Less simple ISRU

So, you've been there. Just using the stock engines don't cut it anymore for you. You have a bunch of hydrogen powered engines, be them from Cryo Engines, SSTU, BDB or some other mod I don't know or remember. Or you're using LH2 powered nuclear thermal rockets. Or you love Nertea's lithium powered engines from NFP. Or the few methalox engines available (I think only from a patch of NFLV). And maybe you also like off planet building, with either Global Construction or EPL.

So you set up a mining site well beyond Kerbin. Ok, maybe "well beyond" means the Mun. But it's not the VAB. And you convert ore to LFO and monoprop. And also to liquid hydrogen. And also to lithium. And also use it for building stuff with Ground Construction. And into other stuff. It's ore for everything. KSPI-E and Kerbalism have their resource chains, but they are complicated mods.

Is there something in the middle? Something that's not as daunting as KSPI-E but also doesn't mean ore is almost magical?

Yes, this. Also Rational Resources. But this too.

What does it does and what it doesn't?

First, it doesn't preclude any stock dynamic. Ore to LFO and monoprop is still there. I'm also not overwriting or deleting stuff from other mods (that wouldn't be cool at all), so Nertea's ore to hydrolox/lithium/methalox patches remain. If you want to continue refueling ships at Minmus or the Mun, you can still do it, as usual.

What it does? It adds *simple* new resource chains using existing CRP resources for liquid hydrogen (plus oxidizer), lithium, sabatier processes for methane production and atmospheric harvesting of xenon (and argon, but if you're using NFP, Nertea already had you covered with that). Here's the simple run down

Resource extraction

From the ground

Water
Hydrates
Spodumene
Carbon Dioxide (dry ice)

From the atmosphere

Carbon dioxide
Xenon
Argon
Oxidizer (oxygen)

Exosphere and oceans

Not implemented

Resource processing

Water or hydrates (hydrates require twice as much mass) → Liquid hydrogen + oxidizer

Spodumene → Lithium

Carbon dioxide + Water or hydrates (twice as much hydrates needed) → Methane + oxidizer

Now for the resource explanations (you can skip this):

Oxidizer

Yes, theoretically, the in-game oxidizer isn't based in liquid oxygen. But the mod community has long equated both for simplicity (and that LF burns with oxygen in the stock jets, I guess), so I'm going with that. The idea of this mod is to keep things somewhat simple, after all.

Hydrates

Based on what I see from CRP and Roverdude's mods, "hydrates" represent several types of inorganic salts like chloraluminite or hydrates formed by cobalt chlorides (the people who included them in CRP can correct me here if I'm wrong) which have roughly 50% of water, or a corresponding mix of hydrogen and oxygen. So as a rule, I'm going with "if you can do it with water, you can do it with twice the mass of hydrates". What can you do with water? Well, high temperature water electrolysis (so you still need radiators) as well as the Sabatier process to produce methane and oxygen.

Why are both available instead of just water? Well, because while hydrates are common, water is not. I did add a bit of water to some specific biomes of the Mun and Minmus to make sure you can run the Sabatier process there and refuel any methalox engine within the Kerbin system (so you can always refuel there), even if realistically, there shouldn't be any there. Also, since you need twice as much hydrates than water to do stuff (as well as extra electric power, since you need to first get the water out of the hydrates before making fuel), it's not efficient to ship hydrates around with rockets – you're flying around twice the mass you'd fly if you've turned it into fuel or if you're using water. But, then again, water isn't that common.

Spodumene

Spodumene is a mineral already included in CRP with the chemical formula $LiAlSi_2O_6$. So we have a bit of lithium to extract from there – but only a bit, there is a reason why salt brines are used on Earth to extract lithium after all. If flying hydrates around isn't efficient, hauling spodumene is absolutely not efficient at all. You're far better off refining it in situ because the vast majority of it will be lost. You could actually get quite a bit of oxidizer from it, but I feel that can be confusing (why are you looking for oxidizer if you intend to fly magnetodynamic thrusters?) and for gameplay reasons, I made the spodumene -> lithium conversion rather fast. If I added oxidizer, it would produce it really, really fast. But if I were to balance it with ore->LFO, lithium would take ages to extract.

Carbon dioxide (and the Sabatier process)

CO_2 is here only to help produce methane, and is the only production chain which requires two raw resources. I didn't yet see many mods with methalox rocketry – only an extra for NFLV, but I may be missing some mods. I also have a mind of checking how to use B9 part switch to make methalox versions of some stock engines. Nertea's Cryo Tanks mod has support for methalox tanks as well as an ore -> methalox patch. I'm not touching those patches, so it's still active if you're looking for a simpler way to produce methalox. But if you're looking for a more realistic way, you can use this mod. You'll also notice that water and CO_2 are both inputs and outputs of the Sabatier process. After digging a bit, I've used this https://marspedia.org/File:Propellant_production.png as a template – only that a lot faster because 420kg of methane per day wouldn't cut it for gameplay purposes. A small byproduct of both water and CO_2 still results, so I found it simpler and more interesting to add them as outputs rather than subtract them as inputs. As with hydrogen production, the Sabatier process can be done with either water or hydrates, and it takes twice as much of hydrates than water. Also keep in mind the resulting proportions don't exactly match those used for engines.

As for CO_2, for simplicity reasons I'm not distinguishing between solid, liquid and gaseous CO_2. Instead I'm using CRP's carbondioxide definition which, based on it's very low density, I guess it was meant to represent gaseous CO_2. Adding the different states would require several

conversions and three different storage tanks, all for a raw resource for a very niche fuel type, and that goes against keeping this mod kind of simple and easy to use and understand. As a result, you'll see CO2 uses large amounts of in-game units. The drills report a large electric consumption to extract it because I've pumped up the efficiency rating of CO2 extraction to extract a large amount of units in a reasonable time, but don't worry – the electric consumption is actually normal.

As for its presence: CO2 melting point is 216.6 °K (-56.6 °C / -69.8° F) so it has no business being solid closer to the Sun than Kerbin. Or in Kerbin. I added a patch to add it to the stock system while removing it from Eve, Gilly and Moho. I did add it to Kerbin shores so the mining rigs can be tested at the Launchpad. And yes, in selected biomes at the Mun and Minmus, even if it shouldn't be there, to keep with the philosophy of not preventing any stock mechanics. Essentially, you should at least be able to refuel methalox ships with the Kerbin system. Yeah, it shouldn't be possible. If you want that part of realism, don't do it, I guess.

As for mod planet packs, some add it in its gaseous form, but it may be lacking in its solid forms. Your mileage may vary.

(New in 0.4) Uranium enrichment for nuclear reactors

CRP added uraninite ages ago, but creating nuclear fuel for nuclear reactors is, AFAIK, only covered in MKS. It's also a bit OP since not only nuclear reactors are themselves OP, but because we're talking about running a nuclear facility capable of making weapons grade uranium in another planet. So the stock 2.5 meters converter can now enrich uranium, but it requires a whopping 3000 EC. This mod also patches the NFE and KPBS centrifuges so they can also do it, but at a more reasonable electrical consumption.

How does this all come together (and mod integration)

(you probably want to read this)

So, how do you get this stuff off the ground (or the atmosphere if you happen to have you nearby) and into something that goes boom – hopefully upwards and sideways?

Storage

As far as storage is concerned, the ore tanks will now hold water, hydrates, uraninite, spodumene and CO2 as well as ore. For simplicity reasons, we can abstract parts of the CO2 extraction process and assume it's frozen solid as part of the atmospheric extraction process.

Atmospheric harvesting

Gaseous resources from the atmosphere can be harvested with the stock precooler and the mk1 fuselage air intakes. The mining rig air speed matters in the efficiency by which the gasses are captured… and chances are your rig isn't zooming around at match 2 – that's a limitation which can't be removed, to my knowledge, with module manager patches. So the percentage of the particular gas in the atmosphere matters a lot. You'll see you're barely sucking CO2 at the Launchpad. Now go and try the same at Duna ;-) Also, it takes more power to harvest CO2 than other gasses because it's being stored in solid form. Or at least in holding tanks which seem to be designed to hold solids, so it's being frozen and that takes more power.

The surface scanner will also scan for atmospheric CO2 and, if NF Propulsion isn't present, for xenon as well. The reason it doesn't scan for xenon if you have NFP is that NFP already includes an atmospheric sensor that scans for both xenon and argon.

Surface mining

The drills now come with the option to harvest water, hydrates, spodumene, uranium and carbon dioxide. Not much more that needs to be said about it.

Resource conversion

All done in the stock converters. And the Kerbal Planetary System converter. And the Mining Expansion converters.

In short, the stock system is to use drills to harvest ore, store it in holding tanks and use the ISRU converters to, well, convert it. All these processes require quite a bit of electricity and generate heat. This mod uses the same parts and system and just adds a few more toggles and more places to look for more raw materials.

Mod integration

Scansat

Scansat already covers water, spodumene and hydrates by default. CO2 has been integrated into the planetary overlays and maps, so you can use Scansat to plan your mining, refining and colonization efforts.

Kerbal Planetary Base Systems

The converter, regular drill (not the dirt drill) and the ore holding tanks are all patched to extract, store and process the new resource chains

Feline Utility Rover

The converter has been integrated too

Mining Expansion

It's fully integrated. As with KPBS, you can use the drills, converters and holding tanks to mine, store and process hydrates, water, co2 and spodumene.

Stockalike Station Parts Redux

Water is already available for the SSPR storage parts by default. The existing hydrates template in SSPR is set to be activated if either MKS or TAC LS aren't already triggering it. Spodumene and CO2 options are added. Remember, though, some resources are better processed in situ, since conversion rates aren't necessarily 1:1

Near Future Construction

Water, Spodumene, Hydrates and CO2 templates have been added to the trusses capable of holding ore

MKS

Very little actually. If Umbra Space Industries is present, the logistic module will be added to the ore holding tanks, which should allow them to participate in the USI logistics system. If both USI

and NFP are present, the module is also added to NFP lithium tanks (though I'd remove it if @Nertea objects, as it's his mod, same with the SSPR integration). MKS already handles hydrates and water by default, so hydrolox production shouldn't be a problem: raw resources can be remotely mined and transported with the logistics system to a larger inhabited base for processing. Remote mining and processing of spodumene and CO2/methalox is, as of initial release, slow. Full integration would require adding spodumene and CO2 to the automated drills as well as adding the conversion recipes to the automated processing units as well as, perhaps, adding them to the MKS tanks. Nothing of this is, as of yet, implanted, so crewless production of methane and lithium will be slow

Planet Packs

~~No integration (yet).~~ Spodumene, water and hydrates have a global definition in CRP, so unless the mod author has removed them, they will be there. Gaseous CO2 may or may not be available, that depends on the planet pack author. Solid CO2 will be there in smaller amounts (at least as of initial release) since I've added a global definition – which also means it will be around in hot planets where it shouldn't be, so I'm open to suggestions about removing it~~. I am considering adding a surface CO2 config for RSS, but I don't know if the RO/RSS crowd would be interested.~~

Added a resource configuration for Real Solar System, which increases surface water in bodies with abundant known surface ice and a bit of surface carbon dioxide where it's known to be.

Off-planet manufacturing mods

Not integrated either. While part of the reason I made these patches is because of "one resource to rule them all", which is what happens with Global Construction without MKS, I'd be messing with those mods resource chains rather than adding new chains for existing mod fuels. So I'm not doing it. And yes, that means nothing stops you from extracting ore to use with GC to both build ships and use it as fuel, and also that EPL still requires metal ore for building and ore for the smelter.

Making an additional resource chain for GC material kits would interfere with the more complex MKS resource chain, and I'm not messing with other people's mods. As for EPL, while both hydrates and spodumene contain aluminum, which could reasonably be abstracted into "stuff spaceships can be made of", adding metal ore as a byproduct of their isru chains would mean messing with EPL's gameplay. And on top, EPL's metal ore and its smelting process is based in an iron ore (hematite IIRC), not aluminum. So while I considered it as a way to add more flexibility to the base locations, I'm not touching it.

Dependencies

Module Manager, of course, since this is a collection of patches

Community Resource Pack, for the resources

B9 Part Switch, for the tanks

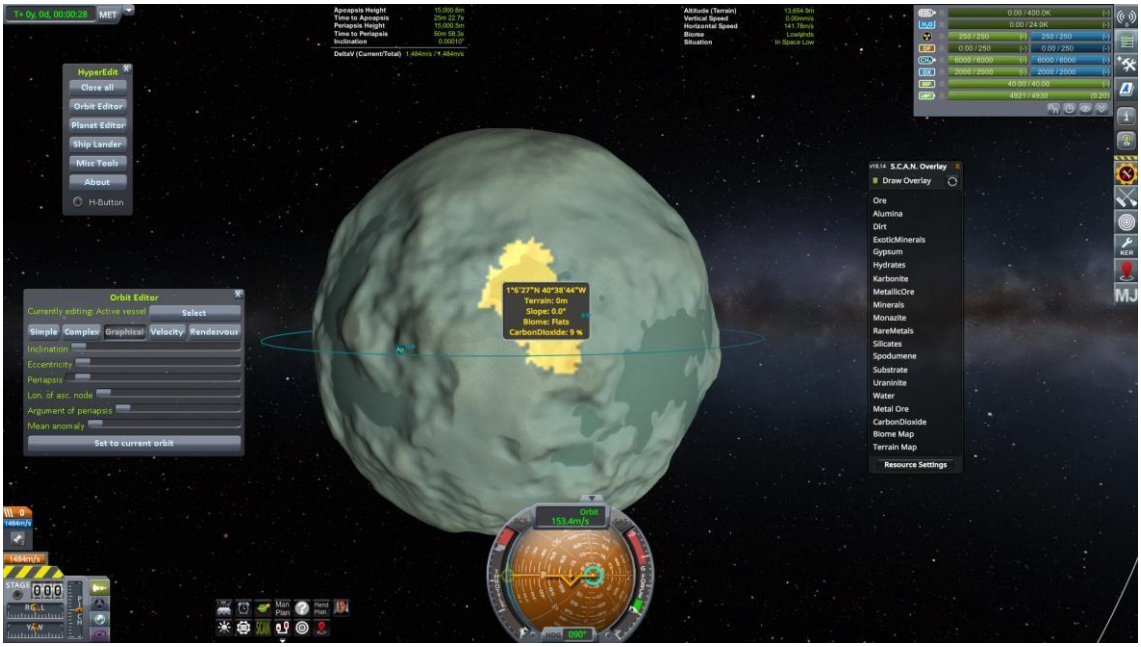
I haven't included them in the download, as Less Simple ISRU, being a collection of patches, can work with KSP 1.8 or 1.9, but B9 Part Switch require different downloads for either versions. So if you don't have them already, download them.

Pictures

Because of course

Solar panels courtesy of Suicidal Insanity's MK2 Expansion, drills from Mining Expansion (also by Suidical Insanity) and Nertea's NFP methalox engines. Also, I didn't pack enough panels and the lander doesn't really have enough dV to get back to space, so don't copy that design. That's the Sabatier process running at Duna, processing hydrates. And yes, the 1.25m convert-O-Tron is, well, the 1.25m convert-O-Tron: The crew isn't happy.

Now Minmus, showing Kerbal Planetary Base System integration, and radiators by Nertea's Heat Control. Also the Sabatier process, this time with water



Scansat integration (and hyperedit to cheat the probe into orbit). Yes, dry ice (solid CO2) shouldn't be there, but I'm don't want to cut Minmus refueling bases.

More Scansat, mining and processing with Mining Expansion's largest parts. Lithium processing for NFP largest engines. Val is happy.

The surface scanner and high temperature electrolysis to produce liquid hydrogen and oxidizer. Tanks by cryotanks.

Of course, I'm open to suggestions (except for CO2 Nuclear Thermal engines, Rational Resources already has those) as well as any correction to balance and the resource's proportions (I do think I got them right, but I may be mistaken in something)

Changelog

0.40: Added uranium enrichment, fixed Cryotanks 1.6.1 causing a conflict with this mod. Updated version file.

0.30: Various fixes by @AccidentalDisassembly. Updated version file for 1.10

0.20: Added Near Future Construction integration, RSS integration and updated readme file 0.10:

initial release

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