Analysis of a Federal LCFS
(Sec 121 of Waxman-Markey Discussion Draft)

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The estimates and conclusions presented here do not reflect the views of the U.S. Department of Energy. They are provided only to stimulate discussion at the Asilomar Transportation Conference.

Outline of Presentation

- Definition of a “Federal LCFS”
- How a Federal LCFS Could be Met
- Upstream Emissions of Petroleum Fuels (Including Canadian Oil Sands)
- Abatement of Oil Sands Emissions
- Biofuels with Current Policies
- Methodology
- Estimated Impacts of a Federal LCFS
- Conclusions

Original Waxman-Markey Discussion Draft LCFS (= Federal LCFS)

- **The average lifecycle emissions of transportation fuels must be 5% lower than the baseline fuel by 2023 and 10% lower by 2030.**
- **From 2014-2022, the average lifecycle emissions of transportation fuels must not exceed those of the baseline fuel *not counting the renewable fuels used to meet the Renewable Fuels Standard.***
- **The baseline fuel is defined to be the average fuel sold into U.S. commerce during 2005.**
- **This section was deleted from HR 2454. It was used as a proxy to model a "Federal LCFS."**

Ways a Federal LCFS Could Be Met

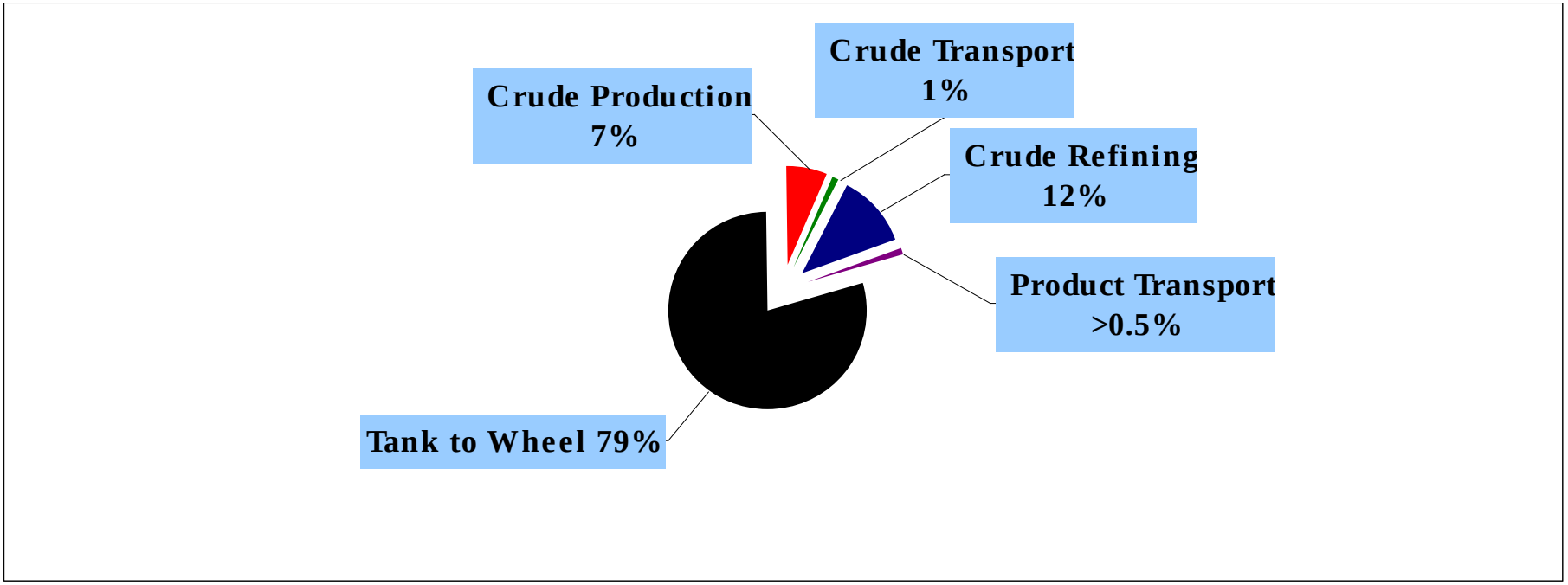
Things to do:

- **Use biofuels with reduced CO_2 emissions.**
- **Increase refinery efficiency.**
- **Use refinery feed stocks that have lower life cycle emissions.**
- **Purchase credits, including credits from non-obligated parties such as utilities that sell electricity for EVs/PHEVs.**

Things not to do:

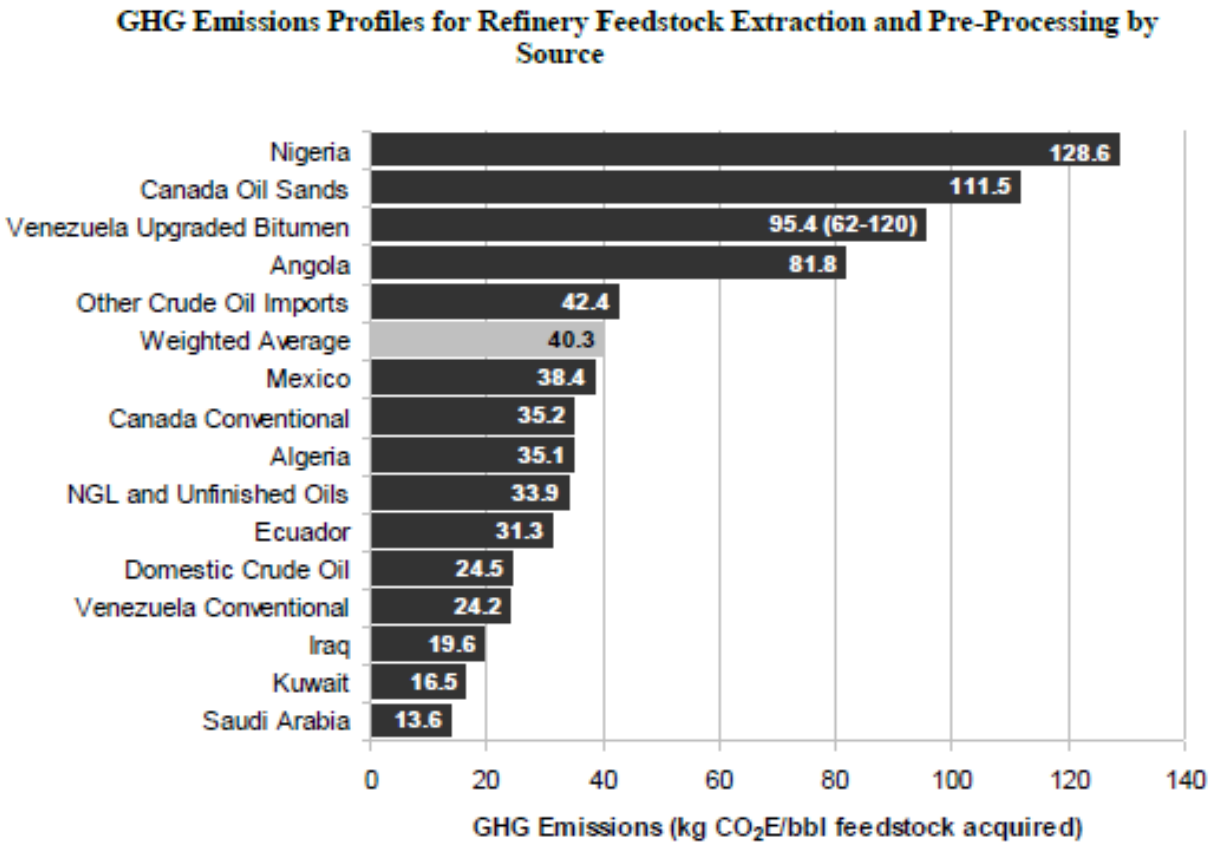
- **Use more Canadian oil sands refinery feed stocks or heavy crude feed stocks.**
- **Use coal-to-liquid fuels.**

Well-To-Wheels GHG By Process
CA ULSD



Source: Detailed California-Modified GREET Pathway for Ultra Low Sulfur Diesel (ULSD) from Average Crude Refined in California, CARB, Feb 28 2009

Upstream GHG Emissions By Feedstock



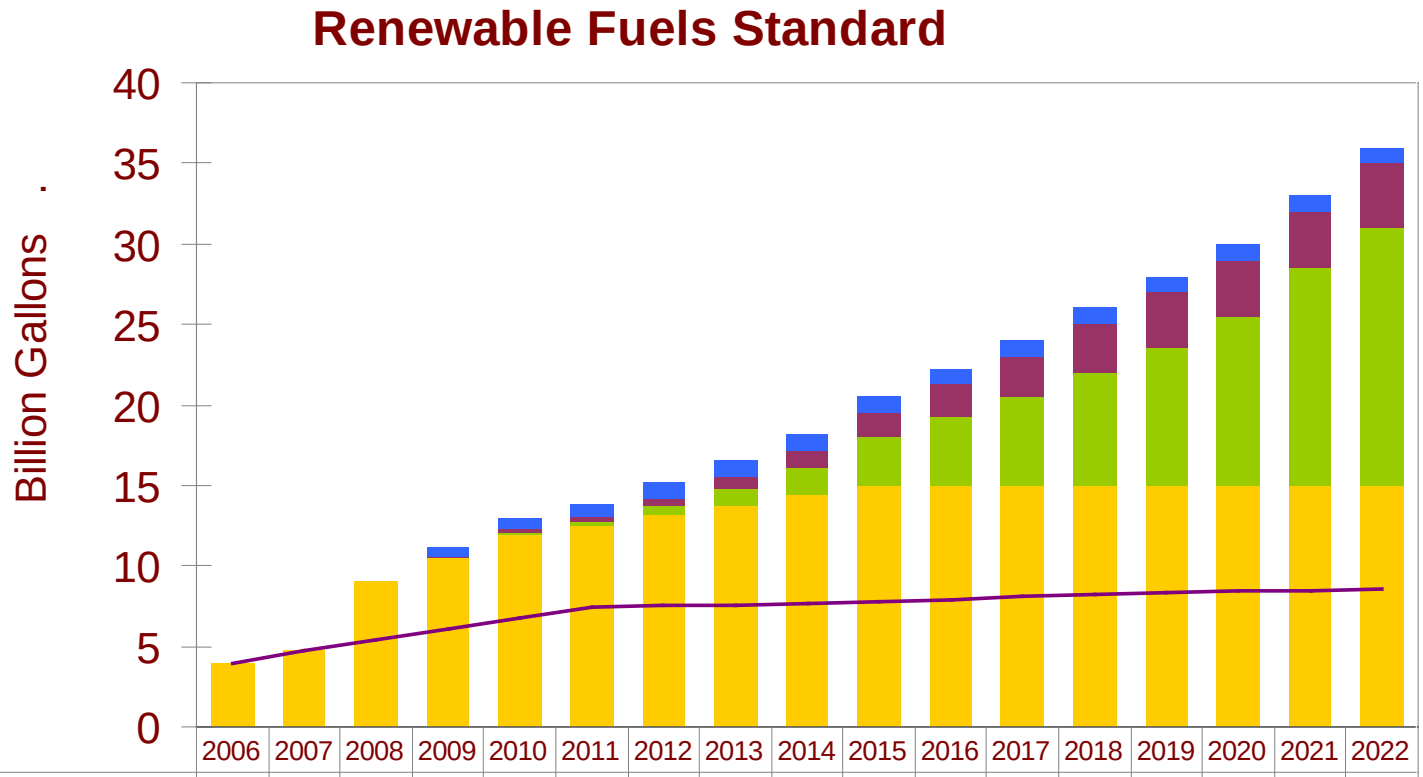
Source: "An Evaluation of the Extraction, Transport and Refining of Imported Crude Oils and the Impact on Life Cycle Greenhouse Gas Emissions", DOE/NETL-2009/1362, March 27, 2009

Mitigating the GHG Emissions of Oil Sands

- Most petroleum emissions are downstream
  - For conventional feedstock to ULSD WTW upstream <25% total
  - Wide variety for conventional crude Bonnie Light to Arab Medium ~10%
  - With some overlap oil sands pathways ~10% higher than conventional crudes
- Ways to mitigate GHG
  - Improve energy efficiency (cogen, refinery ops, SOR)
  - Add CCS for heat supply (partial remediation)
    - Long-term (commercial, at least a decade off)
    - At least $100/ton (natural gas /post-combustion capture)
    - Add $8/barrel bitumen (discounted ~50% to WTI)
    - Alternate fuels (pet coke, bitumen) or technologies (gasification) with CCS more expensive
  - Exotic proposals – nuclear
    - Size mismatch for conventional unit; no approved small designs (e.g., PBMR)
    - High cost, decades away from deployment, uncertain (must be developed for other markets before it would be available for this application).

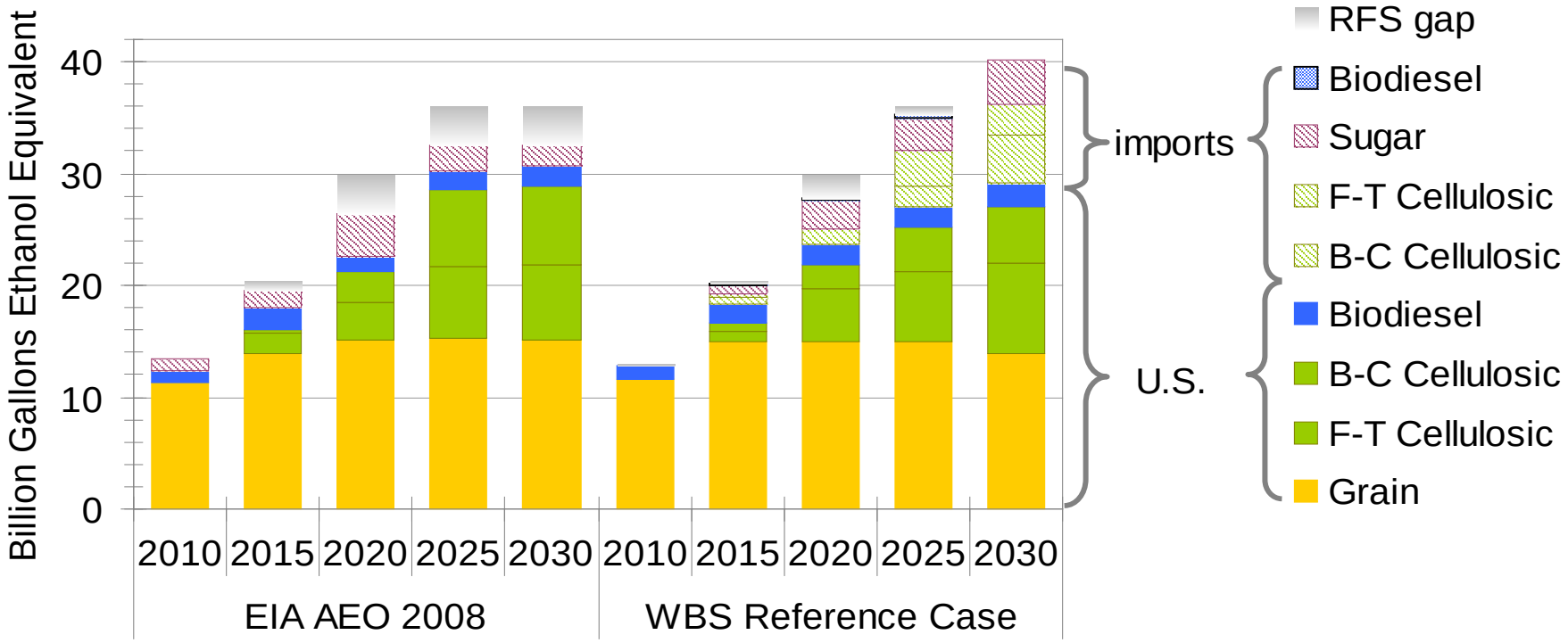
Federal Renewable Fuel Standard

(RFS fuels can not be counted towards the Federal RFS until after 2022.)



	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Biodiesel	0	0	0	0.5	0.65	0.8	1	1	1	1	1	1	1	1	1	1	1
Any Advanced	0	0	0	0.1	0.2	0.3	0.5	0.75	1	1.5	2	2.5	3	3.5	3.5	3.5	4
Cellulosic Advanced					0.1	0.25	0.5	1	1.75	3	4.25	5.5	7	8.5	10.5	13.5	16
Any Renewable Fuels	4	4.7	9	10.5	12	12.5	13.2	13.8	14.4	15	15	15	15	15	15	15	15
Old RFS	4	4.7	5.4	6.1	6.8	7.4	7.5	7.6	7.7	7.8	7.9	8.1	8.2	8.3	8.4	8.5	8.6

The RFS Already Maximizes U.S. Low-GHG Biofuel Use Through 2025



- **The 2008 AEO & a 2008 DOE Policy Analysis Office study project that RFS2 cellulosic biofuel waivers will be required through 2030 (AEO) or 2025 (Policy Analysis Office). Since then, the recession has further delayed investment.**

Models Used for this Study

Global Energy Technology Perspectives (IEA-ETP)

- 15 regions
- Developed at IEA with ETSAP
- Calibrated to WEO

Ten Region U.S. MARKAL Model

- Key Regional Differences
  - Fossil fuel and renewable resource availability
  - Economic and population growth rates
  - End-use demand patterns and levels of energy intensity
  - Energy infrastructure and transportation options and costs
  - Policies and regulations
- Calibrated to AEO

MARKAL Model Improvements Implemented for this Study

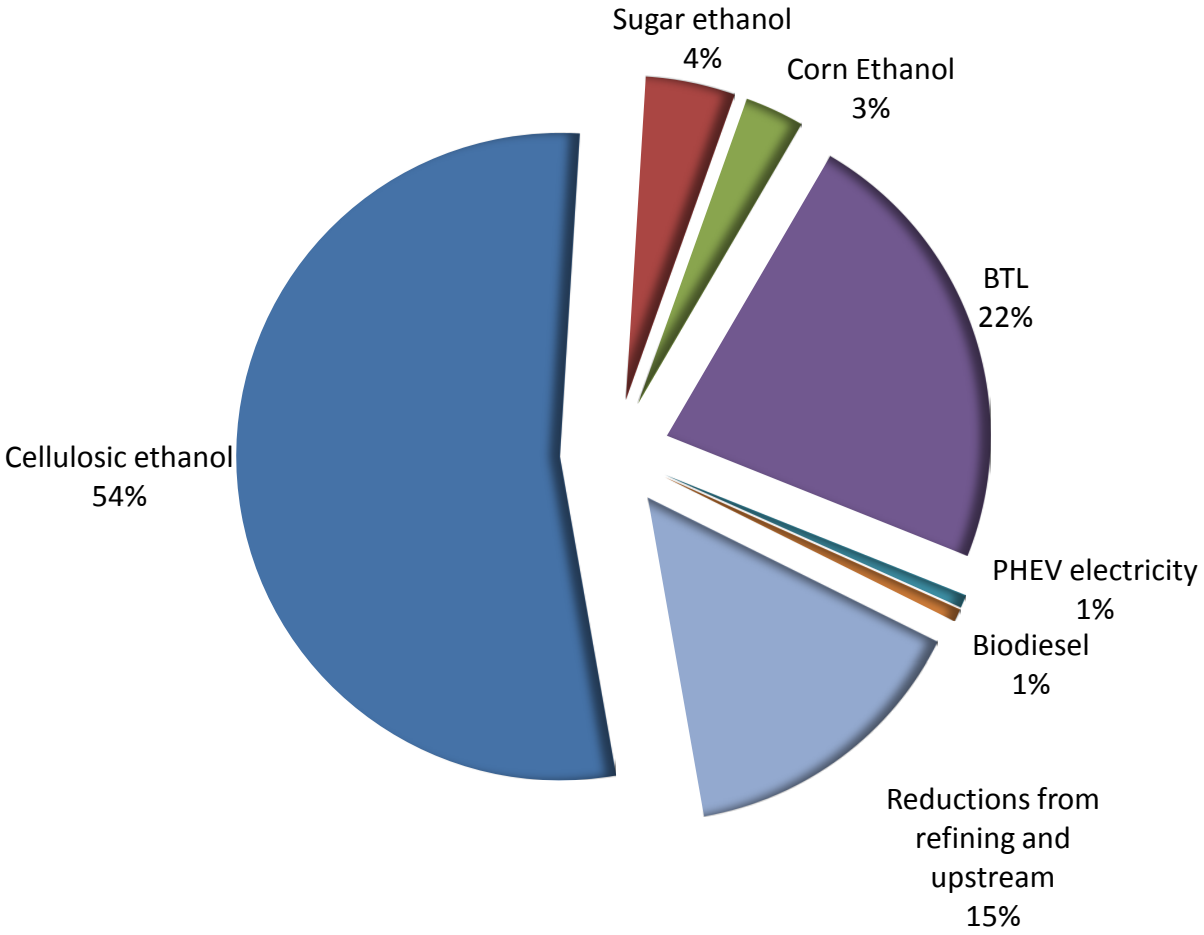
- **Introduced framework for tracing carbon intensity of liquid fuels.**
- **Introduced market for tradable LCFS credits.**
- **Introduced State LCFS regulations as outlined by CARB, a Federal LCFS policy as outlined in original Waxman-Markey draft and assumed anti-backsliding regulation.**

Modeling Scenario

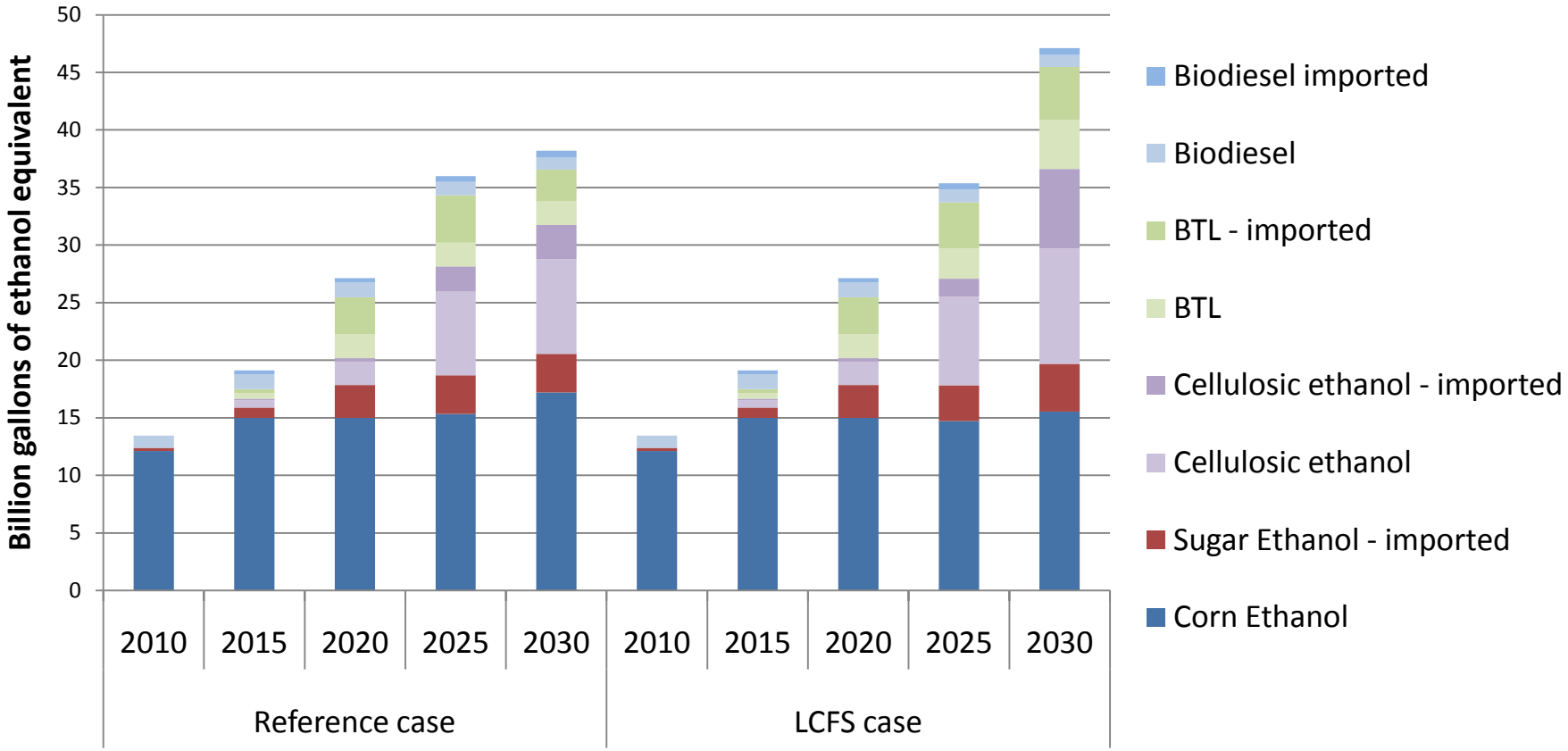
- It is assumed that the Alberta oil sands producers would react to a Federal LCFS "lock out" by building the Enbridge pipeline to Kitimat to permit oil sands exports to Asian markets.
- This is estimated to delay expanded oil sands production by 5 years.
- While alternative sources of process energy and CO_2 capture and storage could reduce the upstream emissions of oil sands processing, it is assumed that these technologies would take time and would not deter expanded production of oil sands using current technologies.

How the LCFS is Met in 2030

- **Approx. 275 million tonnes of CO_2 equivalent credits are required by 2030.**



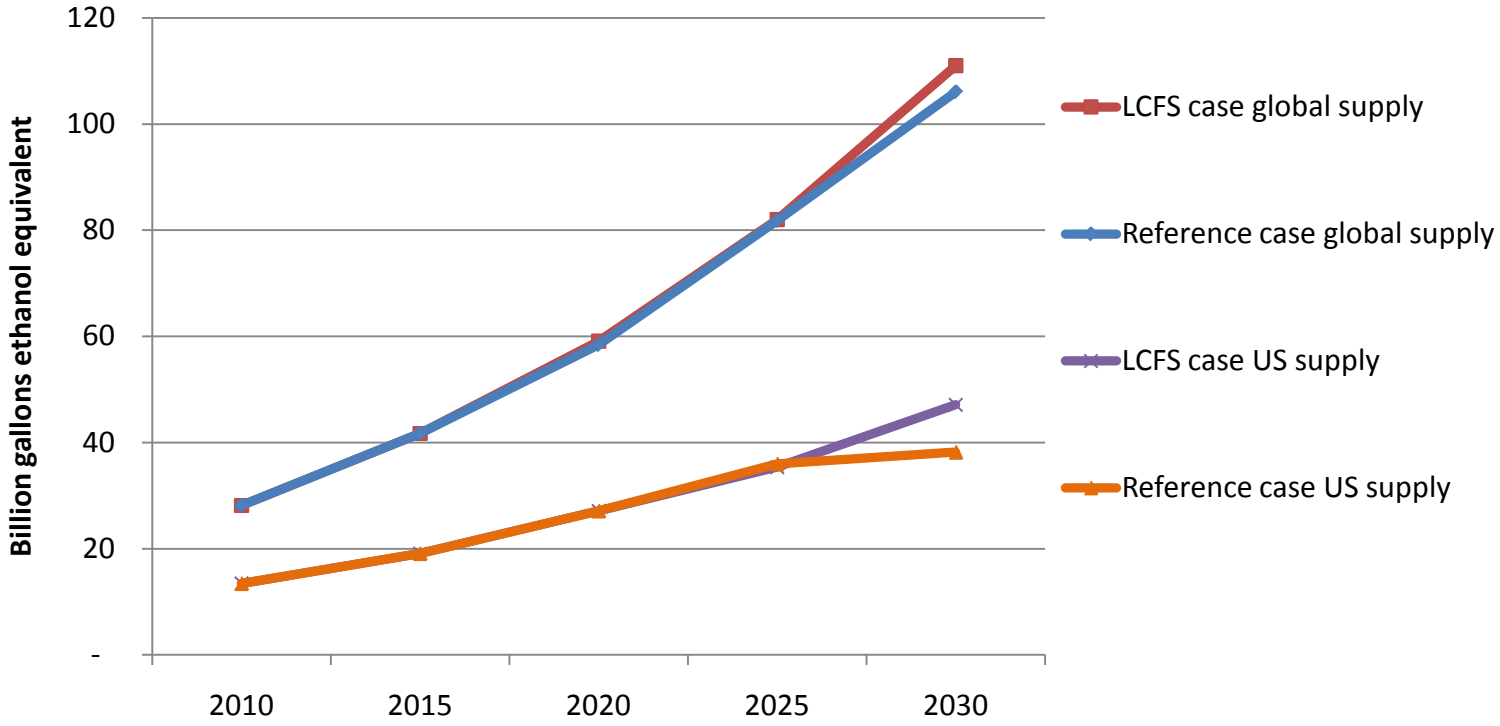
The RFS leads to increased US demand for low-GHG biofuels in 2030



The LCFS does not lead to increased biofuel production until after 2025, when a substantial increase is required. The majority of the increased supply has to be purchased in international markets, since US supply is already close to the maximum feasible.

Impact of LCFS on World and U.S. Biofuels Use

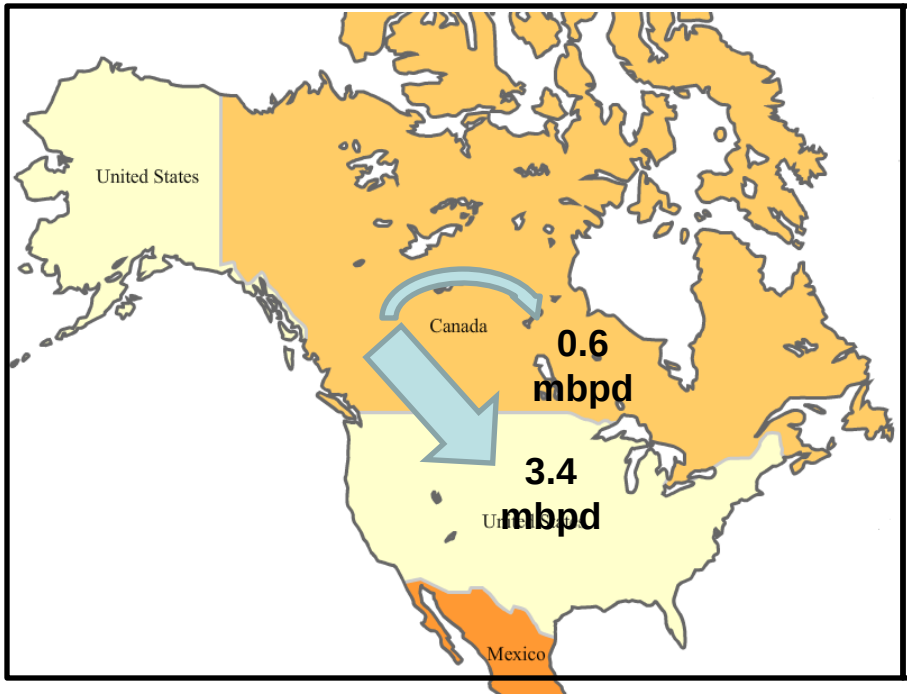
- **High oil prices and world-wide policy incentives already provide strong incentives for biofuels production. The main impact of the LCFS is to divert biofuels from other markets**



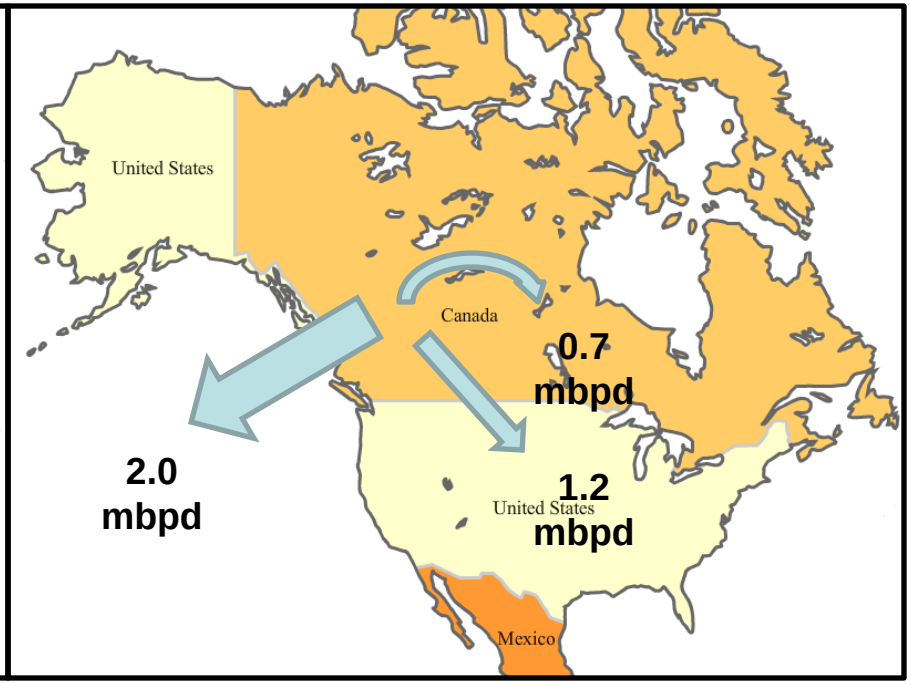
Alberta Oil Sands

The US LCFS limits flow of oil sands to the USA, but only marginally reduces overall oil sands production.

Reference case 2025

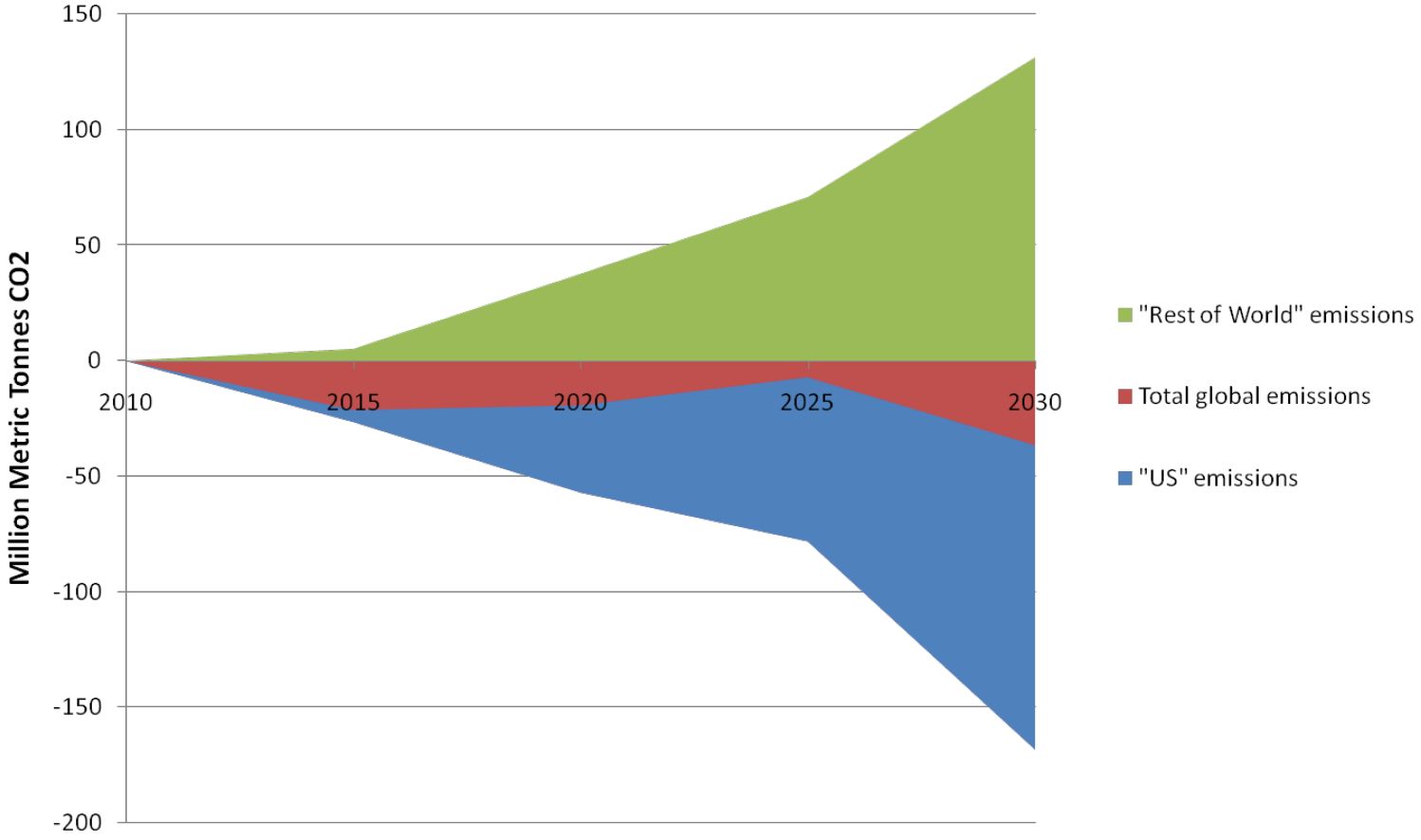


LCFS case 2025



Impact of U.S. LCFS on CO_2 Emissions

Relative to our Reference Case, the US LCFS limits leads to significant reductions in emissions attributed to the LCFS, but these reductions are largely offset by increased emissions in the rest of the world: Canadian oil sands go elsewhere & most increased biofuel use is at the expense of biofuel use elsewhere.



Conclusions

- **High oil prices & current world-wide policies already provide strong incentives for low-emission biofuel production.**
- **A national LCFS* is not estimated to:**
  - **significantly increase world-wide biofuel production.**
  - **discourage production of petroleum feed stocks with higher GHG emissions.**
  - **appreciably reduce world-wide carbon emissions.**
- **The *average* cost per ton of reduced CO_2 emissions is $300, not counting the energy security cost of relying on 2 MBD more oil from the Middle East instead of Canada.**
- **The LCFS allowance value would be an order of magnitude lower.**

*** As defined in Sec. 121 of the W-M discussion draft.**

Designing a Better LCFS

- **A more effective LCFS could be developed if it were designed to be a more targeted policy instead of "silver-bullet" to promote all low-carbon alternatives to petroleum fuels.**
- **In particular, a LCFS could be designed to replace the current volume-based Renewable Fuel Standard and encourage increased investment in sustainable low-carbon biofuels.**
- **Control of the upstream emissions of petroleum feedstocks might be best addressed in a cap-and-trade allowance program. This would not divert Canadian oil sands to other markets & would encourage reductions in upstream oil sands emissions.**
- **Better policies than LCFS available to commercialize PHEVs & EVs:**
  - **Battery development (e.g., DOE's battery RD&D).**
  - **Grants and loans to vehicle manufacturers and infrastructure (e.g., ARRA expenditures; Sec. 121-125 of HR2454).**
  - **Tax credits to purchase vehicles (e.g. ARRA's $7,500 credit for PHEVs)**
  - **Inclusion of PHEVs as an available technology to meet CAA GHG emissions standards for light duty vehicles.**