

# **Advanced Energy & American Manufacturing: An Economic Impact Analysis**

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Advanced Energy Economy  
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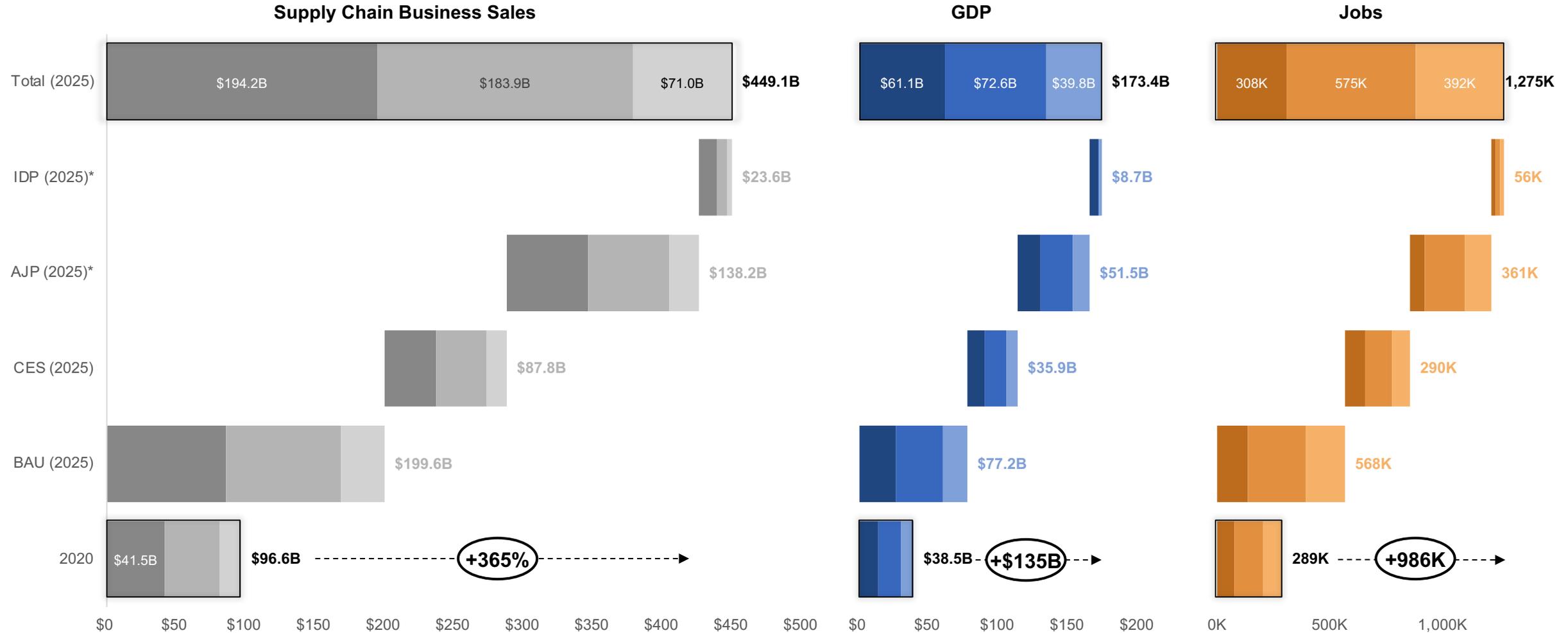
# Executive Summary

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1. As of 2020, Advanced Energy generated \$240B in U.S. Revenue, according to the AEE's latest Market Report. For the purpose of this analysis, we examined a subset of advanced energy technologies (AETs) to explore their role in the US manufacturing sector and the impact of potential federal policies.
2. The AETs examined in this report generate \$61.2B in direct business sales, of which domestically-produced units account for over two-thirds of market share. Most of the AETs analyze herein have more than 55% of their units produced in the US, comprising a \$41.6B domestic market the contributes to the economy
3. The supply chain business sales for AETs in 2020 is \$96.6B, contributing \$38.5B in GDP and 288,800 jobs
4. Under a business-as-usual scenario, the market for AETs is expected to grow two-fold, from \$41.6B of direct business sales of domestically-produced units in 2020, to \$85.8B in 2025
5. With the introduction of a Clean Energy Standard, the market for AETs could triple in size, from \$41.6B of direct business sales of domestically-produced units in 2020, to \$122.9B in 2025
6. The American Jobs Plan estimates an expenditure on AETs of \$408B, of which \$293B could be used for the purchase of domestically manufactured units. The American Jobs Plan boosts the sector by contributing an additional \$51.5B GDP and 361,000 jobs to the economy each year for five years
7. Increasing the domestic production of Smart Grid Communications Devices and DG Solar increase per-unit costs by 4.6% and 4.2%, which translates to a \$1B premium. Increasing domestic production of Smart Grid Communications Devices and DG Solar creates an additional \$8.7B in GDP and 56,000 jobs per year
8. If planned policies are implemented, the advanced energy manufacturing sector could grow 365% in five years, creating nearly a million additional jobs

# Summary: if planned policies are implemented, the advanced energy manufacturing sector could grow 365% in five years, creating nearly a million additional jobs

Planned policies of the CES, American Jobs Plan, and Increasing Domestic Production compound on the sector's BAU growth.



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# This study set out to analyze the economic impacts on domestic production of Advanced Energy Technologies (AETs) under the proposed American Jobs Plan

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The proposed American Jobs Plan, which includes a national Clean Energy Standard (CES), aims to spur grid decarbonization and transportation electrification. In doing so it should grow the advanced energy manufacturing (AEM) sector in the US. This study examines four questions to explore the nature and magnitude of that impact on domestic AEM:

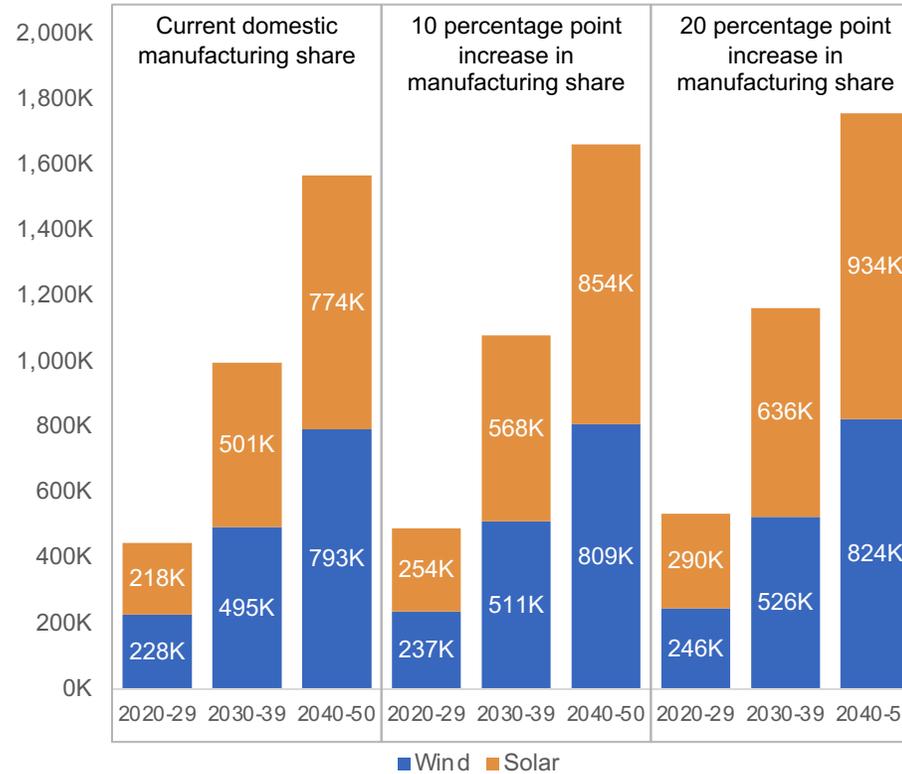
1. What is the current state of domestic AEM, and how does it affect the U.S. economy today and into the future?
2. What effects would implementation of Clean Energy Standard (CES) have on domestic AEM?
3. What effects would federal investment in advanced energy infrastructure, akin to the American Jobs Plan (AJP), have on domestic AEM?
4. If the percentage of domestic production were raised for specific advanced energy technologies, what would the impact be on the U.S. economy?

# Primer: analysis from Princeton University indicates that the increasing domestic manufacturing of utility-scale solar and wind products could spur job creation

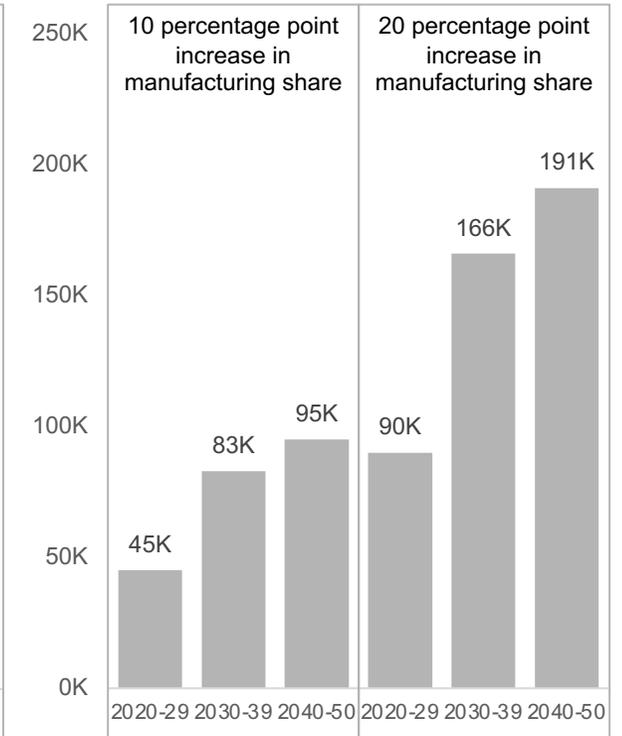
Researchers from Princeton University analyzed the average wage and current domestic manufacturing share as they relate to utility-scale solar and wind products. The study considered a scenario where the domestic manufacturing share of solar and wind products was increased by 10-percentage points across the supply chains. This resulted in the potential to support an additional 45,000 jobs annually in the 2020s.

The study also considered the collection of practices and policies that could be put in place to support the growth of labor and domestic manufacturing capacity. This included local hiring requirements, prevailing wage standards, unionization, gender and racial equity hiring requirements, workforce development and training. For instance, it found that increasing occupational wages by 10% generates \$5B in additional wages, equivalent to \$12-13k increase per worker.

**Average annual employment (thousand jobs)**



**Net average annual employment (thousand jobs)**



This report will now build off this work by Princeton University to expand the scope to consider other Advanced Energy Technologies (AETs).

# Advanced Energy Technologies (AETs) scope and definitions

For the purposes of this study, a subset of eight Advanced Energy Technologies (AETs), which encompass both grid decarbonization and transportation electrification, were selected. Broadly speaking, these technologies fall into the categories of energy efficiency (heat pumps, building controls, water heaters), renewable generation (DG solar) transportation electrification (EVs and DC charges), and smart grid (grid communications and AMI). This is not an exhaustive set of all AETs and complements the analysis of utility-scale wind and solar in existing literature<sup>1</sup>.



## Distributed Generation (DG) Solar

Includes commercial and residential solar photovoltaic panels.

- **NAICS 334413** Solar Cells Manufacturing



## Heat Pumps

Includes commercial and residential air source heat pumps, air-to-water systems, and air-to-air systems

- **NAICS 333415** Heat Pump Manufacturing (100%)



## Smart Grid Communications

Includes switches, routers, and other network infrastructure

- **NAICS 334111** Computer Servers (30%)
- **NAICS 334210** Data Communications Equipment (bridges, gateways, routers) Manufacturing (15%)
- **NAICS 334220** Communications Equipment, Mobile and Microwave Manufacturing (55%)



## Electric Vehicles (EVs)

Includes Battery Electric Vehicles (BEVs), Plug-in Hybrid Vehicles (PHEVs), and Fuel Cell Vehicles

- **NAICS 336111** Electric Automobiles for Highway Use Manufacturing (100%)



## Building Controls

Includes advanced thermostats, lighting controls, and smart plugs that monitors and manages buildings, in commercial and residential use.

- **NAICS 334210** Data Communications Equipment (bridges, gateways, routers) Mfg (25%)
- **NAICS 334512** Building Services Monitoring Controls, Automatic, Manufacturing (75%)



## Advanced Metering Infrastructure (AMI)

Includes commercial and residential smart meters devices that measure energy consumption of electricity, gas, and water

- **NAICS 334514** Consumption Meters (e.g. gas, water) Manufacturing (100%)



## DC Chargers

Includes Direct Current Fast Chargers (DCFC) and Level 3 EV chargers

- **NAICS 335999** Semiconductor Battery Chargers Manufacturing (100%)



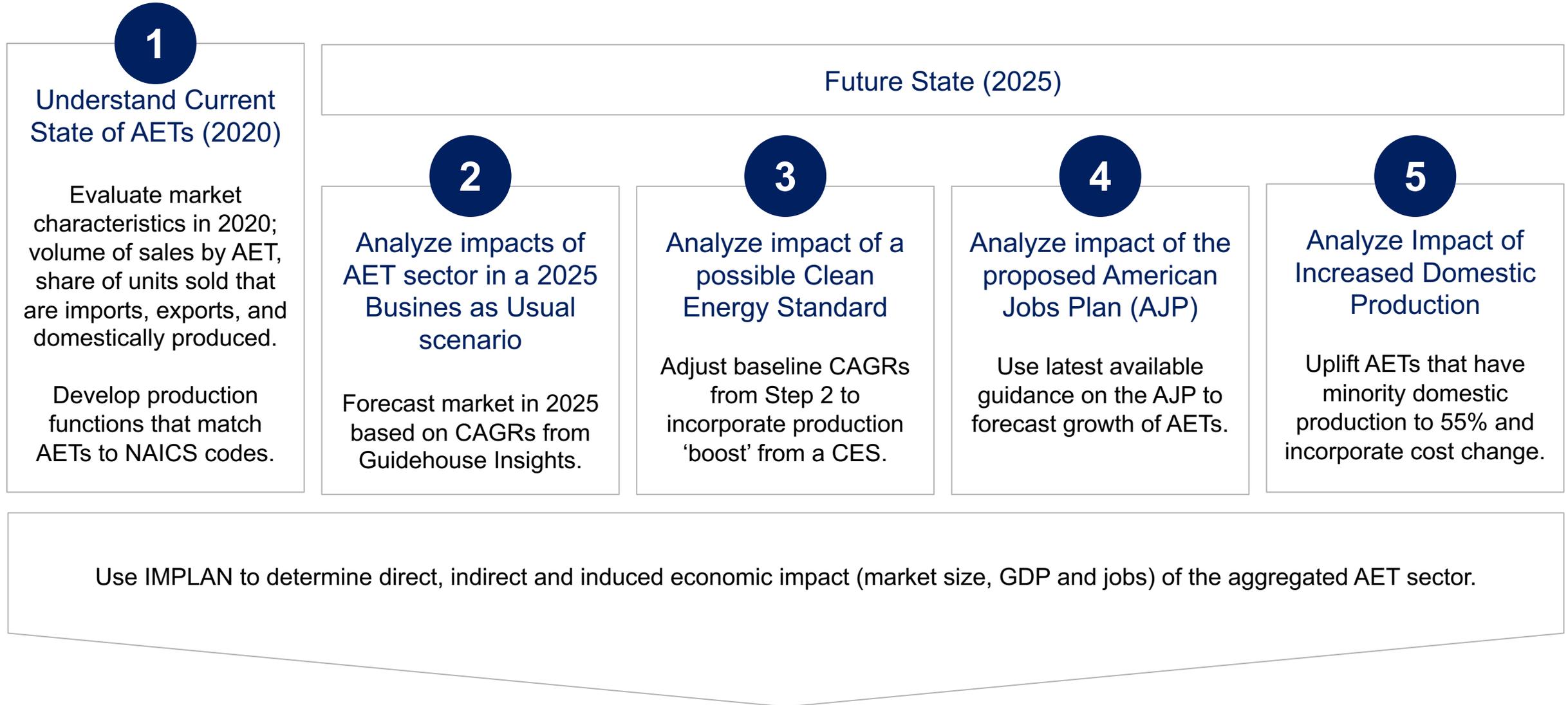
## Water Heaters

Includes commercial and residential electric water heaters.

- **NAICS 333318** Water Heaters (except boilers), Commercial-Type, Manufacturing (15%)
- **NAICS 335220** Hot Water Heaters (including nonelectric), Household-Type, Manufacturing (85%)

<sup>1</sup>E.N. Mayfield and J.D. Jenkins (2021), *Influence of high road labor policies and practices on renewable energy costs, decarbonization pathways, and labor outcomes*. Princeton University [https://netzeroamerica.princeton.edu/img/Working\\_Paper-High\\_Road\\_Labor\\_and\\_Renewable\\_Energy-PUBLIC\\_RELEASE-4-13-21.pdf](https://netzeroamerica.princeton.edu/img/Working_Paper-High_Road_Labor_and_Renewable_Energy-PUBLIC_RELEASE-4-13-21.pdf)

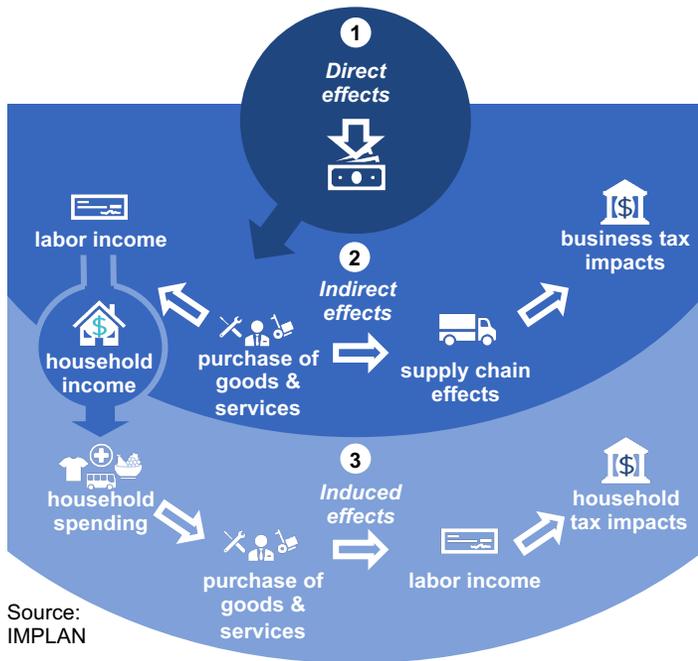
# We employed a five-step process to analyze the economic impacts of Advanced Energy Technologies (AETs) under various scenarios



# Economic impact analysis allows us to understand the direct, indirect and induced effects of the American Jobs Plan on domestic advanced energy manufacturing

In this study, input-output economic impact analysis was employed. While other techniques exist, this method was chosen because the primary focus of the analysis is the economic impacts of spending on AET's at two different snapshots in time, current (2020) and future (2025), for which this method is appropriate and sufficient.

Input-output analysis models how money through a supply chain circulates through the economy; the effects are categorized into direct, indirect, and induced. This analysis results in three types of metrics referenced in this report; business sales, Gross Domestic Product (GDP), and jobs.



## Type of impact

## Example

<b>Direct Effects</b> resulting from direct spending	Spending on purchase of Advanced Energy Technologies
<b>Indirect Effects</b> resulting from industries purchasing from each other	Spending on materials, components and services
<b>Induced Effects</b> resulting from household spending of labor income	Spending on housing, healthcare, transportation, food, retail and entertainment by workers

## Metrics used in this report

-  **Supply Chain Business Sales**
-  **Gross Domestic Product**
-  **Jobs**

Sales of goods and services across the supply chain. Direct business sales are a subset of this and refer to the sales of AETs themselves

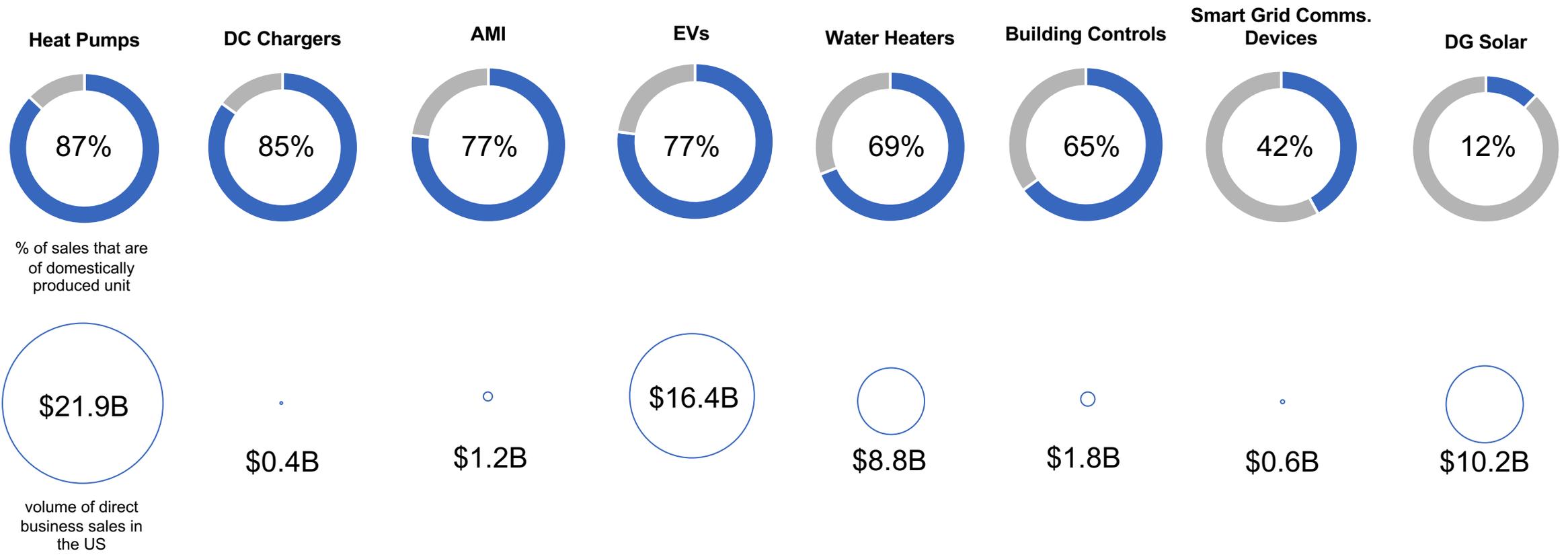
The sum of the value added or 'premium' created from each stage of the supply chain

The number of jobs created from the supply chain activity stimulated through expenditure

# Current State 1: AETs generate \$61.2B in direct business sales, of which domestically-produced units account for over two-thirds of market share

For the AETs in scope, the vast majority sold are manufactured in the United States, accounting for \$41.6B (nearly two thirds of the \$61.2B market). Of these, most AETs have at least 55% stem from domestically produced units. The exceptions are Smart Grid Communications Devices (42%) and Distributed Generation Solar (12%), with combined sales of \$10.8B of which only \$1.4B are domestically produced.

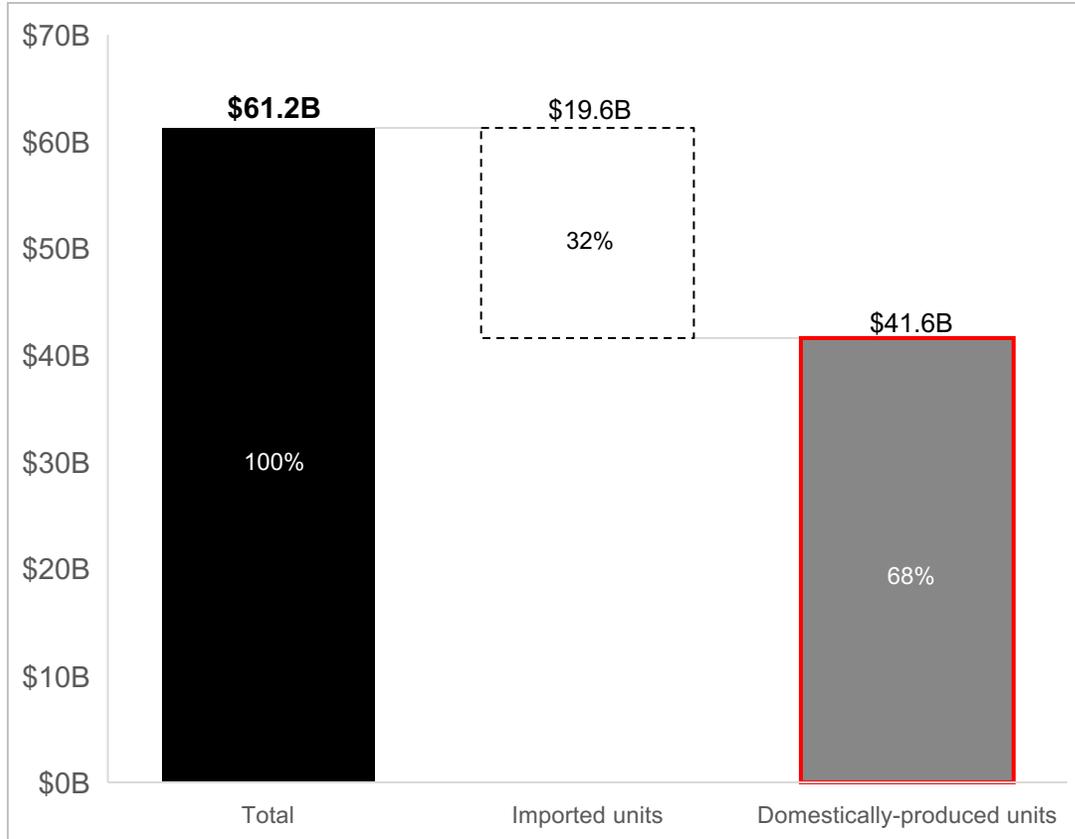
For the purposes of this study, “domestically-produced” is used to refer units that have their final assembly occur within the United States. It does not refer to the countries of origin of the unit’s content.



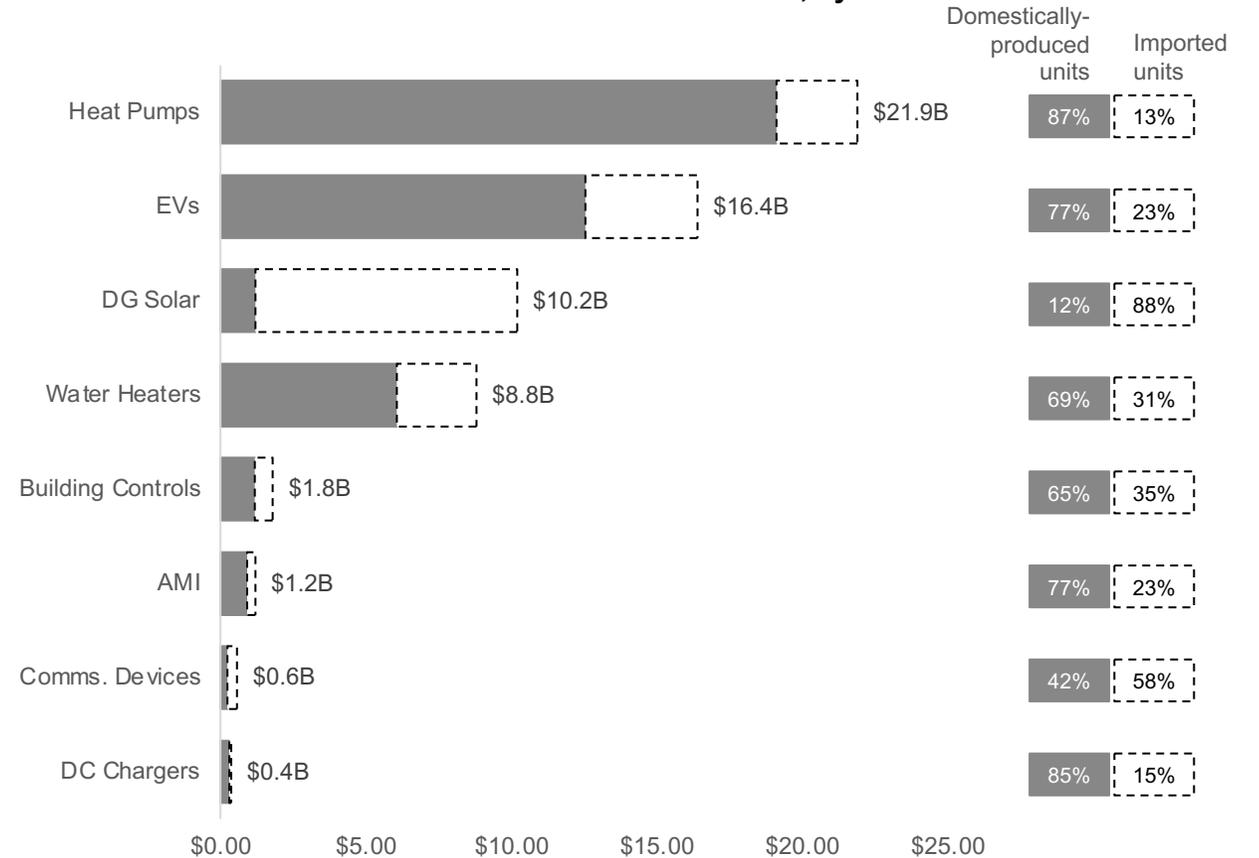
# Current State 1: most AET categories have more than 55% of their units produced in the US, comprising a \$41.6B domestic market the contributes to the economy

Many AET categories have significant shares of domestic production – most notably heat pumps (87%) and DC chargers (85%). This domestic production accounts for over two thirds (68%) of the volume of direct business sales of these AETs in the US, with the remainder (32%) being imported.

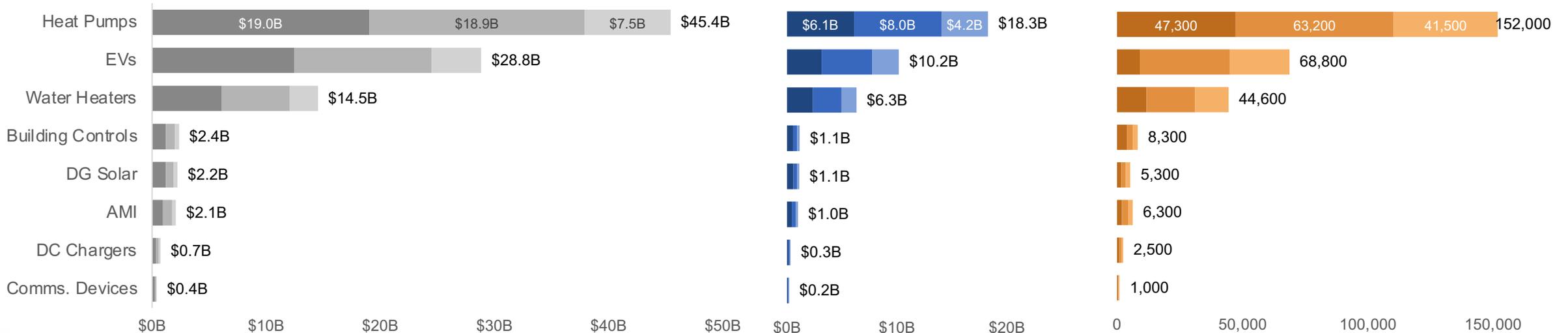
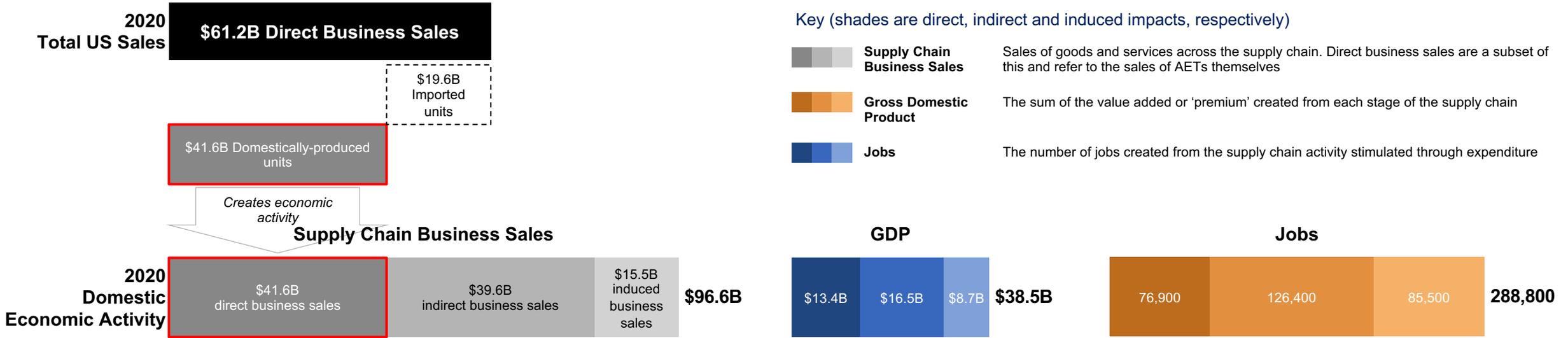
Direct Business Sales



Direct Business Sales, by AET



# Current State 1: the supply chain business sales for AETs in 2020 is \$96.6B, contributing \$38.5B in GDP and 288,800 jobs



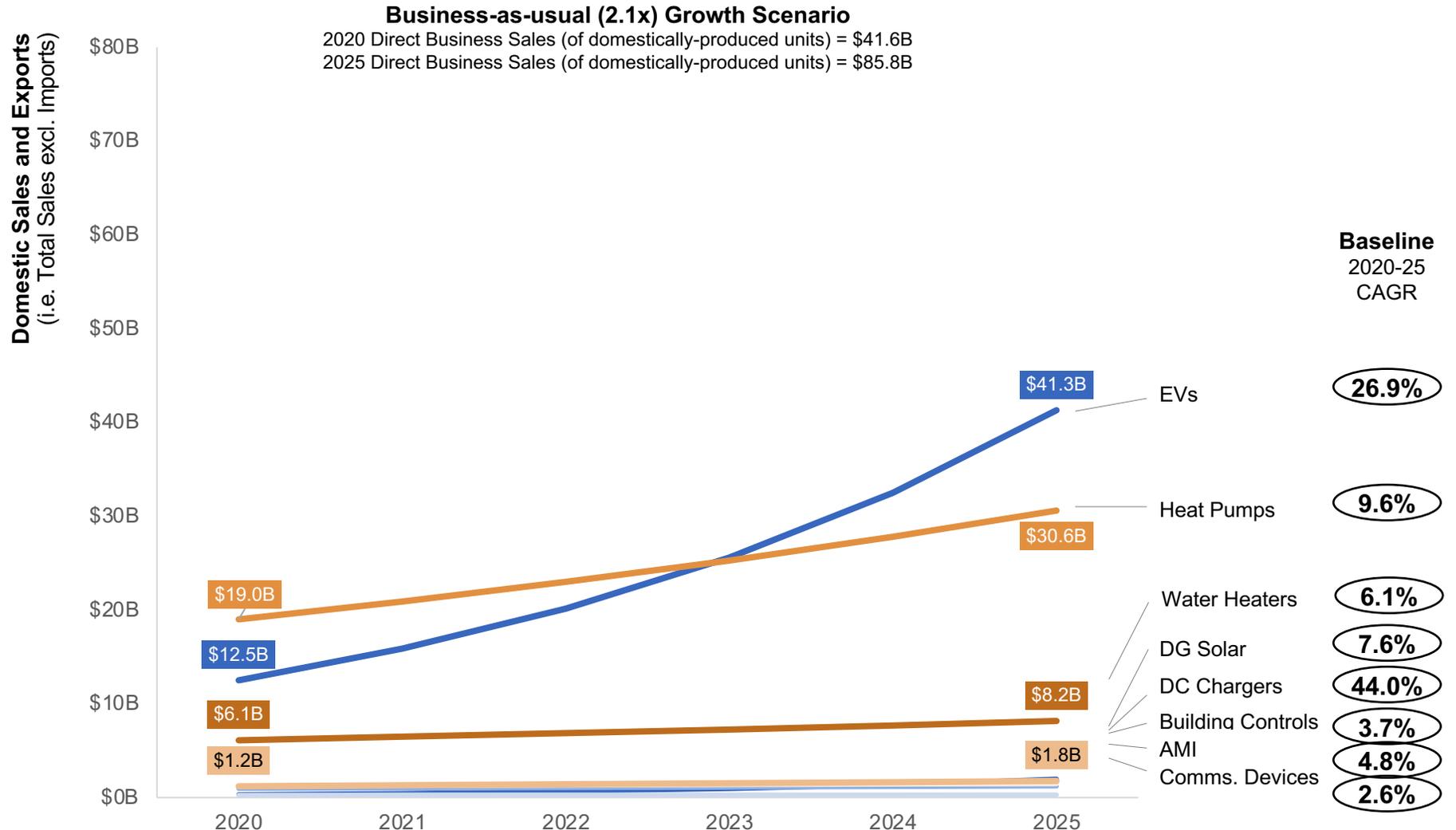
## Future State ②: under a business-as-usual scenario, the market for AETs is expected to grow two-fold, from \$41.6B of direct business sales of domestically-produced units in 2020, to \$85.8B in 2025

Under a business-as-usual (BAU) scenario, the market for AETs experiences a weighted average growth factor of 2.1x.

This rapid growth rate of AETs is indicative of the attention the market is receiving from consumers.

In particular, EVs are expected to see exceptionally rapid growth (26.9% CAGR) with a commensurate growth in DC Chargers (44.0% CAGR) as new models arrive and battery performance increases to create electric options for medium duty vehicles.

Non-transportation AETs continue to grow, albeit at slower rates.



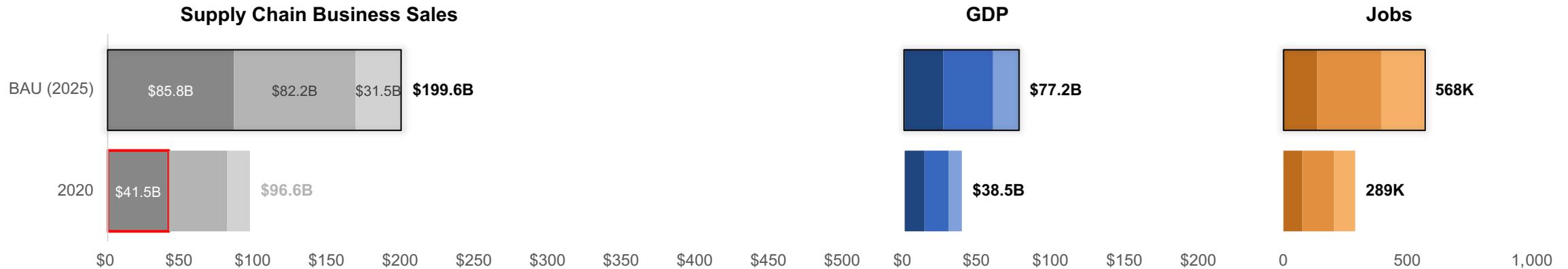
# Future State ②: under a business-as-usual scenario, the economic impacts of AETS correspondingly doubles to generate \$77.2B in GDP and 568,000 jobs

Under a business-as-usual (BAU) scenario, the direct business sales of domestically-produced units increases to \$85.8B. When indirect and induced activities are considered, this results in a total value of \$199.6B in business sales across the AET supply chain.

It is this supply chain economic activity that goes on to create ripple effects in the economy, generating \$77.2B in GDP and creating 568,000 jobs.

Key (shades are direct, indirect and induced impacts, respectively)

- Supply Chain Business Sales** Sales of goods and services across the supply chain. Direct business sales are a subset of this and refer to the sales of AETs themselves
- Gross Domestic Product** The sum of the value added or 'premium' created from each stage of the supply chain
- Jobs** The number of jobs created from the supply chain activity stimulated through expenditure

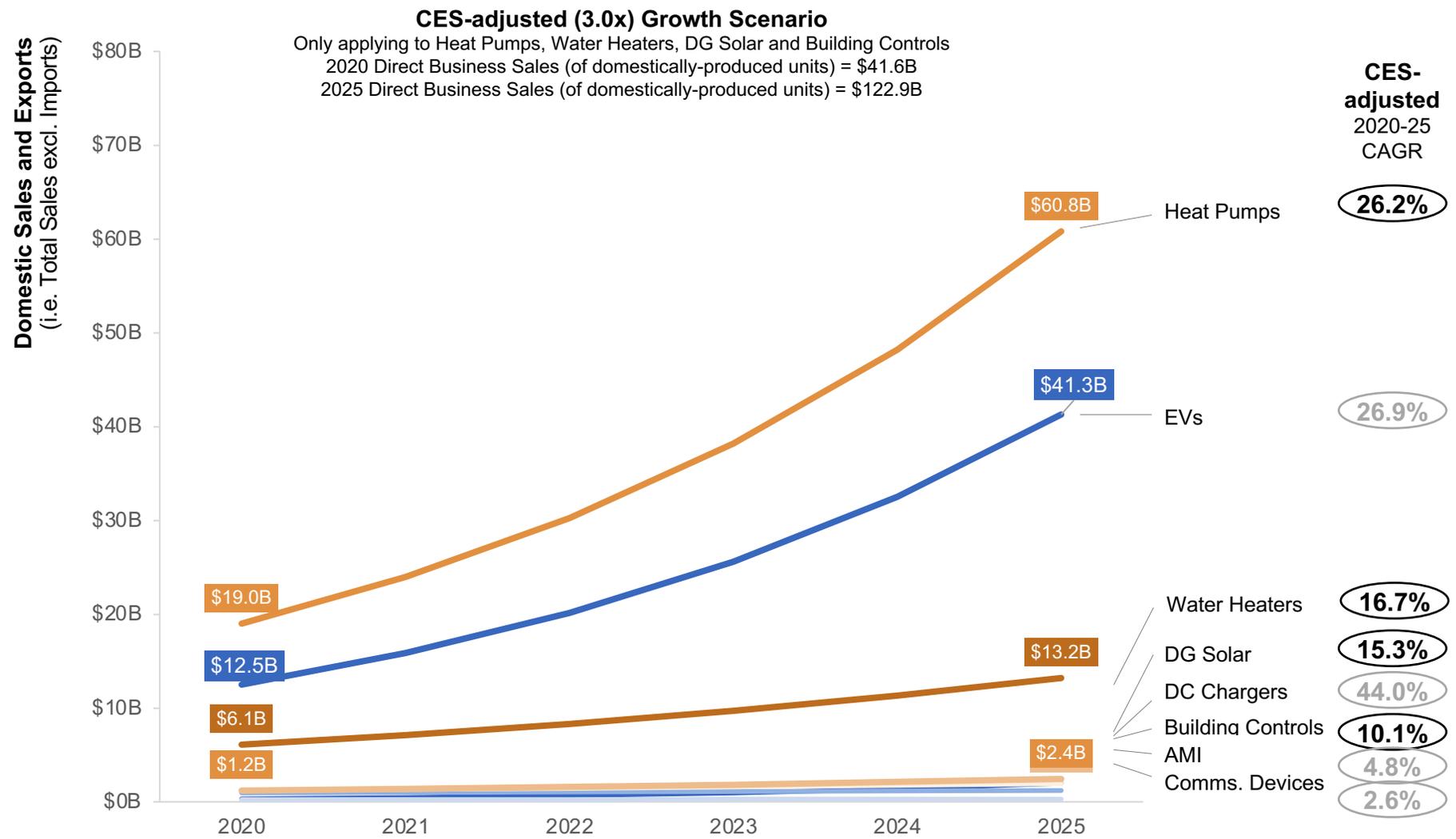


# Future State ③: With the introduction of a Clean Energy Standard, the market for AETs could triple in size, from \$41.6B of direct business sales of domestically-produced units in 2020, to \$122.9B in 2025

Under a Clean Energy Standard (CES) scenario, the market for AETs experiences a weighted average growth factor of 3.0x.

A Clean Energy Standard would accelerate the deployment of renewable generation and energy efficient technologies. Thus, a CES scenario is modelled here as applying only to those AETs related to that function, namely: heat pumps, water heaters, distributed generation solar, and building controls.

This would have the effect of boosting the growth rates of these AETs. Heat pumps, in particular, would now grow at a rate that would see it remain a larger market than EVs.



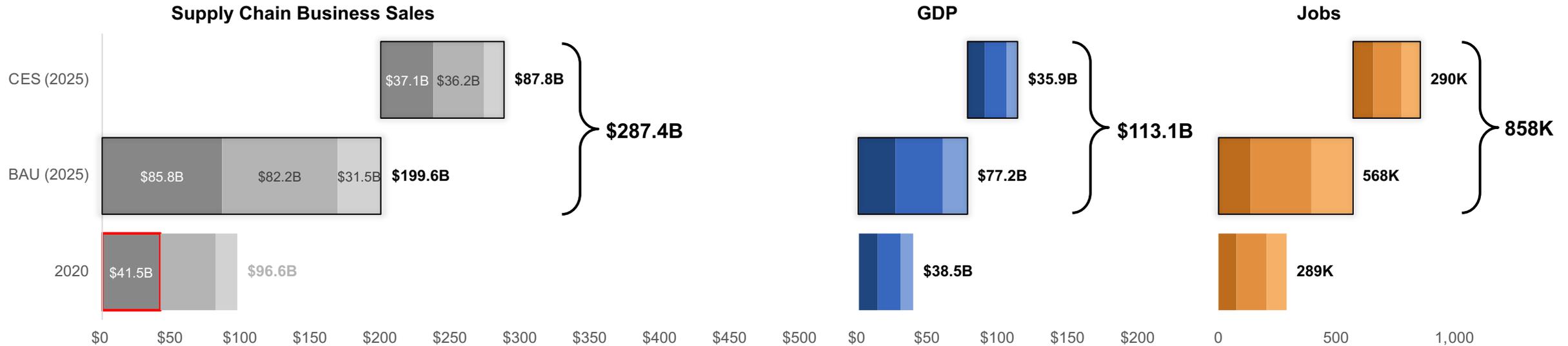
# Future State ③: under a business-as-usual scenario, the economic impacts of AETS correspondingly doubles to generate \$77.2B in GDP and 568,000 jobs

Under a Clean Energy Standard (CES) scenario, the direct business sales of domestically-produced units increases to \$122.9B (the sum of the direct business sales in the BAU and the incremental value under CES). When indirect and induced activities are considered, this results in a total value of \$287.4B in business sales across the AET supply chain.

It is this supply chain economic activity that goes onto create ripple effects in the economy, generating \$113.1B in GDP and creating 858,000 jobs.

Key (shades are direct, indirect and induced impacts, respectively)

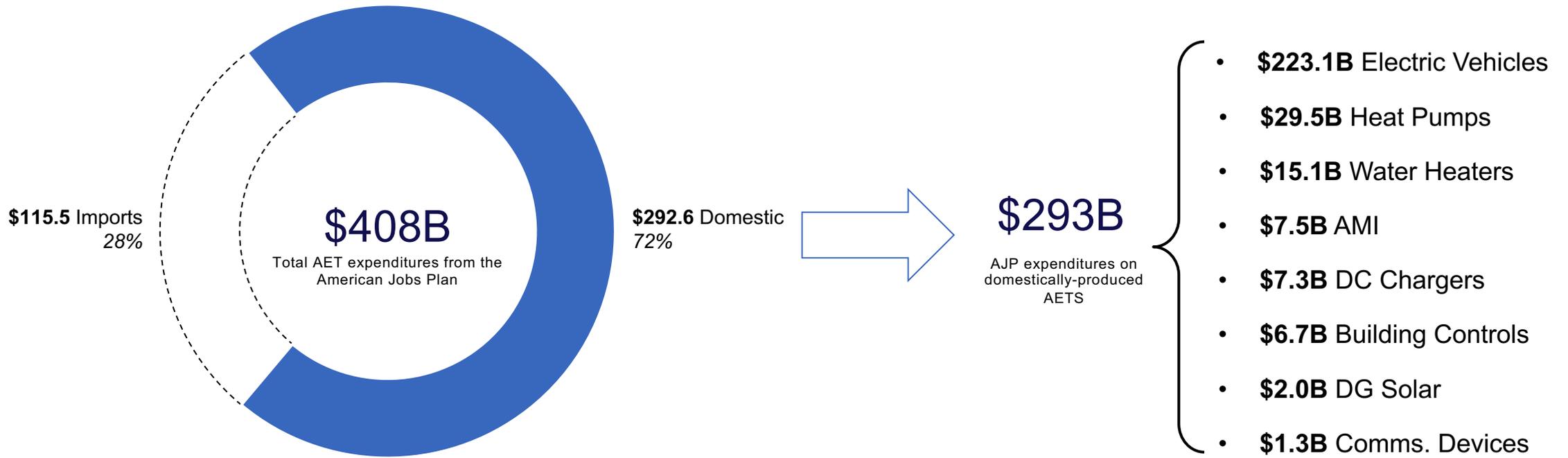
- Supply Chain Business Sales** Sales of goods and services across the supply chain. Direct business sales are a subset of this and refer to the sales of AETs themselves
- Gross Domestic Product** The sum of the value added or 'premium' created from each stage of the supply chain
- Jobs** The number of jobs created from the supply chain activity stimulated through expenditure



# Future State ④: the American Jobs Plan estimates an expenditure on AETs of \$408B, of which \$293B could be used for the purchase of domestically manufactured units

Using analysis from AEE's Advanced Energy Stimulus report<sup>1</sup>, we anticipate that federal stimulus akin to the American Jobs Plan<sup>2</sup> will result in \$408B of new expenditure on this subset of AETs. Of this \$408B, we expect that 72% (\$293B) will be spent on domestically produced units, assuming current domestic production dynamics.

Furthermore, while the budgeted period of the AJP is still under consideration, we expect that the bulk of expenditures will occur in the five years between 2022 and 2026. For the sake of simplicity, we assume that the entirety of the \$293B of expenditure on domestically-produced AETs will be spread equally (\$58.6B per year) over this five-year period.



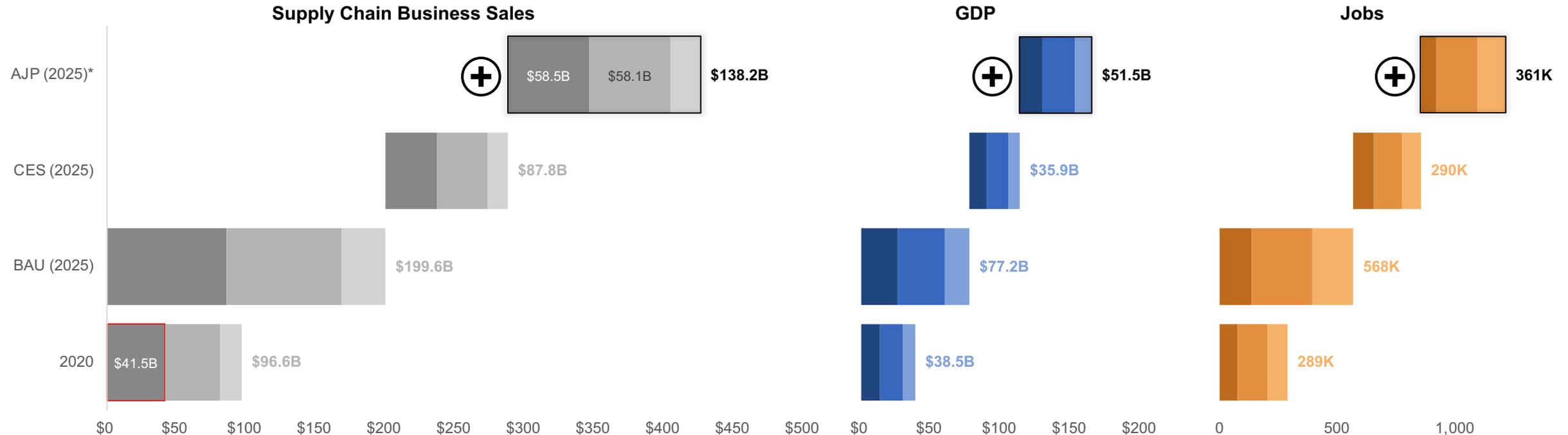
# Future State ④: the American Jobs Plan boosts the sector by contributing an additional \$51.5B GDP and 361,000 jobs to the economy each year for five years

The AJP provides a significant investment in the advanced energy manufacturing sector of \$58.6B per year for five years. This results in supply chain business sales of \$138.2B per year. Crucially, this is in addition to the BAU growth of the sector and the expected impacts from the proposed Clean Energy Standard.

It is worth noting that the economic impact of \$51.5B GDP and 361,000 jobs lasts for as long as Federal funding continues.

Key (shades are direct, indirect and induced impacts, respectively)

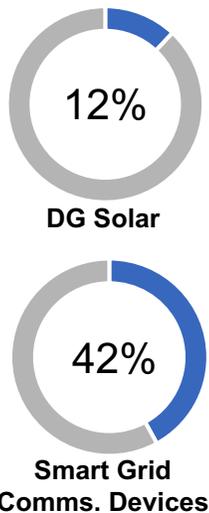
- Supply Chain Business Sales** Sales of goods and services across the supply chain. Direct business sales are a subset of this and refer to the sales of AETs themselves
- Gross Domestic Product** The sum of the value added or 'premium' created from each stage of the supply chain
- Jobs** The number of jobs created from the supply chain activity stimulated through expenditure



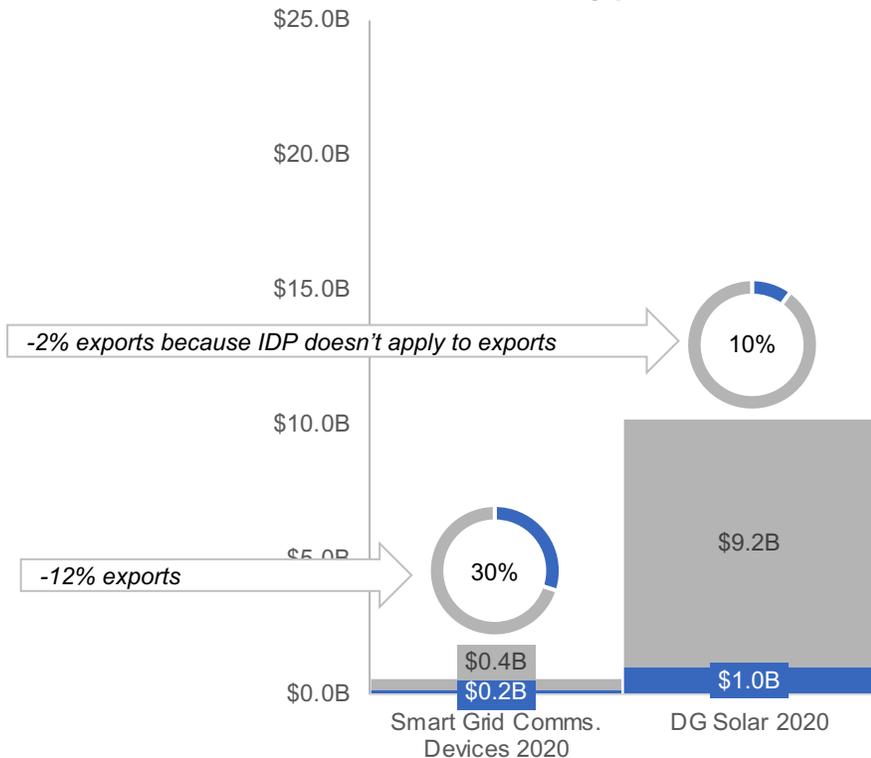
# Future State ⑤: increasing the domestic production of Smart Grid Communications Devices and DG Solar to a minimum of 55% can be considered to support domestic manufacturers

Smart Grid Communications Devices and DG Solar have domestic production levels of 42% and 12%, respectively. Increasing domestic production of these two AET categories would increase business sales and economic activity in both relative and absolute terms. Relative, because of a 55% 'floor' for domestic production; and absolute, because this floor would apply to the growing sales expected for these two AET categories from the combined effect of a Clean Energy Standard and the American Jobs Plan on the business-as-usual growth of the market.

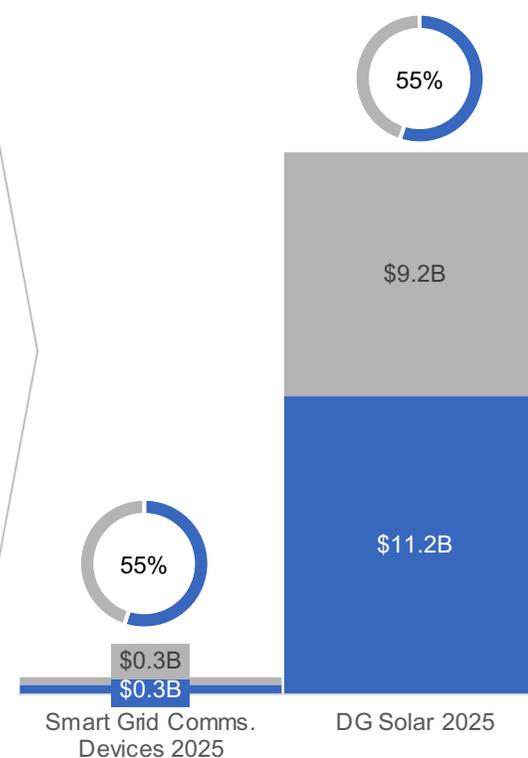
**①**  
Take the % of sales that are domestically produced or exported



**②**  
Exclude exported units to obtain share of sales that are domestically produced in 2020



**③**  
Apply IDP of 55%, compounding the growth in the market due to BAU, CES and AJP in 2025



**④**  
Findings

- Domestic production for DG Solar increases from \$1.0B in 2020 to \$11.2B in 2025; an 11x increase
- For DG Solar, the growth in domestic production is significant because:
  - The share of domestic production in 2020 is low (10%)
  - The market increases in the BAU (7.6% CAGR)
  - The market increases beyond the BAU with a CES (15.3%)
  - The AJP additionally provides \$2B in funding

# Future State 5: increasing the domestic production of Smart Grid Communications Devices and DG Solar increase per-unit costs by 4.6% and 4.2%, which translates to a \$1B premium

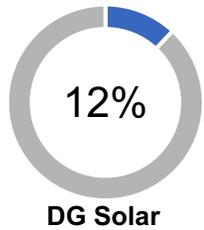
Because domestic manufacturing prices are higher than imported goods in these two categories, an 55% minimum final assembly requirement (2025 CES and AJP scenarios) will result in a price premium of \$1B for increase domestic production.

Take the % of sales that are domestically produced or exported

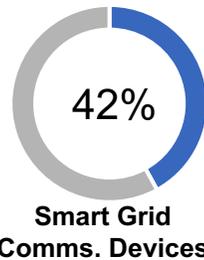
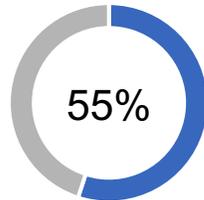
Increased Domestic Production

Increased market size

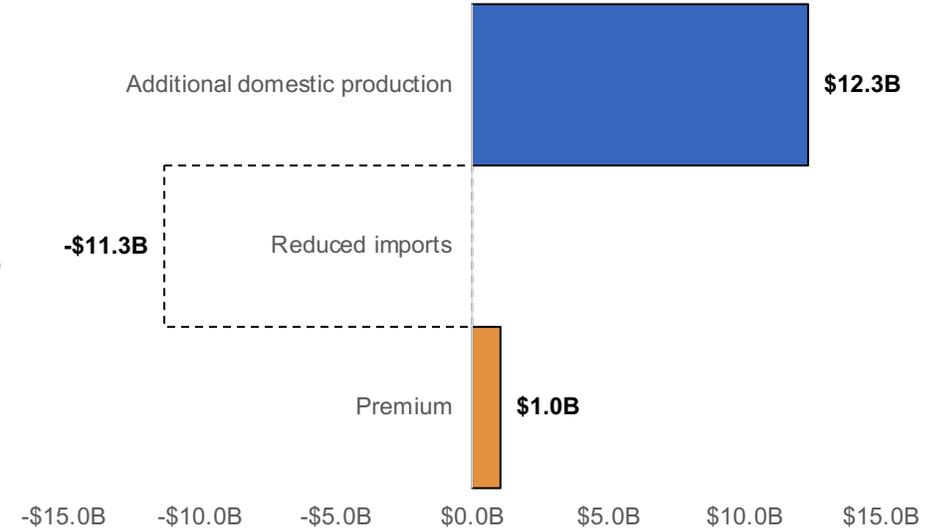
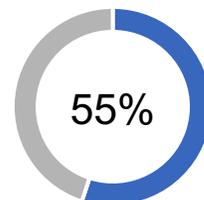
Per-unit cost increases as a result of IDP cascade as the market size for DG Solar and Smart Grid Comms. Devices grow in absolute terms (as forecast by BAU, CES and AJP). This results in a \$1B 'premium' for requiring IDP



+4.6% per-unit cost increase

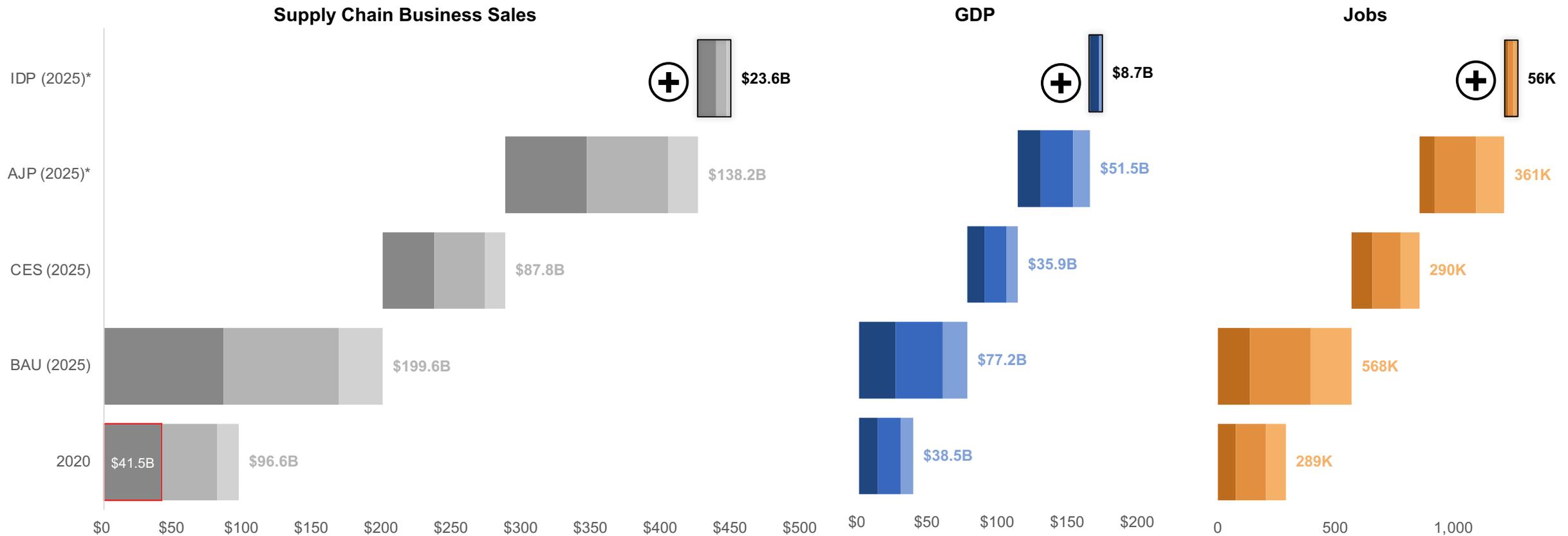


+4.2% per-unit cost increase



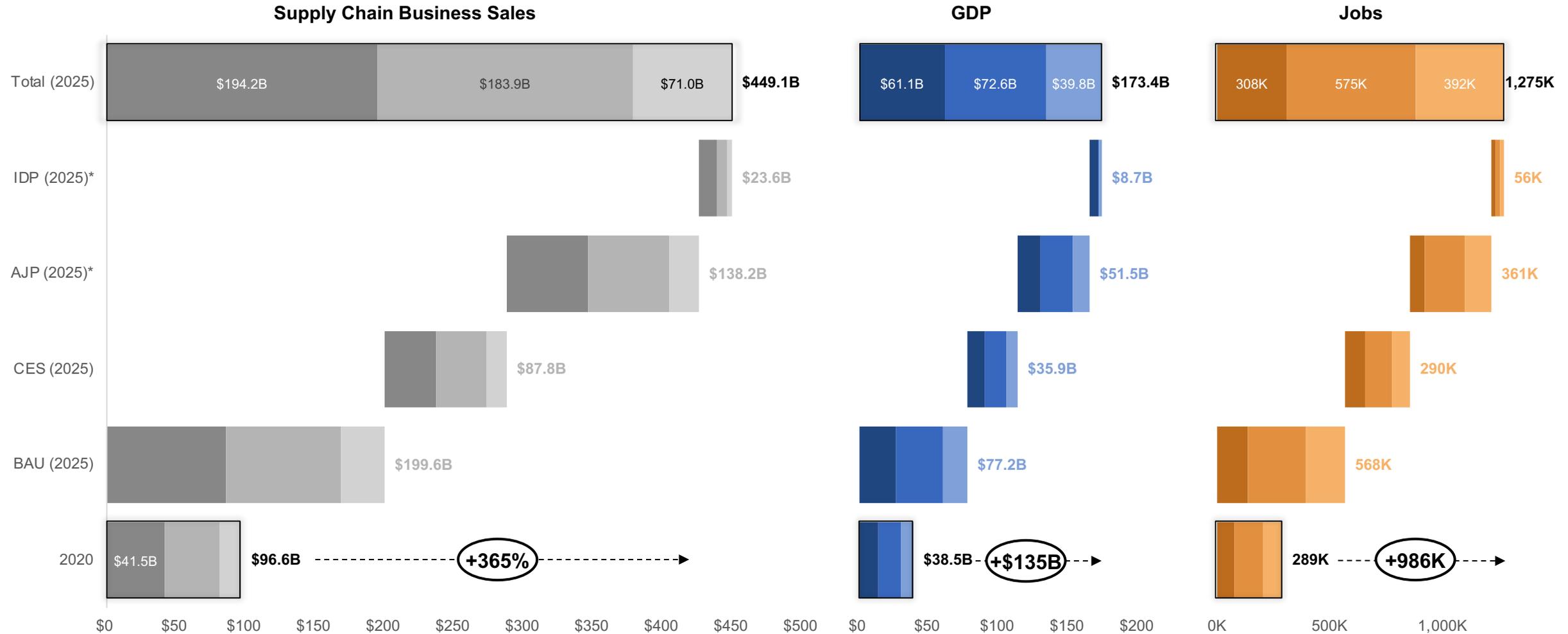
# Future State 5: increasing domestic production of Smart Grid Communications Devices and DG Solar creates an additional \$8.7B in GDP and 56,000 jobs per year

Increasing the domestic production of Smart Grid Communications Devices and DG Solar, creates an appreciable, although comparatively small impact on the economy. This is because of the relatively small current value of domestically produced units in these categories (\$0.2B for Smart Grid Comms. Devices, and \$1.2B for DG Solar). While this will increase in the BAU by 2025, further enabled by a CES, the AJP will result in increased direct annual spending (\$0.5B for Smart Grid Comms. Devices, and \$12.3B for DG Solar).



# Summary: if planned policies are implemented, the advanced energy manufacturing sector could grow 365% in five years, creating nearly a million additional jobs

Planned policies of the CES, American Jobs Plan, and Increasing Domestic Production compound on the sector's BAU growth.



# Policy Recommendations

- **Pass a Robust Advanced Energy Investment Package**

The U.S. has well-established advanced energy manufacturing in a wide variety of sectors, from energy efficiency to transportation electrification. Policymakers should build on this foundation by passing federal investment, akin to what is proposed in the AJP, that includes a CES, tax extenders, a Clean Energy Accelerator, and support for building retrofits, EV charger build-out, and school modernization.

- **Support Demand for Domestic Production**

Policymakers should consider incentive policies that layer on top of existing tax credits, which reward consumers – from individual buyers to large-project developers – for procuring products that meet a domestic production standard. Policymakers should likewise consider transitioning such tax credits to a direct pay structure, expanding access and increasing utilization.

- **Bolster Domestic Advanced Energy Manufacturing**

Policymakers should consider advancing a suite of measures that provide support to domestic advanced energy manufacturing, particularly in strategically important sectors and those where there is not currently substantial domestic production. Such measures may include support for investments in new advanced energy manufacturing facilities, such as provided through the 48C tax credit, and production-based measures.



