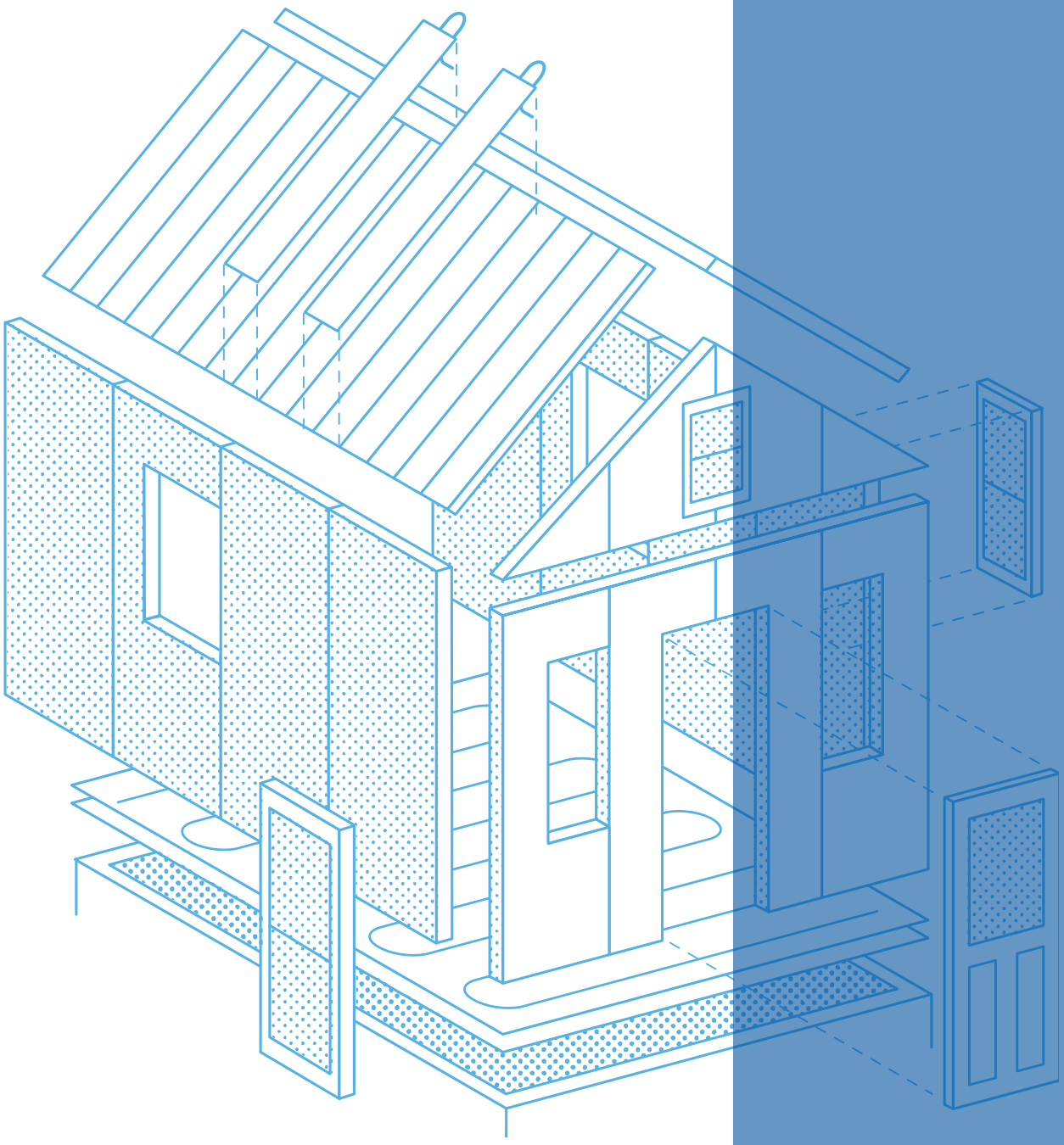


Everything you need to know about SIPs

BASF
The Chemical Company

What are SIPs?

Ready made. High-performance. Contributors to stronger, more energy efficient, comfortable, cost-effective homes and buildings. Is it any wonder that Structural Insulated Panels (SIPs) are rapidly gaining in popularity within the new construction market?

SIPs are walls, roofs, floors and foundations made of panels consisting of a rigid foam insulation core sandwiched between two structural skins. The seamless, closed-cell rigid foam core helps reduce air leakage and thermal bridging through the panels by providing a continuous span of insulation. BASF SIPs core technologies include:

- STYROPOR® expandable polystyrene (EPS)
- ELASTOPOR® and AUTOFROTH® polyurethane
- Custom formulations from BASF Polyurethane Foam Enterprises LLC
- Polyisocyanurate

BASF ELASTOTITE® polyurethane adhesives are used to glue EPS foam cores to the structural skins.

Standard panels are available in 4’ x 8’ or 8’ x 24’ configurations. Thicknesses typically range from 4.5” to 12.25” but custom sizes and thicknesses are also available. Once manufactured, the panels are shipped directly to the construction site for fast and easy installation.

How are they made?

Panels begin life in the factory. CAD drawings of the structure to be built are converted to shop drawings, which are then plugged directly into computer numerical control (CNC) fabrication machines or are used to measure and cut the panels by hand.

Special channels (chases) are cut into the foam to allow for the electrical wiring, and the insulation core is recessed around the edges to accept the connection splines or dimensional lumber used during construction.

BASF offers AUTOFROTH® SL dispensing equipment for polyurethane foam SIPs, with a low capital investment and proven field performance at hundreds of locations across North America. BASF Polyurethane Foam Enterprises also offers custom-built equipment to fit your exact needs.

Are SIPs cost effective?

Building with SIPs offers cost advantages to the builder in terms of speed of construction and reduced labor requirements. Panels are pre-manufactured to exact specifications so they arrive ready to install and come together quickly.

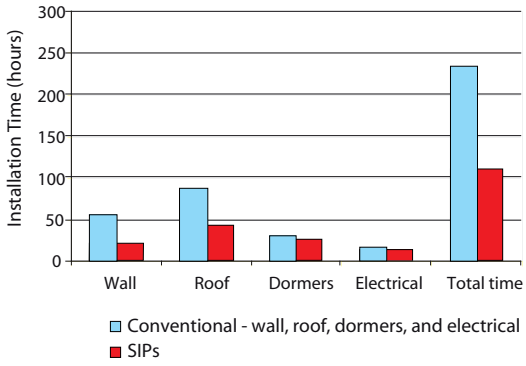
A recent Time & Motion study conducted by Reed Construction Data RSMeans Business Solutions showed that utilizing SIPs reduced installation time by 130 labor hours. When compared to RSMeans labor hours for a conventionally framed home, this labor requirement is equivalent to time savings of approximately 55 percent.[1]

The house used for the study was a two-story, three-bedroom, 1,176-square-foot, cape-style home with three dormers on a 12/12-pitch roof. RSMeans cost data was used to benchmark the time and cost for erecting conventionally-framed stud walls, roofs and dormers using exterior sheathing and fiberglass batt insulation.

Thanks to this speed of construction, SIPs projects are dried-in sooner. There are fewer hand-offs between trades so crews are more productive – no more waiting for the insulation group to come in after the framers, or for the sheathers to come after the insulators.

SIP walls are flat and don't warp, expand or contract, so doors and windows go in quickly as designed. All wall intersections are true so cabinets install fast. It all adds up to reduced special field adjustments and lots of saved time. Perhaps most importantly, these technologies can help reduce call-backs, keeping crews moving forward to the next project and improving overall productivity.

Chart for Actual Installed Time Comparison (hours)



Component	SIP-Built	2"x4" Stick-Built
Wall	24.8	78.12
Roof	50.8	117.48
Dormer	31.33	41.87
Electrical	18.76	21.11
Total Labor Hours	125.69	258.58

Breakdown of labor requirements

Component	SIP-Built	2"x4" Stick-Built
Wall	$1,372 ($0.97/ ft^2)	$3,331 ($2.37/ft^2)
Roof	$2,816 ($1.63/ft^2)	$4,498 ($2.60/ft^2)
Dormer	$1,735 ($2.86/ft^2)	$1,765 ($2.91/ft^2)
Electrical	$870	$979
Total Labor Cost	$6,793	$10,573

Breakdown of labor costs

Are SIPs sustainable?

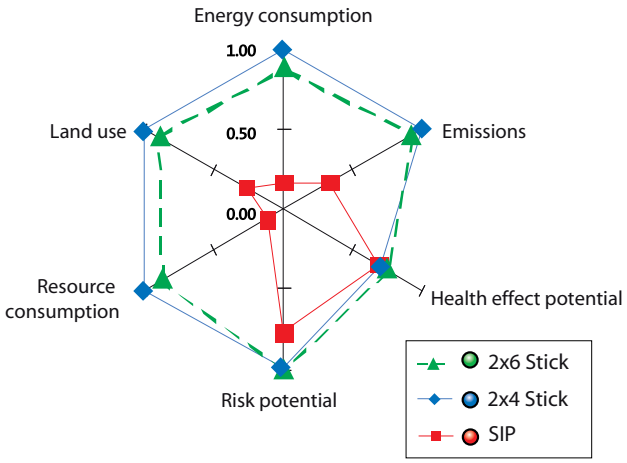
SIPs help raise the social, economic and environmental responsibility of homes and buildings, making a significant contribution toward true sustainability.

The award-winning[2] BASF Eco-Efficiency Analysis studies alternative solutions to include a total cost determination and the calculation of economic and ecological impact over the entire lifecycle of a product or system. In a recent evaluation of residential insulation systems, the SIP-built structure made with EPS cores and OSB facers was the clear winner over 2x4 stick construction with fiberglass batt insulation and 2x6 stick construction with fiberglass batt insulation.

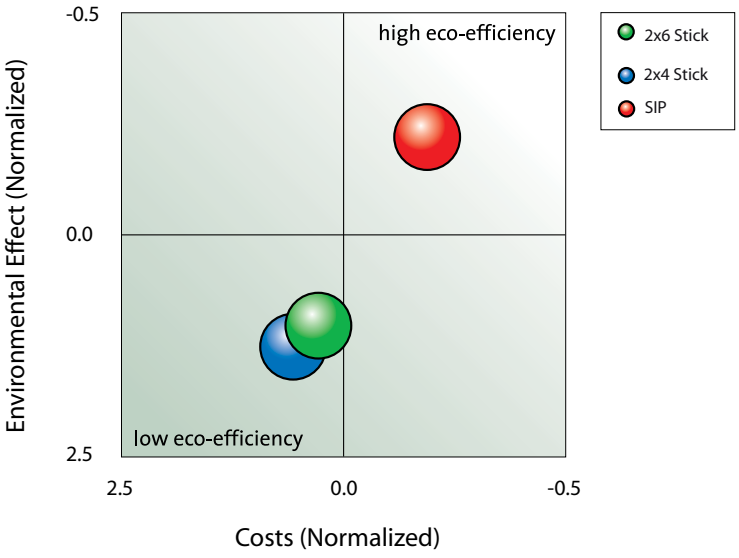
Key contributors to the performance of SIPs in this study include:

- Reduced heating and cooling loads over lifetime of home
  - High R-value
  - Low air leakage rate
- Low environmental impact of materials
- Low maintenance requirements
- Lightweight materials reduce transportation fuel use

Overall ecological footprint results by insulation system. 1.0 = worst position (the lower the score, the higher the eco-efficiency)

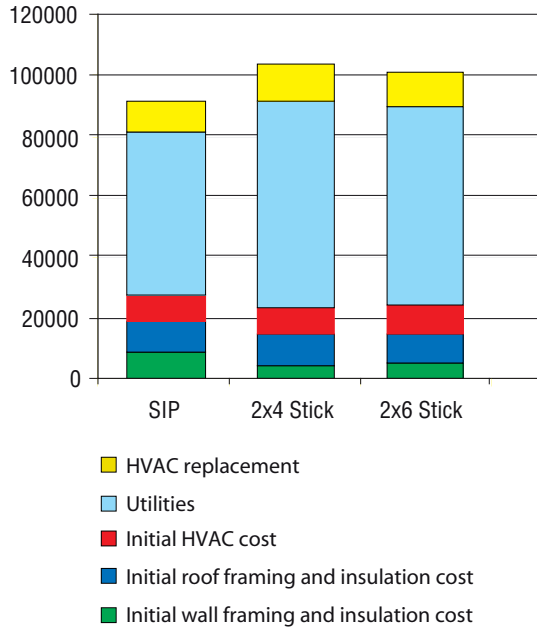


Eco-Efficiency Analysis results for the construction and 60-year use of the walls and roof of 1,100-square-foot, ranch-style, slab-on-grade home, located in the northeastern U.S.



Criteria			
1.0 = worst position, better results = <1	SIP	2”x4” Stick	2”x6” Stick
Energy Consumption	0.20	1.0	0.80
Resource Consumption	0.20	1.0	0.80
Emissions	0.40	1.0	0.90
Health Effect Potential	0.60	0.70	0.70
Risk Potential	0.70	1.0	1.0
Land Use	0.30	1.0	0.90

Overall lifecycle cost results by insulation system.



In addition to its Eco-Efficiency performance, BASF STYROPOR EPS used as SIP cores is GreenGuard® indoor air quality certified and a cradle-to-cradle (C2C) technical nutrient assessed by MBDC (McDonough Baumgart Design Chemistry).

For more information on the Eco-Efficiency Analysis methodology or to obtain detailed results, please visit www.basf.com/usa.

Do SIPs contribute to building performance?

SIPs help deliver on several key benefits that help you give your customers a better home or building.

Energy efficiency

SIPs combine superior insulation with near-zero air leakage to maximize the performance of the building envelope and allow HVAC systems to operate more effectively. You also get:

- Reduced energy consumption[3]
- Lower energy bills
- 90 percent less air leakage than stick-framed structures
- No thermal bridging or convection looping

SIPs make such a large contribution to energy efficiency that two of the first three LEED® Platinum homes in the United States were built with SIP envelopes. ENERGY STAR® exempts SIP-built homes from the 17-point thermal bypass insulation inspection and blower door tests required for qualification in the program.

Whether your goal is 'green' or avant garde design, disaster resistance or near-zero energy, SIPs bring several key benefits to your project.

Durability

SIPs help improve structural strength for resistance to natural disasters. You also get:

- Structural characteristics similar to a steel I-Beam
- Superior structural stability with stiffness, strength, and predictable performance
- Lower maintenance requirements

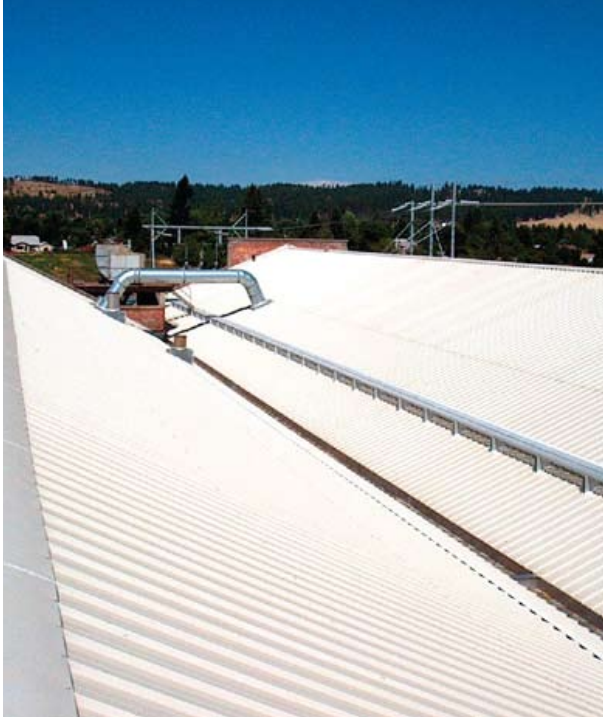
SIPs make it easy to build a home that is designated *Fortified...for safer living*®, making it eligable for significant reductions in insurance premiums. In fact, the *Fortified...for safer living* program is sponsored by the Institute for Business & Home Safety, an insurance industry initiative.

Occupant comfort, health and safety

SIPs help make indoor environments healthier, safer, more comfortable and more enjoyable. You also get:

- Increased control over temperature and humidity levels – the upstairs of a SIP house is rarely more than one degree warmer than downstairs
- Significantly reduced drafts
- Improved sound transfer control – even near airports, highways and inner urban areas
- Improved indoor air quality with low VOCs or infiltration of allergens or pollutants (the American Lung Association and the Environmental Protection Agency [EPA] both recommend that houses be built airtight to help improve indoor air quality)

SIPs help reduce the risk of mold growth by stopping condensation and moisture movement within the walls. Foam core materials like polyurethane and polystyrene are almost water impermeable and do not offer a food source for mold.



Affordability

SIPs help make homes and buildings more affordable to own. In 2005, the average household spent $4,443 on energy[4]. SIPs help significantly reduce energy consumption and reduce that average household's annual energy cost by as much as $2,665. You also get:

- Lower construction costs
- Lower landfill feeds through reduced construction waste
- Lower maintenance requirements
- Ability to downsize HVAC equipment at the design phase

Because of their supreme energy efficiency, many SIP projects are eligible for special mortgage rates and government incentives. And thanks to the inherent durability of SIP-built structures, maintenance requirements are lower.

Design freedom

Rounded roofs, arched windows and other complex designs are made simple with engineered SIPs. The manufacturing process means that no design element is too hard to accomplish. You also get:

- CNC cutting machines capable of cutting almost any shape or size of panel
- Reduced complexity of measurement and mathematics
- Open and airy feel with no need for false ceilings
- Ability to maximize daylighting design techniques

Even interior decorators get added freedom. Hang a picture anywhere on the wall. No more searching for – and being confined to – a supporting stud to secure the nail. Instead, just pick the spot that looks best.

Types of SIPs

There are three main types of SIPs, although the SIPs themselves can be encased in different outer materials called facers or skins. The inner insulation core is usually made from expandable polystyrene (EPS), polyurethane or polyisocyanurate. Each delivers a strong, light building material with exceptional insulation properties.

How do they compare?

EPS cores offer a nominal R-value of R-4 to R-5 per inch (2.5 cm) and tend to be the lowest-cost option. Polyurethane and polyisocyanurate cores can be more expensive than EPS, but offer a nominal R-value of R-6 to R-7 per inch (2.5 cm). The assembled R-value of the panels may vary depending on type of skin or facer used.

Types of SIP skins

Most SIPs feature OSB as the skins or facers that encompass the inner foam insulation core of the panel. But other skins are available, including:

- Metal
- Fiber cement
- Fiber reinforced concrete
- Plywood
- Gypsum board

OSB is made with layers of precision-manufactured wood “strands” that are aligned, formed into panels and then pressed with an exterior grade adhesive resin such as LUPRANATE® isocyanate, a formaldehyde-free binder. It offers high-quality at a cost-effective price and delivers uniformity, strength and versatility (OSB SIPs require a 0.5-inch gypsum wallboard covering as a fire thermal barrier).

Metal skins offer an increased range of design possibilities for profiles, textures and colors, as is available in the steel roll-forming industry. Metal- and cementitious-faced SIPs are not subject to wood rot or termites.

BASF ELASTOTITE® polyurethane adhesives provide a bond between EPS foam cores and all types of skins used in SIPs.

Sealants finish the job

Insulating air sealants – such as BASF single- and plural-component polyurethane foams – are installed from within the building structure to seal and insulate ‘hard-to-build’ areas, such as windows, doors, penetrations, parapets and soffits to create insulating air barrier system continuity from the foundation up through the walls and across the roof.

ZERODRAFT® insulating air sealants are commonly used with SIPs to help join panels together quickly, increase energy efficiency and increase structural strength.

Expandable Polystyrene

Facer	Adhesive

OSB

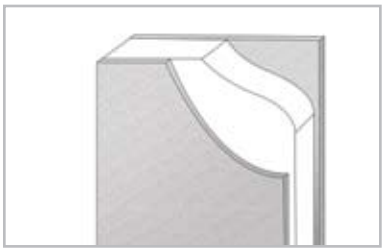
polyurethane/emulsion polymer

Metal

polyurethane/emulsion polymer

Plywood

polyurethane/emulsion polymer

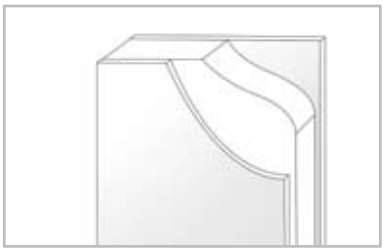


Fiber cement

polyurethane/emulsion polymer

Fiber reinforced polyester

polyurethane/emulsion polymer



Gypsum

polyurethane/emulsion polymer

Polyurethane

Facer	Adhesive

OSB

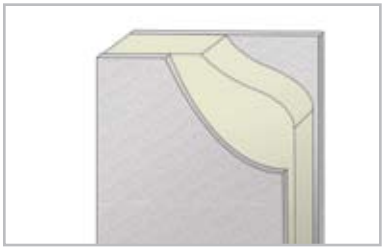
self-adhering

Metal

self-adhering

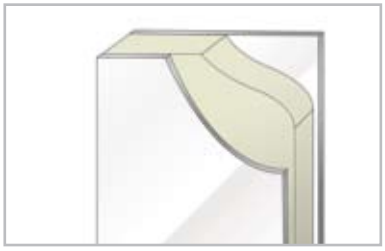
Plywood

self-adhering



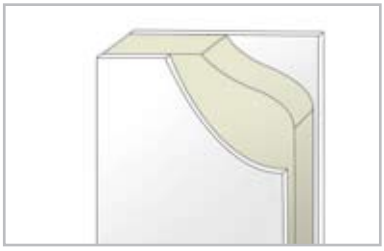
Fiber cement

self-adhering



Fiber reinforced polyester

self-adhering



Gypsum

self-adhering

The role of the world's leading chemical company

BASF products are found almost everywhere in a building. Chemistry makes a significant contribution to the highest levels of energy, environmental and economic performance of buildings.

BASF chemistry contributing to the performance of SIPs can include:

- STYROPOR® EPS foam cores
- ELASTOPOR® or AUTOFROTH® polyurethane foam cores
- Custom-formulated polyurethane foam cores
- ELASTOTITE® polyurethane adhesives
- ZERODRAFT® single- and plural-component insulating air sealants
- LUPRANATE® formaldehyde-free binders for engineered wood and OSB
- Fiber reinforced facers

www.HighPerformanceCommunity.com

www.basf-pfe.com

www.basf.com/pur-construction

www.plasticsportal.com

www.BetterHomeBetterPlanet.com

1 BASF Corporation Time & Motion Study November 2006, Submitted to BuildingInsight, LLC. Conducted by Reed Construction Data/RSMeans
2 In 2005, the BASF Eco-Efficiency Analysis process won three major awards of interest to the building and construction industry: the Design for Sustainability Award (Society of Plastics Engineers), the Presidential Green Chemistry Challenge Award (U.S. Environmental Protection Agency), and the Best Sustainable Practice Award in the Sustainable Research, Development, Construction Process and Demonstration (Sustainable Buildings Industry Council).
3 Energy Savings from Small Near-Zero-Energy Houses, Oak Ridge National Laboratory, 2002
4 OCTOBER 2006 METRO ECONOMIES REPORT, HOUSING AND ENERGY OUTLOOK, Household Budgets in the U.S. and Its Metro Economies: Energy and Housing Costs, United States Conference of Mayors

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