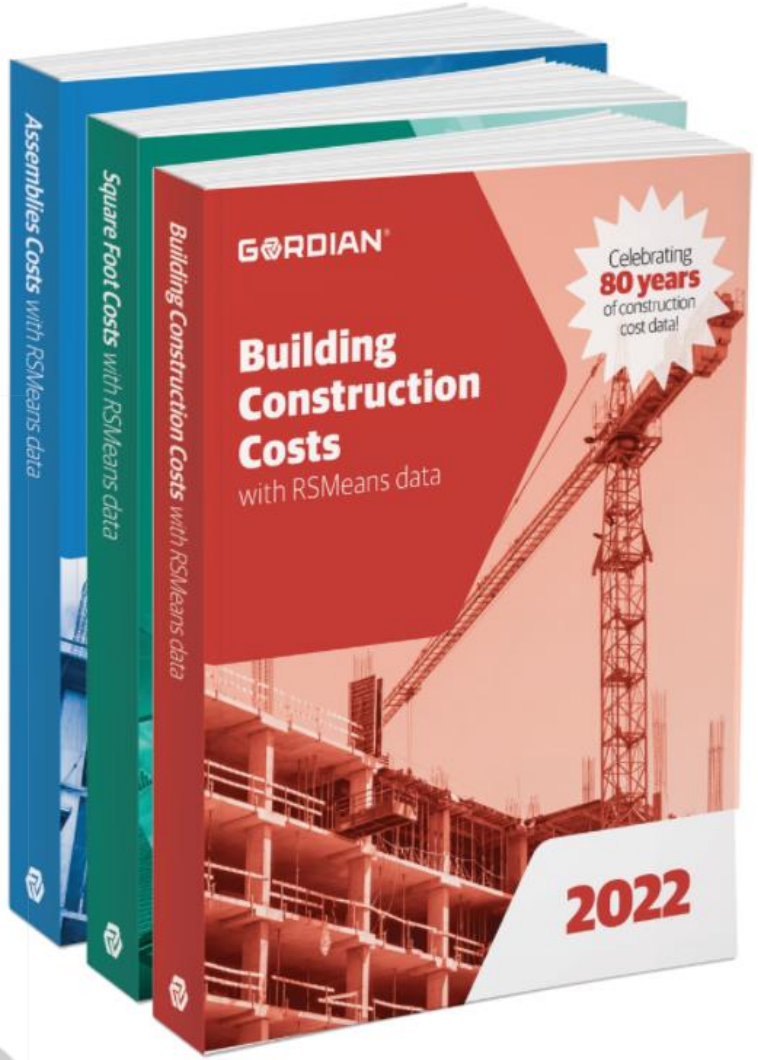
JANUARY 4, 2022

Estimating Accuracy

- Class C – Study Level (Order of Magnitude)
  - Also called ROM or Parametric
  - Based On: Studies, alternatives, investments types, program
  - By Type of Project Per Sq Ft Unit Costs
  - Contingency: 20% - 50%
- Class B – Budgetary Level
  - Based On: Plans from 20%-30% completion
  - By Major Work Element per Unit Price Installed
  - Contingency: 15 - 20%
- Class A – Engineer’s Estimate
  - Based On: PS&E from 30%-100% completion
  - Detailed Work Elements, broken down by material, labor, freight/taxes, indirects
  - Contingency: 5 - 15%
- Change Order Estimates (same as Class A)

Unit Price Sources

- Recent Bids
- *Engineering News Record*
- Richardson Engineering Services, Inc. (Process Plants)
- Dodge Digest
- National Construction Estimator
- RS Means
- Econometric Consultant Data and Projections (IHS Markit)



Quantity Takeoff Tips

- Dimensions, Scaling
- On-Site Staging & Laydown Areas
- Abnormal Conditions – See Geo Report
- Available Materials
- Proprietary, Sole or limited source products
- Special Labor Provisions
- Special Commissioning (LEED, BIM, Recycling, Made in USA, “Green”)
- Extended Warranties
- Specification back-check
- Schedule vs Production Rates

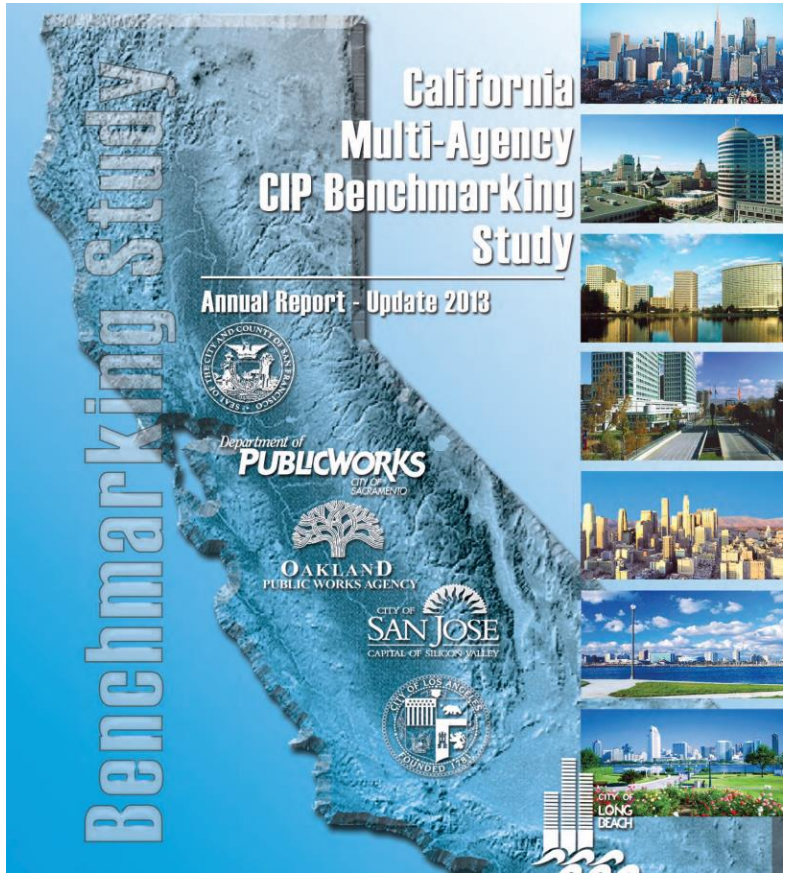
Factors To Include

- City Costs Index (LA-Long Beach = x1.12)
- Project Size Multiplier
- Site Constraints
- Freight and Taxes
- Contractor Markups
- Inflation or Escalation Factor
- Design Contingency Factor
- Market Volatility Factor

Typically Design Contingency does NOT include for Change Orders during construction – check with Owner

Typical Factor Values

- Based on a typical street improvement project with construction cost of $1 to $10 M
- Values may vary greatly depending on the specific project, but generally they fall in the range of +/- 50%



	PROJECT RELATED COSTS - TYPICAL ROM	PCT of Total Hard Construction Costs**
	CONTRACTOR RELATED COSTS	
1	Mobilization - Demobilization	5.0%
2	Traffic Management/Control	3.0%
3	Utility Investigation/Relocation/Protection	5.0%
4	Environmental Mitigation Requirements	2.0%
5	Bonding and Insurance	3.0%
6	Phasing Costs	3.0%
7	Construction Surveying	3.0%
7	Freight and Taxes	11.0%
8	General Conditions	10.0%
9	General Contractor Mark Up (Ovhd & Profit)	15.0%
	TOTAL CONTRACTOR RELATED COSTS	60.0%
	CLIENT/OWNER RELATED COSTS	
1	Preliminary Design & Project Development (A/E Fees)	10.0%
2	Final Design (A/E Fees)	10.0%
3	Owners Facilities, Security, Administration, Scheduling & Cost Control	5.0%
4	Construction Management (Site Inspection & Supervision)	20.0%
5	Close Out and O&M Training	2.0%
	TOTAL CLIENT RELATED COSTS	47.0%
1	Contingencies	5% to 30%
2	Escalation to Start Date @ 3% per Year	3.0%
3	Prevailing Wages, add to base labor	15.0%

Estimate Quick Checks

1. Basis of Design
2. Recent Bids and Parametrics
3. Spot-check key Quantities that drive the project.
4. Check Unit Prices on major elements with high costs (LS vs. EA)
5. Check the Quotes match the Estimate and Specifications
6. Check Factors for Reasonableness
7. Review contractor markups – Subcontractor, General Contractor overhead+ profit, Mob/Demob, Sales Tax, Bonds and Insurance.
8. Reasonable Schedule

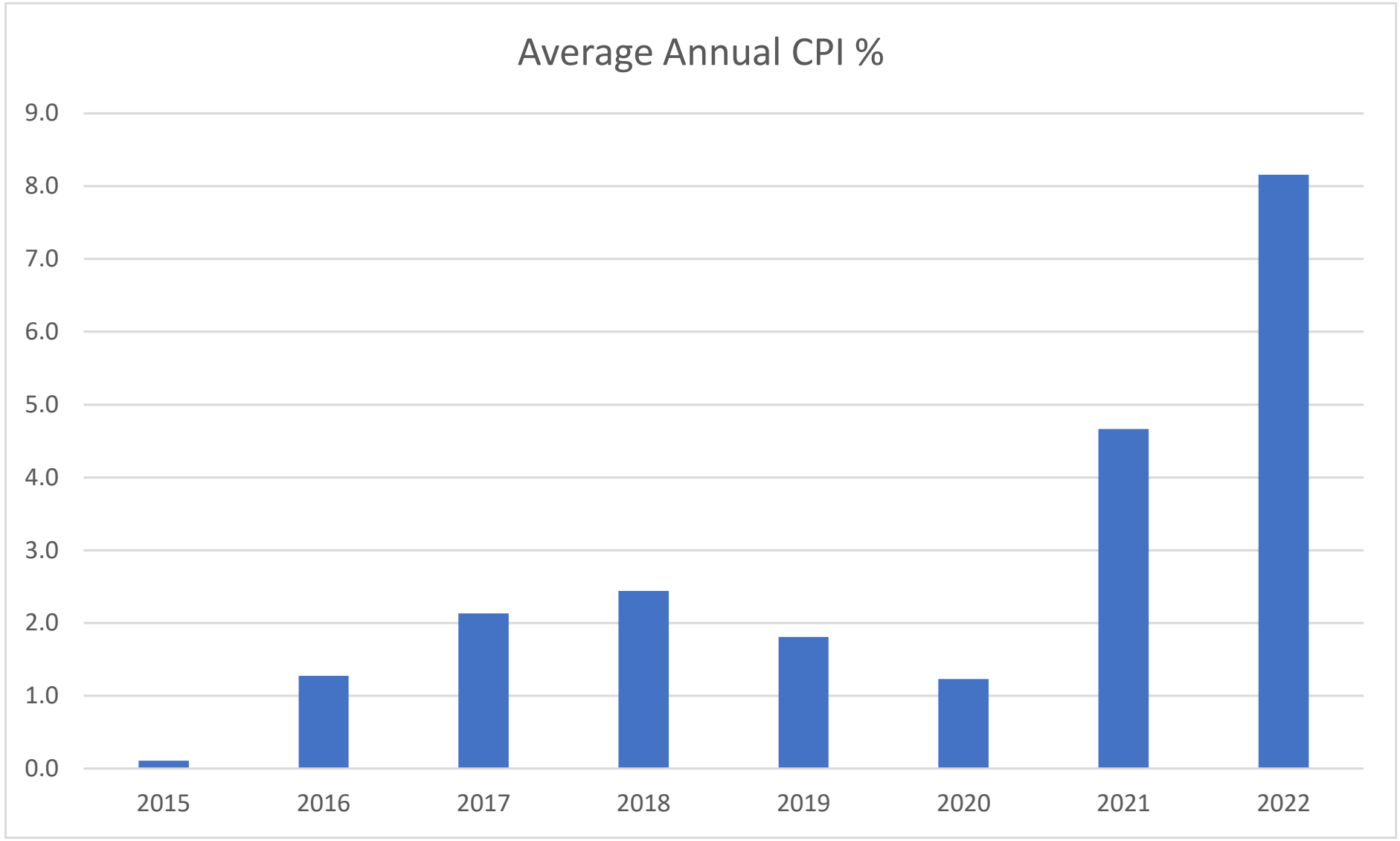
   Ask yourself, “What’s not included?” Check against previous budget estimates, bids for similar work, Owners expectations, etc...

Inflation

The cost of capital (interest rates) is at its highest in 15 years

Inflation Impacts (CPI) Y/Y

Consumer Price Index	+7.1%
Food	**+10.6%**
Meats, Poultry, Fish, and Eggs	+6.8%
Energy	**+13.1%**
Gasoline	+10.1%
Electricity	+13.7%
Natural Gas	+15.5%
Other Commodities	**+6.0%**
Apparel	+3.6%
New Vehicles	+7.2%
Used Cars and Trucks	-3.3%
Motor Vehicle Maint/Repair	+11.7%
Airline Fares	+36.0%


Average Annual CPI %
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
2015
2016
2017
2018
2019
2020
2021
2022

Material Impacts

Costs vs. Bid Prices for New Nonresidential Construction

Year-over-year change in PPIs, Sep 2020 - Sep 2022, not seasonally adjusted

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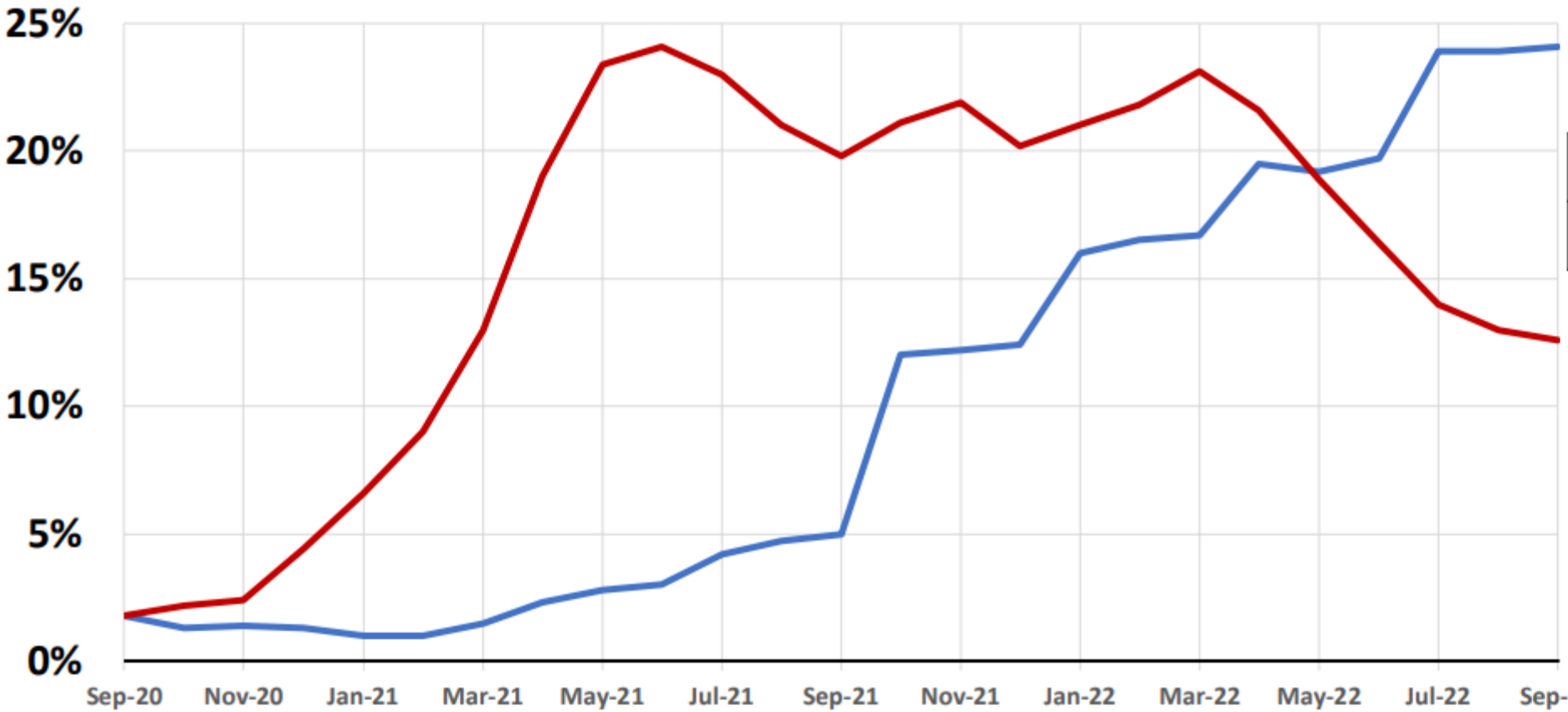

	12 months to:	
	Sep-20	Sep-22
Bid Price PPI	1.8%	24.1%
Inputs PPI	1.8%	12.6%

PPIs for Construction Bid Prices and Selected Inputs

Cumulative change in PPIs, April 2020-September 2022 (not seasonally adjusted)

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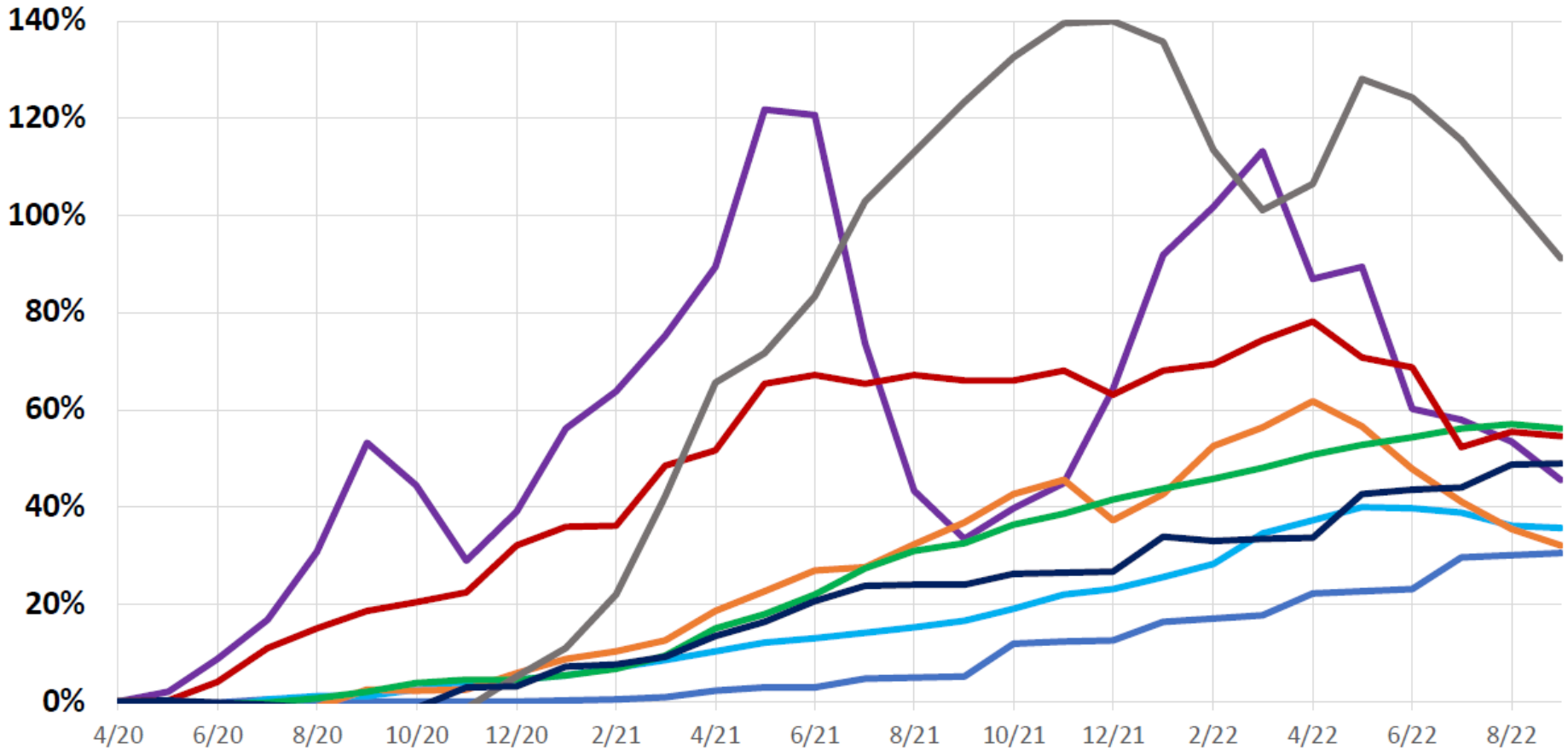
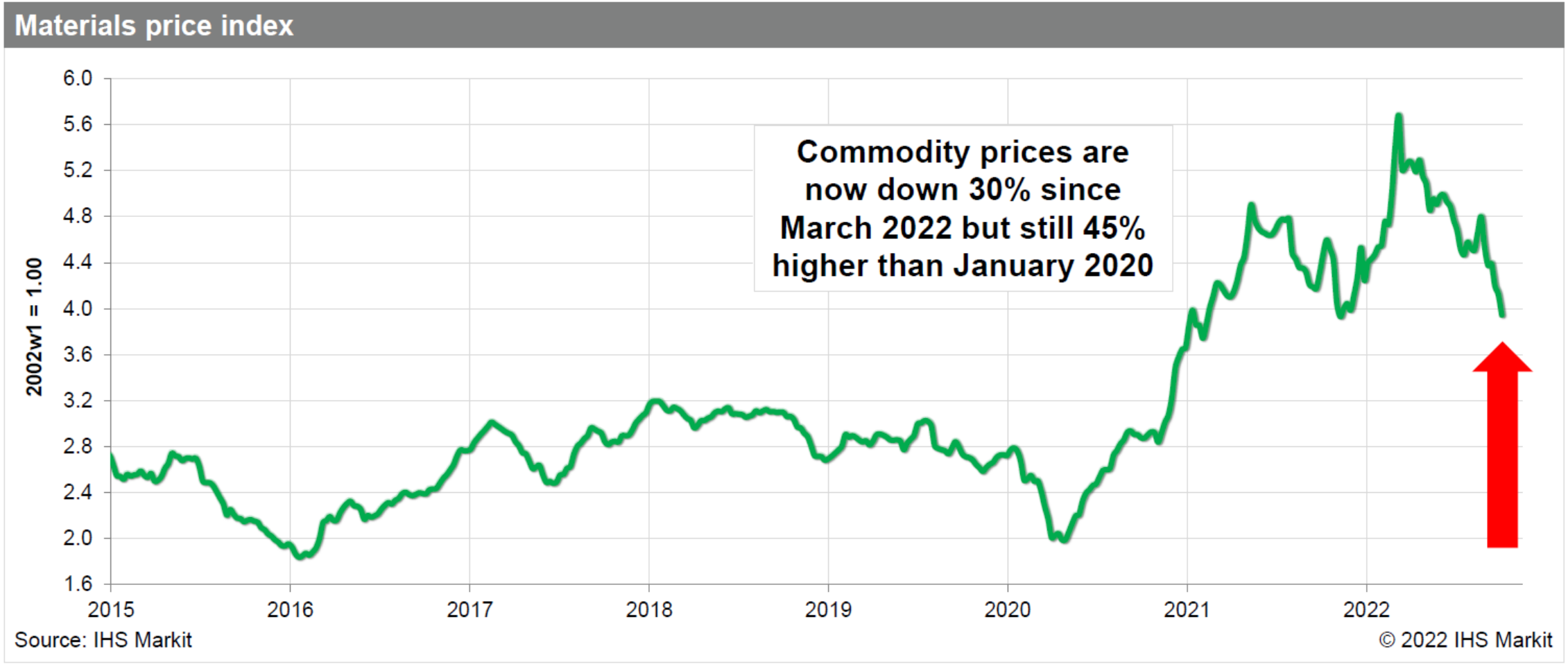


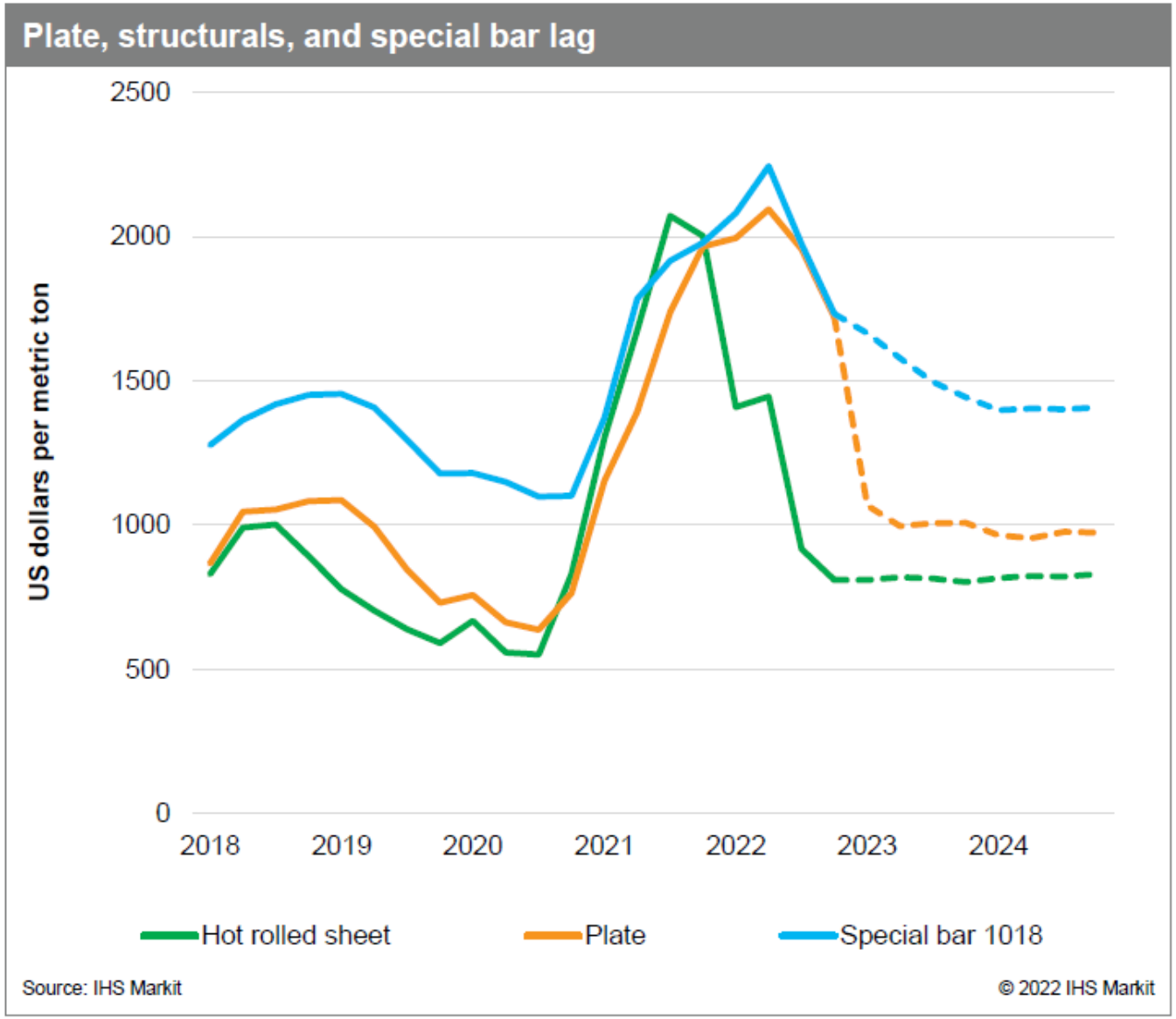
% Change: April 2020 - September 2022	
Steel Mill Products	91.3%
Plastic Construction Products	56.2%
Copper & Brass Mill Shapes	54.6%
Lumber and Plywood	45.6%
Gypsum Building Materials	49.0%
Aluminum Mill Shapes	32.1%
Truck Transportation	35.7%
'Bid Price' *(new nonresidential building construction)*	30.5%

Material Price Index

One of the primary drivers of stronger inflation has been commodity prices



Steel Plate and Structurals



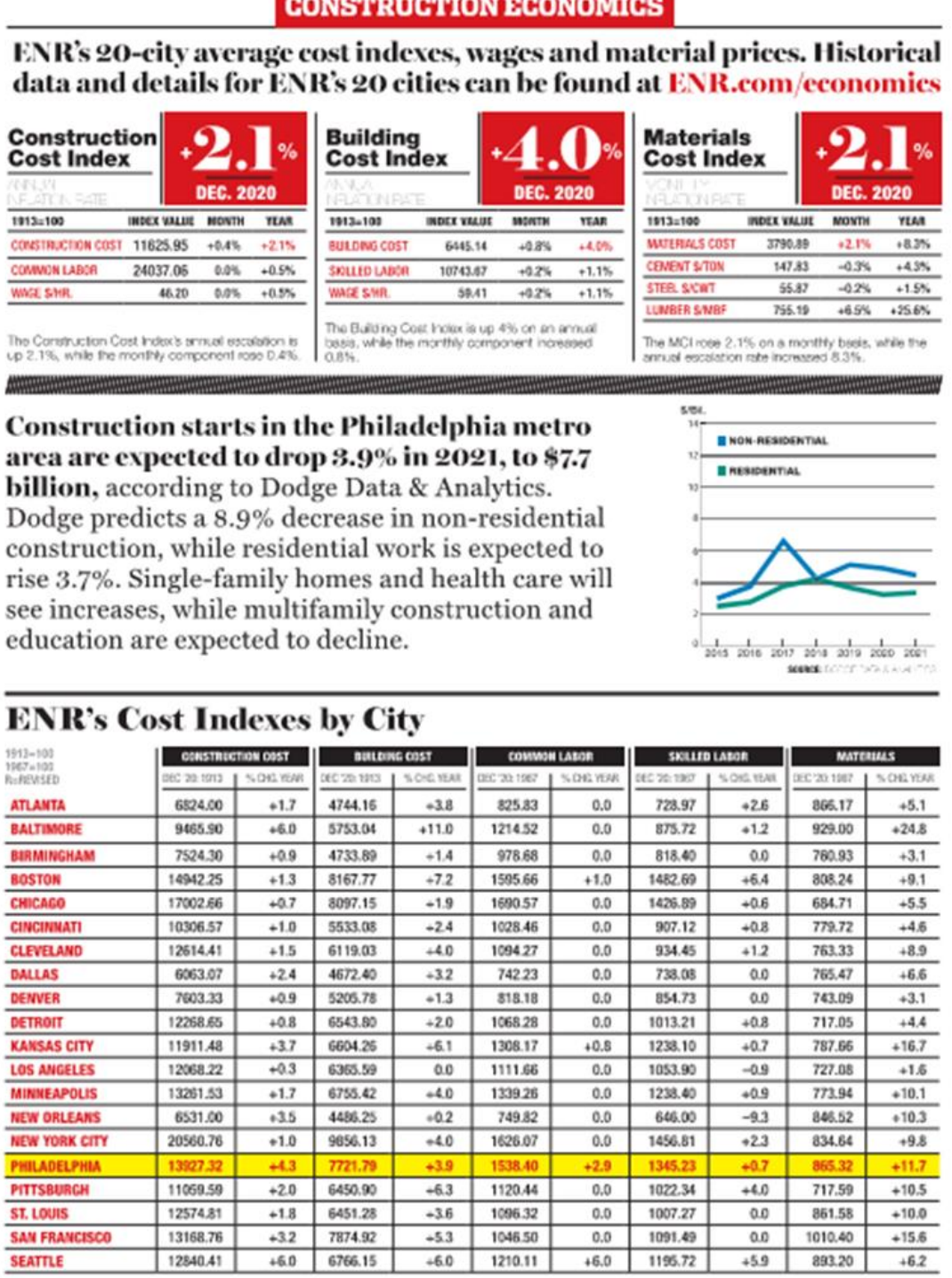
Current Material Information

ENR COST INDEX

(Dec 2021 Vs Dec 2022)

Construction	
YTD	+2.1%
Los Angeles	**+0.3%**
Building	
YTD	+4.0%
Los Angeles	**+0.0%**
Material (cement, steel & lumber)	
YTD	+8.3%
Los Angeles	**+1.6%**

Average Ready-Mix Concrete 4,000 psi = $152.35 CY National
4,000 psi = $107.94 CY 2012
5,000 psi = $181.99 CY National
4,000 psi = $188.28 CY Los Angles



CONSTRUCTION ECONOMICS

ENR's 20-city average cost indexes, wages and material prices. Historical data and details for ENR's 20 cities can be found at ENR.com/economics

Construction Cost Index +2.1% DEC. 2020

1913=100	INDEX VALUE	MONTH	YEAR
CONSTRUCTION COST	11625.95	+0.4%	+2.1%
COMMON LABOR	24037.06	0.0%	+0.5%
WAGE $/HR.	46.20	0.0%	+0.5%

The Construction Cost Index's annual escalation is up 2.1%, while the monthly component rose 0.4%.

Building Cost Index +4.0% DEC. 2020

1913=100	INDEX VALUE	MONTH	YEAR
BUILDING COST	6445.14	+0.8%	+4.0%
SKILLED LABOR	10743.67	+0.2%	+1.1%
WAGE $/HR.	59.41	+0.2%	+1.1%

The Building Cost Index is up 4% on an annual basis, while the monthly component increased 0.8%.

Materials Cost Index +2.1% DEC. 2020

1913=100	INDEX VALUE	MONTH	YEAR
MATERIALS COST	3790.89	+2.1%	+8.3%
CEMENT $/TON	147.83	-0.3%	+4.3%
STEEL $/CWT	55.87	-0.2%	+1.5%
LUMBER $/MBF	755.19	+6.5%	+25.6%

The MCI rose 2.1% on a monthly basis, while the annual escalation rate increased 8.3%.

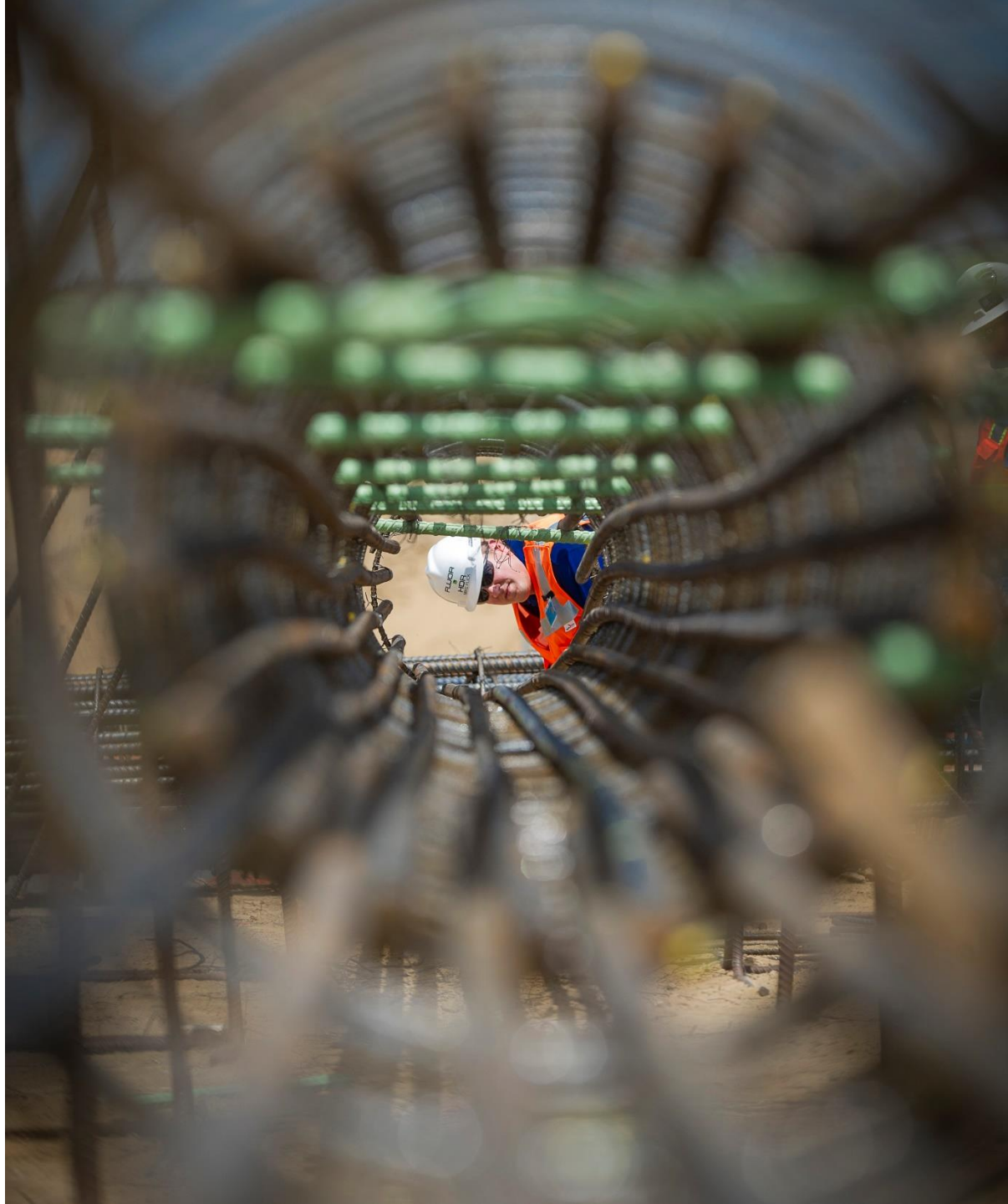
Construction starts in the Philadelphia metro area are expected to drop 3.9% in 2021, to $7.7 billion, according to Dodge Data & Analytics. Dodge predicts a 8.9% decrease in non-residential construction, while residential work is expected to rise 3.7%. Single-family homes and health care will see increases, while multifamily construction and education are expected to decline.

ENR's Cost Indexes by City

1913=100 1967=100 Re/REVISED	CONSTRUCTION COST		BUILDING COST		COMMON LABOR		SKILLED LABOR		MATERIALS	
	DEC '20: 1913	% CHG. YEAR	DEC '20: 1913	% CHG. YEAR	DEC '20: 1967	% CHG. YEAR	DEC '20: 1967	% CHG. YEAR	DEC '20: 1967	% CHG. YEAR
ATLANTA	6824.00	+1.7	4744.16	+3.8	825.83	0.0	728.97	+2.6	866.17	+5.1
BALTIMORE	9465.90	+6.0	5753.04	+11.0	1214.52	0.0	875.72	+1.2	929.00	+24.8
BIRMINGHAM	7524.30	+0.9	4733.89	+1.4	978.68	0.0	818.40	0.0	760.93	+3.1
BOSTON	14942.25	+1.3	8167.77	+7.2	1595.66	+1.0	1482.69	+6.4	808.24	+9.1
CHICAGO	17002.66	+0.7	8097.15	+1.9	1690.57	0.0	1426.89	+0.6	684.71	+5.5
CINCINNATI	10306.57	+1.0	5533.08	+2.4	1028.46	0.0	907.12	+0.8	779.72	+4.6
CLEVELAND	12614.41	+1.5	6119.03	+4.0	1094.27	0.0	934.45	+1.2	763.33	+8.9
DALLAS	6063.07	+2.4	4672.40	+3.2	742.23	0.0	738.08	0.0	765.47	+6.6
DENVER	7603.33	+0.9	5205.78	+1.3	818.18	0.0	854.73	0.0	743.09	+3.1
DETROIT	12268.65	+0.8	6543.80	+2.0	1068.28	0.0	1013.21	+0.8	717.05	+4.4
KANSAS CITY	11911.48	+3.7	6604.26	+6.1	1308.17	+0.8	1238.10	+0.7	787.66	+16.7
LOS ANGELES	12068.22	+0.3	6365.59	0.0	1111.66	0.0	1053.90	-0.9	727.08	+1.6
MINNEAPOLIS	13261.53	+1.7	6755.42	+4.0	1339.26	0.0	1238.40	+0.9	773.94	+10.1
NEW ORLEANS	6531.00	+3.5	4486.25	+0.2	749.82	0.0	646.00	-9.3	846.52	+10.3
NEW YORK CITY	20560.76	+1.0	9856.13	+4.0	1626.07	0.0	1456.81	+2.3	834.64	+9.8
PHILADELPHIA	13927.32	+4.3	7721.79	+3.9	1538.40	+2.9	1345.23	+0.7	865.32	+11.7
PITTSBURGH	11059.59	+2.0	6450.90	+6.3	1120.44	0.0	1022.34	+4.0	717.59	+10.5
ST. LOUIS	12574.81	+1.8	6451.28	+3.6	1096.32	0.0	1007.27	0.0	861.58	+10.0
SAN FRANCISCO	13168.76	+3.2	7874.92	+5.3	1046.50	0.0	1091.49	0.0	1010.40	+15.6
SEATTLE	12840.41	+6.0	6766.15	+6.0	1210.11	+6.0	1195.72	+5.9	893.20	+6.2

BLS DATA *(Nov 2021-2022)*

Ready-Mix Concrete	**+12.5%**
Steel Products	**+31.5%**
Steel Pipe	**+13.5%**
PVC Pipe	**+20.6%**
PVC Conduit	**+12.2%**
Copper Wire	**+8.7%**
Aluminum Mill Shapes	**+12.6%**
Fabricate Structural Metal	**+12.9%**
Fabricated Rebar	**+3.5%**
Prefabricated Metal Buildings	**-2.2%**
Stainless Steel Pipe	**+31.5%**
Ductile Iron Pipe	**+25.2%**
Diesel Fuel	**+59.5%**
Asphalt Products	**+20.4%**
Truck Transportation of Freight	**+11.8%**

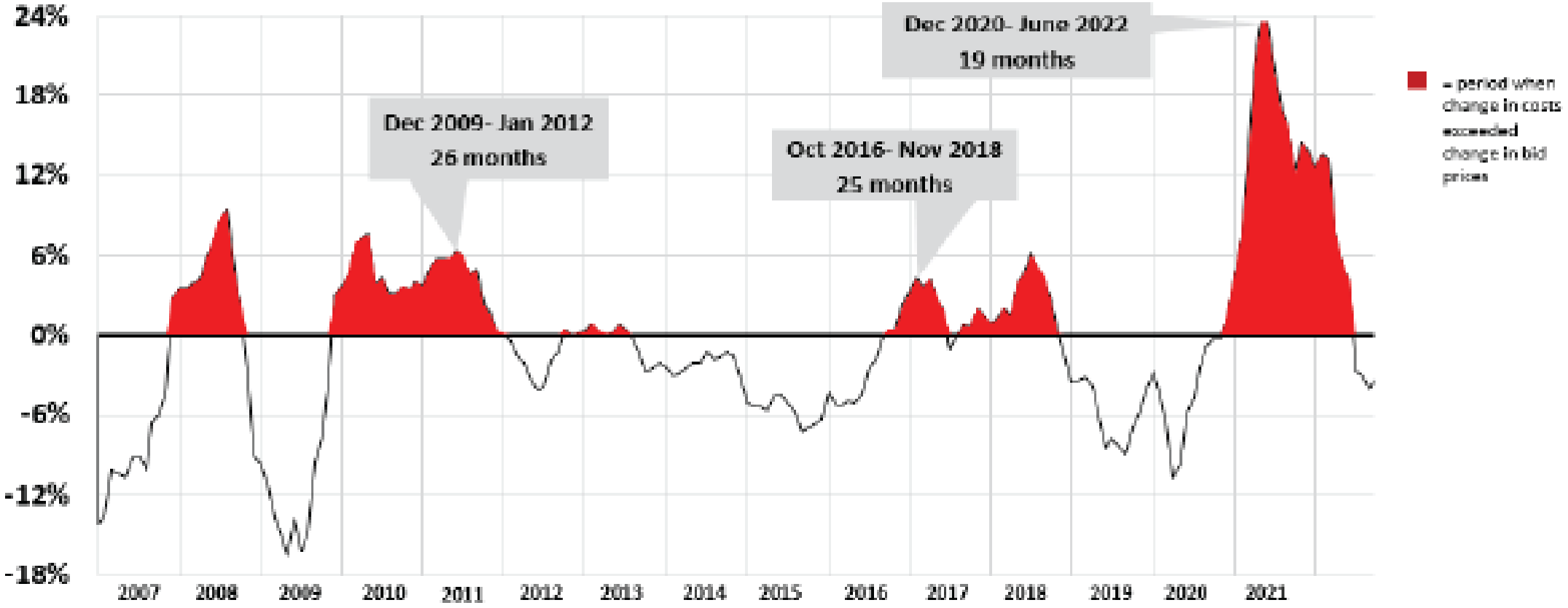


BLS DATA *(Nov 2020-2022)*

Ready-Mix Concrete	**+20.5%**
Steel Products	**+64.6%**
Steel Pipe	**+51.7%**
PVC Pipe	**+105.8%**
PVC Conduit	**+95.4%**
Copper Wire	**+12.0%**
Aluminum Mill Shapes	**+23.3%**
Fabricate Structural Metal	**+47.9%**
Fabricated Rebar	**+56.9%**
Prefabricated Metal Buildings	**+41.4%**
Stainless Steel Pipe	**+51.7%**
Ductile Iron Pipe	**+40.9%**
Diesel Fuel	**+200.9%**
Asphalt Products	**+30.1%**
Truck Transportation of Freight	**+17.9%**

Cost squeeze on contractors can last two years or more

Difference between year-over-year change in materials costs vs. bid prices, Jan 2007-Oct 2022



Source: Source: Bureau of Labor Statistics, www.bls.gov/ppi, producer price indexes for goods inputs to nonresidential construction (material costs) and new school building construction (bid prices)

Market Volatility

Supply-Chain Issues

- **Longer fabrication times**
  - Pre-engineered metal building – 48-week lead time
  - Roofing materials – 4 to 6-month lead time
  - Ductile Iron Pipe – 26-week lead time 38-weeks for Protecto 401 + new Scrap Iron surcharge
  - Ductile Iron Pipe – 4” to 12” – one year lead time. Developers are buying it all up.
  - PLC Components – 6-months lead time
  - Primary Transformers – 5,000 kVA – 70 Weeks – one project 130 weeks.
  - Secondary Transformers – 2,500 kVA – 60 Weeks
  - Switchboard – 480/277V – 50 Weeks
  - VFD – 480/277 V – 40+ Weeks
  - Process Equipment and Pumps – 30 Weeks to 40 Weeks.

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Supply-Chain Issues

AGC REPORTS

- **Plant shutdowns and transportation issues**
  - Port of Long Beach and LA - 8 ships – is improving – trucker shortage +30% (80,000)
  - New California emission standards – trucks – 50% blocked from entry to ports
  - Current China Covid-19 Lockdown – has 412 ships waiting to unload – a ripple effect
- **Texas freeze and Hurricane Ida effects on plastics, glues, and resins**
  - PVC pipe, fiberglass, vinyl siding, moisture barriers, paint, coatings, geotextiles, roofing, insulation, plywood, oriented strand board, i-joists, wraps – Inputs +170%

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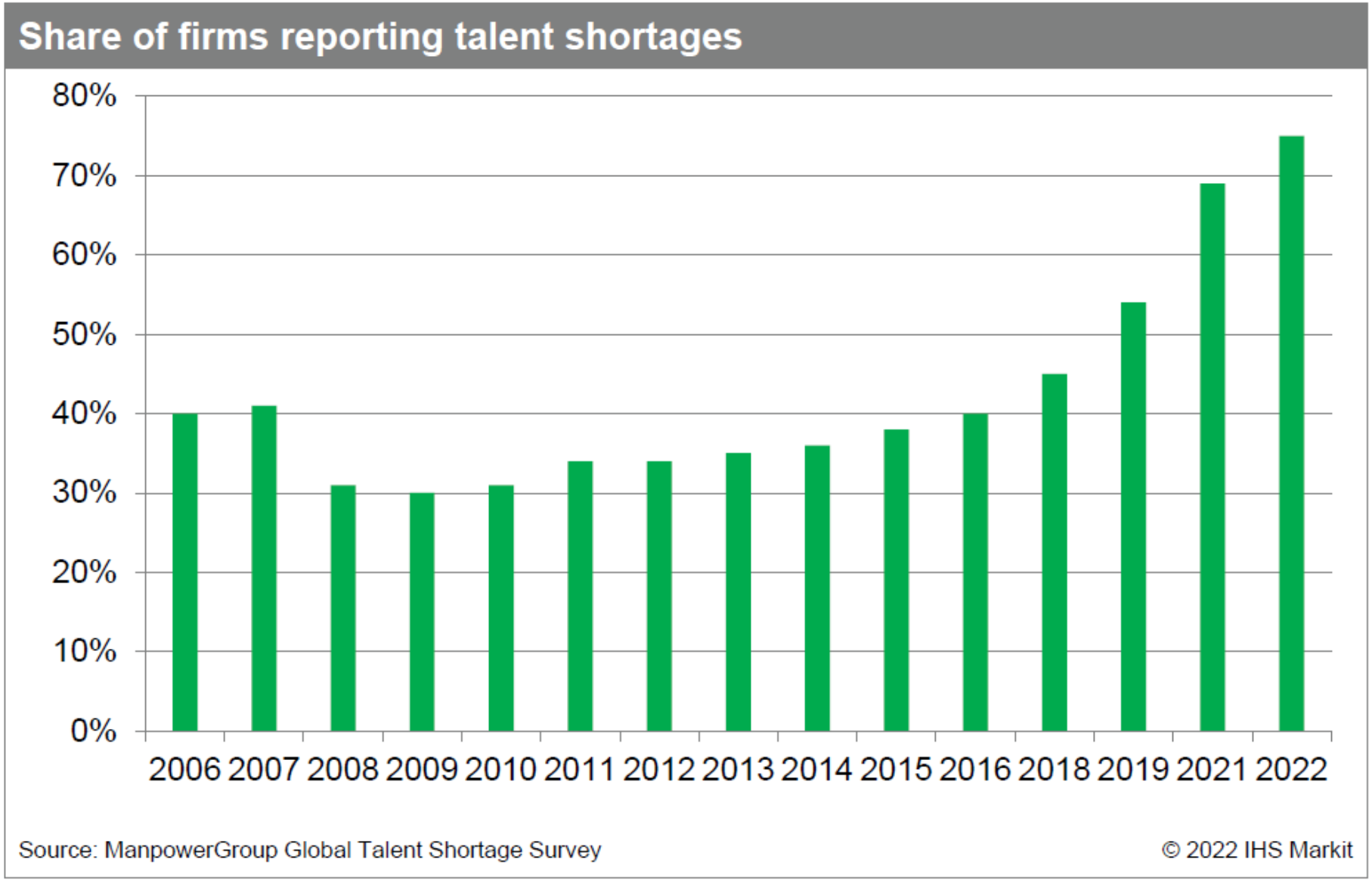
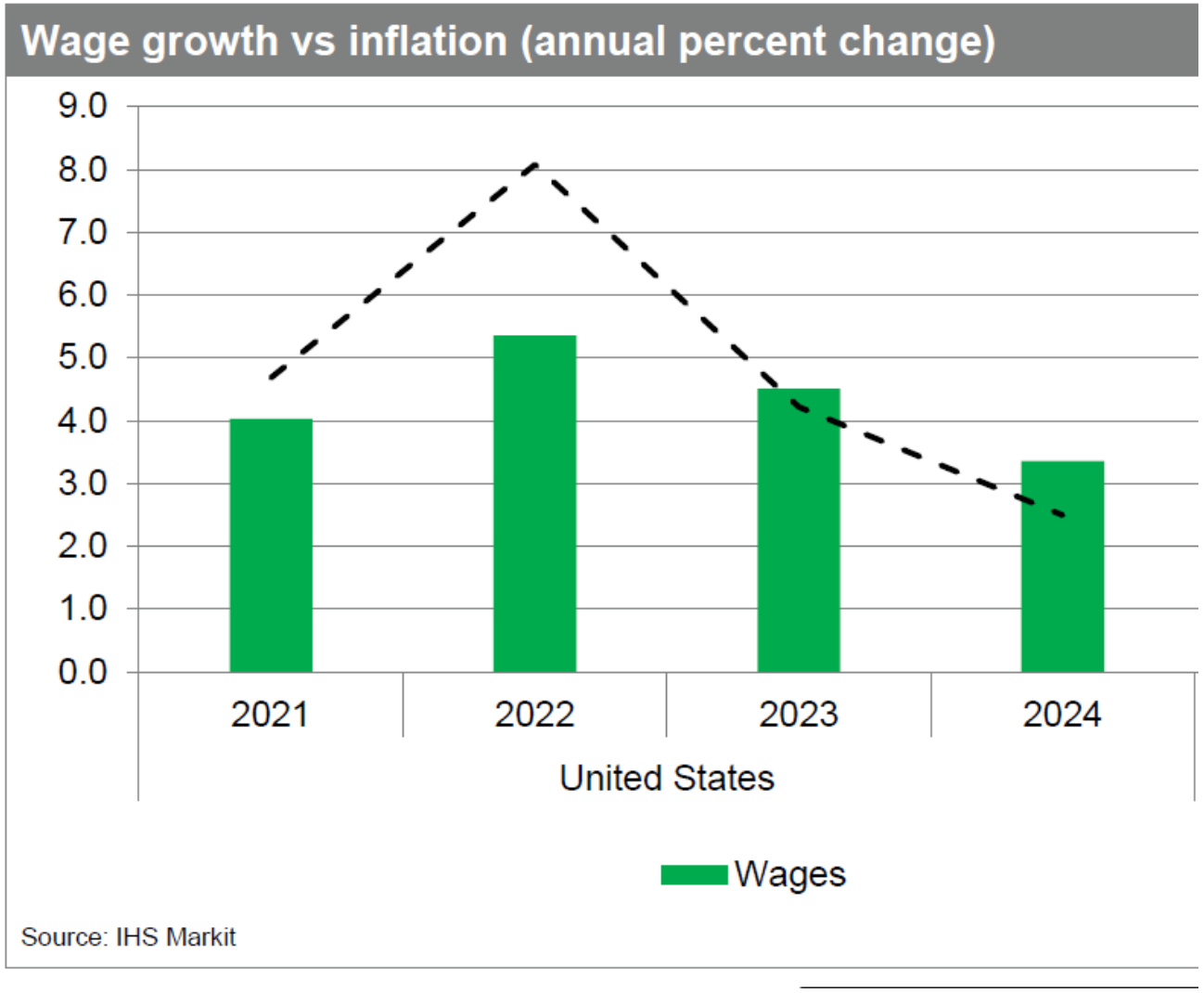
Significant Labor Shortages



Wage Growth Will Remain Elevated into 2023, Easing 2024



Price Volatility

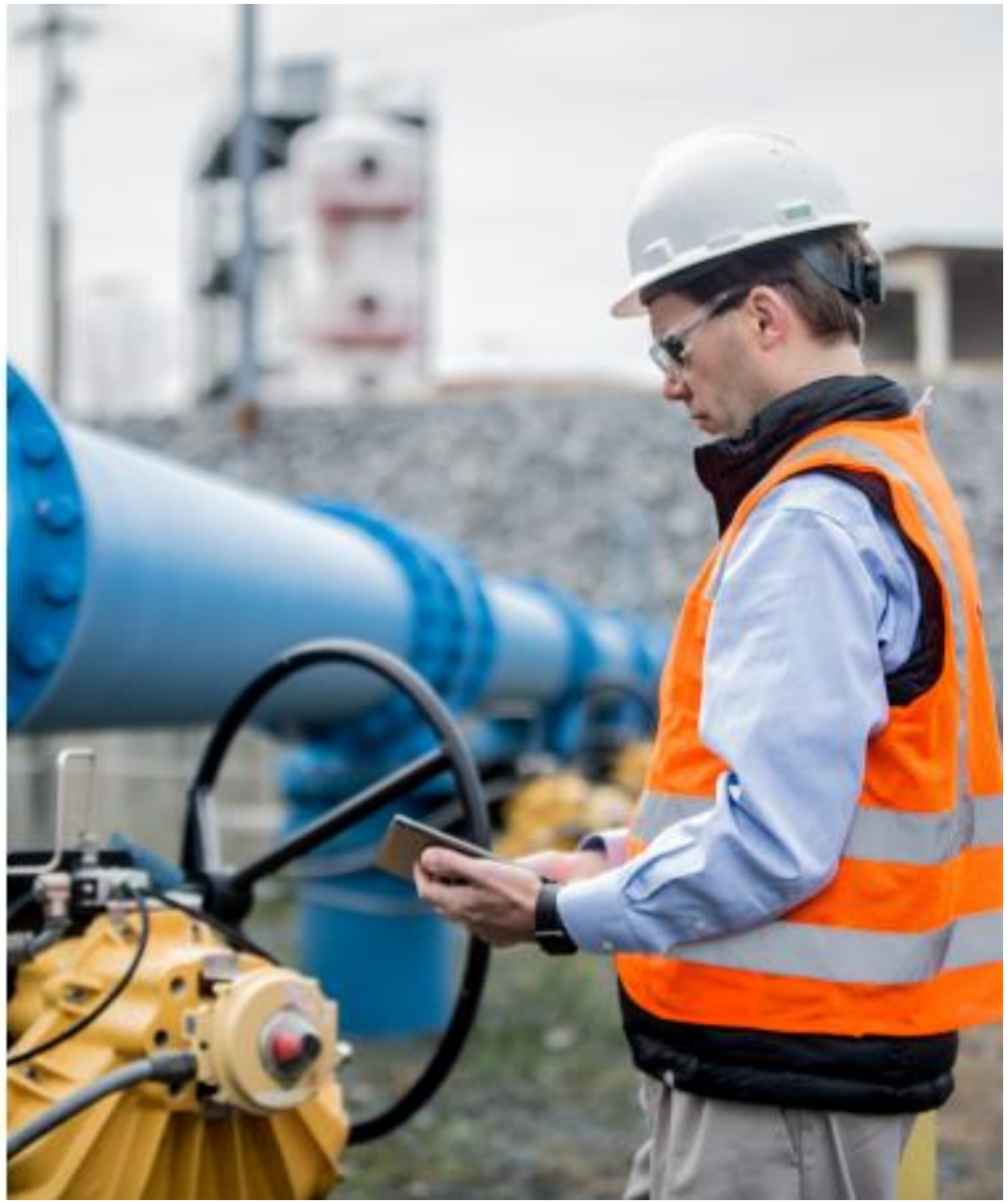
AGC REPORTS

- Drastic shortening of producers to hold their prices
- Monthly price increases
- 1-day to 5-day price guarantee
- Price-increase on steel the day after the increase took effect

Bidding Environment

JUNE/JULY 2021

- **Solids Handling**
  - OPCC $137.5M / Low Bid 179.8M = 23.5%
    Higher than OPCC = $42.3M
  - Spread 3 bidders – Low to High 20.3%
- **Dam Removal**
  - OPCC $14.5M / Low Bid $18.1M = 24.4%
    Higher than OPCC = $3.5M
  - Spread 5 Bidders – Low to High 47.6%
- **Water Treatment – Filter Upgrade**
  - OPCC $165M / Low Bid $235M = 42.4%
    Higher OPCC = $70M
  - Spread 2 Bidders – Low to High 6.4%



Infrastructure Bill

Administration – Requires Steel Act and Buy American (April 2022)

NEW + BASELINE CONSTRUCTION – RELATED FUNDING INCLUDED IN THE SENATE INFRASTRUCTURE BILL

ROADS & BRIDGES
$351B

TRANSIT
$146B

PASSENGER & FREIGHT
$102B

WATER INFRASTRUCTURE
$60B

BROADBAND
$45B

AIRPORTS
$45B

PORTS & WATERWAYS
$17B

POWER & GRID
$17B

ELECTRIC VEHICLE INFRASTRUCTURE
$7.5B

AGC THE CONSTRUCTION ASSOCIATION

Russian Invasion of Ukraine

S&P REPORTS

- **Everything Changed**
  - Many Metals at Multi-Year Highs – Steel, Aluminum, Neon
  - Beware of Supply Shocks – Steel Will Be Major Issue (Supply and Raw Materials)
  - Electrical Steel – Motors, Generators, Transformers – Supply Shortage and Extreme Price Increase
  - Ports, Rail, and Truck Backlog Still Exist
  - Pig Iron (Use in Steel/Castings Mfg) – Russia Exports 40% and Ukraine Exports 20%
  - Aluminum – 34-Year High at $3,500mt – Could Go to $4,000mt
  - Manufactured Equipment is Peaking
  - Year of Year Change:
    - Transformers 25.3% Y/Y and 58.2% 2 years
    - Motors/Generators 15.5% Y/Y and 23.8% 2 years
    - Pumps and Compressor 16.1% Y/Y and 24.3% 2 years
    - Fans and Blowers 14.2% Y/Y and 33.7% 2 years

Buy American Act – Impacts to Projects

- Required if State or Federal loans are used.
- Steel – from melting process through the coating process.
- To be manufactured in the United States if the cost of components mined, produced, or manufactured in the United States accounts for at least 55% of the cost of all components or the end product.
- EPA has set up a separate group for reviewing wavers – which may be more difficult to obtain.

- Includes
  - Steel Products
  - Any item Manufactured from Steel
  - Non-Ferris metals (Copper, Aluminum)
  - PVC and Polymers
  - Glass
  - Lumber
  - Drywall

- Not required
  - Ready-mix concrete
  - Aggregate
- Include in OPCC:
  - 10% to 15% on qualified materials
  - Contractor – 1 Full-Time Person for 6 months to handle the paperwork on $25M job.

Inputs to Market Volatility Adjustment Factor

- Supply-chain issues
- Price volatility
- Transportation issues
- Labor shortages
- Labor premiums to keep craft labor (+$5/hr to +$8/hr)
- Longer than normal lead times (ductile iron pipe 6-9 months)
- Covid-19 mandates
- Russian invasion of Ukraine
- China lockdown – 412 Ship
- Factor 3% to 20% - This is in addition to Escalation.

Best Practices for the Current Environment

Addressing Current Market Conditions

- Use Local Published Data (Ex. Saylor Consulting in San Francisco)
    - Recommending 5% per year escalation rate
- Check Labor Conditions and Material Price Trends
- Check Schedule and Site Constraints
- Update all Capital Plans with Escalation and Market Volatility Adjustment Factor
- Keep track of historical bids

KEY ACTIONS:

- Ensure proper Design Contingency at each design phase
- Properly calculate escalation using realistic milestones – for materials and labor
- Include a market volatility adjustment factor – 3% to 20% for pricing and supply-chain issue

Pete's Perspective

- **Not a short-term problem**
- Volatility – Combination of material prices, supply-chain issues, price uncertainty
- Suggested actions:
  - Update any OPCC older than 1 year
  - Update the final estimate prior to the bid date
  - Get updated process equipment or pipe quotes
  - Encourage Owners to budget for change orders and include escalation clauses

Questions